TASNEEF
هيئة الإمـــــارات للتصـــنـيـف
EMIRATES CLASSIFICATION SOCIETY

Rules for the Classification of Ships

Effective from 1 January 2026

Part E

Service Notations

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EMIRATES CLASSIFICATION SOCIETY

GENERAL TERMS AND CONDITIONS
OF EMIRATES CLASSIFICATION SOCIETY – L.L.C – O.P.C (TASNEEF)
EFFECTIVE AS OF 1 APRIL 2025

DEFINITIONS

Administration	means the government of the state whose flag the Ship is entitled to fly or under whose authority the Ship is authorised to operate in the specific case.
Client	means the interested party and any other party who requires the Services.
Certificate of Classification	means a certificate of classification, issued by a Society and the certificate confirms that the vessel's structure, machinery, and equipment meet the society's specific technical rules and regulations.
Interested Party	means the party, other than the society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the Ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.
Owner	means the registered owner, the Ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the Ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in part a, chapter 2 of the rules for the classification of Ships or in the corresponding rules indicated in the specific rules.
Register of Ships	means a register book, also known as a Register of Ships, is a comprehensive record of vessels that are classified by a society.
Rules	means the documents below issued by the Society: a. Rules for the classification of Ships or other special units. b. Complementary rules containing the requirements for certification of products, plants, systems and other or containing the requirements for the assignment of additional class notations. c. Rules for the application of statutory rules, containing the rules to perform the duties delegated by administrations. d. Guides to carry out particular activities connected with Services. e. Any other technical document, as for example rule variations or interpretations.

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Services	means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.
Ship	means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.
Society	means Emirates Classification Society LLC OPC and/or its affiliated entities providing the Services.
Surveyor	means technical staff acting on behalf of the society in performing the Services.
UAE	means United Arab Emirates.

ARTICLE 1

1.1 The purpose of the Society is, among others, the classification and certification of Ships and the certification of their parts and components.

1.2 The Society (a) sets forth and develops Rules; (b) publishes the Register of Ships[1]; and (c) issues certificates, statements and reports based on its survey activities.

1.3 The Society also takes part in the implementation of national and international rules and standards as delegated by various Governments.

1.4 The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which is regulated by these general conditions unless expressly excluded in the particular contract.

ARTICLE 2

2.1 The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, though committed, also through its research and development services, to continuous updating, does not guarantee they meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

2.2 The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatement. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification. The Rules for Classification of Ships are published on the Society's website: www.tasneefmaritime.ae

2.3 The Society exercises due care and skill:

(a) in the selection of its Surveyors; and

(b) in the performance of its Services, taking into account the level of its technical knowledge at the time the

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Services are performed.

2.4 Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of each component of the Ship or of the items subject to certification. The surveys and checks made by the Society, either on board Ships or with remote techniques, do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks to qualified service suppliers, who will carry out these duties under their responsibility. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

ARTICLE 3

3.1 The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflect the discretionary opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).

3.2 The Society is under no obligation to make statements or provide information about elements or facts which are not part of the specific scope of the Service requested by the Interested Party or on its behalf.

3.3 No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as part of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, are governed by the Rules of the Society, whom is the sole subject entitled to make such authentic interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

3.4 The classification of a Ship, or the issuance of a certificate or other document connected with classification or certification and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaworthiness, structural integrity, quality or fitness for a particular purpose or service of any Ship, structure, material, equipment or machinery inspected or tested by the Society.

3.5 Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certification or other activity at the time of the check.

3.6 The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by

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the Society are in no way intended to replace the duties and responsibilities of other parties including, without limitation, Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

3.7 These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, the Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.

3.8 In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.

3.9 In consideration of the above, and within the limits of liability under Article 5 below, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered, where these are attributable to the Interested Party.

3.10 Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the Services rendered by the Society are described in the Rules applicable to the specific Service rendered.

ARTICLE 4

4.1 Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2 In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees and costs, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of non-payment of the invoice within the contractually agreed terms, the Society reserves the right to request, in addition to the full payment of the principal amount due and without the need for further formal notice, also:

(a) Late payment interest at a rate of 5% per annum, calculated from the due date of the invoice until full payment is received, in accordance with the applicable laws in the United Arab Emirates or the country from where the invoice is issued. Any applicable VAT, taxes, or statutory levies shall be borne by the Client as per the laws

of the respective jurisdiction;

(b) full reimbursement of any costs incurred for debt recovery, including, but not limited to, legal fees, administrative expenses, and the costs of any extrajudicial actions; and

(c) any additional amount due as compensation for damages suffered as a result of the delay or non-compliance, where documented.

4.3 The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.

4.4 The Society may withhold, suspend or withdraw any certificate, report or service in the event of non-payment of fees due to any member of the Society by the Client in relation to the entire business relationship between any member of the Society and the Client or by any other companies belonging to the same group as the Client. This also applies when the obligation to pay rests with a builder or with the Ship's previous Owner.

4.5 For every case of termination or suspension of the contract, the fees for the activities performed until the time of the termination or of the suspension shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination or of the suspension.

4.6 With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any statutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

ARTICLE 5

5.1 In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see Article 2), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

5.2 Therefore, subject to what provided for in Article 5.3 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

5.3 Notwithstanding the provisions in Article 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific Services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only).

5.4 Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the

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performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED 300,000 (Three Hundred Thousand Dirhams). Payment of compensation under this Article will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in Article 5.

5.5 Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: THREE MONTHS from the date on which the Services were performed or THREE MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

ARTICLE 6

6.1 Any dispute, controversy, or claim arising out of or relating to these Rules, the Services of the Society, or the interpretation, breach, or termination thereof, shall first be referred to the parties' senior management for amicable resolution within thirty (30) days of written notice by either party.

6.2 If the dispute is not resolved amicably under Article 6.1, it shall be exclusively governed by and construed in accordance with the laws of the Emirate of Abu Dhabi and the applicable federal laws of the United Arab Emirates. The courts of Abu Dhabi shall have exclusive jurisdiction to settle any such dispute.

ARTICLE 7

7.1 All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorisation of the Interested Party, except as provided for or required by any applicable legislation from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, conditions of class, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

7.2 Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

7.3 Notwithstanding the general duty of confidentiality owed by the Society to its clients in Article 7.1 above, the Society's clients hereby accept that the Society will participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the Ship which may be the specific property of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

7.4 In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificates, documents and information relevant to the classed unit, including its history file,

as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty to ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.

7.5 In the event that the ownership of the Ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which have come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

ARTICLE 8

8.1 The Society shall not be obliged to perform any obligation towards the Client (including, without limitation, obligation to (a) perform, deliver, accept, sell, purchase, pay or receive money to, from or through a person or entity, or (b) engage in any other act) if this would be in violation of, inconsistent with or expose the Society to punitive measures under any United Nations resolutions and/or under any laws, regulations, decrees, ordinances, orders, demands, requests, rules or requirements of EU, United Kingdom, and/or United States of America and which relate to foreign trade controls, export controls, embargoes or international boycotts (applying, without limitation, to the financing, payment, insurance, transportation, delivery or storage of product and/or services) hereinafter referred to as "Trade Sanctions".

8.2 Recurring the above circumstances during the performance of the contract, the Society shall be entitled at its sole and absolute discretion:

(a) to immediately suspend payment or performance of the Services which are the object of the contract until such;

(b) time as the Trading Sanctions are in force;

(c) to a full disengagement from the obligation affected by the Trading Sanctions, in the event that the inability to fulfill the said obligation persists until the term provided for the fulfilment hereunder, provided that where the relevant obligation relates to payments for activities and/or Services which have already been delivered, the affected payment obligation shall remain only suspended until such time as the Trading Sanctions no longer apply to the payment ; and/or

(d) to terminate the contract, without prejudice of the Society's rights pursuant to Article 4.

ARTICLE 9

Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

ARTICLE 10

When the Society provides its Services to a consumer - i.e. a natural person who does not act within the scope of his business or professional activity - the following provisions do not apply Article 3 (as far as the Society is solely entitled to the authentic interpretation of the Rules); Article 4, (as far as the payment of the fees is also due for Services not

concluded due to causes not attributable to the Interested Party); Article 5 (as far as the exclusion of liability is concerned), and Article 6 (as far as the jurisdiction of a Board of Arbitrators based in Abu Dhabi is concerned).

ARTICLE 11

11.1 The Society and the Interested Party shall promote safety, protect human health and environment and create safe working conditions for their personnel.

11.2 The Interested Party shall guarantee that the working environment in which the Society's Surveyor will be required to work is adequate, safe and in all respect compliant with the applicable legislation and Rules and shall adopt all necessary measures to mitigate and/or control any relevant risk.

11.3 Furthermore, in accordance with the applicable legislation and Rules, the Interested Party shall provide the Society with complete and detailed information relevant to any actual or potential specific risk existing in the work areas where the Surveyor will be required to operate and relevant to the performance of the Services as well as with any specific safety measure that the Society's Surveyor is requested to comply with.

11.4 The Society reserves not to commence and/or to suspend the Services and/or to terminate the contract, claiming compensation for any damage occurred, if it considers that the safety requirements listed in this Article are not satisfactorily met.

EXPLANATORY NOTE TO PART E

1. Reference edition

The reference edition for Part E is the TASNEEF Rules 2000 edition, which is effective from 1 June 2000.

2. Amendments after the reference edition

2.1 TASNEEF Rules 2000 has been completely rewritten and reorganised.

2.2 Except in particular cases, the Rules are updated and published annually.

3. Effective date of the requirements

3.1 All requirements in which new or amended provisions with respect to those contained in the reference edition have been introduced are followed by a date shown in brackets.

The date shown in brackets is the effective date of entry into force of the requirements as amended by the last updating. The effective date of all those requirements not followed by any date shown in brackets is that of the reference edition.

3.2 Item 6 below provides a summary of the technical changes from the preceding edition. In general, this list does not include those items to which only editorial changes have been made not affecting the effective date of the requirements contained therein.

4. Rule Variations and Corrigenda

Until the next edition of the Rules is published, Rule Variations and/or corrigenda, as necessary, will be published on the TASNEEF web site (www.tasneef.ae). Except in particular cases, paper copies of Rule Variations or corrigenda are not issued.

5. Rule subdivision and cross-references

5.1 Rule subdivision

The Rules are subdivided into six parts, from A to F.

Part A: Classification and Surveys

Part B: Hull and Stability

Part C: Machinery, Systems and Fire Protection

Part D: Materials and Welding

Part E: Service Notations

Part F: Additional Class Notations

Each Part consists of:

- Chapters
- Sections and possible Appendices
- Articles
- Sub-articles
- Requirements

Figures (abbr. Fig) and Tables (abbr. Tab) are numbered in ascending order within each Section or Appendix.

5.2 Cross-references

Examples: Pt A, Ch 1, Sec 1, [3.2.1]or Pt A, Ch 1, App 1, [3.2.1]

- Pt A means Part A

The part is indicated when it is different from the part in which the cross-reference appears. Otherwise, it is not indicated.

- Ch 1 means Chapter 1

The Chapter is indicated when it is different from the chapter in which the cross-reference appears. Otherwise, it is not indicated.

- Sec 1 means Section 1 (or App 1 means Appendix 1)

The Section (or Appendix) is indicated when it is different from the Section (or Appendix) in which the cross-reference appears. Otherwise, it is not indicated.

- [3.2.1] refers to requirement 1, within sub-article 2 of article 3.

Cross-references to an entire Part or Chapter are not abbreviated as indicated in the following examples:

- Part A for a cross-reference to Part A
- Part A, Chapter 1 for a cross-reference to Chapter 1 of Part A.

6. Summary of amendments introduced in the edition effective from 1 January 2026

This edition of Part E contains amendments whose effective date is **1 January 2026**.

The date of entry into force of each new or amended item is shown in brackets after the number of the item concerned.

RULES FOR THE CLASSIFICATION OF SHIPS

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Chapter 1

RO-RO CARGO SHIPS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **ro-ro cargo ship**, as defined in Pt A, Ch 1, Sec 2, [4.2.3].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable and with the requirements of this Chapter, which are specific to ro-ro cargo ships.

1.2 Summary table

1.2.1 Tab 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to ro-ro cargo ships.

Table 1 *(1/1/2007)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and cargo system	Sec 3
Electrical installations	Sec 4
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for ro-ro cargo ships are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 The requirements of this Section apply to multi-deck ships with double bottom and, in some cases, with wing tanks up to the lowest deck above the full load waterline, intended for the carriage of:

- vehicles which embark and disembark on their own wheels, and/or goods in or on pallets or containers which can be loaded and unloaded by means of wheeled vehicles
- railway cars, on fixed rails, which embark and disembark on their own wheels.

1.2 Definitions

1.2.1 Ro-ro cargo spaces *(1/1/2005)*

Ro-ro cargo spaces are spaces not normally subdivided in any way and normally extending for either a substantial length or the entire length of the ship, in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles [including road or rail tankers], trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction.

1.2.2 Special category spaces *(1/1/2005)*

Special category spaces are those enclosed vehicle spaces above or below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be arranged on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.

2 Structure design principles

2.1 General

2.1.1 Wood sheathing is recommended for caterpillar trucks and unusual vehicles.

It is recommended that a piece of wood of suitable thickness should be provided under each crutch in order to distribute the mass over the plate and the nearest stiffeners.

2.2 Hull structure

2.2.1 Framing

In general, the strength deck and the bottom are to be longitudinally framed.

Where a transverse framing system is adopted for such ships, it is to be considered by the Society on a case-by-case basis.

3 Design loads

3.1 Wheeled loads

3.1.1 The wheeled loads induced by vehicles are defined in Pt B, Ch 5, Sec 6, [6].

4 Hull girder strength

4.1 Basic criteria

4.1.1 Strength deck

In addition to the requirements in Pt B, Ch 6, Sec 1, [2.2], the contribution of the hull structures up to the strength deck to the longitudinal strength is to be assessed through a finite element analysis of the whole ship in the following cases:

- when the size of openings in side shell and/or longitudinal bulkheads located below the strength deck decreases significantly the capability of the plating to transmit shear forces to the strength deck
- when the ends of superstructures which are required to contribute to longitudinal strength may be considered not effectively connected to the hull structures.

5 Hull scantlings

5.1 Plating

5.1.1 Minimum net thicknesses

The net thickness of the weather strength deck and trunk deck plating is to be not less than the value obtained, in mm, from the following formula:

$t = 2,1 + 0,013\ L\ k^{1/2} + 4,5\ s$

where:

s : Length, in m, of the shorter side of the plate panel.

5.1.2 Deck plating in way of side doors and stern doors *(1/12/2008)*

The plating net thickness of all decks in way of the position of side doors and stern doors is to be increased over a length of at least 1/3 of the door width.

This increase in net thickness is to be not less than 50% and the resulting thickness is not required to be greater than 8,0 mm.

5.1.3 Plating under wheeled loads

The net thickness of plate panels subjected to wheeled loads is to fulfil the applicable requirements in Pt B, Ch 7, Sec 1.

5.2 Ordinary stiffeners

5.2.1 Ordinary stiffeners under wheeled loads

The strength checks of ordinary stiffeners subjected to wheeled loads are to be carried out in accordance with the applicable requirements in Pt B, Ch 7, Sec 2.

5.3 Primary supporting members

5.3.1 Primary supporting members under wheeled loads

The strength checks of primary supporting members subjected to wheeled loads are to be carried out in accordance with the applicable requirements in Pt B, Ch 7, Sec 3 and Pt B, Ch 7, App 2.

6 Other structures

6.1 Bow doors and inner doors

6.1.1 The requirements applicable to bow doors and inner doors are defined in Pt B, Ch 9, Sec 5.

6.2 Side doors and stern doors

6.2.1 Side doors and stern doors may be either below or above the freeboard deck.

6.2.2 The requirements applicable to side doors and stern doors are defined in Pt B, Ch 9, Sec 6.

6.2.3 *(1/1/2005)*

The requirements in [6.2.4] to [6.2.7] apply to doors in the boundary of ro-ro spaces and special category spaces as defined in [1.2.1] and [1.2.2] through which such spaces may be flooded.

Where no part of the door is below the uppermost waterline and the area of the door opening is not greater than 6 m^2, the requirements in [6.2.4] to [6.2.7] need not be applied.

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

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

6.2.5 *(1/1/2005)*

The indicator system is to be designed on the fail-safe principle and is to show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured.

The power supply for the indicator system for operating and closing doors is to be independent of the power supply for operating and closing the doors and is to be provided with a back-up power supply from the emergency source of power or other secure power supply, e.g. UPS.

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

Note 1: The indicator system is considered designed on the fail-safe principal when the following conditions occur.

- The indication panel is provided with:
  - a power failure alarm
  - an earth failure alarm
  - a lamp test
  - separate indication for door closed, door locked, door not closed and door unlocked.
- Limit switches are electrically closed when the door is closed (when several limit switches are provided they may be connected in series).
- Limit switches are electrically closed when securing arrangements are in place (when several limit switches are provided they may be connected in series).
- Two electrical circuits (also in one multicore cable) are fitted, one for the indication of door closed / not closed and the other for door locked / unlocked.
- In the case of dislocation of limit switches, indication to show: not closed / unlocked / securing arrangement not in place - as appropriate.

6.2.6 *(1/1/2005)*

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

6.2.7 *(1/7/2012)*

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

6.3 Movable decks and inner ramps

6.3.1 The requirements applicable to movable decks and inner ramps are defined in Pt B, Ch 9, Sec 8, [1].

6.4 External ramps

6.4.1 The requirements applicable to external ramps are defined in Pt B, Ch 9, Sec 8, [2].

7 Hull outfitting

7.1 Equipment

7.1.1 Number of mooring lines

The specific requirements in Pt B, Ch 10, Sec 4, [3.5] for ships with the service notation **ro-ro cargo ship** are to be complied with.

SECTION 3 MACHINERY

1 Application

1.1 Applicable Ships

1.1.1 *(1/7/2011)*

The requirements of item [2] apply to cargo ships of 500 gross tonnage or more.

2 Scuppers and sanitary discharges

2.1 Drainage of vehicle and ro-ro cargo spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion

2.1.1 **Prevention of build-up of free surfaces** *(1/7/2011)*

In cargo spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion when fixed pressure water-spraying systems are fitted, in view of the serious loss of stability which could arise due to large quantities of water accumulating on the deck or decks during the operation of the fixed pressure water-spraying system, the following arrangements are to be provided:

a) the drainage and pumping arrangements are to be such as to prevent the build-up of free surfaces. In such case, the drainage system is to be sized to remove no less than 125% of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles, taking into account the guidelines developed by IMO (see Note 1). The drainage system valves are to be operable from outside the protected space at a position in the vicinity of the extinguishing system controls. Bilge wells are to be of sufficient holding capacity and are to be arranged at the side shell of the ship at a distance from each other of not more than 40 m in each watertight compartment. If this is not possible, the adverse effect upon stability of the added weight and free surface of water is to be taken into account to the extent deemed necessary by the Society in its approval of the stability information (see Note 2). Such information is to be included in the stability information supplied to the Master. See Pt B, Ch 3, App 2.

b) for closed vehicles spaces, where fixed pressure water-spraying systems are fitted, means are to be provided to prevent the blockage of drainage arrangements, taking into account the guidelines developed by IMO (see Note 1),

Note 1: see resolution MSC.1/Circ. 1320 "Guidelines for the drainage of fire-fighting water from closed vehicle and ro-ro spaces and special category spaces of passenger and cargo ships"

Note 2: see Resolution A.123(V) "Recommendation On Fixed Fire-Extinguishing Systems For Special Category Spaces".

2.1.2 **Scupper draining** *(1/7/2011)*

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.

3 Sounding pipes

3.1 General

3.1.1 *(1/7/2009)*

Requirements stipulated in Pt C, Ch 1, Sec 10, [9.2] apply except that sounding pipes used in flammable (except lubricating) oil systems may terminate in the ro-ro space on condition that the following provisions are satisfied:

a) an oil-level gauge meeting the provisions in Pt C, Ch 1, Sec 10, [2.9.2] is additionally fitted;

b) the sounding pipes terminate in locations remote from ignition hazards unless precautions are taken, such as the fitting of effective screens, to prevent the fuel oil from coming into contact with a source of ignition in the case of spillage through the terminations of the sounding pipes;

c) the terminations of sounding pipes are fitted with self-closing blanking devices and with a small diameter self-closing control cock located below the blanking device for the purpose of ascertaining before the blanking device is opened

that fuel oil is not present. Provision is to be made so as to ensure that any spillage of fuel oil through the control cock involves no ignition hazard.

Where sounding pipe termination is above the bulkhead or freeboard deck, a flush type sounding head may be accepted by the Society on a case-by-case basis.

SECTION 4 ELECTRICAL INSTALLATIONS

1 General

1.1 Documentation to be submitted

1.1.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following is to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas.

Table 1 : Electrical equipment permitted in closed ro-ro cargo spaces *(1/1/2022)*

Hazardous area	Spaces		Electrical equipment
	N°	Description	
Zone 1	1	Closed ro-ro cargo spaces except areas under item 3	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category “ib” not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules d) certified flameproof Ex(d) e) certified pressurised Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: • a non-metallic impervious sheath in combination with braiding or other metallic covering • copper or stainless steel sheath (for mineral-insulated cables only)
Zone 1	2	Exhaust ventilation ducts	As stated under item 1
Zone 2	3	On condition that the ventilation system is so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least 10 air changes per hour whenever vehicles are on board: • areas above a height of 450mm from the deck • areas above a height of 450mm from each platform for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward • areas above platforms for vehicles, if fitted, with openings of sufficient size permitting penetration of petrol gases downward	a) any type that may be considered for zone 1 b) tested specially for zone 2 (e.g. type “n” protection) c) pressurised d) encapsulated e) the type which ensures the absence of sparks and arcs and of “hot spots” during its normal operation (electrical equipment having an enclosure of at least IP55) f) cables sheathed with at least a non -metallic external impervious sheath

1.2 Safety characteristics

1.2.1 The explosion group and temperature class of electrical equipment of a certified safe type for use with explosive petrol-air mixtures are to be at least IIA and T3.

2 Installation

2.1 Installations in closed ro-ro cargo spaces

2.1.1 Except as provided for in [2.1.2], electrical equipment is to be of a certified safe type as stated in Pt C, Ch 2, Sec 3, [10.1.5] and electrical cables are to be as stated in Pt C, Ch 2, Sec 3, [10.2.2].

2.1.2 Above a height of 450 mm from the deck and from each platform for vehicles, if fitted, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment as stated in Pt C, Ch 2, Sec 3, [10.1.6] and electrical cables as stated in Pt C, Ch 2, Sec 3, [10.2.3]are permitted, on condition that the ventilation system is so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least 10 air changes per hour whenever vehicles are on board.

2.1.3 Electrical equipment and cables in an exhaust ventilation duct are to be as stated in [2.1.1].

2.1.4 The requirements in this item are summarised in Tab 1.

2.2 Installations in cargo spaces other than ro-ro cargo spaces but intended for the carriage of motor vehicles

2.2.1 The provisions of [2.1] apply.

2.2.2 All electric circuits terminating in cargo holds are to be provided with multipole linked isolating switches located outside the holds. Provision is to be made for locking in the off position.

This requirement does not apply to safety installations such as fire, smoke or gas detection systems.

3 Type approved components

3.1 Type approval and case by case approval

3.1.1 Alarm systems for closing devices of openings and water leakage detection systems if of electronic type, as well as television surveillance systems, are to be type approved or in accordance with [3.1.2].

3.1.2 Case-by-case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

Chapter 2
CONTAINER SHIPS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **container ship**, as defined in Pt A, Ch 1, Sec 2, [4.2.6].

1.1.2
Ships assigned with the additional service feature **equipped for carriage of containers** are to comply with the applicable requirements of this Chapter, in particular with Sec 2, [3.2.1], Sec 2, [3.3.1], Sec 2, [3.5.4] and Sec 2, [4.2].

1.1.3 Ships dealt with in this Chapter are to comply with the requirements stipulated in Part A, Part B, Part C and Part D, as applicable and with the requirements of this Chapter, which are specific to container ships.

1.2 Summary table

1.2.1 Tab 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to container ships.

Table 1 *(1/7/2016)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
Longitudinal strength standard for container ships	App 1
(1) No specific requirements for container ships are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 The requirements of this Section apply to double bottom ships of double or single side skin construction, intended to carry containers in holds or on decks. When single side skin construction is adopted, an efficient torsion box girder at the topsides or an equivalent structure is to be fitted. Typical midship sections are shown in Fig 1 and Fig 2.

The application of these requirements to other ship types is to be considered by the Society on a case-by-case basis.

Figure 1 : Container ship of double side skin construction

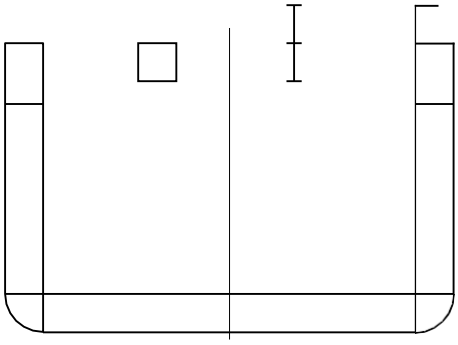
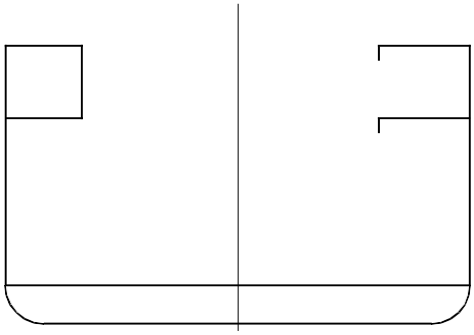


Figure 2 : Container ship of single side skin construction



2 Stability

2.1 Intact stability

2.1.1 General

The stability for the loading conditions defined in Pt B, Ch 3, App 2, [1.2.4] is to be in compliance with the requirements of Pt B, Ch 3, Sec 2.

2.1.2 Additional criteria

In addition to [2.1.1], the initial metacentric height is to be equal to or greater than 0,20 m.

2.1.3 Alternative criteria for ships greater than 100 m in length

For ships greater than 100 m in length, the Society may apply the following criteria instead of those in Pt B, Ch 3, Sec 2:

- *the area under the righting lever curve (GZ curve), in m·rad, is to be not less than 0,009/C up to an angle of heel of 30°, and not less than 0,016/C up to 40° or the angle of flooding θ_f if this angle is less than 40°*

- *the area under the righting lever curve (GZ curve), in m·rad, between the angles of heel of 30° and 40° or between 30° and θ_f, if this angle is less than 40°, is to be not less than 0,006/C*
- *the righting lever GZ, in m, is to be at least 0,033/C at an angle of heel equal to or greater than 30°*
- *the maximum righting lever GZ, in m, is to be at least 0,042/C*
- *the total area under the righting lever curve (GZ curve), in m·rad, up to the angle of flooding θ_f is not to be less than 0,029/C.*

where:

C : *Coefficient defined by:*

$$C = \sqrt{\frac{T}{KG}}\sqrt{\frac{100}{L}}\left(\frac{C_B}{C_W}\right)^2 \frac{TD'}{B_m^2}$$

T : *Mean draught, in m*

KG : *Height of the centre of mass above base, in m, corrected for free surface effect, not be taken as less than T*

C_B : *Block coefficient*

C_W : *Waterplane coefficient*

D' : *Moulded depth, in m, corrected for defined parts of volumes within the hatch coamings obtained from the following formula:*

$$D' = D + \left(\frac{2b - B_D}{B_D}\right)\left(\frac{2\Sigma \ell_H}{L}\right)h$$

h : *Mean height, in m, of hatch coamings within L/4 forward and aft from amidships (see Fig 3)*

b : *Mean width, in m, of hatch coamings within L/4 forward and aft from amidships (see Fig 3)*

B_m, B_D : *Breadths, in m, defined in Fig 3*

ℓ_H : *Length, in m, of each hatch coaming within L/4 forward and aft from amidships (see Fig 4).*

Figure 3 : Definition of dimensions

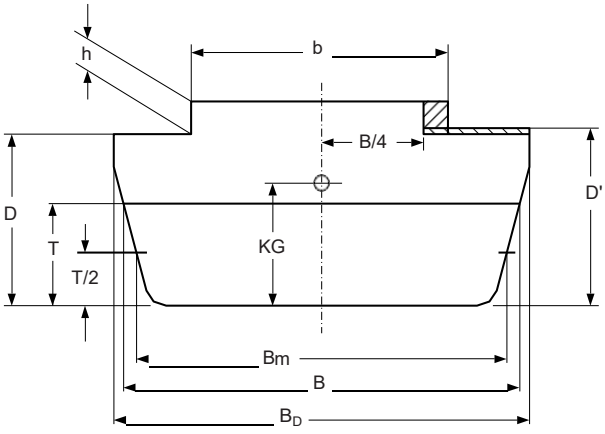
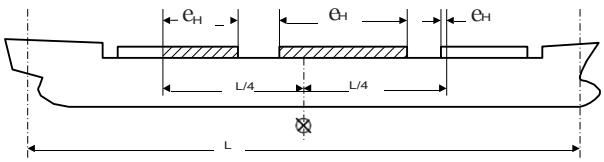


Figure 4 : Definition of dimensions



2.1.4 Additional requirements for open top container ships *(1/10/2005)*

Intact stability calculations are to be investigated for the ship in the intact condition and considering the effect of the ingress of green water through the open hatchways in the following way*:*

- *for the intact condition described in [2.1.5] with the assumptions in [2.1.6], the stability of the ship is to comply with the survival criteria of Pt F, Ch 13, Sec 11: the factor of survival "s" is to be equal to one.*

2.1.5 Loading condition for open top container ships

The ship is at the load line corresponding to the minimum freeboard assigned to the ship and, in addition, all the open holds are completely filled with water, with a permeability of 0,70 for container holds, to the level of the top of the hatch side or hatch coaming or, in the case of a ship fitted with cargo hold freeing ports, to the level of those ports.

Intermediate conditions of flooding the open holds (various percentages of filling the open holds with green water) are to be investigated.

2.1.6 Assumptions for the stability calculation for open top container ships

Where cargo hold freeing ports are fitted, they are to be considered closed for the purpose of determining the flooding angle, provided that the reliable and effective control of closing of these freeing ports is to the satisfaction of the Society.

For the condition with flooded holds relevant to the intact ship, the free surfaces may be determined as follows:

- *the holds are fully loaded with containers*
- *the sea water enters the containers and will not pour out during heeling, condition simulated by defining the amount of water in the containers as fixed weight items*
- *the free space surrounding the containers is to be flooded with sea water*
- *the free space is to be evenly distributed over the full length of the open cargo holds.*

3 Structure design principles

3.1 Materials

3.1.1 Steels for hull structure

The material classes required in Pt B, Ch 4, Sec 1, [2.4] for the strength deck plating, the sheerstrake and the torsion box girder structure within 0,4L amidships are to be maintained in way of the entire cargo hold region.

3.2 Strength principles

3.2.1 General

Local reinforcements of the hull structure are to be provided under container corners and in way of cell guides, if fitted.

3.2.2 Structural continuity

In double side skin ships, where the machinery space is located between two holds, the inner side is, in general, to be continuous within the machinery space. Where the machinery space is situated aft, the inner side is to extend as far abaft as possible and be tapered at the ends.

3.3 Bottom structure

3.3.1 Floor and girder spacing

The floor spacing is to be such that floors are located in way of the container corners. Floors are also to be fitted in way of watertight bulkheads.

Girders are generally to be fitted in way of the container corners.

3.3.2 Reinforcements in way of cell guides

The structures of the bottom and inner bottom on which cell guides rest are to be adequately stiffened with doublers, brackets or other equivalent reinforcements.

3.4 Side structure

3.4.1 Framing arrangement

The topside torsion box girders are to be longitudinally framed.

Where the side is longitudinally framed, side transverses are to be fitted in line with the double bottom floors.

3.5 Deck structure

3.5.1 Longitudinal girders between hatchways

The width of the longitudinal deck girders and hatch coaming flanges is to be such as to accommodate the hatch covers and their securing arrangements.

The connections of the longitudinal deck girders and hatch coamings with the machinery space structure, and aft and fore part structures are to ensure proper transmission of stresses from the girders to the adjacent structures.

3.5.2 Cross decks

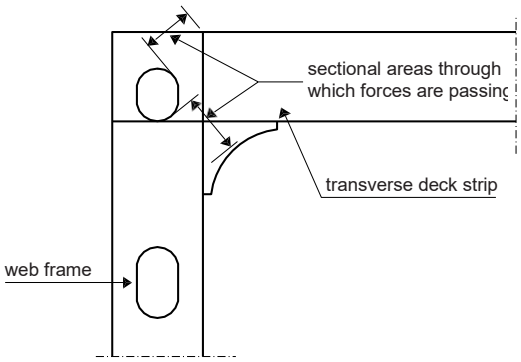
Side or centreline longitudinal deck girders transmit the following longitudinal forces to transverse deck strips: forces due to hull girder bending and forces due to local bending of the girders.

When the arrangement of hatches involves the interruption of girders (a ship with two side hatches in one hold and a centreline hatch in the adjacent one), the transverse strip between the two holds is to be able to bear the longitudinal force exerted by the interrupted girder. Calculation of the strength of these strips is to be made.

Transverse deck strips between hatches are also subjected to a shear force induced by the overall torsion of the ship. The adequate strength of these strips is to be verified also taking account of this force.

Transverse deck strips between hatches are to be suitably overlapped at ends. It is necessary to ascertain that the forces induced by the strips may be transmitted to the web frame (see Fig 5).

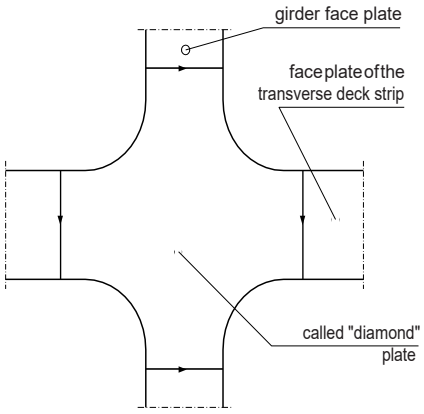
Figure 5 : Transverse deck strip between hatches



3.5.3 Connection of longitudinal deck girders between hatchways with face plate of cross decks

Where longitudinal deck girders between hatchways intersect cross decks, the connection between their face plates is generally to be as shown in Fig 6. If necessary, the girder height is to be gradually modified.

Figure 6 : Connection of longitudinal girders between hatchways with face plates of cross decks



3.5.4 Deck and hatch cover reinforcements

Deck or hatch cover structures are to be reinforced taking into account the loads transmitted by the corners of containers and cell guides.

3.6 Bulkhead structure

3.6.1 Transverse box structures in way of transverse watertight bulkheads

Bottom and top transverse box structures are generally to be provided in way of transverse watertight bulkheads at the inner bottom and deck level, respectively.

3.6.2 Primary supporting members

The vertical primary supporting members of transverse watertight bulkheads are to be fitted in line with the deck girders and the corresponding bottom girders.

3.6.3 Reinforcements in way of cell guides

When cell guides are fitted on transverse or longitudinal bulkheads which form boundaries of the hold, such structures are to be adequately reinforced taking into account the loads transmitted by cell guides.

4 Design loads

4.1 Hull girder loads

4.1.1 Still water loads

The design still water torsional torque induced by the non-uniform distribution of cargo, consumable liquids and ballast is to be considered. If no specific data are provided by the Designer, it is to be obtained at any hull transverse section, in kN.m, from the following formula:

$M_{SW,T} = 31,4F_TSTB$

where:

F_T : Distribution factor defined in Tab 1 as a function of the x co-ordinate of the hull transverse section with respect to the reference co-ordinate system defined in Pt B, Ch 1, Sec 2, [4]

S : Number of container stacks over the breadth B

T : Number of container tiers in cargo hold amidships (excluding containers on deck or on hatch covers).

Where the value of $M_{SW,T}$ obtained from the above formula is greater than 49000 kN.m, the Society may require more detailed calculations of $M_{SW,T}$ to be carried out by the Designer.

Table 1 : Distribution factor F_T

Hull transverse section location	Distribution factor F_T
$0 \le x < 0,5L$	x / L
$0,5L \le x \le L$	(1- x / L)

4.2 Forces on containers

4.2.1 Still water and inertial forces

The still water and inertial forces applied to one container located at the level “i”, as defined in Fig 7, are to be obtained, in kN, as specified in Tab 2.

Where empty containers are stowed at the top of a stack, the internal pressures and forces are to be calculated considering mass of empty containers equal to:

- 0,14 times the mass of a loaded container, in the case of steel containers
- 0,08 times the mass of a loaded container, in the case of aluminium containers

Table 2 : Container at level “i” - Still water and inertial forces

Ship condition	Load case	Still water force F_S and inertial force F_W , in kN
Still water		$F_{S,i} = M_i g$
Upright (positive heave motion)	“a”	No inertial force
	“b”	$F_{W,X,i} = M_i a_{X1}$ in x direction $F_{W,Z,i} = -M_i a_{Z1}$ in z direction

Note 1:

g : Gravity acceleration, in m/s^2:
$g = 9,81\ m/s^2$

M_i : Mass, in t, of the container considered at the level “i”

C_{FA} : Combination factor, to be taken equal to:

- $C_{FA} = 0,7$ for load case “c”
- $C_{FA} = 1,0$ for load case “d”

a_{X1}, a_{Z1} : Accelerations, in m/s^2, determined at the container‘s centre of gravity for the upright ship condition, and defined in Pt B, Ch 5, Sec 3, [3.4]

a_{Y2}, a_{Z2} : Accelerations, in m/s^2, determined at the container‘s centre of gravity for the inclined ship condition, and defined in Pt B, Ch 5, Sec 3, [3.4].

Ship condition	Load case	Still water force F_S and inertial force F_W , in kN
Inclined (negative roll angle)	"c"	$F_{W,Y,i} = M_i C_{FA} a_{Y2}$ in y direction $F_{W,Z,i} = M_i C_{FA} a_{Z2}$ in z direction
	"d"	

Note 1:

g : Gravity acceleration, in m/s^2:
$g = 9,81\ m/s^2$

M_i : Mass, in t, of the container considered at the level "i"

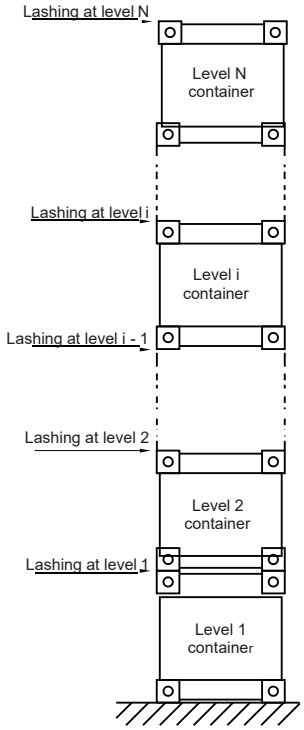
C_{FA} : Combination factor, to be taken equal to:

- $C_{FA} = 0,7$ for load case "c"
- $C_{FA} = 1,0$ for load case "d"

a_{X1}, a_{Z1} : Accelerations, in m/s^2, determined at the container's centre of gravity for the upright ship condition, and defined in Pt B, Ch 5, Sec 3, [3.4]

a_{Y2}, a_{Z2} : Accelerations, in m/s^2, determined at the container's centre of gravity for the inclined ship condition, and defined in Pt B, Ch 5, Sec 3, [3.4].

Figure 7 : Containers level in a stack



4.2.2 Wind forces applied to one container

The forces due to the effect of the wind, applied to one container stowed above deck at the level "i", are to be obtained, in kN, from the following formulae:

- in x direction:
  $F_{x,wind,i} = 1,2 h_C b_C$
- in y direction:
  $F_{y,wind,i} = 1,2\ h_C \ell_C$

where:

h_C : Height, in m, of a container

ℓ_C, b_C : Dimension, in m, of the container stack in the ship longitudinal and transverse direction, respectively.

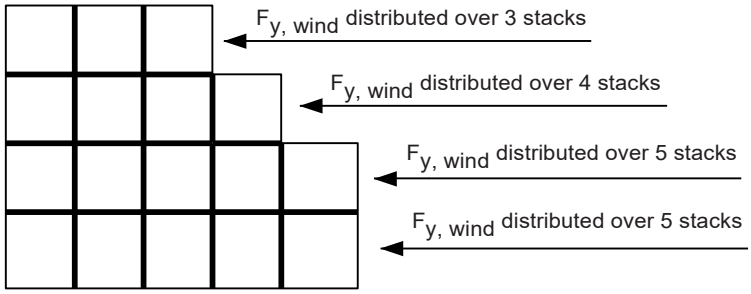
These forces are only acting on the stack exposed to wind. In the case of M juxtaposed and connected stacks of the same height, the wind forces are to be distributed over the M stacks.

In the case of juxtaposed and connected stacks of different heights, the wind forces are to be distributed taking into account the number of stacks at the level considered (see example in Fig 8).

4.2.3 Stacks of containers

The still water, inertial and wind forces, to be considered as being applied at the centre of gravity of the stack, and those transmitted at the corners of such stack are to be obtained, in kN, as specified in Tab 3.

Figure 8 : Distribution of wind forces in the case of stacks of different heights



4.2.4 Effect of cell guides

Where cell guides support the containers stowed in holds, the values of $R_{W,1}$ and $R_{W,2}$ calculated according to [4.2.3] for inclined ship condition, may be assumed to be not greater than ($F_{W,Z}$ / 4 + 160), provided that arrangements of cell guides and horizontal transverse cross-ties, according to [10.2], ensure the blocking of the corners of containers.

Any other arrangement may be accepted, to the Society's satisfaction.

4.2.5 Requirements for Lashing Software *(1/7/2025)*

The use of on-board lashing softwares is not a requirement of class.

If the ship is equipped with lashing software on-board, the lashing software is to comply with the requirements in Pt F, Ch 13, Sec 5, [3.5].

5 Yielding checks

5.1

5.1.1 *(1/7/2016)*

The requirements in App 1, [4] are to be applied in addition of those indicated in Pt B, Ch 6, Sec 2.

6 Buckling check

6.1

6.1.1 *(1/7/2016)*

The requirements in App 1, [5] are to be applied to plate panels and ordinary stiffeners subjected to hull girder bending and shear stresses in addition of those given in Pt B, Ch 7, Sec 1, [5] and. Pt B, Ch 7, Sec 2, [5].

7 Ultimate strength check

7.1

7.1.1 *(1/7/2016)*

The requirements in App 1, [6] are to be applied in lieu of those indicated in Pt B, Ch 6, Sec 3.

8 Hull scantlings

8.1 Plating

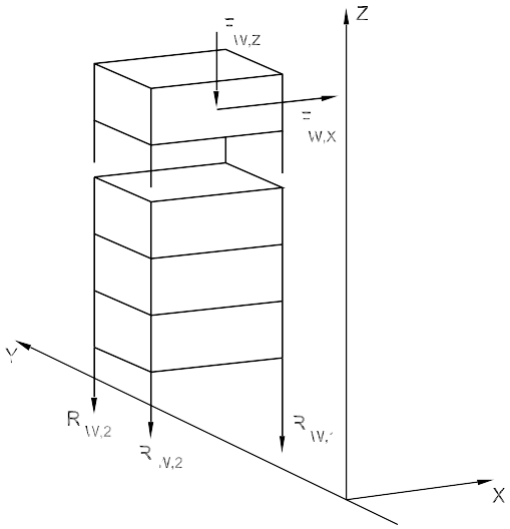
8.1.1 Thickness of the strake below the sheerstrake

The thickness of the strake below the sheerstrake may not be less than 0,7 times that of the sheerstrake.

8.1.2 Thickness of the strake below the upper strake of torsion box girders

The thickness of the strake below the upper strake of torsion box girders may not be less than 0,7 times that of the upper strake.

Figure 9 : Inertial and wind forces - Upright ship condition



8.2 Primary supporting members

8.2.1 Scantlings of primary supporting members of ships greater than 150 m in length are to be analysed according to Pt B, Ch 7, App 3, as deemed necessary by the Society on a case-by-case basis.

9 Other structures

9.1 Non-weathertight hatch covers above superstructure deck

9.1.1 Non-weathertight hatch covers may be fitted to hatchways located on weather decks which are at least two standard heights of superstructure above the assumed freeboard deck. Where any part of a hatchway is forward of a point located one quarter of the ship's length (0,25L) from the forward perpendicular, that hatchway is to be located on a weather deck at least three standard heights of superstructure above the actual or assumed freeboard deck.

The assumed freeboard deck is used only for the purpose of measuring the height of the deck on which the hatchways are situated. The assumed freeboard deck may be an actual freeboard deck or a virtual deck from which a freeboard can be calculated resulting in a draught not less than that corresponding to the freeboard actually assigned.

Figure 10 : Inertial and wind forces - Inclined ship condition

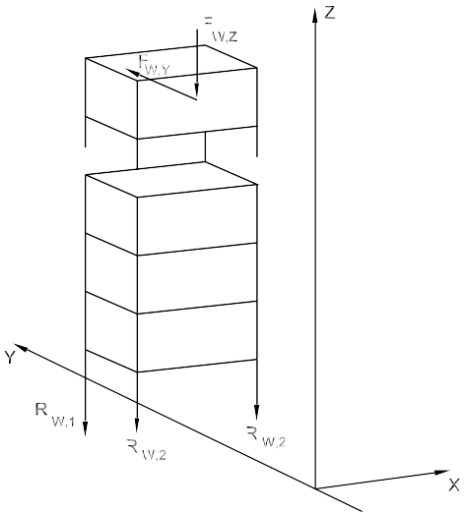


Table 3 : Containers - Still water, inertial and wind forces

Ship condition	Load case	Still water force F_S and inertial and wind force F_W, in kN, acting on each container stack	Vertical still water force R_S and inertial and wind force R_W, in kN, transmitted at the corners of each container stack
Still water condition		$F_S = \sum_{i=1}^{N} F_{S,i}$	$R_S = \frac{F_S}{4}$
Upright condition (see Fig 9)	"a"	No inertial forces	No inertial forces
	"b"	• in x direction $F_{W,X} = \sum_{i=1}^{N}(F_{W,X,i} + F_{X,wind,i})$ • in z direction $F_{W,Z} = \sum_{i=1}^{N} F_{W,Z,i}$	$R_{W,1} = \frac{F_{W,Z}}{4} + \frac{N_C h_C F_{W,X}}{4\ell_C}$ $R_{W,2} = \frac{F_{W,Z}}{4} - \frac{N_C h_C F_{W,X}}{4\ell_C}$
Inclined condition (negative roll angle) (see Fig 10)	"c" and "d"	• in y direction $F_{W,Y} = \sum_{i=1}^{N}(F_{W,Y,i} + F_{Y,wind,i})$ • in z direction $F_{W,Z} = \sum_{i=1}^{N} F_{W,Z,i}$	$R_{W,1} = \frac{F_{W,Z}}{4} + \frac{N_C h_C F_{W,Y}}{4b_C}$ $R_{W,2} = \frac{F_{W,Z}}{4} - \frac{N_C h_C F_{W,Y}}{4b_C}$

Note 1:

N : Number of containers per stack

h_C : Height, in m, of a container

ℓ_C, b_C : Dimension, in m, of the container stack in the ship longitudinal and transverse direction, respectively.

9.1.2 The hatchway coamings are to be not less than 600 mm in height.

9.1.3 The non-weathertight gaps between hatch cover panels are to be considered as unprotected openings with respect to the requirements of intact and damage stability calculations.

The non-weathertight gaps between hatch cover panels are to be as small as possible commensurate with the capacity of the bilge system and expected water ingress, and the capacity and operational effectiveness of the fire-fighting system and, in general, less than 50 mm.

9.1.4 Labyrinths, gutter bars or equivalent are to be fitted near the edges of each panel in way of the gaps to minimise the amount of water that can enter the container hold from the top surface of each panel.

9.1.5 Scantlings of the hatch cover panels as well as details of the securing arrangements for the supporting structure and coamings are to be equivalent to those for weathertight covers, and are to be obtained in accordance with the applicable requirements of Pt B, Ch 9, Sec 7.

10 Fixed cell guides

10.1 General

10.1.1 Containers may be secured within fixed cell guides, permanently connected by welding to the hull structure, which prevent horizontal sliding and tipping (see Fig 11).

10.1.2 When containers are secured by fixed cell guides, the scantlings of such cell guides and supports are to be approved and checked using the criteria in [10.2] and [10.3].

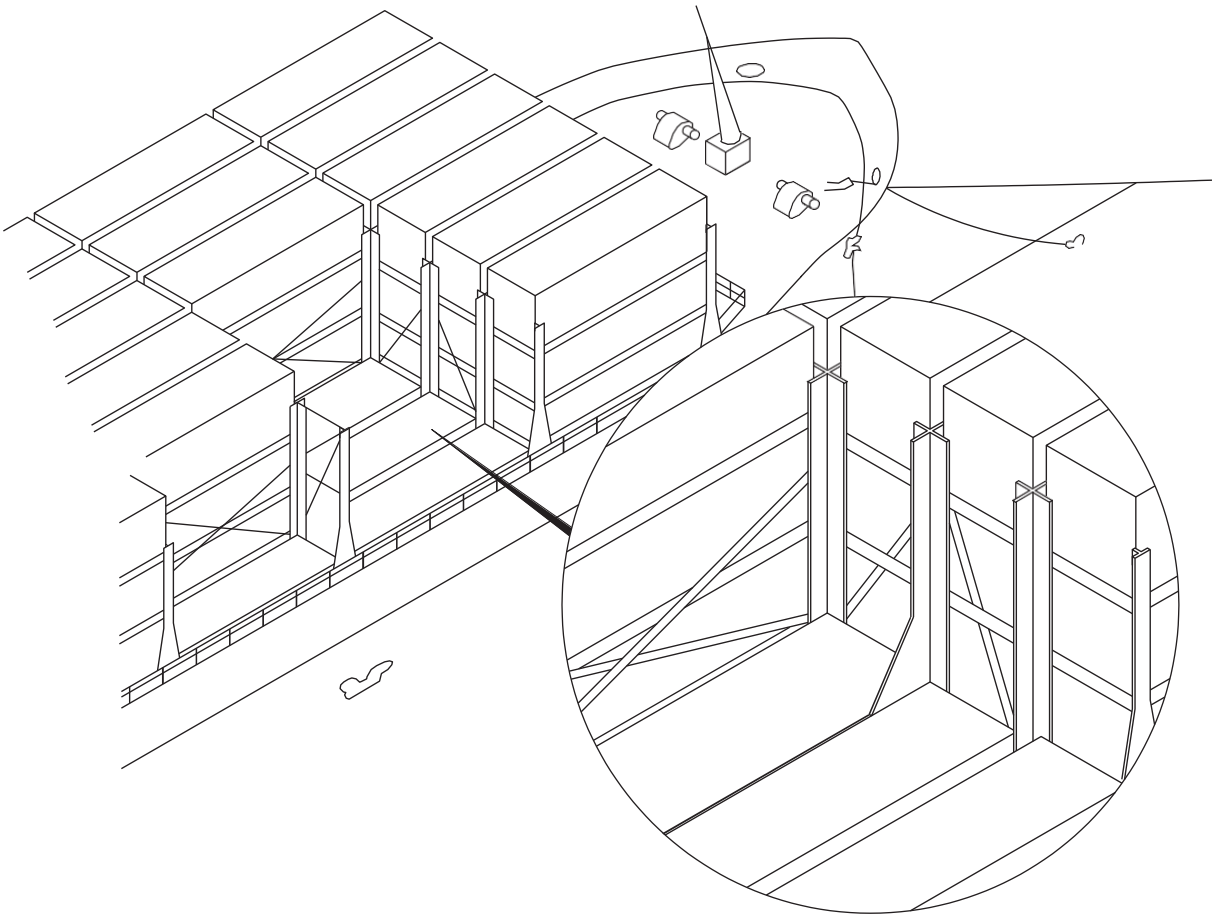
10.2 Arrangement of fixed cell guides

10.2.1 Vertical guides generally consist of sections with equal sides, not less than 12 mm in thickness, extended for a height sufficient to give uniform support to containers.

10.2.2 Guides are to be connected to each other and to the supporting structures of the hull by means of cross-ties and longitudinal members such as to prevent deformation due to the action of forces transmitted by containers.

In general, the spacing between cross-ties connecting the guides may not exceed 5 metres, and their position is to coincide as nearly as possible with that of the container corners (see Fig 12).

Figure 11 : Containers within fixed cell guides



Cross-ties are to be longitudinally restrained at one or more points so that their elastic deformation due to the action of the longitudinal thrust of containers does not exceed 20 mm at any point.

10.2.3 In stowing containers within the guides, the maximal clearance between container and guide is not to exceed 25 mm in the transverse direction and 38 mm in the longitudinal direction.

10.2.4 The upper end of the guides is to be fitted with a block to facilitate entry of the containers. Such appliance is to be of robust construction so as to withstand impact and chafing.

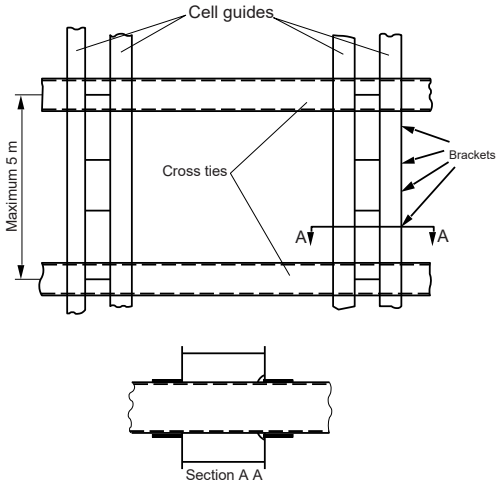
10.3 Strength criteria

10.3.1 The local stresses in the elements of cell guides, transverse and longitudinal cross-ties, and connections with the hull structure are to be less than the following values:

- normal stress: 150/k N/mm^2
- shear stress: 100/k N/mm^2
- von Mises equivalent stress: 175/k N/mm^2,

where k is the material factor, defined in Pt B, Ch 4, Sec 1, [2.3].

Figure 12 : Typical structure of cell guides



11 Approval and Certification of Container Securing Systems

11.1 General

11.1.1 *(1/7/2025)*

All seagoing dedicated container ships are to comply with the minimum requirements in this Article.

It is important for the safety of the ship and the protection of the cargo and personnel that the cargo is secured properly especially accounting for strength of the supporting structures and securing fittings. Hereto, a scope containing the following for approval and/or certification of container securing systems is defined:

- fixed and portable container securing fittings;
- arrangement plan of fixed container securing fittings;
- drawings of container supporting structures (container stanchions, hatch covers, lashing bridges, and cell guides, if any);
- cargo safe access plan;
- container stowage and securing plan;
- lashing software.

11.2 Fixed and Portable Container Securing Fittings

11.2.1 General *(1/7/2025)*

Fixed container securing fittings are used to secure and support containers and are permanently welded to the ship structure.

Portable (see Note 1) container securing fittings are used to secure containers and are not categorised as fixed container securing fittings.

Minimum Breaking Load corresponds to the minimum load at which the first crack appears in the tested representative samples.

Minimum Proof Load corresponds to the test load specified in Pt F, Ch 13, Sec 5, [3.2] and [3.3] below which visible permanent deformation is not allowed.

Note 1: “Portable” and “loose” container securing fittings are used interchangeably in different container securing contexts.

11.2.2 Drawings *(1/7/2025)*

Drawings of fixed and portable container securing fittings showing dimensions, materials, design loads, and manufacturer’s markings are to be approved in accordance with [11].

11.2.3 **Prototype Testing** *(1/7/2025)*

Each fixed and portable container securing fitting type is subject to prototype testing to determine the minimum breaking loads.

The minimum breaking load obtained from prototype testing is to be equal to or exceed the design minimum breaking load.

11.2.4 Production Testing *(1/7/2025)*

Fixed and portable container securing fittings are subject to production testing prior to delivery or installation.

A number of samples from a batch of the container securing fittings is to be loaded to minimum proof load of the fittings, as per Pt F, Ch 13, Sec 5, [3.3.4].

The production testing approval documents of delivered container securing fittings are to be kept on board and may be included in the approved Cargo Securing Manual.

11.2.5 Arrangement Plan of Fixed Container Securing Fittings *(1/7/2025)*

The plan detailing the arrangement of the fixed container securing fittings is to be approved. The arrangement plan is to include the following for all areas where the fittings are installed:

- The type of fixed container securing fittings such as container foundations (see Note 1) and lashing eye plates
- Unambiguous location of installed fittings such as their location relative to clearly described locations of the ship structures.

Note 1: Container foundations are called twistlock foundations, or base foundations in different container securing contexts. Likewise, “foundation” and “socket” are used interchangeably.

11.3 Drawings of Container Supporting Structures

11.3.1 *(1/7/2025)*

The drawings of the structures necessary for conducting container stowage and securing are subject to approval.

The drawings are to be detailed enough to allow their model generation for structural analyses.

A plan is to be provided showing all relevant design loads for structural assessment of the container supporting structures and their foundations.

Structures involved in container stowage and securing include:

- hatch covers
- container stanchions (see Note 1)
- lashing bridges
- cell guides.

Note 1: Container stanchions are called container stools, or container pedestals in different container securing contexts.

11.4 Cargo Safe Access Plan

11.4.1 *(1/7/2025)*

The cargo safe access plan is to be examined for its compliance with the requirements prescribed in MSC.1/Circ.1353/Rev.2.

11.5 Container Stowage and Securing Plan

If the stowage and securing plan, as referred to in MSC.1/Circ.1353/Rev.2 4.2.1 and 4.2.2, is required by the Administration, the plan is subject to approval in accordance with [11.5.1] and [11.5.2].

11.5.1 Container Stowage Plan *(1/7/2025)*

The container stowage plan is to include at least the following information for each container type the ship is designed for:

- longitudinal and athwartship views of under deck and on deck stowage locations of containers including reefers as appropriate;
- alternative stowage patterns for containers of different dimensions;
- maximum stack masses (see Note 1);
- maximum stack heights with respect to approved sight lines; and
- maximum nominal container capacity.

Note 1: “Mass” and “weight” are used interchangeably in different container securing contexts.

11.5.2 **Container Securing Arrangement Plan** *(1/7/2025)*

The container securing arrangement plan is to contain all information necessary to prepare lashing calculations in accordance with Pt F, Ch 13, Sec 5, [4], [5] and [6]. The container securing arrangement plan is to include at least the following information:

- summary of ship particulars such as IMO No., length and breadth;
- summary of loading conditions showing relevant input parameters such as draught and GM;
- longitudinal views of under deck and on deck stowage locations of containers as appropriate showing nominal capacity;
- maximum stack masses;
- relevant properties of securing fittings, including permissible loads;
- graphical presentation of container and lashing arrangements in each bay on deck and in holds for sample loading conditions in accordance with Pt F, Ch 13, Sec 5, [3.5.5] for each container type the ship is allowed to carry;
- stack total mass and the sequence of masses in a stack;
- minimum quantity of fittings required to secure containers for the presented sample loading conditions.

11.6 Lashing Software

11.6.1 *(1/7/2025)*

See the requirements in [4.2.5].

12 Construction and testing

12.1 Special structural details

12.1.1 The specific requirements in Pt B, Ch 12, Sec 2, [2.7] for ships with the service notation **container ship** are to be complied with.

SECTION 3 MACHINERY

1 Open top container ships

1.1 Bilge system arrangements

1.1.1 *(1/1/2007)*
The bilge system arrangements of open top container ships are to comply with the relevant requirements of IMO MSC/Circ.608/rev.1 “Interim guidelines for open top container ships”.

APPENDIX 1 LONGITUDINAL STRENGTH STANDARD FOR CONTAINER SHIPS

Symbols

T : Scantling draught, in m

C_B : Block coefficient at scantling draught

C_W : Waterplane coefficient at scantling draught, to be taken as:

$$C_W = \frac{A_W}{(LB)}$$

where L is rule length as defined in Pt B, Ch 1, Sec 2, [3.1] and B is moulded breadth as defined in Pt B, Ch 1, Sec 2, [3.4]

A_W : Waterplane area at scantling draught, in m^2

C : Wave parameter defined in [3.2]

M_{SW} : Vertical still water bending moment in seagoing condition, in kNm, at the cross section under consideration, as defined in [3.1.1]

M_{SWmax} : Permissible maximum vertical still water bending moments in seagoing condition, in kNm, at the cross section under consideration, see [3.1.2]

M_{SWmin} : Permissible minimum vertical still water bending moments in seagoing condition, in kNm, at the cross section under consideration, see [3.1.2]

M_{WV} : Vertical wave bending moment in seagoing condition, in kNm, at the cross section under consideration, as defined in [3.2.2]

Q_{SW} : Vertical still water shear force in seagoing condition, in KN, at the cross section under consideration as defined in [3.1.1]

Q_{SWmax} : Permissible maximum still water vertical shear forces in seagoing condition, in KN, at the cross section under consideration, see [3.1.2]

Q_{SWmin} : Permissible minimum still water vertical shear forces in seagoing condition, in KN, at the cross section under consideration, see [3.1.2]

Q_{WV} : Vertical wave shear force in seagoing condition, in KN, at the cross section under consideration, as defined in [3.2.3]

t_n : Net thickness, in mm, defined in [2.1]

R_{eH} : Specified minimum yield stress of the material in N/mm^2

k : Material factor, as defined in Pt B, Ch 4, Sec 1, [2.3]

E : Young's modulus, in N/mm^2, to be taken equal to:

- for steels in general:
  $E = 2,06 \cdot 10^5 N/mm^2$
- for stainless steels:
  $E = 1,95 \cdot 10^5 N/mm^2$
- for aluminium alloys:
  $E = 7,0 \cdot 10^4 N/mm^2$

ν : Poisson's ratio. Unless otherwise specified, a value of 0,3 is to be considered

z : Z coordinate, in m, of the calculation point with respect to the reference co-ordinate system defined in Pt B, Ch 1, Sec 2, [4]

σ_1 : Hull girder bending stress, in N/mm^2, defined in [3.4.1]

τ_1 : Hull girder shear stress, in N/mm^2, defined in [3.4.2]

R_{eH_S} : Specified minimum yield stress of the stiffeners, in N/mm^2

R_{eH_P} : Specified minimum yield stress of the plate, in N/mm^2

a : Length of the longer side of the plate panel as shown in Tab 6, in mm

b : Length of the shorter side of the plate panel as shown in Tab 6, in mm

d : Length of the side parallel to the axis of the cylinder corresponding to the curved plate panel as shown in Tab 7, in mm

ℓ : Span, in mm, of ordinary stiffeners equal to the spacing between primary supporting members

s : Spacing of stiffeners, in mm, to be taken as the mean spacing between the stiffeners of the considered stiffened panel

R : Radius of curved plate panel, in mm

t_P : Net thickness, in mm, of plate panel

h_W : Web height, in mm, of an ordinary stiffener

t_W : Web net thickness, in mm, of an ordinary stiffener

b_f : Face plate width, in mm, of an ordinary stiffener

t_f : Face plate net thickness, in mm, of an ordinary stiffener

σ_E : Elastic buckling reference stress, in N/mm^2, obtained from the following formulae:

- For the application of plate limit state according to [5.5.1]:

$$\sigma_E = \frac{\pi^2 E}{12(1-\nu^2)}\left(\frac{t_p}{b}\right)^2$$

- For the application of curved plate panels according to [5.6.1]:

$$\sigma_E = \frac{\pi^2 E}{12(1-\nu^2)}\left(\frac{t_p}{d}\right)^2$$

1 General

1.1 Application

1.1.1 Application *(1/7/2016)*

The requirements of this Appendix apply to ships with the service notation **container ship** with a length L of 90 m and greater and operated in unrestricted service.

1.1.2 Load limitations *(15/4/2019)*

The wave induced load requirements apply to monohull displacement ships in unrestricted service and are limited to ships meeting the following criteria:

- 90 m $\leq$ L $\leq$ 500 m
- 5 $\leq$ L/B $\leq$ 9
- 2 $\leq$ B/T $\leq$ 6
- 0,55 $\leq C_B \leq$ 0,9

For ships that do not meet all of the aforementioned criteria, special considerations such as direct calculations of wave induced loads may be required by the Society.

1.1.3 Longitudinal extent of strength assessment *(1/7/2016)*

The stiffness, yield strength, buckling strength and hull girder ultimate strength assessment are to be carried out in way of 0,2L to 0,75L with due consideration given to locations where there are significant changes in hull cross section, e.g. changing of framing system and the fore and aft end of the forward bridge block in case of two-island designs.

In addition, strength assessments are to be carried out outside this area. As a minimum assessments are to be carried out at forward end of the foremost cargo hold and the aft end of the aft most cargo hold. Evaluation criteria used for these assessments will be determined by the Society on a case-by-case basis.

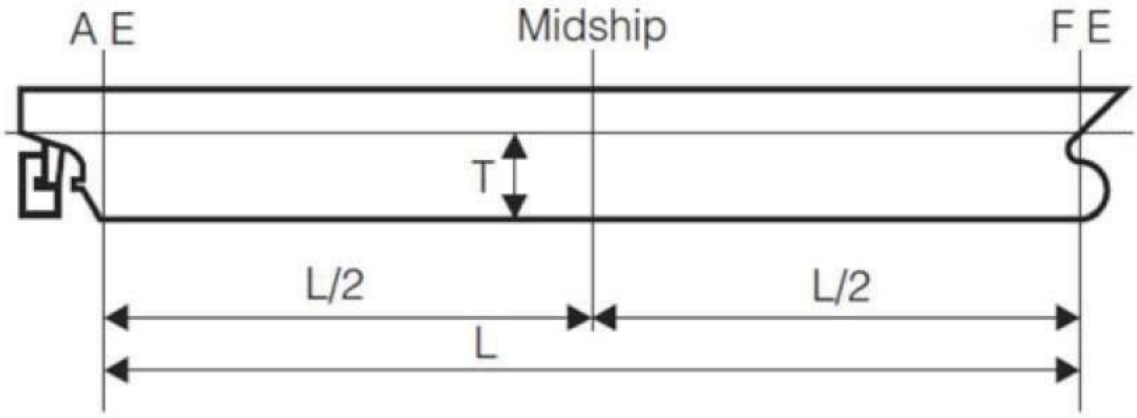
1.2 Definitions

1.2.1 Force and aft end *(1/7/2016)*

The fore end (FE) of the rule length L, see Fig 1, is the perpendicular to the scantling draught waterline at the forward side of the stem.

The aft end (AE) of the rule length L, see Fig 1, is the perpendicular to the scantling draught waterline at a distance L aft of the fore end (FE).

Figure 1 : End of length L *(1/7/2016)*



2 Structure design principles

2.1 Corrosion margin and net thickness

2.1.1 Net scantling definitions *(15/4/2019)*

The strength is to be assessed using the net thickness approach on all scantlings.

The net thickness t_n, in mm, for the plates, webs and flanges is obtained from the following formula:

$t_n = t_{as_built} - t_{vol_add} - \alpha\, t_c$

where:

t_{as_built} : as built thickness, in mm

t_{vol_add} : voluntary addition, in mm

α : corrosion addition factor, whose value are defined in Tab 1

t_c : corrosion addition, in mm, defined in

Table 1 : Values of corrosion addition factor *(15/4/2019)*

Structural requirement	Property / analysis type	α
Strength assessment (see [4])	Section properties	0,5
Hull girder buckling strength (see [5])	Section properties (stress determination)	0,5
	Buckling capacity	1,0
Hull girder ultimate strength (see [6])	Section properties	0,5
	Buckling / collapse capacity	0,5

2.1.2 Determination of corrosion addition *(15/4/2019)*

The corrosion addition for each of the two sides of a structural member, t_{c1} or t_{c2} is specified in Tab 2. The total corrosion addition, t_c, in mm, for both sides of the structural member is obtained by the following formula:

$$t_c = (t_{c1} + t_{c2}) + t_{res}$$

where:

t_{res} is the reserve thickness to be taken as 0,5 mm.

For an internal member within a given compartment, the total corrosion addition, t_c is obtained from the following formula:

$$t_c = (2t_{c1}) + t_{res}$$

The corrosion addition of a stiffener is to be determined according to the location of its connection to the attached plating.

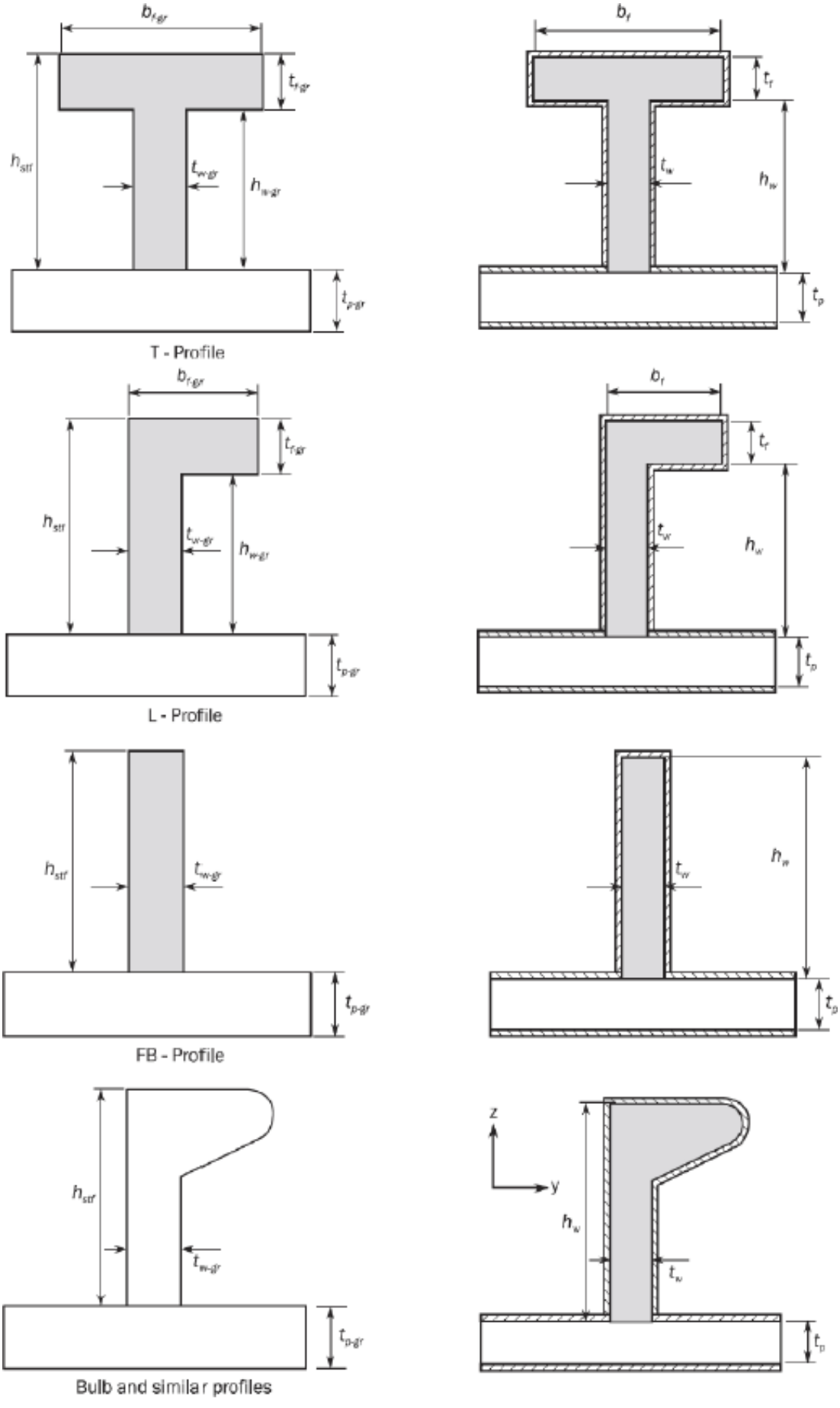
Table 2 : Corrosion addition for one side of a structural member *(1/7/2016)*

Compartment type	One side corrosion addition t_{c1} or t_{c2} [mm]
Exposed to sea water	1,0
Exposed to atmosphere	1,0
Ballast water tank	1,0
Void and dry spaces	0,5
Fresh water, fuel oil and lube oil tank	0,5
Accommodation spaces	0,0
Container holds	1,0
Compartment types not mentioned above	0,5

2.1.3 Determination of net section properties *(1/7/2016)*

The net section modulus, moment of inertia and shear area properties of a supporting member are to be calculated using the net dimensions of the attached plate, web and flange, as defined in Fig 2. The net cross-sectional area, the moment of inertia about the axis parallel to the attached plate and the associated neutral axis position are to be determined through applying a corrosion magnitude of 0,5 αt_c deducted from the surface of the profile cross-section.

Figure 2 : Net sectional properties of supporting members *(1/7/2016)*



3 Design loads

3.1 Hull girder still water loads

3.1.1 General *(1/7/2016)*

Still water bending moments, M_{SW} in kNm, and still water shear forces, Q_{SW} in kN, are to be calculated at each section along the ship length for design loading conditions as specified in [3.1.2].

3.1.2 Design loading conditions *(1/7/2016)*

In general, the design cargo and ballast loading conditions, based on amount of bunker, fresh water and stores at departure and arrival, are to be considered for the M_{SW} and Q_{SW} calculations. Where the amount and disposition of consumables at any intermediate stage of the voyage are considered more severe, calculations for such intermediate conditions are to be submitted in addition to those for departure and arrival conditions.

Also, where any ballasting and/or de-ballasting is intended during voyage, calculations of the intermediate condition just before and just after ballasting and/or de-ballasting any ballast tank are to be submitted and where approved included in the loading manual for guidance.

The permissible vertical still water bending moments M_{SWmax} and M_{SWmin} and the permissible vertical still water shear forces Q_{SWmax} and Q_{SWmin} in seagoing conditions at any longitudinal position are to envelop:

- The maximum and minimum still water bending moments and shear forces for the seagoing loading conditions defined in the Loading Manual.
- The maximum and minimum still water bending moments and shear forces specified by the designer.

The Loading Manual should include the relevant loading conditions, which envelop the still water hull girder loads for seagoing conditions, including those specified in the following (subdivided into departure and arrival conditions):

- Homogeneous loading conditions at maximum draught
- Ballast conditions
- Special loading conditions, e.g. container conditions at less than the maximum draught, empty holds, etc., as applicable
- Short voyage or harbour conditions, where applicable
- Docking condition afloat
- Loading and unloading transitory conditions, where applicable.

3.2 Hull girder wave loads

3.2.1 Wave parameter *(15/4/2019)*

The wave parameter is defined as follows:

$$C = 1 - 1,50\left(1 - \sqrt{\frac{L}{L_{ref}}}\right)^{2,2} \text{ for } L \le L_{ref}$$

$$C = 1 - 0,45\left(\sqrt{\frac{L}{L_{ref}}} - 1\right)^{1,7} \text{ for } L > L_{ref}$$

where:

L_{ref} : Reference length, in m, to be taken as:

- $L_{ref} = 315\ C_W^{-1,3}$ for the determination of vertical wave bending moments according to [3.2.2]
- $L_{ref} = 330\ C_W^{-1,3}$ for the determination of vertical wave shear moments according to [3.2.3].

3.2.2 Vertical wave bending moments *(15/4/2019)*

The distribution of the vertical wave bending moments, M_{WV} in KNm, along the ship length is given in Fig 4, where:

$$M_{WV,H} = 1,5 f_R L^3 C C_W \left(\frac{B}{L}\right)^{0,8} f_{NL-Hog}$$

$$M_{WV,S} = -1,5 f_R L^3 C C_W \left(\frac{B}{L}\right)^{0,8} f_{NL-Sag}$$

where:

f_R : Factor related to the operational profile to be taken equal to 0,85

$f_{NL\text{-}Hog}$: Non-linear correction for hogging, to be taken as:

$$f_{NL-Hog} = 0,3\frac{C_B}{C_W}\sqrt{T}$$

not to be taken greater than 1,1

$f_{NL\text{-}Sag}$: Non-linear correction for sagging, to be taken as:

$$f_{NL-Sag} = 4,5\frac{T + 0,2f_{Bow}}{C_W\sqrt{C_B}L^{0,3}}$$

not to be taken less than 1,0

f_{Bow} : Bow flare shape coefficient, to be taken as:

$$f_{Bow} = \frac{A_{DK} - A_{WL}}{0,2Lz_f}$$

A_{DK} : Projected area in horizontal plane of uppermost deck, in m^2 including the forecastle deck, if any, extending from 0,8L forward (see Fig 3). Any other structures, e.g. plated bulwark, are to be excluded.

A_{WL} : Waterplane area, in m^2, at draught T, extending from 0,8L forward

z_f : Vertical distance, in m, from the waterline at draught T to the uppermost deck (or forecastle deck), measured at FE (see Fig 3). Any other structures, e.g. plated bulwark, are to be excluded.

3.2.3 Vertical wave shear forces *(15/4/2019)*

The distribution of the vertical wave shear forces, Q_{WV} in kN, along the ship length is given in Fig 5, where:

$$Q^{Aft}_{WV,H} = 5,2f_RL^2CC_W\left(\frac{B}{L}\right)^{0,8}(0,3 + 0,7f_{NL-Hog})$$

$$Q^{Fore}_{WV,H} = -5,7f_RL^2CC_W\left(\frac{B}{L}\right)^{0,8}f_{NL-Hog}$$

$$Q^{Aft}_{WV,S} = -5,2f_RL^2CC_W\left(\frac{B}{L}\right)^{0,8}(0,3 + 0,7f_{NL-Sag})$$

$$Q^{Fore}_{WV,S} = 5,7f_RL^2CC_W\left(\frac{B}{L}\right)^{0,8}(0,25 + 0,75f_{NL-Sag})$$

$$Q^{Mid}_{WV} = 4,0f_RL^2CC_W\left(\frac{B}{L}\right)^{0,8}$$

Figure 3 : Projected area A_{DK} and vertical distance z_f *(1/7/2016)*

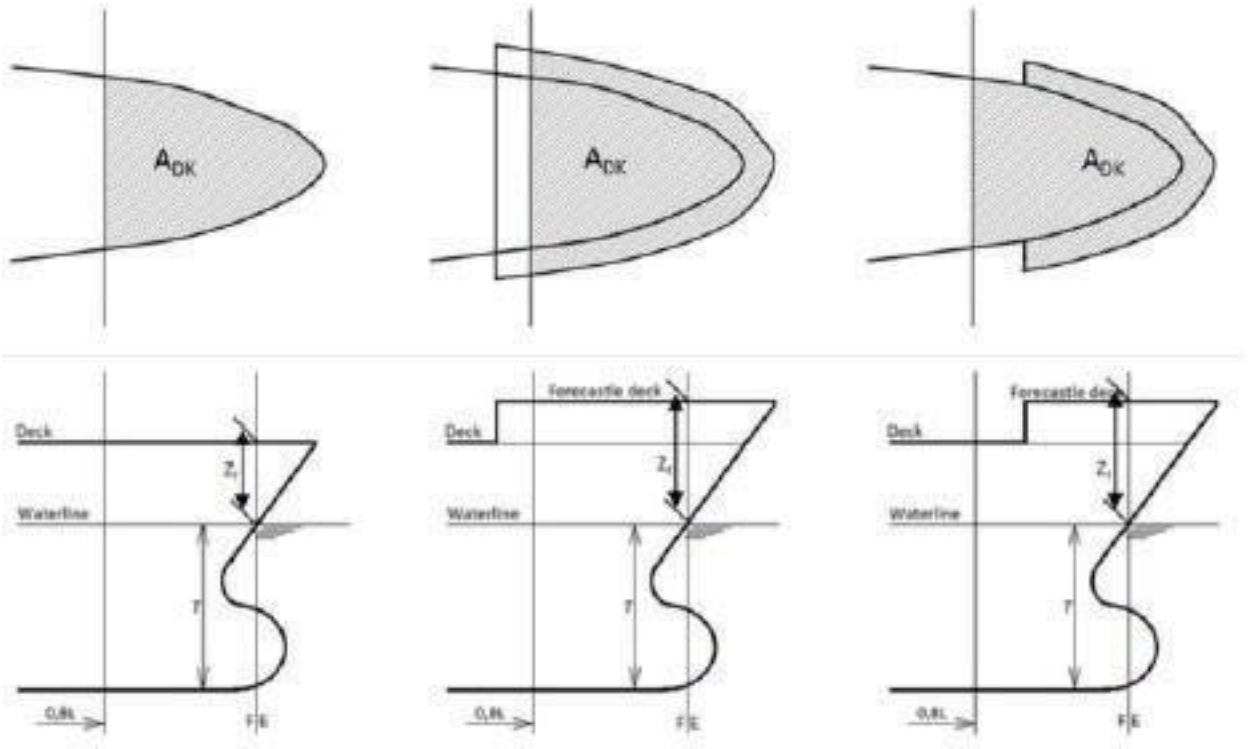


Figure 4 : Distribution of vertical wave bending moment M_{WV} along the ship length *(1/7/2016)*

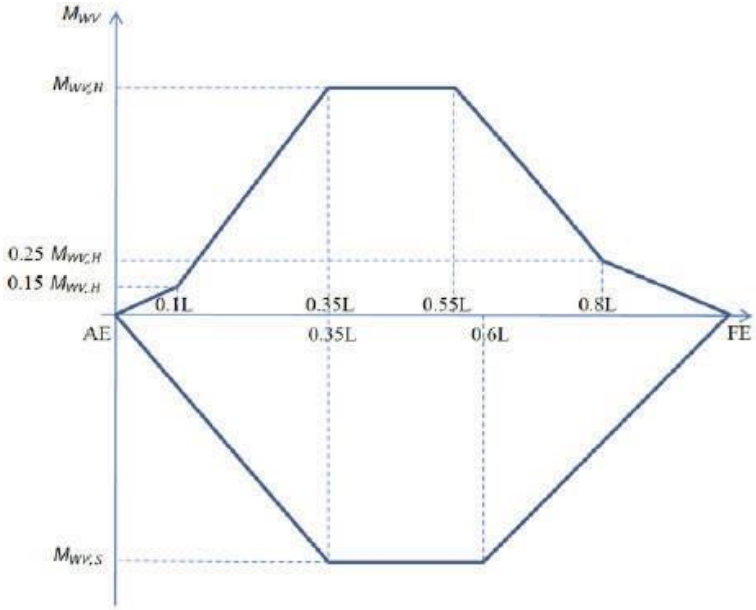
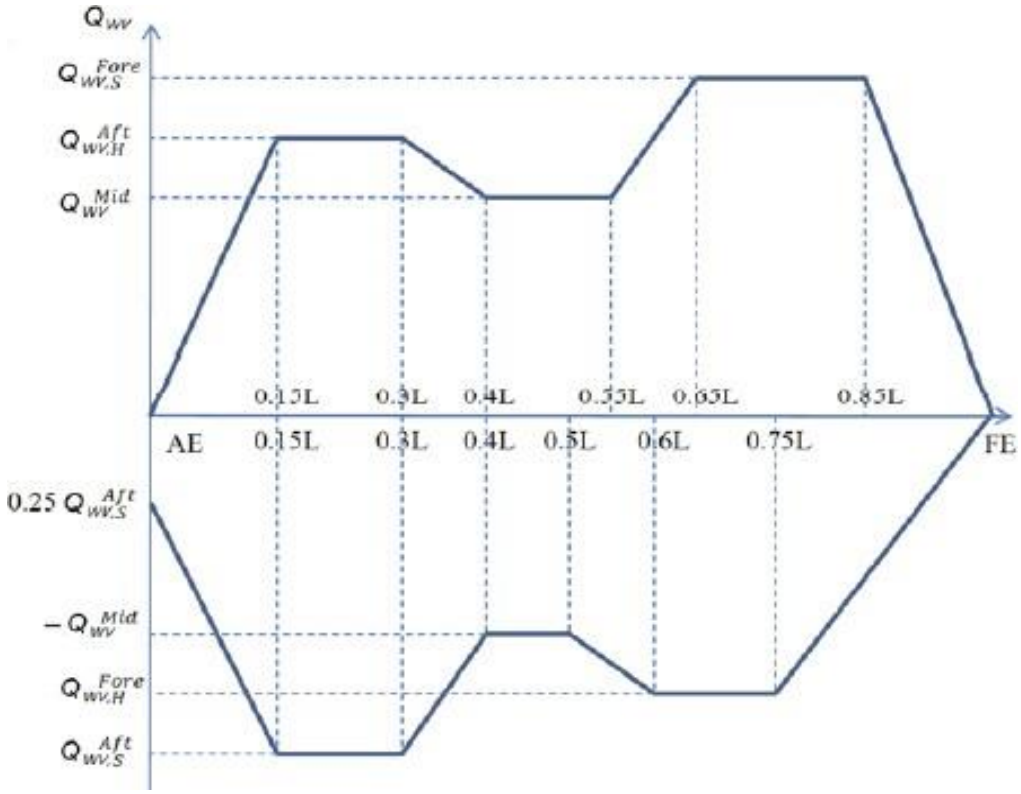


Figure 5 : Distribution of vertical wave shear Q_{WV} along the ship length *(1/7/2016)*



3.3 Hull girder load cases

3.3.1 Combination of still water and wave bending moments and shear forces *(1/7/2016)*

For the strength assessment, the maximum hogging and sagging load cases given in Tab 3 are to be checked. For each load case the still water condition at each section as defined in [3.1] is to be combined with the wave condition as defined in [3.2], refer also to Fig 6.

Table 3 : Combination of still water and wave bending moments and shear forces *(15/4/2019)*

Load case	Bending moment		Shear force	
	M_{SW}	M_{WV}	Q_{SW}	Q_{WV}
Hogging	M_{SWmax}	$M_{WV,H}$	Q_{SWmax} for $x \leq 0,5L$	Q_{WVmax} for $x \leq 0,5L$
			Q_{SWmin} for $x > 0,5L$	Q_{WVmin} for $x > 0,5L$
Sagging	M_{SWmin}	$M_{WV,S}$	Q_{SWmin} for $x \leq 0,5L$	Q_{WVmin} for $x \leq 0,5L$
			Q_{SWmax} for $x > 0,5L$	Q_{WVmax} for $x > 0,5L$

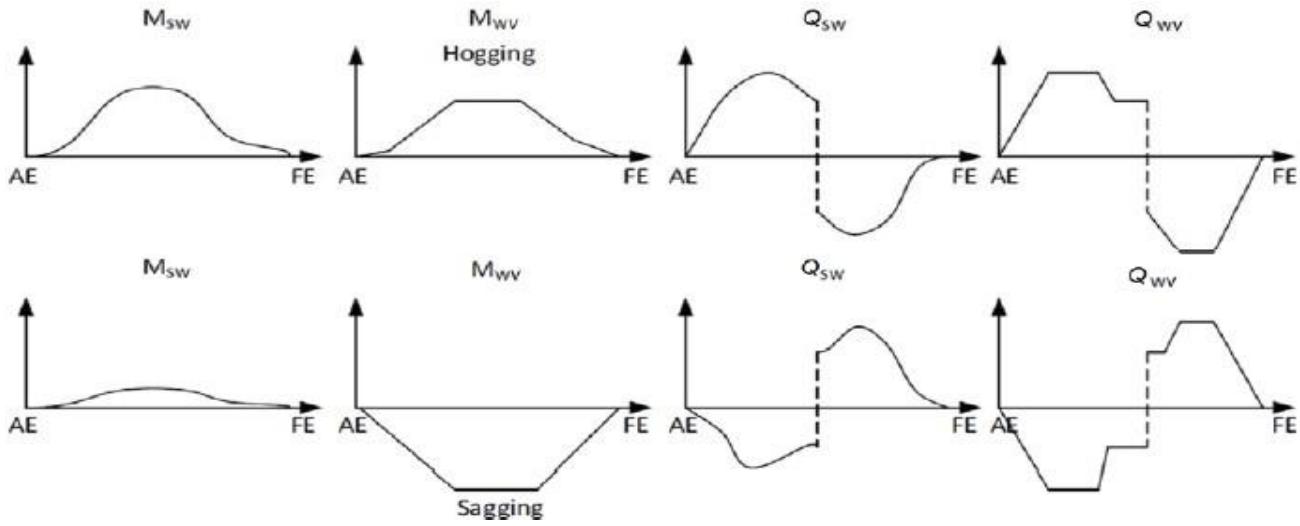
$M_{WV,H}$: Wave bending moment in hogging at the cross section under consideration, to be taken as the positive value of M_{WV} as defined in Fig 4

$M_{WV,S}$: Wave bending moment in sagging at the cross section under consideration, to be taken as the negative value of M_{WV} as defined in Fig 4

Q_{WVmax} : Maximum value of the wave shear force at the cross section under consideration, to be taken as the positive value of Q_{WV} as defined in Fig 5

Q_{WVmin} : Minimum value of the wave shear force at the cross section under consideration, to be taken as the negative value of Q_{WV} as defined in Fig 5

Figure 6 : Load combination to determine the maximum hogging and sagging load cases as given in Tab 3
(1/7/2016)



3.4 Hull girder stresses

3.4.1 Normal stresses *(15/4/2019)*

The normal stresses induced by vertical bending moments, in N/mm^2, are obtained at the load calculation point under consideration, for the “hogging” and “sagging” load cases defined in [3.3] as follows:

$$\sigma_1 = \frac{M_{SW} + M_{WV}}{I_{net}}(z - N)10^{-3}$$

where:

I_{net} : Net vertical hull girder moment of inertia at the cross section under consideration, to be determined using net scantlings as defined in [2.1], in m

N : Distance from the baseline to the horizontal neutral axis, in m.

3.4.2 Shear stresses *(1/7/2016)*

The shear stresses τ_1, in N/mm^2, induced by vertical shear forces at the load calculation point under consideration are obtained through direct calculation analyses based on thin walled beam models, as specified in Pt B, Ch 6, Sec 1, [2.6], using the net scantlings as defined in [2.1].

The hull girder loads to be considered in these analyses are the vertical shear forces Q_{SW} and Q_{WV}, defined in [3.1] and [3.2] for the "hogging" and "sagging" load cases defined in [3.3].

4 Yielding checks

4.1 General

4.1.1 *(1/7/2016)*

Continuity of structure is to be maintained throughout the length of the ship. Where significant changes in structural arrangement occur adequate transitional structure is to be provided.

4.2 Moment of inertia

4.2.1 Stiffness criterion *(1/7/2016)*

The two load cases "hogging" and "sagging" as listed in [3.3] are to be checked.

The net moment of inertia, in m^4, is not to be less than:

$$I_{net} \geq 1,55L\,|M_{SW} + M_{WV}|10^{-7}$$

4.3 Checking criteria

4.3.1 General acceptance criteria *(1/7/2016)*

The yield strength assessment is to check, for each of the load cases "hogging" and "sagging" as defined in [3.3], that the equivalent hull girder stress σ_{EQ}, in N/mm^2, is less than the allowable stress σ_{ALL}, in N/mm^2, as follows:

$$\sigma_{EQ} < \sigma_{ALL}$$

where:

$$\sigma_{EQ} = \sqrt{\sigma_x^2 + 3\tau^2}$$

$$\sigma_{ALL} = \frac{R_{eH}}{\gamma_1 \gamma_2}$$

γ_1 : Partial safety factor for material:

$$\gamma_1 = \frac{R_{eH}}{235}$$

γ_2 : Partial safety factor for load combinations and permissible stress:

γ_2 : 1.24, for bending strength assessment according to [4.3.2]

γ_2 : 1.13, for shear strength assessment according to [4.3.3]

4.3.2 Bending strength assessment *(1/7/2016)*

The assessment of the bending stresses is to be carried out according to [4.3.1] at the following locations of the cross section:

- At bottom
- At deck
- At top of hatch coaming
- At any point were there is a change of steel yield strength.

The following combination of hull girder stress as defined in [3.4] is to be considered:

$\sigma_x = \sigma_1$

$\tau = 0$

4.3.3 Shear strength assessment *(1/7/2016)*

The assessment of the shear stresses is to be carried out according to [4.3.1] for all structural elements that contribute to the shear strength capability.

The following combination of hull girder stress as defined in [3.4] is to be considered.

$\sigma_x = 0$

$\tau = \tau_1$

5 Buckling check

5.1 General

5.1.1 Application *(1/7/2016)*

The requirements of this Article apply for the buckling check of plate panels and longitudinal stiffeners subjected to hull girder bending and shear stresses.

5.2 Checking criteria

5.2.1 *(1//7/2016)*

The acceptance criterion for the buckling assessment is defined as follows:

$\eta_{act} \leq 1$

where:

η_{act} : Maximum utilization factor as defined in [5.2.2].

5.2.2 Buckling utilization factor *(1/7/2016)*

The utilization factor η_{act} is defined as the inverse of the stress multiplication factor at failure γ_c (see Fig 7):

$$\eta_{act} = \frac{1}{\gamma_c}$$

Failure limit states for elementary plate panels are defined in [5.5] and [5.6]; failure limit states for overall stiffened panels are defined in [5.7]; failure limit states for longitudinal stiffeners are defined in [5.8].

Each failure limit state is defined by an equation, and γ_c is to be determined such that it satisfies the equation.

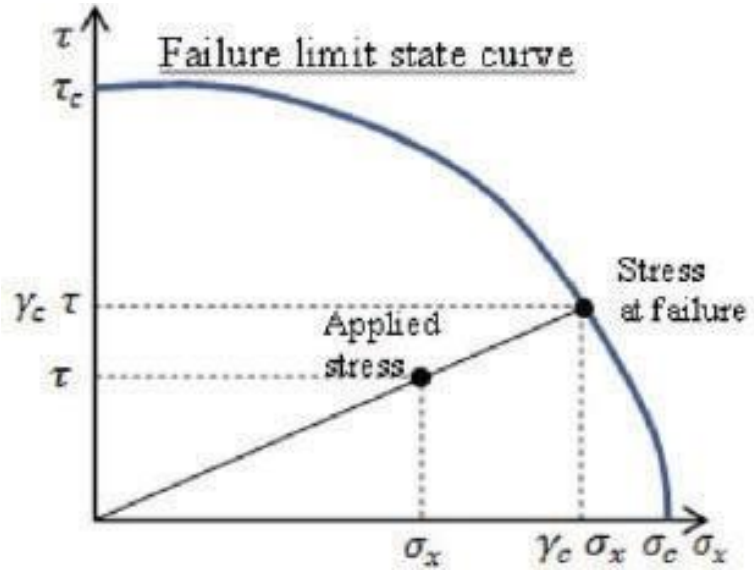
Fig 7 illustrates how the stress multiplication factor at failure γ_c of a structural member is determined for any combination of longitudinal and shear stress.

where:

σ_x , t : Applied stress combination for buckling given in [5.3.1].

σ_c , τ_c : Critical buckling stresses.

Figure 7 : Example of failure limit state curve and stress multiplication factor at failure *(1/7/2016)*



5.3 Stress determination

5.3.1 Stress combinations for buckling assessment *(1/7/2016)*

The following two stress combinations are to be considered for each of the load cases "hogging" and "sagging" as defined in [3.3]. The stresses are to be derived at the load calculation points defined in [5.3.2].

a) Longitudinal stiffening arrangement

Stress combination 1 with:

$\sigma_x = \sigma_1$

$\sigma_y = 0$

$\tau = 0{,}7\ \tau_1$

Stress combination 2 with

$\sigma_x = 0{,}7\ \sigma_1$

$\sigma_y = 0$

$\tau = \tau_1$

b) Transverse stiffening arrangement

Stress combination 1 with:

$\sigma_x = 0$

$\sigma_y = \sigma_1$

$\tau = 0,7\ \tau_1$

Stress combination 2 with

$\sigma_x = 0$

$\sigma_y = 0,7\ \sigma_1$

$\tau = \tau_1$

where:

x axis : Local axis of a rectangular buckling panel parallel to its longer edge

y axis : Local axis of a rectangular buckling panel perpendicular to its longer edge

σ_x : Membrane stress applied in x direction, in N/mm^2

σ_y : Membrane stress applied in y direction, in N/mm^2

τ : Membrane shear stress applied in xy plane, in N/mm^2.

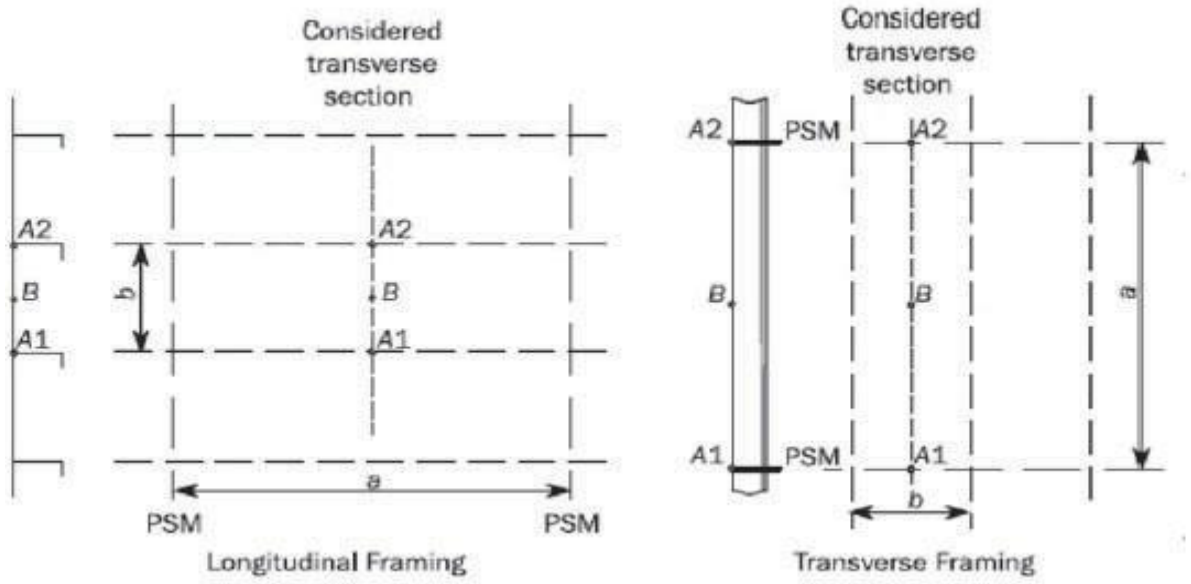
5.3.2 Load calculation points *(1/7/2016)*

The hull girder stresses for elementary plate panels (EPP) are to be calculated at the load calculation points defined in Tab 4.

Table 4 : Load calculation points (LCP) coordinates for plate buckling assessment *(1/7/2016)*

LCP coordinates	Hull girder bending stress		Hull girder shear stress
	Non horizontal plating	Horizontal plating	
x coordinate	Mid-length of the EPP		
y coordinate	Both upper and lower ends of the EPP (points A1 and A2 in Fig 8)	Outboard and inboard ends of the EPP (points A1 and A2 in Fig 8)	Mid-point of EPP (point B in Fig 8)
z coordinate	Corresponding to x and y values		

Figure 8 : LCP for plate buckling assessment, PSM stands for primary supporting members *(1/7/2016)*



The hull girder stresses for longitudinal stiffeners are to be calculated at the following load calculation point:

- at the mid length of the considered stiffener
- at the intersection point between the stiffener and its attached plate.

5.4 Elementary Plate Panel

5.4.1 Definition *(1/7/2016)*

An Elementary Plate Panel (EPP) is the unstiffened part of the plating between stiffeners and/or primary supporting members.

5.4.2 EPP with different thicknesses *(15/4/2019)*

a) Longitudinally stiffened EPP with different thicknesses

In longitudinal stiffening arrangement, when the plate thickness varies over the width, b, in mm, of a plate panel, the buckling capacity is calculated on an equivalent plate panel width, having a thickness equal to the smaller plate thickness, t_1. The width of this equivalent plate panel, b_{eq}, in mm, is defined by the following formula:

$$b_{eq} = \ell_1 + \ell_2 (t_1 / t_2)^{1,5}$$

where:

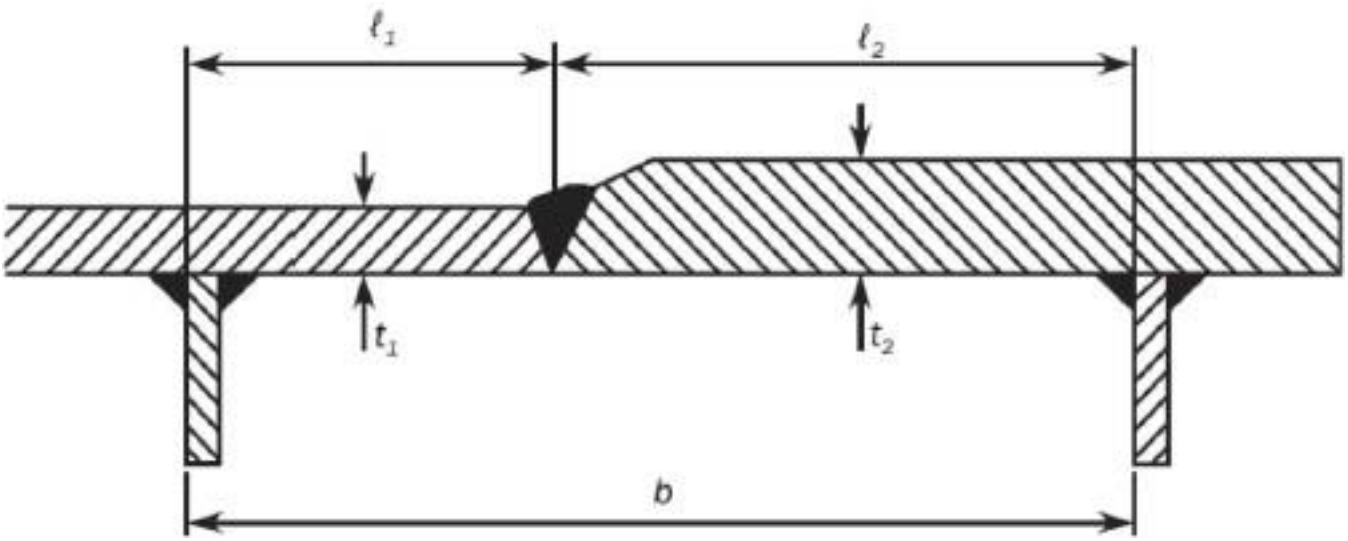
ℓ_1 : Width of the part of the plate panel with the smaller plate thickness, t_1 in mm (see Fig 9).

ℓ_2 : Width of the part of the plate panel with the greater plate thickness, t_2 in mm (see Fig 9).

b) Transversally stiffened EPP with different thickness

In transverse stiffening arrangement, when an EPP is made of different thicknesses, the buckling check of the plate and stiffeners is to be made for each thickness considered constant on the EPP.

Figure 9 : Plate thickness change over the width *(1/7/2016)*



5.5 Buckling capacity of plate panels

5.5.1 Plate limit state *(1/7/2016)*

The plate limit state is based on the following interaction formulae:

a) Longitudinal stiffening arrangement

$$\left(\frac{\gamma_e \sigma_x}{\sigma_{cx}}\right)^{2/\beta_p^{0,25}} + \left(\frac{\gamma_e \tau}{\tau_c}\right)^{2/\beta_p^{0,25}} = 1$$

b) Transverse stiffening arrangement

$$\left(\frac{\gamma_e \sigma_y}{\sigma_{cy}}\right)^{2/\beta_p^{0,25}} + \left(\frac{\gamma_e \tau}{\tau_c}\right)^{2/\beta_p^{0,25}} = 1$$

where:

σ_x , σ_y : Applied normal stress to the plate panel in N/mm^2, defined in [5.3], at load calculation points of the considered elementary plate panel.

τ : Applied shear stress to the plate panel in N/mm^2, defined in [5.3], at load calculation points of the considered elementary plate panel.

σ_{cx} : Ultimate buckling stress, in N/mm², in direction parallel to the longer edge of the buckling panel, defined in [5.5.3].

σ_{cy} : Ultimate buckling stress, in N/mm², in direction parallel to the shorter edge of the buckling panel, defined in [5.5.3].

τ_c : Ultimate buckling shear stress in N/mm², defined in [5.5.3].

β_p : Plate slenderness parameter to be obtained from the following formula:

$$\beta_p = \frac{b}{t_p}\sqrt{\frac{R_{eH_p}}{E}}$$

5.5.2 Reference degree of slenderness *(1/7/2016)*

The reference degree of slenderness is to be obtained from the following formula:

$$\lambda = \sqrt{\frac{R_{eH_p}}{K\sigma_E}}$$

where:

K : Buckling factor as defined in Tab 6 and Tab 7.

5.5.3 Ultimate buckiling stresses *(15/4/2019)*

The ultimate buckling stress of plate panels, in N/mm², is obtained from the following formula:

$$\sigma_{cx} = C_x R_{eH_p}$$

$$\sigma_{cy} = C_y R_{eH_p}$$

The ultimate buckling stresses subject to shear, in N/mm², is obtained from the following formula:

$$\tau_c = C_\tau \frac{R_{eH_p}}{\sqrt{3}}$$

where:

C_x, C_y, $C\tau$:Reduction factor as defined in Tab 6 and Tab 7.

The boundary conditions for plates are to be considered as simply supported (see cases 1, 2 and 15 of Tab 6). If the boundary conditions differ significantly from simple support, a more appropriate boundary condition can be applied according to the different cases of Tab 6 subject to the agreement of the Society on a case-by-case basis.

5.5.4 Correction Factor F_{long} *(15/4/2019)*

The correction factor F_{long} depending on the edge stiffener types on the longer side of the buckling panel is defined in Tab 5. An average value of F_{long} is to be used for plate panels having different edge stiffeners. For stiffener types other than those mentioned in Tab 5, the value of c is to be considered by the Society on a case-by-case basis. In such a case, value of c higher than those mentioned in Tab 5 can be used, provided it is verified by buckling strength check of panel using non-linear FE analysis and deemed appropriate by the Society.

Table 5 : Correction factor F_{long} *(1/7/2016)*

Structural element types			F_{long}	C
Unstiffened Panel			1,0	N/A
Stiffened Panel	Stiffener not fixed at both ends		1,0	N/A
	Stiffener fixed at both ends	Flat bar **(1)**	$F_{long} = c + 1$ for $\frac{t_w}{t_p} > 1$	0,10
		Bulb profile		0,30
		Angle profile	$F_{long} = c\left(\frac{t_w}{t_p}\right)^3 + 1$ for $\frac{t_w}{t_p} \le 1$	0,40
		T profile		0,30
		Girder of high rigidity (e.g. bottom transverse)	1,4	N/A
(1) t_W is the net web thickness, in mm, without the correction defined in [5.8.3]				

The meaning of the symbols in Tab 6 is as follows:

α : Aspect ratio of the plate panel, to be taken as:

$\alpha = a/b$

β : Coefficient to be taken as:

$$\beta = \frac{1-\psi}{\alpha}$$

ω : Coefficient taken as:

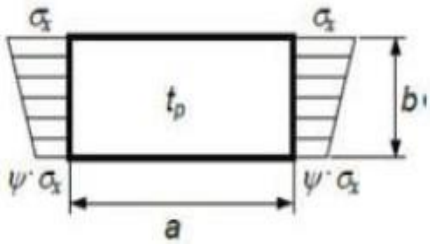
$\omega = \min(3;\alpha)$

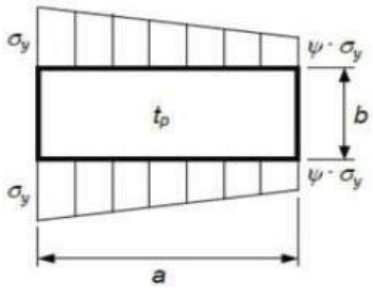
ψ : Edge stress ratio to be taken as: $\psi = \sigma_2/\sigma_1$

σ_1 : Maximum stress, in N/mm²

σ_2 : Minimum stress, in N/mm²

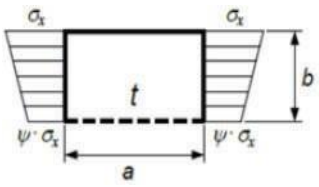
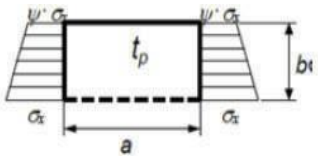
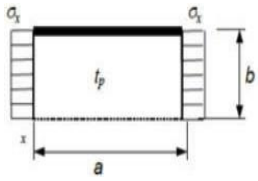
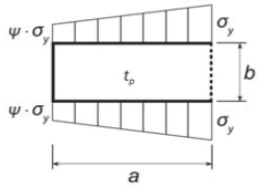
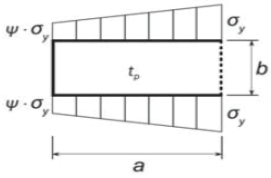
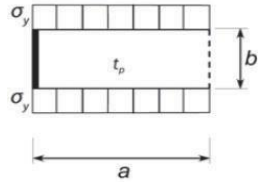
Table 6 : Buckling factor and reduction factor for plane plate panels *(15/4/2019)*

Case	Stress ratio ψ	Aspect ratio α	Buckling factor K	Reduction factor C
1 	$1 \ge \psi \ge 0$		$K_x = F_{long}\frac{8,4}{\psi + 1,1}$	$C_x = 1$ for $\lambda \le \lambda_c$ $C_x = c\left(\frac{1}{\lambda} - \frac{0,22}{\lambda^2}\right)$ for $\lambda > \lambda_c$ where: $c = (1,25 - 0,12\psi) \le 1,25$ $\lambda_c = \frac{c}{2}\left(1 + \sqrt{1 - \frac{0,88}{c}}\right)$
	$0 > \psi > -1$		$K_x = F_{long}[7,63 - \psi(6,26 - 10\psi)]$	
	$\psi \le -1$		$K_x = F_{long}[5,975(1 - \psi)^2]$	
Edge boundary conditions: - - - - - - - - - - Plate edge free ———————— Plate edge simply supported ———————— Plate edge clamped				
(1) Cases listed are general cases. Each stress component (σ_x, σ_y) is to be understood in local coordinates.				

<table>
<tr><th>Case</th><th>Stress ratio
ψ</th><th>Aspect ratio α</th><th>Buckling factor K</th><th>Reduction factor C</th></tr>
<tr><td rowspan="5">2
 
</td><td rowspan="3">$1 \geq \psi \geq 0$</td><td colspan="2">$K_y = \dfrac{2\left(1+\frac{1}{\alpha^2}\right)^2}{1+\psi+\frac{(1-\psi)}{100}\left(\frac{2,4}{\alpha^2}+6,9f_1\right)}$</td><td rowspan="3">$C_y = c\left(\frac{1}{\lambda}-\frac{R+F^2(H-R)}{\lambda^2}\right)$
where:
$c = (1,25 - 0,12\psi) \leq 1,25$

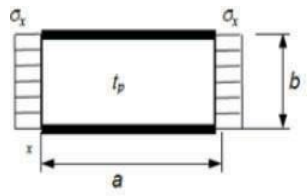
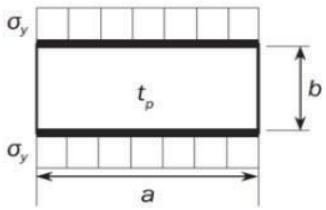
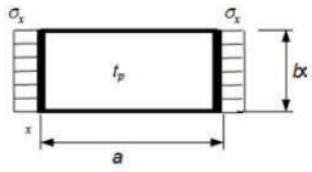
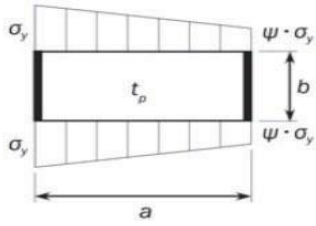
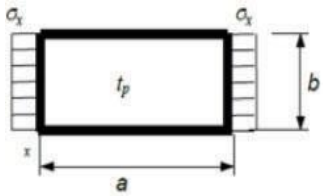
$R = \lambda(1- \lambda/c)$ for $\lambda < \lambda_c$
$R = 0,22$ for $\lambda \geq \lambda_c$
$\lambda_c = 0,5c\left(1+\sqrt{1-\frac{0,88}{c}}\right)$
$F = \left(1-\left(\frac{K}{0,91}-1\right)/\lambda^2\right)c_p \geq 0$
$\lambda^2_p = \lambda^2 - 0,5$ for $1 \leq \lambda^2_p \leq 3$
$c_1 = (1-1/\alpha) \geq 0$
$H = \lambda - \frac{2\lambda}{c(T+\sqrt{T^2-4})} \geq R$
$T = \lambda + \frac{14}{15\lambda} + \frac{1}{3}$</td></tr>
<tr><td>$\alpha \leq 6$</td><td>$f_1 = (1 - \psi)(\alpha - 1)$</td></tr>
<tr><td>$\alpha > 6$</td><td>$f_1 = 0,6\left(1-\frac{6\psi}{\alpha}\right)\left(\alpha+\frac{14}{\alpha}\right)$
but not greater than $14,5 - (0,35 / \alpha^2)$</td></tr>
<tr><td rowspan="4">$0>\psi\geq1-4\alpha/3$</td><td colspan="2">$K = \dfrac{200(1+\beta^2)^2}{(1-1)(100+2,4\beta^2+6,9f+231)}$</td><td rowspan="4"></td></tr>
<tr><td>$\alpha >6(1-\psi)$</td><td>$f_1 = 0,6\left(\frac{1}{\beta}+14\beta\right)$
but not greater than $14,5-0,35\beta^2$
$f_2 = f_3 = 0$</td></tr>
<tr><td>$3(1-\psi) \leq \alpha \leq 6(1-\psi)$</td><td>$f_1 = 1/\beta - 1$
$f_2 = f_3 = 0$</td></tr>
<tr><td>$1,5(1-\psi) \leq \alpha <3(1-\psi)$</td><td>$f_1 = \frac{1}{\beta}-(2-\omega\beta)^4-9(\omega\beta-1)\left(\frac{2}{3}-\beta\right)$
$f_2 = f_3 = 0$</td></tr>
<tr><td colspan="5">Edge boundary conditions:
- - - - - - - - - - Plate edge free
————————— Plate edge simply supported
————————— Plate edge clamped</td></tr>
<tr><td colspan="5">(1) Cases listed are general cases. Each stress component (σ_x, σ_y) is to be understood in local coordinates.</td></tr>
</table>

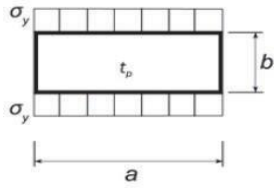
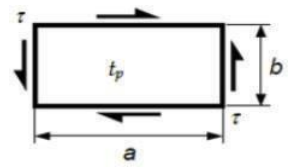
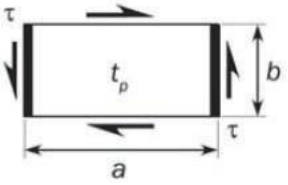
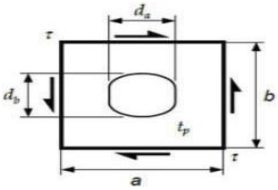
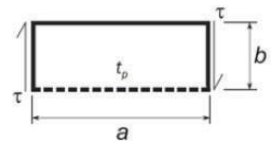
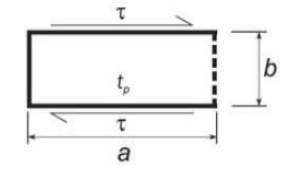
Case	Stress ratio ψ	Aspect ratio α	Buckling factor K	Reduction factor C
		$1-\psi \le \alpha$ <1,5(1-ψ)	For $\alpha > 1,5$: $f_1 = 2\left(\frac{1}{\beta} - 16\left(1 - \frac{\omega}{3}\right)^4\right)\left(\frac{1}{\beta} - 1\right)$ $f_2 = 3\beta - 2$ $f_3 = 0$ For $\alpha \le 1,5$: $f_1 = 2\left(\frac{1,5}{1-\psi} - 1\right)\left(\frac{1}{\beta} - 1\right)$ $f_2 = \frac{\psi(1 - 16f_4^2)}{1-\alpha}$ $f_3 = 0$ $f_4 = (1,5\text{-Min}(1,5;\alpha))^2$	
		0,75(1-ψ) $\le \alpha$ <1-ψ	$f_1 = 0$ $f_2 = 1 + 2,31(\beta - 1) - 48\left(\frac{4}{3} - \beta\right)f_4^2$ $f_3 = 3f_4(\beta - 1)\left(\frac{f_4}{1,81} - \frac{\alpha}{1,31} - \frac{1}{1,31}\right)$ $f_4 = (1,5\text{-Min}(1,5;a))^2$	
	ψ < 1-4α/3	$K_y = 5,972\frac{\beta^2}{1-f_3}$ where: $f_3 = f_5\left(\frac{f_5}{1,81} + \frac{1+3\psi}{5,24}\right)$ $f_5 = \frac{9}{16}(1 + \max(-1;\psi))^2$	
Edge boundary conditions: - - - - - - - - - - Plate edge free ———————— Plate edge simply supported ———————— Plate edge clamped				
(1) Cases listed are general cases. Each stress component (σ_x, σ_y) is to be understood in local coordinates.				

Case	Stress ratio ψ	Aspect ratio α	Buckling factor K	Reduction factor C
3 	$1 \geq \psi \geq 0$		$K_x = \frac{4(0,425 + 1/\alpha^2)}{3\psi + 1}$	$C_x = 1$ for $\lambda \leq 0,7$ $C_x = \frac{1}{\lambda^2 + 0,51}$ for $\lambda > 0,7$
	$0 > \psi \geq -1$		$K_x = 4(0,425 + 1/\alpha^2)(1 + \psi) - 5\psi(1 - 3,42\psi)$	
4 	$1 \geq \psi \geq -1$		$K_x = (0,425 + 1/\alpha^2)\frac{(3 - \psi)}{2}$	
5 		$\alpha \geq 1,64$	$K_x = 1,28$	
		$\alpha < 1,64$	$K_x = (1/\alpha^2) + 0,56 + 0,13\alpha^2$	
6 	$1 \geq \psi \geq 0$		$K_y = \frac{4(0,425 + \alpha^2)}{(3\psi + 1)\alpha^2}$	$C_y = 1$ for $\lambda \leq 0,7$ $C_y = \frac{1}{\lambda^2 + 0,51}$ for $\lambda > 0,7$
	$0 > \psi \geq -1$		$K_y = 4(0,425 + \alpha^2)(1 + \psi)\frac{1}{\alpha^2} - 5\psi(1 - 3,42\psi)\frac{1}{\alpha^2}$	
7 	$1 \geq \psi \geq -1$		$K_y = (0,425 + \alpha^2)\frac{(3 - \psi)}{2\alpha^2}$	
8 	-		$K_y = 1 + \frac{0,56}{\alpha^2} + \frac{0,13}{\alpha^4}$	

Edge boundary conditions:
- - - - - - - - - - Plate edge free
———————— Plate edge simply supported
———————— Plate edge clamped

(1) Cases listed are general cases. Each stress component (σ_x, σ_y) is to be understood in local coordinates.

<table>
<tr><th>Case</th><th>Stress ratio
ψ</th><th>Aspect ratio α</th><th>Buckling factor K</th><th>Reduction factor C</th></tr>
<tr><td>9
 
</td><td>-</td><td colspan="2">$K_x = 6,97$</td><td rowspan="4">$C_x = 1$ for $\lambda \le 0,83$
$C_x = 1,13\left[\frac{1}{\lambda} - \frac{0,22}{\lambda^2}\right]$
for $\lambda > 0,83$</td></tr>
<tr><td>10
 
</td><td>-</td><td colspan="2">$K_y = 4 + \frac{2,07}{\alpha^2} + \frac{0,67}{\alpha^4}$</td></tr>
<tr><td rowspan="2">11
 
</td><td rowspan="2">-</td><td>$\alpha \ge 4$</td><td>$K_x = 4$</td></tr>
<tr><td>$\alpha < 4$</td><td>$K_x = 4 + 2,74\left(\frac{4}{\alpha} - \frac{\alpha}{3}\right)^4$</td></tr>
<tr><td>12
 
</td><td>-</td><td colspan="2">$K_y = K_y$ determined as per case 2</td><td>$C_y = C_{y2}$ for $\alpha < 2$
$C_y = \left(1,06 + \frac{1}{10\alpha}\right) C_{y2}$
for $\alpha \ge 2$
where:
C_{y2}= C_y determined as per case 2</td></tr>
<tr><td rowspan="2">13
 
</td><td rowspan="2">-</td><td>$\alpha \ge 4$</td><td>$K_x = 6,97$</td><td rowspan="2">$C_x = 1$ for $\lambda \le 0,83$
$C_x = 1,13\left[\frac{1}{\lambda} - \frac{0,22}{\lambda^2}\right]$
for $\lambda > 0,83$</td></tr>
<tr><td>$\alpha < 4$</td><td>$K_x = 6,97 + 3,1\left(\frac{4}{\alpha} - \frac{\alpha}{3}\right)^4$</td></tr>
<tr><td colspan="5">Edge boundary conditions:
- - - - - - - - - - Plate edge free
———————— Plate edge simply supported
———————— Plate edge clamped</td></tr>
<tr><td colspan="5">(1) Cases listed are general cases. Each stress component (σ_x, σ_y) is to be understood in local coordinates.</td></tr>
</table>

Case	Stress ratio ψ	Aspect ratio α	Buckling factor K	Reduction factor C
14 	-		$K_y = \frac{6,97}{\alpha^2} + \frac{3,1}{\alpha^2}\left(\frac{4-(1/\alpha)}{3}\right)^4$	$C_y = 1$ for $\lambda \le 0,83$ $C_y = 1,13\left[\frac{1}{\lambda} - \frac{0,22}{\lambda^2}\right]$ for $\lambda > 0,83$
15 	-		$K_\tau = \sqrt{3}\left[5,34 + \frac{4}{\alpha^2}\right]$	$C_\tau = 1$ for $\lambda \le 0,84$ $C_\tau = \frac{0,84}{\lambda}$ for $\lambda > 0,84$
16 	-		$K_\tau = \sqrt{3}\left[5,34 + \mathrm{Max}\left(\frac{4}{\alpha^2};\frac{7,15}{\alpha^{2,5}}\right)\right]$	
17 	-		K = K'r K' = K according to case 15 r = opening reduction factor taken as $r = (1 - d_a/a)(1 - d_b/b)$ with $d_a/a \le 0,7$ and $d_b/b \le 0,7$	
18 	-		$K_\tau = 3^{0,5}(0,6 + 4/\alpha^2)$	$C_\tau = 1$ for $\lambda \le 0,84$ $C_\tau = \frac{0,84}{\lambda}$ for $\lambda > 0,84$
19 	-		$K_\tau = 8$	

Edge boundary conditions:
- - - - - - - - - - Plate edge free
———————— Plate edge simply supported
———————— Plate edge clamped

(1) Cases listed are general cases. Each stress component (σ_x, σ_y) is to be understood in local coordinates.

5.6 Buckling capacity of curved plate panels

5.6.1 Curved plate limit state *(15/4/2019)*

This requirement for curved plate limit state is applicable if R/tp ≤ 2500. Otherwise, the requirement for plate limit state given in [5.5.1] is applicable.

The curved plate limit state is based on the following interaction formula:

$$\left(\frac{\gamma_c \sigma_{cax}}{C_{ax} R_{eH_P}}\right)^{1,25} + \left(\frac{\gamma_c \sqrt{\quad}}{C_\tau R_{eH_P}}\right)^2 = 1$$

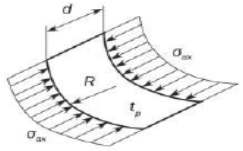
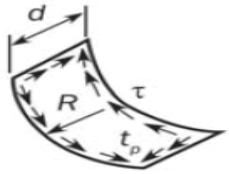
where:

σ_{ax} : Applied axial stress to the cylinder corresponding to the curved plate panel, in N/mm². In case of tensile axial stresses, σ_{ax}=0.

C_{ax} , C_τ : Buckling reduction factor of the curved plate panel, as defined in Tab 7.

The stress multiplier factor γ_c of the curved plate panel needs not be taken less than the stress multiplier factor γ_c for the expanded plane panel according to [5.5.1].

Table 7 : Buckling factor and reduction factor for curved plate panel with R/t_p ≤ 2500 *(15/4/2019)*

Case	Aspect ratio	Buckling factor K	Reduction factor C
1  	$\frac{d}{R} \le 0,5\sqrt{\frac{R}{t_p}}$	$K = 1 + \frac{2 - d^2}{3\sqrt{Rt_p}}$	For general application: $C_{ax} = 1$ for $\lambda \le 0,25$ $C_{ax} = 1,233-0,933\lambda$ for $0,25<\lambda\le1$ $C_{ax} = 0,3/\lambda^3$ for $1 < \lambda \le 1,5$ $C_{ax} = 0,2/\lambda^2$ for $\lambda > 1,5$ For curved single fields, e.g. bilge strake, which are bounded by plane panels: $C_{ax} = 0,65/\lambda^2 \le 1,0$
	$\frac{d}{R} > 0,5\sqrt{\frac{R}{t_p}}$	$K = 0,267\frac{d^2}{\sqrt{Rt_p}}\left(3 - \frac{d}{R}\sqrt{\frac{t_p}{R}}\right) \ge 0,4\frac{d^2}{\sqrt{Rt_p}}$	
2  	$\frac{d}{R} \le 8,7\sqrt{\frac{R}{t_p}}$	$K = \sqrt[3]{28,3 + \frac{0,67d^3}{R^{1,5}t^{1,5}_p}}$	$C_\tau = 1$ for $\lambda \le 0,4$ $C_\tau = 1,274-0,686l$ for $0,4<\lambda\le1,2$ $C_\tau = 0,65/\lambda^2$ for $\lambda > 1,2$
	$\frac{d}{R} > 8,7\sqrt{\frac{R}{t_p}}$	$K = \sqrt[3]{\frac{0,28d^2}{R\sqrt{Rt_p}}}$	
Explanations for boundary of overall stiffened plate ———— Plate edge simply supported			

5.7 Buckling capacity of overall stiffened plate

5.7.1 *(1/7/2016)*

The elastic stiffened panel limit state is based on the following interaction formula:

$$\frac{P_z}{c_f} = 1$$

where P_z and c_f are defined in [5.8.4].

5.8 Buckling capacity of longitudinal stiffeners

5.8.1 Stiffeners limit states *(1/7/2016)*

The buckling capacity of longitudinal stiffeners is to be checked for the following limit states:

- Stiffener induced failure (SI)
- Associated plate induced failure (PI)

5.8.2 Lateral pressure *(1/7/2016)*

The lateral pressure is to be considered as constant in the buckling strength assessment of longitudinal stiffeners.

5.8.3 Stiffener idealization *(15/4/2019)*

a) Effective length of the stiffener ℓ_{eff}

The effective length of the stiffener ℓ_{eff}, in mm, is to be taken equal to:

$\ell_{eff} = \frac{\ell}{\sqrt{3}}$ for stiffener fixed at both ends

$\ell_{eff} = 0{,}75\ell$, for stiffener simply supported at one end and fixed at the other

$\ell_{eff} = \ell$ for stiffener simply supported at both ends

b) Effective width of the attached plating b_{eff1}

The effective width of the attached plating of a stiffener b_{eff1}, in mm, without the shear lag effect is to be taken equal to:

$$b_{eff1} = \frac{C_{x1} b_1 + C_{x2} b_2}{2}$$

where:

C_{x1}, C_{x2}: Reduction factor defined in Tab 6 calculated for the EPP1 and EPP2 on each side of the considered stiffener according to case 1

b_1, b_2 : Width of the plate panel on each side of the considered stiffener, in mm.

c) Effective width of attached plating of stiffeners, b_{eff}, in mm, is to be taken as:

$b_{eff} = \min(b_{eff1}, \chi_s s)$

where:

χ_s : Effective width coefficient to be taken as:

$$\chi_s = \min\left[\frac{1,12}{1 + \frac{1,75}{\left(\frac{\ell_{eff}}{s}\right)^{1,6}}}; 1\right] \quad \text{for} \frac{\ell_{eff}}{s} \geq 1$$

$$\chi_s = 0,407\frac{\ell_{eff}}{s} \quad \text{for} \frac{\ell_{eff}}{s} < 1$$

d) Net thickness of attached plating t_p

The net thickness of plate t_p, in mm, is to be taken as the mean thickness of the two attached plating panels.

e) For accounting the decrease of stiffness due to local lateral deformation, the effective web thickness of flat bar stiffener, in mm, is to be used for the calculation of the net sectional area, A_s, the net section modulus, Z, and the moment of inertia, I, of the stiffener and is taken as:

$$t_{w_red} = t_w\left[1 - \frac{2\pi^2}{3}\left(\frac{h_w}{s}\right)^2\left(1 - \frac{b_{eff1}}{s}\right)\right]$$

f) Net section modulus Z of a stiffener

The net section modulus Z of a stiffener, in cm^3, including effective width of plating b_{eff} is to be taken equal to:

- the section modulus calculated at the top of stiffener flange for stiffener induced failure (SI).
- the section modulus calculated at the attached plating for plate induced failure (PI).

g) Net moment of inertia I of a stiffener

The net moment of inertia I, in cm^4, of a stiffener including effective width of attached plating b_{eff} is to comply with the following requirement:

$$I \geq \frac{st_p^3}{12 \cdot 10^4}$$

h) Idealisation of bulb profile

A bulb section may be taken as equivalent to an angle profile as specified in Pt B, Ch 4, Sec 3, [3.1.2].

5.8.4 Ultimate buckling capacity *(15/4/2019)*

When $\sigma_a + \sigma_b + \sigma_w > 0$, the ultimate buckling capacity for stiffeners is to be checked according to the following interaction formula:

$$\frac{\gamma_c \sigma_a + \sigma_b + \sigma_w}{R_{eH}} = 1$$

where:

σ_a : Nominal axial stress, in N/mm², at mid-span of the stiffener acting on the stiffener with its attached plating, to be obtained from the following formula:

$$\sigma_a = \sigma_x \frac{st_p + A_s}{b_{eff1} t_p + A_s}$$

σ_x : Nominal axial stress, in N/mm², acting on the stiffener with its attached plating, calculated according to [5.3.1] at load calculation point of the stiffener

A_s : Net sectional area, in mm², of the considered stiffener

R_{eH} : Specified minimum yield stress of the material, in N/mm²:

- $R_{eH} = R_{eH_S}$ for stiffener induced failure (SI)
- $R_{eH} = R_{eH_P}$ for plate induced failure (PI)

σ_b : Bending stress in the stiffener, in N/mm², to be obtained from the following formula:

$$\sigma_b = \frac{M_0 + M_1}{Z} 10^{-3}$$

M_1 : Bending moment, in Nmm, due to the lateral load P:

$$M_1 = C_i \frac{|P| s \ell^2}{24} 10^{-3}$$

for continuous stiffener

$$M_1 = C_i \frac{|P| s \ell^2}{8} 10^{-3}$$

for sniped stiffener

P : Lateral load, in kN/m², to be taken equal to the static pressure at the load calculation point of the stiffener

C_i : Pressure coefficient:

$C_i = C_{SI}$ for stiffener induced failure (SI)

$C_i = C_{PI}$ for plate induced failure (PI)

C_{PI} : Plate induced failure pressure coefficient:

$C_{PI} = 1$ if the lateral pressure is applied on the side opposite to the stiffener.

$C_{PI} = -1$ if the lateral pressure is applied on the same side as the stiffener.

C_{SI} : Stiffener induced failure pressure coefficient:

$C_{SI} = -1$ if the lateral pressure is applied on the side opposite to the stiffener.

$C_{SI} = 1$ if the lateral pressure is applied on the same side as the stiffener.

M_0 : Bending moment, in Nmm, due to the lateral deformation w of stiffener:

$$M_0 = F_E \left(\frac{P_z w}{c_f - P_z} \right)$$

with

$$(c_f - P_z) > 0$$

F_E : Ideal elastic buckling force of the stiffener, in N, to be obtained from the following formula:

$$F_E = \left(\frac{\pi}{\ell}\right)^2 EI\, 10^4$$

P_z : Nominal lateral load, in N/mm², acting on the stiffener due to stresses σ_x and τ, in the attached plating in way of the stiffener mid span:

$$P_z = \frac{t_p}{s}\left(\sigma_{x\ell}\left(\frac{\pi s}{\ell}\right)^2 + \sqrt{2}\tau_1\right)$$

$$\sigma_{x\ell} = \gamma_c \sigma_x \left(1 + \frac{A_s}{st_p}\right)$$

but not less than 0

$$\tau_1 = (\gamma_c|\tau|) - t_p\sqrt{R_{eH_P}E\left(\frac{m_1}{\alpha^2} + \frac{m_2}{s^2}\right)}$$

but not less than 0

m_1, m_2 : Coefficients taken equal to:

- $m_1 = 1{,}47$, $m_2 = 0{,}49$ for $\alpha \geq 2$
- $m_1 = 1{,}96$, $m_2 = 0{,}37$ for $\alpha < 2$

w : Deformation of stiffener, in mm, taken equal to:

$w = w_0 + w_1$

w_0 : Assumed imperfection, in mm, taken equal to:

- $w_0 = \ell \cdot 10^{-3}$ in general
- $w_0 = -w_{na}$ for stiffeners sniped at both ends, considering stiffener induced failure (SI)
- $w_0 = w_{na}$ for stiffeners sniped at both ends, considering plate induced failure (PI)

w_{na} : Distance, in mm, from the mid-point of attached plating to the neutral axis of the stiffener calculated with the effective width of the attached plating b_{eff}.

w_1 : Deformation of stiffener at midpoint of stiffener span due to lateral load P, in mm. In case of uniformly distributed load, w_1 is to be taken as:

- in general

$$w_1 = C_i\frac{|P|s\ell^4}{384EI}10^{-7}$$

- for stiffeners sniped at both ends

$$w_1 = C_i\frac{5|P|s\ell^4}{384EI}10^{-7}$$

c_f : Elastic support provided by the stiffener, in N/mm², to be taken equal to:

$$c_f = F_E\left(\frac{\pi}{\ell}\right)^2(1 + c_p)$$

c_p : Coefficient to be taken equal to:

$$c_p = \frac{1}{1 + \frac{0{,}91}{c_{xa}}\left(\frac{12 \cdot I \cdot 10^4}{st_p^3} - 1\right)}$$

c_{xa} : Coefficient to be taken equal as:

$$c_{xa} = \left(\frac{\ell}{2s} + \frac{2s}{\ell}\right)^2 \text{ for } \ell \geq 2s$$

$$c_{xa} = \left(1 + \left(\frac{\ell}{2s}\right)^2\right)^2 \text{ for } \ell < 2s$$

σ_w : Stress due to torsional deformation, in N/mm², to be taken equal to:

- for stiffener induced failure (SI)

$$\sigma_w = E y_w \left(\frac{t_f}{2} + h_w\right) \Phi_0 \left(\frac{\pi}{\ell}\right)^2 \left(1 - \frac{1}{1 - \frac{0,4R}{\sigma_{ET}} eH_S}\right)$$

- for plate induced failure (PI)

$\sigma_w = 0$

y_w : Distance, in mm, from centroid of stiffener cross-section to the free edge of stiffener flange, to be taken as:

- for flat bar

$$y_w = \frac{t_w}{2}$$

- for angle and bulb profiles

$$y_w = b_f - \frac{h_w t_w^2 + t_f b_f^2}{2A_s}$$

- for Tee profile

$$y_w = \frac{b_f}{2}$$

Φ_0 : Coefficient to be taken as:

$$\Phi_0 = \frac{\ell}{h_w} 10^{-3}$$

σ_{ET} : Reference stress for torsional buckling, in N/mm²:

$$\sigma_{ET} = \frac{E}{I_p}\left(\frac{\varepsilon \pi^2 I_\omega}{\ell^2} 10^2 + 0,385 I_T\right)$$

I_p : Net polar moment of inertia of the stiffener about point C as shown in Fig 10, as defined in Tab 8, in cm⁴

I_T : Net St. Venant's moment of inertia of the stiffener, as defined in Tab 8, in cm⁴

I_ω : Net sectional moment of inertia of the stiffener about point C as shown in Fig 10, as defined in Tab 8, in cm⁶

ε : Degree of fixation, to be taken equal to:

$$\varepsilon = 1 + \frac{\left(\frac{\ell}{\pi}\right)^2 10^{-3}}{\sqrt{I_\omega \left(\frac{0,75s}{t_p^3} + \frac{e_f - 0,5t_f}{t_w^3}\right)}}$$

Table 8 : Moments of inertia *(1/7/2016)*

	Flat bars	Bulb, angle and Tee profiles
I_P	$\frac{h_w^3 t_w}{3 \cdot 10^4}$	$\left(\frac{A_w (e_f - 0,5t_f)^2}{3} + A_f e_f^2\right) \cdot 10^{-4}$

Note 1:

A_w : Net web area, in mm²

A_f : Net flange area, in mm²

e_f : Distance from attached plating to centre of flange, in mm, to be taken as:

- $e_f = h_w$ for flat bar profile
- $e_f = h_w - 0,5\ t_f$ for bulbe profile
- $e_f = h_w + 0,5\ t_f$ for angle and Tee profiles

	Flat bars	Bulb, angle and Tee profiles
I_T	$\frac{h_w t_w^3}{3 \cdot 10^4} \cdot \left(1 - 0,63 \frac{t_w}{h_w}\right)$	$\frac{(e_f - 0,5t_f)t_w^3}{3 \cdot 10^4}\left(1 - 0,63 \frac{t_w}{(e_f - 0,5t_f)}\right) + \frac{t_f^3 b_f}{3 \cdot 10^4} \cdot \left(1 - 0,63 \frac{t_f}{b_f}\right)$
I_ω	$\frac{h_w^3 t_w^3}{36 \cdot 10^6}$	For bulb and angle profiles: $\left(\frac{A_f e_f^2 b_f^2}{12 \cdot 10^6}\right) \cdot \frac{A_f + 2,6A_w}{A_f + A_w}$ For Tee profiles: $\left(\frac{b_f^3 t_f e_f^2}{12 \cdot 10^6}\right)$

Note 1:

A_w : Net web area, in mm^2

A_f : Net flange area, in mm^2

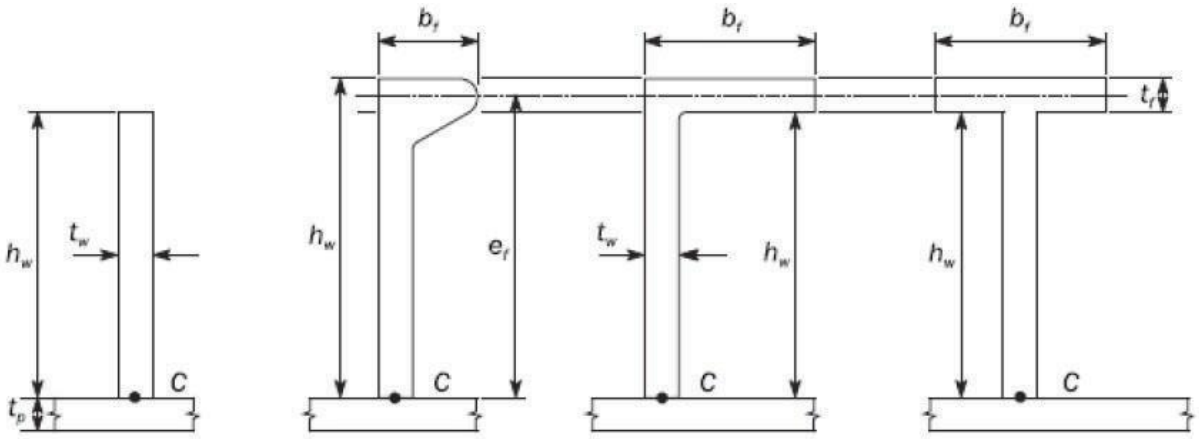
e_f : Distance from attached plating to centre of flange, in mm, to be taken as:

$e_f = h_w$ for flat bar profile

$e_f = h_w - 0,5\ t_f$ for bulbe profile

$e_f = h_w + 0,5\ t_f$ for angle and Tee profiles

Figure 10 : Stiffener cross section *(1/7/2016)*



6 Ultimate strength check

6.1 Hull girder ultimate bending moment

6.1.1 *(1/7/2016)*

The vertical hull girder bending moment, M in hogging and sagging conditions, to be considered in the ultimate strength check is to be taken as:

$$M = \gamma_{s1} M_{SW} + \gamma_{wS1} M_{WV}$$

where:

M_{SW} : Permissible still water bending moment, in kNm defined in [3.3]

M_{WV} : Vertical wave bending moment, in kNm, defined in [3.3]

γ_{s1} : Partial safety factor for the still water bending moment, to be taken as:

$\gamma_{s1} = 1,0$

γ_{w1} : Partial safety factor for the vertical wave bending moment, to be taken as:

$\gamma_{w1} = 1,2$

6.2 Hull girder ultimate bending capacity

6.2.1 General *(1//7/2016)*

The hull girder ultimate bending moment capacity, M_U is defined as the maximum bending moment capacity of the hull girder beyond which the hull structure collapses.

6.2.2 Determination of hull girder ultimate bending moment capacity *(1/7/2016)*

The ultimate bending moment capacities of a hull girder transverse section, in hogging and sagging conditions, are defined as the maximum values of the curve of bending moment M versus the curvature χ of the transverse section considered (M_{UH} for hogging condition and M_{US} for sagging condition, see Fig 11). The curvature χ is positive for hogging condition and negative for sagging condition.

The hull girder ultimate bending moment capacity M_U is to be calculated using the incremental-iterative method as given in Pt B, Ch 6, App 1, [2], using the net thickness approach described in [2.1] for the determination of the geometric properties (I_Y, h_w, t_w, b_f, t_f, A_s, t_p).

As an alternative, a non-linear finite element analysis as indicated in Pt B, Ch 6, App 1, [3] may be used.

6.3 Acceptance criteria

6.3.1 *(1/7/2016)*

The hull girder ultimate bending capacity at any hull transverse section is to satisfy the following criteria:

$$\frac{M_U}{\gamma_M \gamma_{DB}} \geq M$$

where:

M : Vertical bending moment, in kNm, to be obtained as specified in [6.1].

M_U : Hull girder ultimate bending moment capacity, in kNm, to be obtained as specified in [6.2].

γ_M : Partial safety factor for the hull girder ultimate bending capacity, covering material, geometric and strength prediction uncertainties, to be taken as:

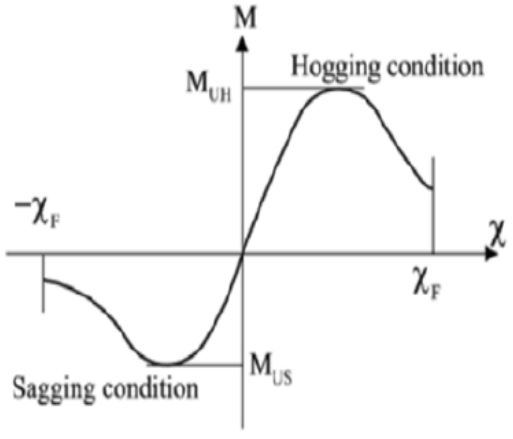
$\gamma_M = 1,05$

γ_{DB} : Partial safety factor for the hull girder ultimate bending moment capacity, covering the effect of double bottom bending, to be taken as:

- For hogging condition: $\gamma_{DB} = 1,15$
- For sagging condition: $\gamma_{DB} = 1,0$

For cross sections where the double bottom breadth of the inner bottom is less than that at amidships or where the double bottom structure differs from that at amidships (e.g. engine room sections), a reduction of factor γ_{DB} for hogging condition may be considered by the Society on a case by case basis.

Figure 11 : Bending moment M versus curvature χ *(1/7/2016)*



6.4 Additional requirements for large container ships

6.4.1 General *(1/7/2017)*

The requirements of this section are applicable to ships with service notation container ship with a breadth B greater than 32,26 m.

6.4.2 Whipping *(1/7/2017)*

Hull girder ultimate strength assessment is to take into consideration the whipping contribution to the vertical bending moment according to the "TASNEEF Guide for whipping and springing assessment".

Chapter 3
LIVESTOCK CARRIERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **livestock carrier**, as defined in Pt A, Ch 1, Sec 2, [4.2.7].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Part A, Part B, Part C and Part D, as applicable and with the requirements of this Chapter, which are specific to livestock carriers.

1.2 Summary table

1.2.1 Tab 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to livestock carriers.

Table 1 *(1/1/2007)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems serving livestock spaces	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for livestock carriers are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 General arrangement design

1.1 Livestock arrangement

1.1.1 The livestock are to be kept in pens. The dimensions of these pens are to be suitable for the livestock carried. In general, the breadth and the length of the pen may not be greater than 4,5 m and 9 m, respectively.

The livestock may not be carried on hatch covers unless the latter are effectively protected.

1.2 Arrangement of spaces dedicated to the carriage of livestock

1.2.1 General

The requirements of this item apply to the arrangement of the spaces dedicated to the carriage of livestock. When deemed necessary by the Society, such spaces may need to be adapted or complemented depending on the species of animals which are to be carried.

1.2.2 Protection of livestock

Arrangements for protecting the livestock from injury, avoidable suffering and exposure to weather, sea or hot parts are to be provided.

1.2.3 Livestock arrangement

Livestock may not be carried, or loaded for carriage, in any part of a ship where the livestock, livestock fittings, livestock equipment or carrying arrangements may:

- obstruct access to any accommodation space or working space necessary for the safe running of the ship, or the means of egress from any hold or underdeck space
- interfere with life-saving or fire-fighting appliances
- interfere with the tank sounding equipment or bilge pumping
- interfere with the operation of closing appliances
- interfere with the operation of freeing ports
- interfere with the lighting or ventilation of other parts of the ships
- interfere with the proper navigation of the ship.

1.3 Means of escape and access

1.3.1 General

In each space in which livestock is carried, not less than two means of escape for persons are to be fitted, widely separated and giving access to an open deck.

Access to livestock space for persons is to be safe. Where it is combined with a ramp used for moving livestock between decks, it is to be separated from the livestock ramp by protective fencing.

1.3.2 Closing arrangement

Pens, stalls and similar fittings are to be provided with a means of access for persons with secure closing arrangement whose structural strength is to be considered by the Society on a case-by-case basis.

1.3.3 Passageway width

If access between a ship side and a pen, stall or similar fitting is required for purposes of safe and proper operation of ship, a passageway not less than 550 mm wide is to be provided between the ship's rail or bulwark and the rails or receptacles of the pen, stall or fitting.

2 Corrosion additions

2.1

2.1.1 General *(1/7/2016)*

In lieu of the values specified in Pt B, Ch 4, Sec 2, [3], the corrosion addition relevant to dry bulk cargo holds intended to carry livestock only is to be taken equal to 0,5 mm.

3 Stability

3.1 Intact stability

3.1.1 General

The stability of the ship for the loading conditions reported in the trim and stability booklet is to be in compliance with the requirements of Pt B, Ch 3, Sec 2.

3.1.2 Additional requirements

Where national or international rules apply, the Society reserves the right to adopt the rules in force in the country in which the ship is registered or in which the ship trades.

4 Hull girder strength

4.1 Application

4.1.1 In general, the decks and platform decks above the strength deck used for the carriage of livestock may not be taken into account for the calculation of the section modulus.

5 Hull scantlings

5.1 Scantlings of plating, ordinary stiffeners and primary supporting members

5.1.1 Movable or collapsible structural elements above the strength deck

In general, the movable or collapsible structural elements above the strength deck used for the stocking and the distribution of livestock on decks or platform decks are not a part of ship classification.

Nevertheless, where the ship's safety may be compromised by lack of strength of these elements, they are to be checked according to the criteria in Part B, Chapter 7 or Part B, Chapter 8, as applicable. In this case, the scantlings of the barriers surrounding each pen are to take into account the loads applied by the livestock as a result of roll and pitch of the ship.

SECTION 3 MACHINERY AND SYSTEMS SERVING LIVESTOCK SPACES

1 General

1.1 Application

1.1.1 The provisions of this Section cover the systems installed on ships having the service notation **livestock carrier** and intended for:

- the supply of food, water and fresh air to the livestock
- the cleaning of the livestock spaces
- the draining of the sewage effluents produced by the livestock.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted for approval.

2 Design of the systems

2.1 General

2.1.1 The piping systems covered by this Section are to be designed, constructed and tested in accordance with the applicable provisions of Pt C, Ch 1, Sec 10.

2.2 Ventilation system

2.2.1 General

Mechanical ventilation is to be provided for the following spaces containing livestock:

- enclosed spaces
- partially closed spaces arranged with pens on more than one deck level and having a breadth greater than 20 m.

2.2.2 Capacity of the mechanical ventilation

The capacity of the mechanical ventilation is not to be less than:

- 20 air changes per hour of each enclosed space
- 15 air changes per hour of each partially closed space,

based on the gross volume of the space, deduced, if possible, from the volume of any tank or trunk within that space.

Note 1: Where the clear height of the space is less than 2,30 m, the Society may require higher air change rates, with a maximum of:

- 30 changes per hour for enclosed spaces
- 22,5 changes per hour for partially closed spaces.

2.2.3 Fans

a) Ventilation circuits are to be supplied by at least two independent fans of such a capacity as to maintain normal ventilation of all the spaces with one fan out of action.

b) Fans driven by electric motors are to be considered as essential auxiliaries. Their electrical supply is to comply with the provisions of Pt C, Ch 2, Sec 3.

2.3 Fodder and fresh water systems

2.3.1 General

a) Spaces intended for livestock are to be provided with receptacles for feeding and watering the animals concerned.

b) The capacity of the receptacles is not to be less than 33% of the daily consumption of the animals concerned, except when the feed system is automatic.

Table 1 : Documents to be submitted

Item No.	Description of the document **(1)**
1	Diagram of the ventilation system, with indication of the gross volume of the enclosed spaces
2	Diagram of storage and distribution systems for fodder and water
3	Diagram of the water cleaning system
4	Diagram of the drainage system
(1) Diagrams are also to include, where applicable: • the (local and remote) control and monitoring systems and automation systems • the instructions for the operation and maintenance of the piping system concerned (for information).	

2.3.2 Fresh water system

a) The fresh water system serving the livestock spaces is to be totally independent from the fresh water system serving the spaces intended for the crew.

b) All livestock spaces are to be provided with fresh water service.

c) The fresh water system is to include at least:
- one main supply pump, of a capacity sufficient to continuously supply fresh water to the livestock
- one standby pump of at least the same capacity.

Note 1: When the water supply system is not automatic, the standby pump may be replaced by a portable pump ready to be connected to at least one fresh water tank.

d) When the water supply is automatic, water receptacles are to be fitted with:
- means of automatic water level control
- devices to avoid the return of water from the receptacle to the fresh water tank.

2.4 Washing system

2.4.1 A water washing system is to be provided with appropriate connections to wash the livestock spaces.

2.5 Drainage system

2.5.1 General

a) Each space intended for the livestock is to be fitted with a pipe or gutter of sufficient size to drain the sewage and the washing effluents.

b) The drainage system serving the livestock spaces is to be independent from any piping system serving the other spaces of the ship, and in particular from the bilge system.

2.5.2 Materials

The pipes and other components of the draining system are to be made of a material resistant to the corrosion due to the effluents.

2.5.3 Draining pipes and discharges

a) Discharges from livestock spaces are to comply with the provisions Pt C, Ch 1, Sec 10, [8].

b) Where necessary, drainage gutters and upper parts of the draining pipes are to be covered by a strainer plate.

c) Draining pipes from livestock spaces are to discharge into a holding tank, wells or overboard.

Note 1: Overboard discharge is subject to the provisions of MARPOL Annex IV - Regulations for the Prevention of Pollution by Sewage. See also Pt F, Ch 7, Sec 1.

d) Means are to be provided to stop the overboard discharge when the ship is in port.

2.5.4 Holding tanks

a) Holding tanks are to be fitted with means to indicate visually the amount of their content.

b) Drainage tanks and wells are to be accessible from outside livestock pens for inspection and cleaning.

2.5.5 Pumps and ejectors

Pumps and ejectors serving the holding tanks or wells are to be capable of conveying semi-solid matter.

Chapter 4
BULK CARRIERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/7/2019)*
Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **bulk carrier ESP** as defined in (Pt A, Ch 1, Sec 2, [4.3.2]), **bulk carrier ESP CSR** (as defined in Pt A, Ch 1, Sec 2, [4.3.3]) and **self-unloading bulk carrier ESP** (as defined in Pt A, Ch 1, Sec 2, [4.3.8]).

1.1.2 *(1/7/2019)*
Ships dealt with in this Chapter are to comply with the applicable requirements stipulated in Part A, Part B, Part C and Part D, and the "Common Structural Rules for Bulk Carriers and Oil Tankers", in addition to the applicable requirements of this Chapter.

1.2 Summary table

1.2.1 *(1/4/2006)*
Tab 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to ships having the notation **bulk carriers ESP**.

1.2.2 *(1/4/2006)*
Tab 2 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to ships having the notation **bulk carrier ESP CSR**.

1.2.3 *(1/7/2019)*
Tab 3 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to ships having the notation **self-unloading bulk carrier ESP**.

Table 1 *(1/4/2006)*

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery	Sec 4
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
Intact stability criteria for grain loading	App 1
(1) No specific requirements for **bulk carriers ESP** are given in this Chapter.	

Table 2 *(1/4/2006)*

Main subject	Reference
Ship arrangement	**(1)**
Hull	**(1)**
Stability	Sec 3, [2]
Machinery	Sec 4
Electrical installations	**(1)**

Main subject	Reference
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
Intact stability criteria for grain loading	App 1
(1) No specific requirements for **bulk carriers ESP CSR** are given in this Chapter.	

Table 3 *(1/7/2019)*

Main subject	Reference
Ship arrangement	**(1)**
Hull	Sec 3, [3], [4], [5]
Stability	**(1)**
Machinery	Sec 4
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
Intact stability criteria for grain loading	App 1
(1) No specific requirements for **self-unloading bulk carriers ESP** are given in this Chapter.	

SECTION 2 SHIP ARRANGEMENT

1 General

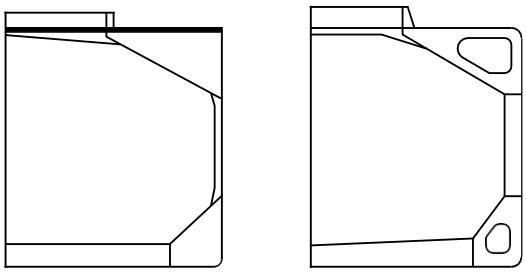
1.1 Application

1.1.1 *(1/4/2006)*
The requirements of this Section apply to ships having notation **bulk carrier ESP**. Typical midship sections are shown in Fig 1.

For the purpose of this Chapter, single side skin bulk carrier means a bulk carrier where one or more cargo holds are bound by the side shell only or by two watertight boundaries, one of which is the side shell, which are less than 1000 mm apart in at least one location. The distance between the watertight boundaries is to be measured perpendicular to the side shell.

The application of these requirements to other ship types is to be considered by the Society on a case-by-case basis.

Figure 1 : Bulk carrier - Single and double side skin construction



2 General arrangement design

2.1 Access arrangement to double bottom and pipe tunnel

2.1.1 Means of access
Adequate means of access to the double bottom and the pipe tunnel are to be provided.

2.1.2 Manholes in the inner bottom, floors and girders
Manholes cut in the inner bottom are to be located at a minimum distance of one floor spacing from the lower stool, or transverse bulkhead if no stool is fitted.

The location and size of manholes in floors and girders are to be determined to facilitate the access to double bottom structures and their ventilation. However, they are to be avoided in the areas where high shear stresses may occur.

2.2 Access arrangement to cargo holds

2.2.1 Means of access
As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds and, in particular, of the lower part of cargo hold side frames.

2.2.2 Hatches of large cargo holds
If separate hatches are used as access to the ladders as required in [2.2.3], each hatch is to have a clear opening of at least 600 mm x 600 mm.

When the access to the cargo hold is arranged through the cargo hatch, the top of the ladder is to be placed as close as possible to the hatch coaming.

Accesses and ladders are to be so arranged that personnel equipped with self-contained breathing apparatus may readily enter and leave the cargo hold.

Access hatch coamings having a height greater than 900 mm are also to have steps on the outside in conjunction with cargo hold ladders.

2.2.3 Ladders within large cargo holds

Each cargo hold is to be provided with at least two ladders as far apart as practicable longitudinally. If possible these ladders are to be arranged diagonally, e.g. one ladder near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side, from the ship's centreline.

Ladders are to be so designed and arranged that the risk of damage from the cargo handling gear is minimised.

Vertical ladders may be permitted provided they are arranged above each other in line with other ladders to which they form access and resting positions are provided at not more than 9 metres apart.

Tunnels passing through cargo holds are to be equipped with ladders or steps at each end of the hold so that personnel may get across such tunnels.

Where it may be necessary for work to be carried out within a cargo hold preparatory to loading, consideration is to be given to suitable arrangements for the safe handling of portable staging or movable platforms.

SECTION 3 HULL AND STABILITY

Symbols

D_1 : Distance, in m, from the base line to the freeboard deck at side amidships (see Fig 13)

h_{DB} : Height, in m, of the double bottom

h_{LS} : Mean height, in m, of the lower stool, measured from the inner bottom

k : Material factor defined in Pt B, Ch 4, Sec 1, [2.3]

t_C : Corrosion addition, in mm, defined in Pt B, Ch 4, Sec 2, Tab 2

ℓ : Span, in m, of side frames; see [3.2.3]

d : Height, in mm, of side frame web; see [3.2.3]

ℓ_C : Span, in m, of the corrugations of vertically corrugated transverse watertight bulkheads; see [3.5.2]

s_C : Spacing of corrugations, in m; see Fig 5

R_{eH} : Minimum upper yield stress, in N/mm^2, of the material as defined in Pt B, Ch 4, Sec 1, [2]

E : Young's modulus, in N/mm^2, to be taken equal to:

- E = 2,06.10^5 N/mm^2 for steels in general
- E = 1,95.10^5 N/mm^2 for stainless steels

ρ_B : Dry bulk cargo density, in t/m^3; the following values may generally be taken:

- ρ_B = 3,0 t/m^3 for iron ore
- ρ_B = 1,3 t/m^3 for cement

φ : Angle of repose, in degrees, of the dry bulk cargo carried; in the absence of more precise evaluation the following values can be taken:

- φ = 30° in general
- φ = 35° for iron ore
- φ = 25° for cement

ρ : Sea water density, in t/m^3

h_F, z_F : Flooding head and distance, respectively, in m, defined in [4.6.3] for transverse bulkheads and [4.7.3] for double bottoms

h_B, z_B : Level height of the dry bulk cargo and distance, respectively, in m, defined in [4.6.4] for transverse bulkheads and [7.2.6] for double bottoms

g : Gravity acceleration, in m/s^2, to be taken equal to 9,81 m/s^2.

1 General

1.1 Application

1.1.1 *(1/4/2006)*

The requirements of this Section apply to ships with the service notation **bulk carrier ESP**.

1.1.2 *(1/4/2006)*

Ships with the service notation **bulk carrier ESP CSR** are to comply with the requirements in [2.1] and [2.2].

1.2 Loading manual and loading instruments

1.2.1 The specific requirements in Pt B, Ch 11, Sec 2 for ships with the service notation **bulk carrier ESP** and equal to or greater than 150 m in length are to be complied with.

2 Stability

2.1 Definitions

2.1.1 Grain

The term grain covers wheat, maize (corn), oats, rye, barley, rice, pulses, seeds and processed forms thereof, whose behaviour is similar to that of grain in its natural state.

2.1.2 Filled compartment trimmed

The term filled compartment trimmed refers to any cargo space in which, after loading and trimming as specified in App 1, the bulk grain is at its highest possible level.

2.1.3 Filled compartment untrimmed

The term filled compartment untrimmed refers to a cargo space which is filled to the maximum extent possible in way of the hatch opening but which has not been trimmed outside the periphery of the hatch opening.

2.1.4 Partially filled compartment

The term partly filled compartment refers to any cargo space where the bulk grain is not loaded in the manner prescribed in [2.1.2] or [2.1.3].

2.1.5 Stowage factor

The term stowage factor, for the purposes of calculating the grain heeling moment caused by a shift of grain, means the volume per unit weight of the cargo as attested by the loading facility, i.e. no allowance is to be made for lost space when the cargo space is nominally filled.

2.1.6 Specially suitable compartment

The term specially suitable compartment refers to a cargo space which is constructed with at least two vertical or sloping, longitudinal, grain-tight divisions which are coincident with the hatch side girders or are so positioned as to limit the effect of any transverse shift of grain. If sloping, the divisions are to have an inclination of not less than 30° to the horizontal.

2.2 Intact stability

2.2.1 General *(1/7/2010)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.5] is to be in compliance with the requirements of Pt B, Ch 3, Sec 2. In addition, for ships engaged in the carriage of grain in bulk, the requirements in [2.2.2] and [2.2.3] are to be complied with.

2.2.2 Grain Loading Manual

Information in printed booklet form is to be provided on board to enable the Master to ensure that the ship complies with the stability requirements reported in the Rules *when carrying grain in bulk.* This booklet is commonly referred to as Grain Loading Manual and *is to include the following information:*

- *ship's particulars*
- *lightship displacement and the vertical distance from the intersection of the moulded base line and midship section to the centre of gravity (KG)*
- *table of liquid free surface corrections*
- *capacities and centres of gravity*
- *curve or table of angle of flooding, where less than 40°, at all permissible displacements*
- *curves or tables of hydrostatic properties suitable for the range of operating drafts*
- *cross curves of stability which are sufficient for the purpose of the requirements in [2.2.3] and which include curves at 12° and 40°*
- *curves or tables of volumes, vertical centres of volumes, and assumed volumetric heeling moments for every hold, filled or partly filled, or combination thereof, including the effects of temporary fittings*
- *tables or curves of maximum permissible heeling moments for varying displacements and varying vertical centres of gravity to allow the Master to demonstrate compliance with* the requirements specified in [2.2.3]
- *loading instructions in the form of notes summarising the requirements of* these Rules
- *a worked example for the guidance of the Master*
- *typical loaded service departure and arrival conditions and, where necessary, intermediate worst service conditions.*

It is recommended that loading conditions should be provided for at least three representative stowage factors.

The Grain Loading Manual may be drawn up in the official language or languages of the Administration of the issuing country; if the language used is neither English nor French, the text is to include a translation into one of these languages.

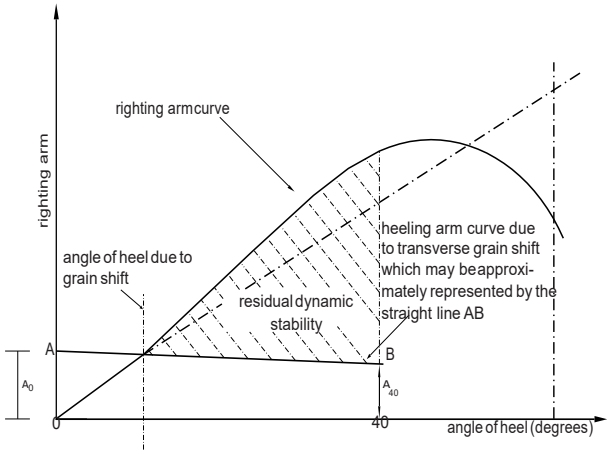
2.2.3 Intact stability criteria for grain loading

The intact stability characteristics of any ship carrying bulk grain are to be shown to meet, throughout the voyage, at least the following criteria after taking into account in the manner described in App 1 and in Fig 2, the heeling moments due to grain shift:

- *the angle of heel due to the shift of grain is to be not greater than 12° or the angle at which the deck edge is immersed, whichever is the lesser*
- *in the statical stability diagram, the net or residual area between the heeling arm curve and the righting arm curve up to the angle of heel of maximum difference between the ordinates of the two curves, or 40° or the angle of flooding, whichever is the least, is in all conditions of loading to be not less than 0,075 m·rad*
- *the initial metacentric height, after correction for the free surface effects of liquids in tanks, as specified in Pt B, Ch 3, Sec 2, [4], is to be not less than 0,30 m.*

After loading, the Master is to ensure that the ship is upright before proceeding to sea.

Figure 1 : Stability curve



3 Structure design principles

3.1 Double bottom structure

3.1.1 Longitudinally framed double bottom

In ships greater than 120 m in length, the double bottom and the sloped bulkheads of hopper tanks are to be longitudinally framed.

The girder spacing is to be not greater than 4 times the spacing of bottom or inner bottom ordinary stiffeners and the floor spacing is to be not greater than 3 frame spaces.

Greater spacing may be accepted by the Society, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

3.1.2 Transversely framed double bottom

The double bottom and the sloped bulkheads of hopper tanks may be transversely framed in ships equal to or less than 120 m in length, when this is deemed acceptable by the Society on a case-by-case basis. In this case, however, the floor spacing is to be not greater than 2 frame spaces.

3.1.3 Floors in way of transverse bulkheads

The thickness and material properties of the supporting floors and pipe tunnel beams are to be not less than those required for the bulkhead plating or, when a stool is fitted, of the stool side plating.

3.2 Single side structure

3.2.1 General

The side within the hopper and topside tanks is, in general, to be longitudinally framed. It may be transversely framed when this is accepted for the double bottom and the deck according to [3.1.2] and [3.4.1], respectively.

3.2.2 Frame spacing *(1/7/2001)*

In general, the frame spacing in cargo holds bounded by the side shell only is to be not greater than the values obtained, in m, from the following formulae:

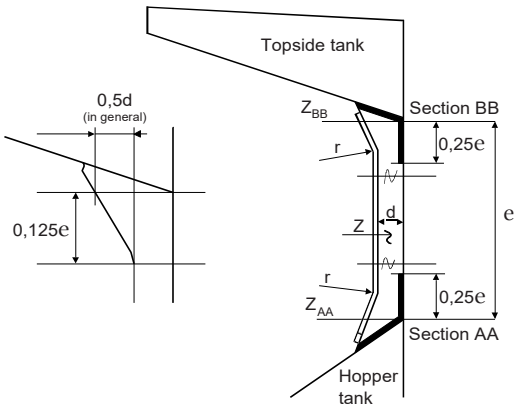
$$s = 0,6 + \frac{L}{320} \qquad \text{for } L < 90\text{m}$$

$$s = 0,9 + 1,25\left(\frac{L}{100}\right)^{0,25} \qquad \text{for } L \geq 90\text{m}$$

3.2.3 Frame span and web height

Frame span ℓ and web height d are to be measured as indicated in Fig 2.

Figure 2 : Frame and end bracket geometry



3.2.4 Symmetrical frame sections

Frames are to be fabricated symmetrical sections with integral upper and lower brackets and are to be arranged with soft toes.

The web depth to thickness ratio is to be not greater than 60 $k^{0,5}$. The outstanding flange is to be not greater than 10 $k^{0,5}$ times the flange thickness. The end of the flange is to be snipped.

The frame flange is to be curved (not knuckled) at the connection with the end brackets. The radius of curvature (see Fig 2) is to be not less than the value obtained, in mm, from the following formula:

$$r = \frac{0,4b_f^2}{t_f}$$

where b_f and t_f are, in mm, the flange width and thickness, respectively.

3.2.5 Asymmetrical frame sections

In ships less than 190 m in length, mild steel frames may be asymmetrical and fitted with overlapped welded brackets. The face plate or flange of the bracket is to be snipped at both ends. Brackets are to be arranged with soft toes.

The web to thickness ratio is to be not greater than 50 $k^{0,5}$. The outstanding flange is to be not greater than 10 $k^{0,5}$ times the flange thickness.

3.2.6 Lower and upper end brackets

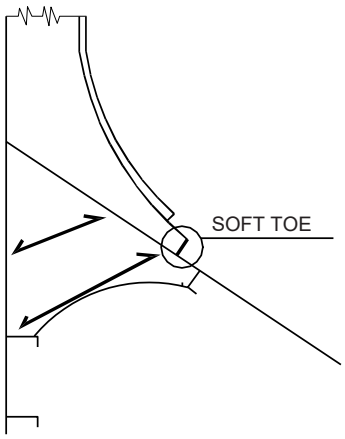
The section modulus of the frame end bracket or integral bracket, calculated, with an attached side plating according to Pt B, Ch 4, Sec 3, [3.3], at the end sections of the span ℓ (sections AA and BB in Fig 2), is to be not less than twice the section modulus required for the frame midspan area according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as applicable.

The dimensions of the lower and upper end brackets are to be not less than those shown in Fig 2.

3.2.7 Connecting brackets within hopper and topside tanks

Structural continuity with the upper and lower end connections of side frames is to be ensured within hopper and topside tanks by connecting brackets as shown in Fig 3.

Figure 3 : Connection with bracket within hopper and topside tanks



3.2.8 Tripping brackets

In way of the foremost cargo hold, side frames of asymmetrical section are to be fitted with sloped tripping brackets every two frames, as shown in Fig 4.

In way of the other holds, side frames of asymmetrical sections are to be fitted with sloped tripping brackets every two frames where the web height d is greater than 600 mm or the span ℓ is greater than 6 m.

3.3 Double side structure

3.3.1 General

The side within the hopper and topside tanks is, in general, to be longitudinally framed. It may be transversely framed when this is accepted for the double bottom and the deck according to [3.1.2] and [3.4.1], respectively.

3.3.2 Side primary supporting members

The spacing of transverse side primary supporting members is to be not greater than 3 frame spaces.

Greater spacing may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

In any case, transverse side primary supporting members are to be fitted in line with web frames in hopper and topside tanks.

3.4 Deck structure

3.4.1 Deck outside the line of hatches and topside tank sloping plates

In ships greater than 120 m in length, the deck outside the line of hatches and the topside tank sloping plates are to be longitudinally framed.

The spacing of web frames in topside tanks is to be not greater than 6 frame spaces.

Greater spacing may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

3.4.2 Deck between hatches

The cross decks between hatches are generally to be transversely framed.

Connection of the strength deck at side with the deck between hatches is to be ensured by a plate of intermediate thickness.

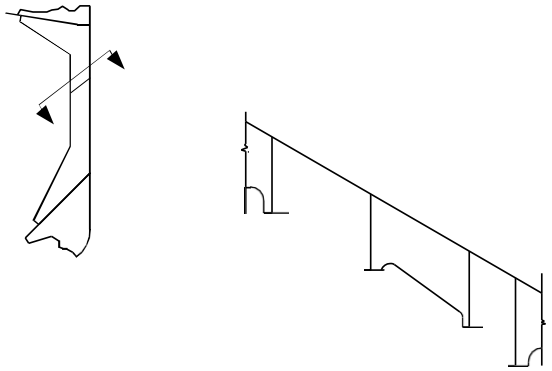
3.4.3 Connection of hatch end beams with deck structures

The connection of hatch end beams with deck structures is to be properly ensured by fitting inside the topside tanks additional web frames or brackets.

3.4.4 Topside tank structure

Topside tank structures are to extend as far as possible within the machinery space and are to be adequately tapered.

Figure 4 : Tripping brackets



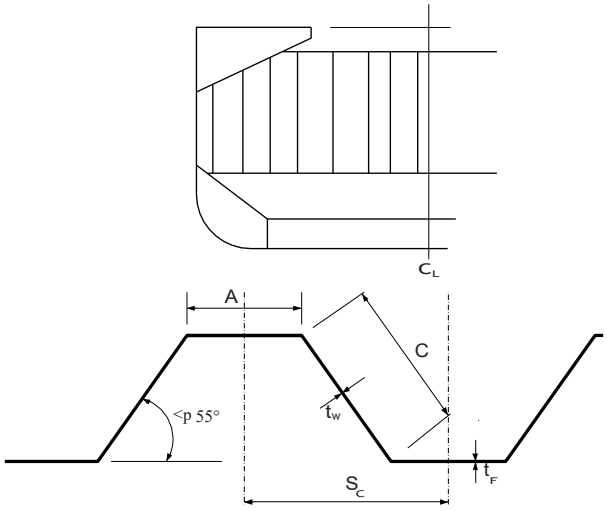
3.5 Transverse vertically corrugated watertight bulkheads

3.5.1 General *(1/7/2004)*

For ships equal to or greater than 190 m in length, transverse vertically corrugated watertight bulkheads are to be fitted with a lower stool and, in general, with an upper stool below the deck. In smaller ships, corrugations may extend from the inner bottom to the deck; if the stool is fitted, it is to comply with the requirements in [3.5.1] to [3.5.5].

The corrugation angle φ shown in Fig 5 is to be not less than 55°.

Figure 5 : Corrugation geometry



The thickness of the lower part of corrugations considered in the application of [3.5.9] and [7.1.3] is to be maintained for a distance from the inner bottom (if no lower stool is fitted) or the top of the lower stool not less than $0,15\ell_C$.

The thickness of the middle part of corrugations considered in the application of [3.5.10] and [7.1.3] is to be maintained for a distance from the deck (if no upper stool is fitted) or the bottom of the upper stool not greater than $0,3\ell_C$.

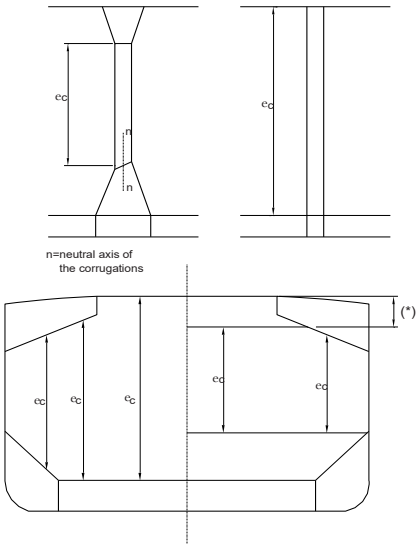
The section modulus of the corrugations in the remaining upper part of the bulkhead is to be not less than 75% of that required for the middle part, corrected for different minimum yield stresses.

3.5.2 Span of corrugations

The span ℓ_C of the corrugations is to be taken as the distance shown in Fig 6. For the definition of ℓ_C, the internal end of the upper stool may not be taken at a distance from the deck at centreline greater than:

- 3 times the depth of corrugations, in general
- twice the depth of corrugations, for rectangular upper stools.

Figure 6 : Span of the corrugations



(*) See [3.5.2].

3.5.3 Lower stool *(1/7/2001)*

The lower stool, when fitted, is to have a height in general not less than 3 times the depth of the corrugations.

The thickness and material of the stool top plate are to be not less than those required for the bulkhead plating above. The thickness and material properties of the upper portion of vertical or sloping stool side plating within the depth equal to the corrugation flange width from the stool top are to be not less than the required flange plate thickness and material to meet the bulkhead stiffness requirement at the lower end of the corrugation.

The ends of stool side ordinary stiffeners are to be attached to brackets at the upper and lower ends of the stool.

The distance from the edge of the stool top plate to the surface of the corrugation flange is to be in accordance with Fig 7.

The stool bottom is to be installed in line with double bottom floors and is to have a width not less than 2,5 times the mean depth of the corrugation.

The stool is to be fitted with diaphragms in line with the longitudinal double bottom girders for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connections to the stool top plate are to be avoided.

Where corrugations are cut at the lower stool, the weld connections of corrugations and stool side plating to the stool top plate are to be in accordance with [12.1]. The weld connections of stool side plating and supporting floors to the inner bottom plating are to be in accordance with [12.1].

3.5.4 Upper stool

The upper stool, when fitted, is to have a height in general between 2 and 3 times the depth of corrugations. Rectangular stools are to have a height in general equal to twice the depth of corrugations, measured from the deck level and at the hatch side girder.

The upper stool is to be properly supported by deck girders or deep brackets between the adjacent hatch end beams.

The width of the upper stool bottom plate is generally to be the same as that of the lower stool top plate. The stool top of non-rectangular stools is to have a width not less than twice the depth of corrugations.

The thickness and material of the stool bottom plate are to be the same as those of the bulkhead plating below. The thickness of the lower portion of stool side plating is to be not less than 80% of that required for the upper part of the bulkhead plating where the same material is used.

The ends of stool side ordinary stiffeners are to be attached to brackets at the upper and lower end of the stool.

The stool is to be fitted with diaphragms in line with and effectively attached to longitudinal deck girders extending to the hatch end coaming girders for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connection to the stool bottom plate are to be avoided.

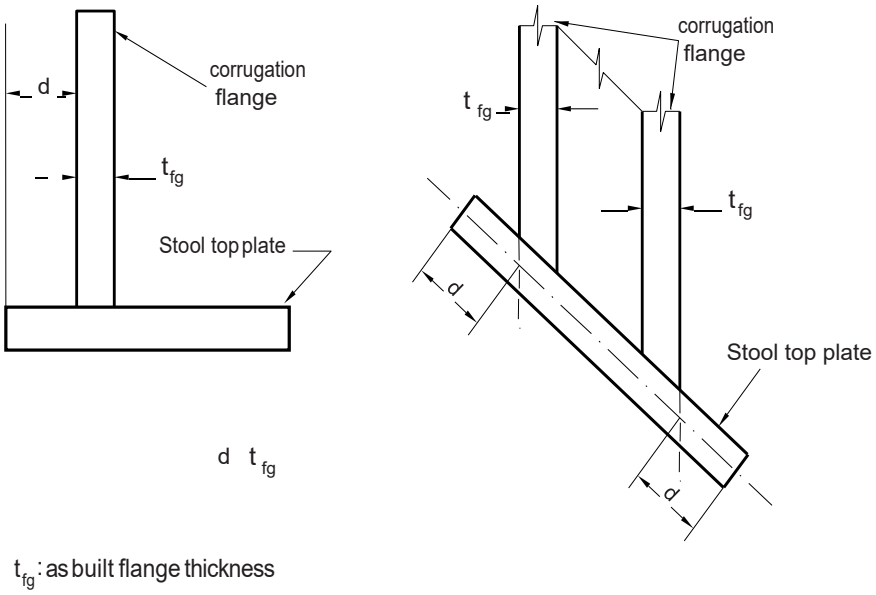
3.5.5 Alignment

At deck, if no upper stool is fitted, two transverse reinforced beams are to be fitted in line with the corrugation flanges.

At bottom, if no lower stool is fitted, the corrugation flanges are to be in line with the supporting floors. The weld connections of corrugations and floors to the inner bottom plating are to be in accordance with [12.1]. The thickness and material properties of the supporting floors are to be not less than those of the corrugation flanges. Moreover, the cut-outs for connections of the inner bottom longitudinals to double bottom floors are to be closed by collar plates. The supporting floors are to be connected to each other by suitably designed shear plates.

Stool side plating is to align with the corrugation flanges; lower stool side vertical stiffeners and their brackets in the stool are to align with the inner bottom longitudinals to provide appropriate load transmission between these stiffening members. Lower stool side plating may not be knuckled anywhere between the inner bottom plating and the stool top plate.

Figure 7 : Permitted distance, d, from the edge of the stool top plate to the surface of the corrugation flange



t_{fg}: as built flange thickness

3.5.6 Effective width of the compression flange

The effective width of the corrugation flange to be considered for the strength check of the bulkhead is to be obtained, in m, from the following formula:

$b_{EF} = C_E A$

where:

C_E : Coefficient to be taken equal to:

$$C_E = \frac{2,25}{\beta} - \frac{1,25}{\beta^2} \quad \text{for } \beta > 1,25$$

$$C_E = 1,0 \quad \text{for } \beta \leq 1,25$$

β : Coefficient to be taken equal to:

$$\beta = 10^3 \frac{A}{t_f} \sqrt{\frac{R_{eH}}{E}}$$

A : Width, in m, of the corrugation flange (see Fig 5)

t_f : Net flange thickness, in mm.

3.5.7 Effective shedder plates

Effective shedder plates are those which:

- are not knuckled
- are welded to the corrugations and the lower stool top plate according to [12.1]
- are fitted with a minimum slope of 45°, their lower edge being in line with the lower stool side plating
- have thickness not less than 75% of that required for the corrugation flanges
- have material properties not less than those required for the flanges.

3.5.8 Effective gusset plates

Effective gusset plates are those which:

- are in combination with shedder plates having thickness, material properties and welded connections according to [3.5.7]
- have a height not less than half of the flange width
- are fitted in line with the lower stool side plating
- are welded to the lower stool plate, corrugations and shedder plates according to [12.1]
- have thickness and material properties not less than those required for the flanges.

3.5.9 Section modulus at the lower end of corrugations

a) The section modulus at the lower end of corrugations (sections 1 in Fig 8 to Fig 12) is to be calculated with the compression flange having an effective flange width b_{ef} not larger than that indicated in [3.5.6].

b) Webs not supported by local brackets.

Except in case e), if the corrugation webs are not supported by local brackets below the stool top plate (or below the inner bottom) in the lower part, the section modulus of the corrugations is to be calculated considering the corrugation webs 30% effective.

c) Effective shedder plates.

Provided that effective shedder plates, as defined in [3.5.7], are fitted (see Fig 8 and Fig 9), when calculating the section modulus of corrugations at the lower end (sections 1 in Fig 8 and Fig 9), the area of flange plates may be increased by the value obtained, in cm^2, from the following formula:

$$I_{SH} = 2{,}5A \sqrt{t_F t_{SH}}$$

without being taken greater than $2{,}5At_F$,

where:

A : Width, in m, of the corrugation flange (see Fig 5)

t_{SH} : Net shedder plate thickness, in mm

t_F : Net flange thickness, in mm.

Figure 8 : Symmetrical shedder plates

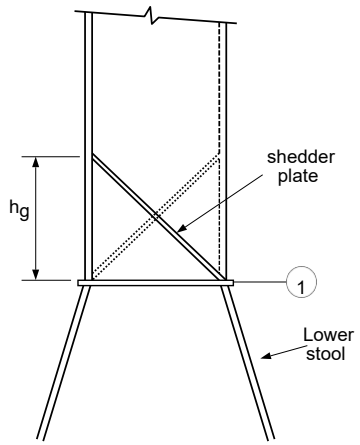
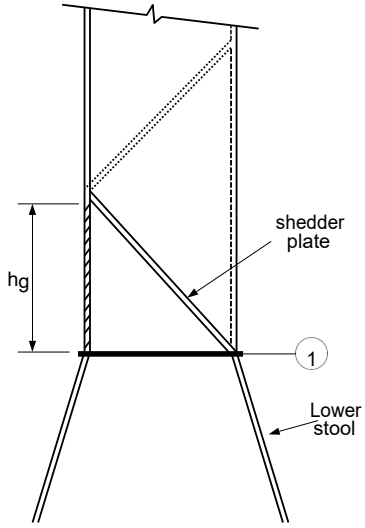


Figure 9 : Asymmetrical shedder plates



d) Effective gusset plates.

Provided that effective gusset plates, as defined in [3.5.8], are fitted (see Fig 10 to Fig 12), when calculating the section modulus of corrugations at the lower end (cross-sections 1 in Fig 10 to Fig 12), the area of flange plates may be increased by the value obtained, in cm^2, from the following formula:

$I_G = 7 h_G t_F$

where:

h_G : Height, in m, of gusset plates (see Fig 10 to Fig 12), to be taken not greater than $(10/7)S_{GU}$

S_{GU} : Width, in m, of gusset plates

t_F : Net flange thickness, in mm, based on the as-built condition.

Figure 10 : Symmetrical gusset/shedder plates

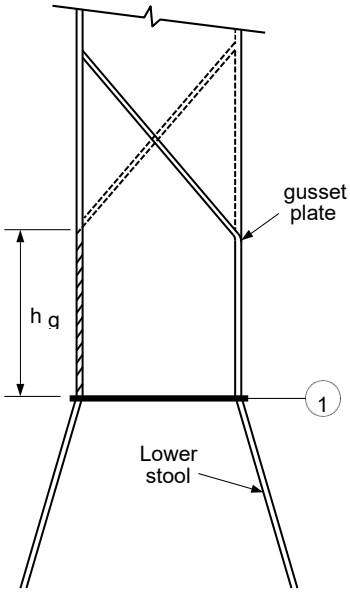
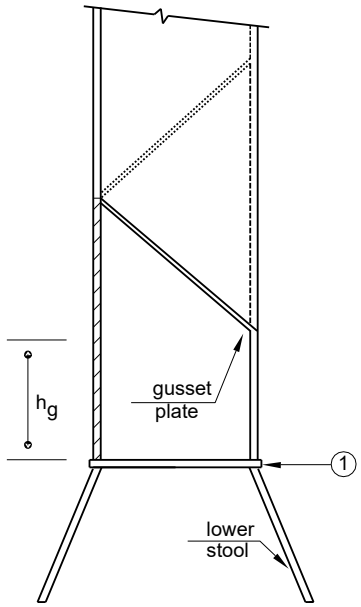


Figure 11 : Asymmetrical gusset/shedder plates

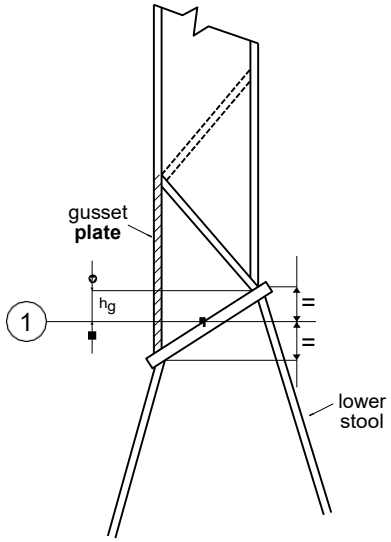


e) Sloping stool top plate

If the corrugation webs are welded to a sloping stool top plate which has an angle not less than 45° with the horizontal plane, the section modulus of the corrugations may be calculated considering the corrugation webs fully effective. For angles less than 45°, the effectiveness of the web may be obtained by linear interpolation between 30% for 0° and 100% for 45°.

Where effective gusset plates are fitted, when calculating the section modulus of corrugations the area of flange plates may be increased as specified in d) above. No credit may be given to shedder plates only.

Figure 12 : Asymmetrical gusset/shedder plates
Sloping stool top plate



3.5.10 Section modulus at sections other than the lower end of corrugations

The section modulus is to be calculated with the corrugation webs considered effective and the compression flange having an effective flange width, b_{EF}, not larger than that obtained in [3.5.6].

3.5.11 Shear area

The shear area is to be reduced in order to account for possible non-perpendicularity between the corrugation webs and flanges. In general, the reduced shear area may be obtained by multiplying the web sectional area by (sin φ), φ being the angle between the web and the flange (see Fig 5).

4 Design loads

4.1 Hull girder loads

4.1.1 Application *(1/7/2003)*

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1.2], still water loads are to be calculated for the loading conditions specified in [4.2] and in [4.3].

For the purpose of applying the requirements in [4.2] and in [4.3], maximum draught is to be taken as moulded summer load line draught.

4.1.2 General *(1/7/2003)*

A bulk carrier may in actual operation be loaded differently from the design loading conditions specified in the loading manual, provided that limitations for longitudinal and local strength as defined in the loading manual and loading instrument on board and applicable stability requirements are not exceeded.

4.1.3 Departure and arrival conditions *(1/7/2003)*

Unless otherwise specified, each of the design loading conditions defined in [4.2] and in [4.3] is to be investigated for the arrival and departure conditions, defined as:

- Departure condition: with bunker tanks not less than 95% full and other consumables 100%
- Arrival condition: with 10% of consumables.

4.2 Hull girder loads in cargo loaded conditions

4.2.1 Still water loads for ships with additional service feature BC-C *(1/7/2003)*

Still water hull girder loads are to be calculated in homogeneous cargo loaded condition, where the cargo density corresponds to all cargo holds, including hatchways, being 100% full at maximum draught with all ballast tanks empty.

4.2.2 Still water loads for ships with additional service feature BC-B *(1/7/2003)*

Still water hull girder loads are to be calculated in the following loading conditions:

- homogeneous cargo loaded condition, as specified in [4.2.1]
- homogeneous cargo loaded condition with cargo density 3,0 t/m^3, and the same filling rate (cargo mass/hold cubic capacity) in all cargo holds at maximum draught with all ballast tanks empty.

  In cases where the cargo density applied for this design loading condition is less than 3,0 t/m^3, the maximum density of the cargo that the vessel is allowed to carry is to be indicated with the additional service feature **maximum cargo density** (in t/m^3).

4.2.3 Still water loads for ships with additional service feature BC-A *(1/7/2003)*

Still water hull girder loads are to be calculated in the following loading conditions:

- homogeneous cargo loaded conditions, as specified in [4.2.2]
- at least one cargo loaded condition with specified holds empty, with cargo density 3,0 t/m^3, and the same filling rate (cargo mass/hold cubic capacity) in all loaded cargo holds at maximum draught with all ballast tanks empty.

  The combination of specified empty holds is to be indicated with the additional service feature **allowed combination of specified empty holds**.

  In such cases where the design cargo density applied is less than 3,0 t/m^3, the maximum density of the cargo that the vessel is allowed to carry is to be indicated within the annotation, e.g. additional service feature **allowed combination of specified empty holds, with maximum cargo density** (in t/m^3).

4.2.4 Partly filled ballast tanks in cargo loaded conditions *(1/7/2003)*

For cargo loading conditions involving partially filled peak and/or other ballast tanks, the requirements specified in Pt B, Ch 5, Sec 2, [2.1.2], b) apply to the peak tanks only.

4.3 Hull girder loads in ballast conditions

4.3.1 Ballast tank capacity and disposition *(1/7/2003)*

All bulk carriers are to have ballast tanks of sufficient capacity and so disposed as to fulfil the following requirements in [4.3.2] and in [4.3.3].

4.3.2 Normal ballast condition *(1/7/2003)*

Still water hull girder loads are to be calculated for normal ballast condition. Normal ballast condition is a ballast (no cargo) condition where:

- the ballast tanks may be full, partially full or empty. Where the partially full option is exercised, the requirements in Pt B, Ch 5, Sec 2, [2.1.2], b) are to be complied with
- any cargo hold or holds adapted for the carriage of water ballast at sea are empty
- the propeller is fully immersed, and
- the trim is by the stern and does not exceed $0{,}015L_{LL}$, where L_{LL} is the length between perpendiculars of the ship, defined in Pt B, Ch 1, Sec 2, [3.2].

In the assessment of the propeller immersion and trim, the draughts at the forward and aft perpendiculars may be used.

In addition to the requirements specified above, still water hull girder loads are to be calculated by considering a condition with all ballast tanks 100 % full.

4.3.3 Heavy ballast condition *(1/7/2003)*

Still water hull girder loads are to be calculated for heavy ballast condition. Heavy ballast condition is a ballast (no cargo) condition where:

a) the ballast tanks may be full, partially full or empty. Where the partially full option is exercised, the requirements in Pt B, Ch 5, Sec 2, [2.1.2], b) are to be complied with,

b) at least one cargo hold adapted for carriage of water ballast at sea, where required or provided, is full

c) the propeller immersion I/D is to least 60% where:
   - I = the distance from propeller centreline to the waterline
   - D = propeller diameter

d) the trim is by the stern and does not exceed $0{,}015L_{LL}$, where L_{LL} is the length between perpendiculars of the ship, defined in Pt B, Ch 1, Sec 2, [3.2]

e) the moulded forward draught in the heavy ballast condition is not less than the lesser of 0,03L or 8 m.

In addition to the requirements specified above, still water hull girder loads are to be calculated for a condition with all ballast tanks 100 % full and one cargo hold adapted and designated for the carriage of water ballast at sea, where provided, 100 % full; where more than one hold is adapted and designated for the carriage of water ballast at sea, two or more holds are not required to be assumed 100 % full simultaneously in the still water hull girder load calculation, except where this is expected in the heavy ballast condition. Unless each hold is individually investigated, the designated heavy ballast hold and any/all restrictions for the use of other ballast hold(s) are to be indicated in the loading manual.

4.4 Hull girder loads in flooded conditions of bulk carriers equal to or greater than 150m in length

4.4.1 Application *(1/7/2014)*

These requirements apply, in addition to those in Pt B, Ch 6, Sec 2, to bulk carriers of 150 m in length and upwards, intending to carry solid bulk cargoes having a density of 1,0 t/m^3 or above, and with:

a) Single side skin construction, or

b) Double side skin construction in which any part of the longitudinal bulkhead is located within B/5 or 11,5 m, whichever is less, inboard from the ship's side at right angles to the centreline at the assigned summer load line.

4.4.2 Flooding assumptions *(1/7/2019)*

Each cargo hold is to be considered individually flooded up to the equilibrium waterline. This application is to be applied to self-unloading bulk carriers where the unloading system maintains the watertightness during seagoing operations. In self-unloading bulk carriers with unloading systems that do not maintain watertightness, the longitudinal strength the flooded conditions are to be considered using the extent to which the flooding may occur.

In calculating the weight of ingressed water, the following assumptions are to be made.

Appropriate permeabilities and bulk densities are to be used for any cargo carried. For iron ore, a minimum permeability of 0,3 with a corresponding bulk density of 3,0 t/m^3 is to be used. For cement, a minimum permeability of 0,3 with a corresponding bulk density of 1,3 t/m^3 is to be used. In this respect, “permeability” for dry bulk cargo means the ratio of the floodable volume between the particles, granules or any larger pieces of the cargo, to the gross volume of the bulk cargo.

The permeability of empty cargo spaces and volume left in loaded cargo spaces above any cargo is to be taken equal to 0,95.

For packed cargo conditions (such as in the case of steel mill products), the actual density of the cargo is to be used with a permeability of zero.

4.4.3 Still water hull girder loads *(1/7/2003)*

The still water loads in flooded conditions are to be calculated for each of the cargo and ballast conditions considered in the intact longitudinal strength calculations, as specified in [4.1], [4.2] and [4.3].

4.4.4 Wave hull girder loads *(1/7/2003)*

The wave loads in flooded conditions are to be assumed to be equal to 80% of those defined in Pt B, Ch 5, Sec 2, [3.1].

4.5 Internal pressures and forces due to dry bulk cargoes

4.5.1 Application *(1/7/2003)*

The requirements in [4.5] apply for the evaluation of the cargo mass to be considered for calculating still water and wave pressures and forces due to dry bulk cargoes.

4.5.2 Definitions *(1/7/2003)*

The maximum allowable or minimum required cargo mass in a cargo hold, or in two adjacently loaded holds, is related to the net load on the double bottom. The net load on the double bottom is a function of draft, cargo mass in the cargo hold, as well as the mass of fuel oil and ballast water contained in double bottom tanks.

The following definitions apply:

M_H : the actual cargo mass in a cargo hold corresponding to a homogeneously loaded condition at maximum draught.

M_{Full} : the cargo mass in a cargo hold corresponding to cargo with virtual density (homogeneous mass/hold cubic capacity, minimum 1,0 t/m^3) filled to the top of the hatch coaming. M_{Full} is in no case to be less than M_H.

M_{HD} : the maximum cargo mass allowed to be carried in a cargo hold according to design loading condition(s) with specified holds empty at maximum draft.

4.5.3 General conditions applicable for all ships *(1/7/2003)*

Any cargo hold is to be capable of carrying M_{Full} with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at maximum draught.

Any cargo hold is to be capable of carrying minimum 50% of M_H, with all double bottom tanks in way of the cargo hold being empty, at maximum draught.

Any cargo hold is to be capable of being empty, with all double bottom tanks in way of the cargo hold being empty, at the deepest ballast draught.

4.5.4 Condition applicable for all notations, except when the ship is assigned with the additional service feature no MP *(1/7/2003)*

Any cargo hold is to be capable of carrying M_{Full} with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of maximum draught.

Any cargo hold is to be capable of being empty with all double bottom tanks in way of the cargo hold being empty, at 83% of maximum draught.

Any two adjacent cargo holds are to be capable of carrying M_{Full} with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of the maximum draught. This requirement for the mass of cargo and fuel oil in double bottom tanks in way of the cargo hold also applies to the condition where the adjacent hold is filled with ballast, if applicable.

Any two adjacent cargo holds are to be capable of being empty, with all double bottom tanks in way of the cargo hold being empty, at 75% of maximum draught.

4.5.5 Additional conditions applicable to ship with additional service feature BC-A only *(1/7/2003)*

Cargo holds, which are intended to be empty at maximum draught, are to be capable of being empty with all double bottom tanks in way of the cargo hold also being empty.

Cargo holds, which are intended to be loaded with high density cargo, are to be capable of carrying M_{HD} plus 10% of M_H, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in

the double bottom being empty in way of the cargo hold, at maximum draught. In operation the maximum allowable cargo mass is to be limited to M_{HD}.

Any two adjacent cargo holds which, according to a design loading condition, may be loaded with the next holds being empty, are to be capable of carrying 10% of M_H in each hold in addition to the maximum cargo load according to that design loading condition, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at maximum draught. In operation the maximum allowable mass is to be limited to the maximum cargo load according to the design loading conditions.

4.5.6 Additional conditions applicable for ballast holds only *(1/7/2003)*

Cargo holds which are designed as ballast water holds are to be capable of being 100% full of ballast water including hatchways, with all double bottom tanks in way of the cargo hold being 100% full, at any heavy ballast draught. For ballast holds adjacent to topside wing, hopper and double bottom tanks, it is strengthwise acceptable that the ballast holds are filled when the topside wing, hopper and double bottom tanks are empty.

4.5.7 Additional conditions applicable during loading and unloading in harbour only *(1/7/2003)*

Any single cargo hold is to be capable of holding the maximum allowable seagoing mass at 67% of maximum draught, in harbour condition.

Any two adjacent cargo holds are to be capable of carrying M_{Full}, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of maximum draught, in harbour condition.

At reduced draught during loading and unloading in harbour, the maximum allowable mass in a cargo hold may be increased by 15% of the maximum mass allowed at the maximum draught in seagoing condition, but may not exceed the mass allowed at maximum draught in the seagoing condition. The minimum required mass may be reduced by the same amount.

4.5.8 Hold mass curves *(1/7/2003)*

Based on the design loads for local strength, as specified in [4.5.1] to [4.5.7], except [4.5.6], hold mass curves are to be included in the loading manual and the loading instrument, showing maximum allowable and minimum required mass as a function of draught, in seagoing condition as well as during loading and unloading in harbour (See Pt B, Ch 11, Sec 2).

At draughts other than those specified in the design loading conditions above, the maximum allowable and minimum required mass are to be adjusted for the change in buoyancy acting on the bottom. Change in buoyancy is to be calculated using water plane area at each draught.

Hold mass curves for each single hold, as well as for any two adjacent holds, are to be included.

4.6 Local loads in flooding conditions on transverse vertically corrugated watertight bulkheads of bulk carriers equal to or greater than 150 m in length

4.6.1 Application *(1/7/2014)*

These requirements apply, in lieu of those in Pt B, Ch 5, Sec 6, [9], to all bulk carriers with transverse vertically corrugated watertight bulkheads and which are of 150 m in length and upwards, intending to carry solid bulk cargoes having a density of 1,0 t/m^3 or above, and with:

a) Single side skin construction, or

b) Double side skin construction in which any part of the longitudinal bulkhead is located within B/5 or 11,5 m, whichever is less, inboard from the ship's side at right angles to the centreline at the assigned summer load line.

Each cargo hold is to be considered individually flooded.

4.6.2 General *(1/7/2019)*

The loads to be considered as acting on each bulkhead are those given by the combination of those induced by cargo loads with those induced by the flooding of one hold adjacent to the bulkhead under examination. In any case, the pressure due to the flooding water alone is to be considered.

This application is to be applied to self-unloading bulk carriers where the unloading system maintains the watertightness during seagoing operations. In self-unloading bulk carriers with unloading systems that do not maintain watertightness, the combination loads acting on the bulkheads in the flooded conditions are to be considered using the extent to which the flooding may occurs.

The most severe combinations of cargo induced loads and flooding loads are to be used for the check of the scantlings of each bulkhead, depending on the loading conditions included in the loading manual:

- homogeneous loading conditions
- non-homogeneous loading conditions,

considering the individual flooding of both loaded and empty holds.

For the purpose of this item, homogeneous loading condition means a loading condition in which the ratio between the highest and the lowest filling ratio, evaluated for each hold, does not exceed 1,20, to be corrected for different cargo densities.

Non-homogeneous part loading conditions associated with multiport loading and unloading operations for homogeneous loading conditions need not be considered according to these requirements.

The specified design load limits for the cargo holds are to be represented by loading conditions defined by the Designer in the loading manual.

For the purpose of this item, holds carrying packed cargoes are to be considered as empty holds for this application.

Unless the ship is intended to carry, in non-homogeneous conditions, only iron ore or cargo having bulk density equal to or greater than 1,78 t/m^3, the maximum mass of cargo which may be carried in the hold is also to be considered to fill that hold up to the upper deck level at centreline.

4.6.3 Flooding head

The flooding head h_F (see Fig 13) is the distance, in m, measured vertically with the ship in the upright position, from the calculation point to a level located at a distance z_F, in m, from the base line equal to:

- in general:
  - D_1 for the foremost transverse corrugated bulkhead
  - $0,9D_1$ for other bulkheads;

  where the ship is to carry cargoes having bulk density less than 1,78 t/m^3 in non-homogeneous loading conditions, the following values may be assumed:
  - $0,95D_1$ for the foremost transverse corrugated bulkhead
  - $0,85D_1$ for other bulkheads
- for ships less than 50000 t deadweight with type B freeboard:
  - $0,95D_1$ for the foremost transverse corrugated bulkhead
  - $0,85D_1$ for other bulkheads;

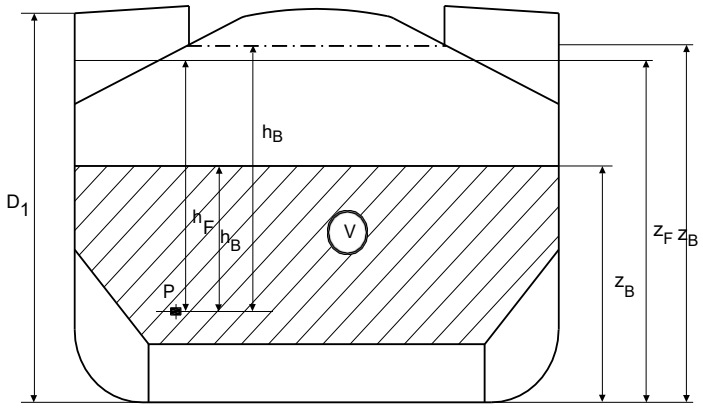
  where the ship is to carry cargoes having bulk density less than 1,78 t/m^3 in non-homogeneous loading conditions, the following values may be assumed:
  - $0,9D_1$ for the foremost transverse corrugated bulkhead
  - $0,8D_1$ for other bulkheads.

4.6.4 Level height of the dry bulk cargo

The level height of the dry bulk cargo h_B, is the vertical distance, in m, from the calculation point to the horizontal plane corresponding to the level height of the cargo, located at a distance z_B (see Fig 13), from the base line.

In the absence of more precise information, z_B may be obtained according to Pt B, Ch 5, Sec 6, [3.1.2].

Figure 13 : Transverse bulkheads - Flooding head and level height of the dry bulk cargo



V=Volume of cargo
P=Calculation point

4.6.5 Pressures and forces on a corrugation in non-flooded bulk cargo loaded holds

At each point of the bulkhead, the pressure is to be obtained, in kN/m^2, from the following formula:

$$p_B = \rho_B g z_B \tan^2\left(45 - \frac{\varphi}{2}\right)$$

The force acting on a corrugation is to be obtained, in kN, from the following formula:

$$F_B = \rho_B g s_C \frac{(z_B - h_{DB} - h_{LS})^2}{2} \tan^2\left(45 - \frac{\varphi}{2}\right)$$

4.6.6 Pressures and forces on a corrugation in flooded bulk cargo loaded holds

Two cases are to be considered, depending on the values of z_F and z_B (see [4.6.3] and [4.6.4]):

- $z_F \geq z_B$

  At each point of the bulkhead located at a distance between z_B and z_F from the base line, the pressure, in kN/m^2, is to be obtained from the following formula:

  $$p_{B,F} = \rho g h_F$$

  At each point of the bulkhead located at a distance lower than z_B from the base line, the pressure, in kN/m^2, is to be obtained from the following formula:

  $$p_{B,F} = \rho g h_F + [\rho_B - \rho(1 - perm)] g h_B \tan^2\left(45 - \frac{\varphi}{2}\right)$$

  where perm is the permeability of cargo, to be taken as 0,3 for iron ore, coal cargoes and cement.

  The force acting on a corrugation is to be obtained, in kN, from the following formula:

  $$F_{B,F} = s_C \left[\rho g \frac{(z_B - z_F)^2}{2} + \frac{\rho g (z_B - z_F) + (p_B)_{B,F\,LE}}{2} (z_{DB} - h_{LS})\right]$$

  where $(p_{B,F})_{LE}$ is the pressure $p_{B,F}$, in kN/m^2, calculated at the lower edge of the corrugation.

- $z_F < z_B$

  At each point of the bulkhead located at a distance between z_F and z_B from the base line, the pressure is to be obtained, in kN/m^2, from the following formula:

  $$p_{B,F} = \rho_B g z_B \tan^2\left(45 - \frac{\varphi}{2}\right)$$

  At each point of the bulkhead located at a distance lower than z_F from the base line, the pressure is to be obtained, in kN/m^2, from the following formula:

  $$p_{B,F} = \rho g h_F + [\rho_B h_B - \rho (1\text{-}perm) h_F] g \tan^2\left(45 - \frac{\varphi}{2}\right)$$

  where perm is the permeability of cargo, to be taken as 0,3 for iron ore, coal cargoes and cement.

  The force acting on a corrugation is to be obtained, in kN, from the following formula:

$$F_{B,F} = s_C\left[\rho_B g \frac{(z_B - z_F)^2}{2} \tan^2\left(45 - \frac{\varphi_F}{2}\right)\right] + s_C\left[\frac{\rho_B g(z_B - z_F)\tan^2\left(45 - \frac{\varphi}{2}\right) + (p_{B,F})_{LE}}{2}(z_F - h_{DB} - h_{LS})\right]$$

where $(p_{B,F})_{LE}$ is the pressure $p_{B,F}$, in kN/m^2, calculated at the lower edge of the corrugation.

4.6.7 Pressures and forces on a corrugation in flooded empty holds

At each point of the bulkhead, the still water pressure induced by the flooding head h_F to be considered is to be obtained, in kN/m^2, from the following formula:

$$p_F = \rho g h_F$$

The force acting on a corrugation is to be obtained, in kN, from the following formula:

$$F_F = s_C \rho g \frac{(z_F - h_{DB} - h_{LS})^2}{2}$$

4.6.8 Resultant pressures and forces

Resultant pressures and forces to be calculated for homogeneous and non-homogeneous loading conditions are to be obtained according to the following formulae:

- Homogeneous loading conditions

  At each point of the bulkhead structures, the resultant pressure to be considered for the scantlings of the bulkhead is to be obtained, in kN/m^2, from the following formula:

  $$p = p_{B,F} - 0{,}8p_B$$

  The resultant force acting on a corrugation is to be obtained, in kN, from the following formula:

  $$F = F_{B,F} - 0{,}8F_B$$

  where:

  p_B : Pressure in the non-flooded holds, in kN/m^2, to be obtained as specified in [4.6.5]

  $p_{B,F}$: Pressure in the flooded holds, in kN/m^2, to be obtained as specified in [4.6.6]

  $F_{B,F}$: Force acting on a corrugation in the flooded holds, in kN, to be obtained as specified in [4.6.6].

- Non-homogeneous loading conditions

  At each point of the bulkhead structures, the resultant pressure to be considered for the scantlings of the bulkhead is to be obtained, in kN/m^2, by the following formula:

  $$p = p_{B,F}$$

  The resultant force acting on a corrugation is to be obtained, in kN, by the following formula:

  $$F = F_{B,F}$$

  where:

  $p_{B,F}$: Pressure in the flooded holds kN/m^2, to be obtained as specified in [4.6.6]

  $F_{B,F}$: Force acting on a corrugation in the flooded holds kN/m^2, to be obtained as specified in [4.6.6].

4.6.9 Bending moment, shear force and shear stresses in a corrugation

The design bending moment in a corrugation is to be obtained, in kN.m, from the following formula:

$$M = \frac{F\ell_C}{8}$$

where F is the resultant force, in kN, to be calculated according to [4.6.8].

The design shear force in a corrugation is to be obtained, in kN, from the following formula:

$$Q = 0{,}8F$$

The shear stresses in a corrugation are to be obtained, in N/mm^2, from the following formula:

$$\tau = 10\frac{Q}{A_{SH}}$$

where A_{SH} is the shear area, in cm^2, to be calculated according to [3.5.11].

4.7 Local loads in flooding conditions on the double bottom of single side skin bulk carriers equal to or greater than 150 m in length

4.7.1 Application *(14/2006)*

These requirements apply, in lieu of those in Pt B, Ch 5, Sec 6, [9], to all bulk carriers equal to or greater than 150 m in length, intended for the carriage of bulk cargoes having dry bulk density 1,0 t/m^3 or above.

Each cargo hold is to be considered individually flooded.

4.7.2 General

The loads to be considered as acting on the double bottom are those given by the external sea pressures and the combination of the cargo loads with those induced by the flooding of the hold which the double bottom belongs to.

The most severe combinations of cargo induced loads and flooding loads are to be used, depending on the loading conditions included in the loading manual:

- homogeneous loading conditions
- non-homogeneous loading conditions
- packed cargo conditions (such as in the case of steel mill products).

For each loading condition, the maximum dry bulk cargo density to be carried is to be considered in calculating the allowable hold loading.

4.7.3 Flooding head

The flooding head h_F (see Fig 14) is the distance, in m, measured vertically with the ship in the upright position, from the inner bottom to a level located at a distance z_F, in m, from the base line equal to:

- in general:
  - D_1 for the foremost hold
  - $0,9D_1$ for other holds.
- for ships less than 50000 t deadweight with type B freeboard:
  - $0,95D_1$ for the foremost hold
  - $0,85D_1$ for other holds.

4.8 Additional requirements on local loads for ships with the additional service feature heavycargo

4.8.1 Application

For ships with a service notation completed by the additional service feature **heavycargo [HOLDi, Xi kN/m^2, ρi kN/m^3 - HATCHi, Yi kN/m^2]** (see Pt A, Ch 1, Sec 2, [4.3.2]), the values Xi and ρi, relevant to bulk cargoes carried in holds, and Yi, relevant to uniform cargoes carried on hatch covers, are to be taken according to [4.8.2] and [4.8.3], respectively.

4.8.2 Characteristics of bulk cargoes carried in holds *(1/7/2005)*

ρi is, for each hold, the mass density of the cargo which fills the hold up to the upper deck level at centreline for the maximum mass which may be carried in that hold; ρi is to be defined by the Designer and is to be greater than 1,0 t/m^3.

Xi is the maximum allowable local pressure on the inner bottom of each hold and is to be specified by the Designer. In any case, it is to be not less than the value obtained, for each hold, from the formula for p_S on the inner bottom in Pt B, Ch 5, Sec 6, [3.1.1], where the hold is to be considered as being completely filled and ρ_B is to be taken equal to ρi defined above.

4.8.3 Characteristics of uniform cargoes carried on hatch covers *(1/7/2005)*

Yi is the maximum allowable local pressure on each hatch cover and is to be specified by the Designer. For each hatch cover, it is to be taken as the p_S value in Pt B, Ch 5, Sec 6, [4.1.1] for the hatch cover scantling. Yi is to be greater than 10 kN/m^2.

4.9 Loading conditions for primary structure analysis

4.9.1 The following loading conditions are to be considered in the analysis of the primary structure:

- homogeneous loading
- alternate loading, the loaded hold being completely filled with cargo

- alternate loading, the cargo density being the minimum obtained from the loading booklet, but taken not less than 3 t/m^3
- heavy ballast, the ballast hold being full.

Unless otherwise specified, these loading conditions are to be associated with the ship in upright conditions.

5 Hull girder strength

5.1 Hull girder strength in flooded conditions of bulk carriers equal to or greater than 150m in length

5.1.1 Application *(1/7/2014)*

These requirements apply, in addition to those in Pt B, Ch 6, Sec 2, to bulk carriers of 150 m in length and upwards, intending to carry solid bulk cargoes having a density of 1,0 t/m^3 or above, and with:

a) Single side skin construction, or

b) Double side skin construction in which any part of the longitudinal bulkhead is located within B/5 or 11,5 m, whichever is less, inboard from the ship's side at right angles to the centreline at the assigned summer load line.

Such ships are to have their hull girder strength checked for specified flooded conditions, in each of the cargo and ballast loading conditions defined in Pt B, Ch 6, Sec 2, [2.1] and in [4.1], [4.2] and [4.3], and in every other condition considered in the intact longitudinal strength calculations, including those included in the loading manual, according to Pt B, Ch 11, Sec 2, except that harbour conditions, docking condition afloat, loading and unloading transitory conditions in port and loading conditions encountered during ballast water exchange need not be considered.

The damaged structure is assumed to remain fully effective in resisting the applied loading.

5.1.2 Stresses *(1/4/2006)*

The normal stresses at any point are to be obtained, in N/mm^2, from the following formula:

$$\sigma_{1F} = \frac{M_{SW,F} + M_{WV,F}}{Z_A} 10^3$$

where:

$M_{SW,F}$: Still water bending moment, in kNm, in flooded conditions, at the hull transverse section under consideration, to be calculated according to [4.4]

$M_{WV,F}$: Vertical wave bending moment, in kNm, in flooded conditions, at the hull transverse section under consideration, to be taken, according to [4.4], equal to:

- in hogging conditions:
  $M_{WV,F} = 0,8M_{WV,H}$
- in sagging conditions:
  $M_{WV,F} = 0,8M_{WV,S}$

$M_{WV,H}$, $M_{WV,S}$: Vertical wave bending moments, in kN.m, in hogging and sagging conditions, at the hull transverse section under consideration, defined in Pt B, Ch 5, Sec 2, [3.1]

Z_A : Section modulus, in cm^3, at the considered point of the hull girder.

The shear stresses at any point are to be obtained, in N/mm^2, from the following formula:

$$\tau_{1F} = \delta(Q_{SW,F} + Q_{WV,F} - \varepsilon \Delta Q_C)\frac{S}{I_Y t}$$

where:

δ : Shear distribution coefficient defined in Tab 2

$Q_{SW,F}$: Still water shear force, in kN, in flooded conditions, at the hull transverse section under consideration, to be calculated according to [4.4]

$Q_{WV,F}$: Vertical wave shear force, in kN, in flooded conditions, at the hull transverse section under consideration, to be taken, according to [4.4], equal to:

$Q_{WV,F} = 0,8Q_{WV}$

Q_{WV} : Vertical wave shear force, in kN, at the hull transverse section under consideration, defined in Pt B, Ch 5, Sec 2, [3.4]

$\varepsilon = \text{sgn}(Q_{SW,F})$

ΔQ_C : Shear force correction, in kN, to be calculated according to Pt B, Ch 6, Sec 2, [2.4.1], where the mass P is to include the mass of the ingressed water in the hold considered and the draught T_1 is to be measured up to the equilibrium waterline

I_Y : Moment of inertia, in m^4, of the hull transverse section around its horizontal neutral axis, to be calculated according to Pt B, Ch 6, Sec 1, [2.4]

S : First moment, in m^3, of the hull transverse section around its horizontal neutral axis, to be calculated according to Pt B, Ch 6, Sec 1, [2.5]

t : Thickness, in mm, of the side plating.

5.1.3 Checking criteria

It is to be checked that the stresses σ_{1F} and τ_{1F} calculated according to [5.1.2] are in compliance with the following formulae:

$\sigma_{1F} \leq \sigma_{1,ALL}$

$\tau_{1F} \leq \tau_{1,ALL}$

where $\sigma_{1,ALL}$ and $\tau_{1,ALL}$ are the allowable normal and shear stresses defined in Pt B, Ch 6, Sec 2, [3.1] and Pt B, Ch 6, Sec 2, [3.2], respectively.

6 Hull scantlings

6.1 Plating

6.1.1 Minimum net thickness of side plating for single side skin bulk carriers

The net thickness of the side plating located between hopper and topside tanks is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = L^{0,5} - t_C$

6.1.2 Buckling check for bulk carriers equal to or greater than 150 m in length *(1/4/2006)*

These requirements apply, in addition to those in Pt B, Ch 7, Sec 1, [5], to all bulk carriers equal to or greater than 150 m in length, intended for the carriage of bulk cargoes having dry bulk density of 1,0 t/m^3 or above.

For such ships, the buckling strength of plating contributing to the hull girder longitudinal strength is also to be checked in the flooded conditions specified in [4.4]. This check is to be carried out according to Pt B, Ch 7, Sec 1, [5.4.1] and Pt B, Ch 7, Sec 1, [5.4.2], where the compression stress is to be calculated according to the following formula:

$$\sigma_{X1,F} = \gamma_{S1}\sigma_{S1,F} + \gamma_{W1}\sigma_{WV1,F}$$

where:

γ_{S1}, γ_{W1} : Partial safety factors, defined in Pt B, Ch 7, Sec 1, [1.2] for buckling checks

$\sigma_{S1,F}$, $\sigma_{WV1,F}$: Hull girder normal stresses, in N/mm^2, defined in Tab 1.

Table 1 : Hull girder normal compression stresses in flooded conditions

Condition	$\sigma_{S1,F}$ in N/mm^2	$\sigma_{WV1,F}$ in N/mm^2
$z \geq N$	$\left\lvert \frac{M_{SW,FS}}{I_Y}(z-N) \right\rvert 10^{-3}$	$\left\lvert \frac{0,5M_{WV,S}}{I_Y}(z-N) \right\rvert 10^{-3}$
$z < N$	$\left\lvert \frac{M_{SW,FH}}{I_Y}(z-N) \right\rvert 10^{-3}$	$\left\lvert \frac{0,5M_{WV,H}}{I_Y}(z-N) \right\rvert 10^{-3}$

Note 1:

$M_{SW,FS}$, $M_{SW,FH}$: Still water bending moment, in kNm, in flooded conditions, in sagging and hogging conditions, respectively, at the hull transverse section under consideration, to be calculated according to [4.4]

$M_{WV,S}$, $M_{WV,H}$: Vertical wave bending moments, in kN.m, in sagging and hogging conditions, respectively, at the hull transverse section under consideration, defined in Pt B, Ch 5, Sec 2, [3.1].

Table 2 : Shear stresses induced by vertical shear forces *(1/4/2006)*

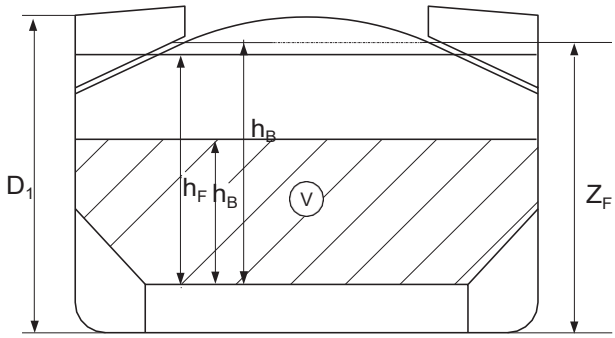
Ship typology	Location	t, in mm	δ	Meaning of symbols used in the definition of δ
Single side skin bulk carrier	Sides	t_S	0,5	
Double side skin bulk carrier	Sides	t_S	$(1 - \phi) / 2$	$\phi = 0,275 + 0,25\alpha$ $\alpha = t_{ISM}/t_{SM}$
	Inner sides	t_{IS}	$\phi / 2$	

Note 1:

t_S, t_{IS} : Minimum thicknesses, in mm, of side, inner side plating, respectively

t_{SM}, t_{ISM} : Mean thicknesses, in mm, over all the strakes of side, inner side plating, respectively. They are calculated as $\Sigma(\ell_i t_i)/\Sigma\ell_i$, where ℓ_i and t_i are the length, in m, and the thickness, in mm, of the i^{th} strake of side, inner side.

Figure 14 : Double bottom - Flooding head and level height of the dry bulk cargo



V=Volume of cargo

6.2 Ordinary stiffeners

6.2.1 Minimum net thicknesses of side frames for single side skin bulk carriers

The net thicknesses of side frames and their brackets, in way of cargo holds, are to be not less than the values given in Tab 3.

6.2.2 Scantlings of side frames adjacent to the collision bulkhead

The net scantlings of side frames in way of the foremost cargo hold and immediately adjacent to the collision bulkhead are to be increased by 25% with respect to those determined according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as applicable, in order to prevent excessive imposed deformation on the side shell plating.

As an alternative, supporting structures are to be fitted which maintain the continuity of fore peak girders within the foremost cargo hold.

6.2.3 Hopper and topside tank ordinary stiffeners

These requirements apply to the ordinary stiffeners of side and sloped longitudinal bulkheads, within hopper and topside tanks, which support the connecting brackets fitted in way of the side frame brackets, according to [3.2.7].

The scantlings of these ordinary stiffeners are to be determined according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as applicable, with their span measured according to Pt B, Ch 4, Sec 3, [3.2] between hopper or topside tank primary supporting members.

Alternative arrangements may be considered by the Society on a case-by-case basis. In these cases, the scantlings of the above ordinary stiffeners are to be determined for the purpose of effectively supporting the connecting brackets.

6.2.4 Buckling check for bulk carriers equal to or greater than 150 m in length *(1/4/2006)*

These requirements apply, in addition to those in Pt B, Ch 7, Sec 2, [4], to all bulk carriers equal to or greater than 150 m in length, intended for the carriage of bulk cargoes having dry bulk density of 1,0 t/m^3 or above.

For such ships, the buckling strength of ordinary stiffeners contributing to the hull girder longitudinal strength is also to be checked in the flooded conditions specified in [4.4]. This check is to be carried out according to Pt B, Ch 7, Sec 2, [4.4.1], where the compression stress is to be calculated according to the following formula:

$$\sigma_{X1,F} = \gamma_{S1}\,\sigma_{S1,F} + \gamma_{W1}\,\sigma_{WV1,F}$$

where:

γ_{S1}, γ_{W1} : Partial safety factors, defined in Pt B, Ch 7, Sec 2, [1.2] for buckling checks

$\sigma_{S1,F}$, $\sigma_{WV1,F}$: Hull girder normal stresses, in N/mm^2, defined in Tab 1.

Table 3 : Minimum net thicknesses of side frames

Item	Minimum net thickness, in mm
Side frame webs	C_L (7,0 + 0,03L_1) - t_C
Lower end bracket	The greater of: • C_L (7,0 + 0,03L_1) + 2 - t_C • as fitted net thickness of side frame web
Upper end bracket	The greater of: • C_L (7,0 + 0,03L_1) - t_C • as fitted net thickness of side frame web
Note 1: C_L : Coefficient equal to: • 1,15 for side frames in way of the foremost cargo hold • 1,0 for side frames in way of other cargo holds L_1 : Ship's length, in m, defined in Pt B, Ch 1, Sec 2, [2].	

7 Scantlings of transverse vertically corrugated watertight bulkheads and double bottom of bulk carriers equal to or greater than 150 m in length

7.1 Evaluation of scantlings of transverse vertically corrugated watertight bulkheads in flooding conditions

7.1.1 Application *(1/7/2014)*

These requirements apply to the transverse vertically corrugated watertight bulkheads of bulk carriers which are bounded by at least one cargo hold that is to be considered individually flooded according to the requirements in [4.6.1] and which are of 150 m in length and upwards, intending to carry solid bulk cargoes having a density of 1,0 t/m^3 or above, and with:

a) Single side skin construction, or

b) Double side skin construction in which any part of the longitudinal bulkhead is located within B/5 or 11,5 m, whichever is less, inboard from the ship's side at right angles to the centreline at the assigned summer load line.

7.1.2 Plating

The bulkhead local net plate thickness t, in mm, is to be not less than that obtained from the following formula:

$$t = 14{,}9 s_W \sqrt{\frac{1{,}05p}{R_{eH}}}$$

where:

p : Resultant pressure, in kN/m^2, as defined in [4.6.8]

s_W : Plate width, in m, to be taken equal to the width of the corrugation flange or web, whichever is the greater (see Fig 5).

For built-up corrugation bulkheads, when the thicknesses of the flange and web are different:

- the net thickness of the narrower plating is to be not less than that obtained, in mm, from the following formula:

$$t_N = 14{,}9 s_N \sqrt{\frac{1{,}05p}{R_{eH}}}$$

- the net thickness of the wider plating is not to be less than the greater of those obtained, in mm, from the following formulae:

$$t_W = 14{,}9 s_W \sqrt{\frac{1{,}05p}{R_{eH}}}$$

$$t_W = \sqrt{\frac{462 s_W^2}{R_{eH}} + t_{NP}^2}$$

where:

t_{NP} : Actual net thickness of the narrower plating, in mm, to be not taken greater than:

$$t_{NP} = 14{,}9 s_w \sqrt{\frac{1{,}05p}{R_{eH}}}$$

7.1.3 Bending capacity of corrugations

The bending capacity of the corrugations is to comply with the following formula:

$$10^3 \frac{M}{(0{,}5W_{LE} + W_M)R_{eH}} \leq 0{,}95$$

where :

M : Bending moment in a corrugation, to be calculated according to [4.6.9]

F : Resultant force, in kN, to be calculated according to [4.6.8]

W_{LE} : Net section modulus, in cm^3, of one half pitch corrugation, to be calculated at the lower end of the corrugations according to [3.5.9], without being taken greater than the value obtained from the following formula:

$$W_{LE,M} = W_G + 10^3 \left(\frac{Qh_G - 0{,}5h_G^2 s_C p_G}{R_{eH}} \right)$$

W_G : Net section modulus, in cm^3, of one half pitch corrugation, to be calculated in way of the upper end of shedder or gusset plates, as applicable, according to [3.5.10]

Q : Shear force in a corrugation, to be calculated according to [4.6.9]

h_G : Height, in m, of shedders or gusset plates, as applicable (see Fig 8 to Fig 12)

p_G : Resultant pressure, in kN/m^2, to be calculated in way of the middle of the shedders or gusset plates, as applicable, according to [4.6.8]

W_M : Net section modulus, in cm^3, of one half pitch corrugation, to be calculated at the mid-span of corrugations according to [3.5.10], without being taken greater than $1{,}15W_{LE}$.

7.1.4 Shear yielding check of the bulkhead corrugations

The shear stress τ, calculated according to [4.6.9], is to comply with the following formula:

$$\tau \leq \frac{R_{eH}}{2}$$

7.1.5 Shear buckling check of the bulkhead corrugation webs

The shear stress τ, calculated according to [4.6.9], is to comply with the following formula:

$$\tau \leq \tau_C$$

where:

τ_C : Critical shear buckling stress to be obtained, in N/mm^2, from the following formulae:

$$\tau_c = \tau_E \quad \text{for } \tau_E \leq \frac{R_{eH}}{2\sqrt{3}}$$

$$\tau_c = \frac{R_{eH}}{\sqrt{3}} \left(1 - \frac{R_{eH}}{4\sqrt{3}\tau_E} \right) \quad \text{for } \tau_E > \frac{R_{eH}}{2\sqrt{3}}$$

τ_E : Euler shear buckling stress to be obtained, in N/mm^2, from the following formula:

$$\tau_E = 0{,}9 k_t E \left(\frac{t_w}{10^3 C} \right)^2$$

k_t : Coefficient to be taken equal to 6,34

t_W : Net thickness, in mm, of the corrugation webs

C : width, in m of the corrugation webs (see Fig 5).

7.1.6 Lower and upper stool side plating and ordinary stiffeners

When lower or upper stools are fitted, according to [3.5.3] and [3.5.4] respectively, the net thickness of their side plating and the section modulus of their ordinary stiffeners are to be not less than those required in Pt B, Ch 7, Sec 1, [3.5] and Pt B, Ch 7, Sec 2, [3.8] for flooding conditions, considering the load model in [4.6].

7.2 Evaluation of double bottom capacity and allowable hold loading in flooding conditions

7.2.1 Application *(1/7/2014)*

These requirements apply to the double bottoms of bulk carriers which belong to cargo holds that are to be considered individually flooded according to the requirements in [4.7.1] and which are of 150 m in length and upwards, intending to carry solid bulk cargoes having a density of 1,0 t/m^3 or above, and with:

a) Single side skin construction or

b) Double side skin construction in which any part of the longitudinal bulkhead is located within B/5 or 11,5 m, whichever is less, inboard from the ship's side at right angles to the centreline at the assigned summer load line.

7.2.2 Shear capacity of the double bottom

The shear capacity of the double bottom is to be calculated as the sum of the shear strength at each end of:

- all floors adjacent to both hopper tanks, less one half of the shear strength of the two floors adjacent to each stool, or transverse bulkhead if no stool is fitted (see Fig 15); the floor shear strength is to be calculated according to [7.2.4]
- all double bottom girders adjacent to both stools, or transverse bulkheads if no stool is fitted; the girder shear strength is to be calculated according to [7.2.5].

Where in the end holds, girders or floors run out and are not directly attached to the boundary stool or hopper tank girder, their strength is to be evaluated for the one end only.

The floors and girders to be considered in calculating the shear capacity of the double bottom are those inside the hold boundaries formed by the hopper tanks and stools (or transverse bulkheads if no stool is fitted). The hopper tank side girders and the floors directly below the connection of the stools (or transverse bulkheads if no stool is fitted) to the inner bottom may not be included.

When the geometry and/or the structural arrangement of the double bottom is/are such as to make the above assumptions inadequate, the shear capacity of the double bottom is to be calculated by means of direct calculations to be carried out according to Pt B, Ch 7, App 1, as far as applicable.

7.2.3 Net thicknesses

The floor and girder shear strength is to be calculated using the net thickness of floor and girder webs, to be obtained, in mm, from the following formula:

$$t_N = t - 2{,}5$$

where:

t : actual gross thickness, in mm, of floor and girder webs.

7.2.4 Floor shear strength

The floor shear strength, in kN, is to be obtained from the following formulae:

- in way of the floor panel adjacent to the hopper tank:

$$S_{F1} = A_F \frac{\tau_A}{\eta_1} 10^{-3}$$

- in way of the openings in the outermost bay (i.e. that bay which is closer to the hopper tank):

$$S_{F2} = A_{F,H} \frac{\tau_A}{\eta_2} 10^{-3}$$

where:

A_F : Net sectional area, in mm^2, of the floor panel adjacent to the hopper tank

$A_{F,H}$: Net sectional area, in mm^2, of the floor panels in way of the openings in the outermost bay (i.e. that bay which is closer to the hopper tank)

τ_A : Allowable shear stress, in N/mm^2, equal to the lesser of:

$$\tau_A = 0{,}645 \frac{R_{eH}^{0,6}}{(s/t_N)^{0,8}} \quad \text{and} \quad \tau_A = \frac{R_{eH}}{\sqrt{3}}$$

t_N : Floor web net thickness, in mm, defined in [7.2.3]

s : Spacing, in m, of stiffening members of the panel considered

η_1 : Coefficient to be taken equal to 1,1

η_2 : Coefficient generally to be taken equal to 1,2; it may be reduced to 1,1 where appropriate reinforcements are fitted in way of the openings in the outermost bay, to be examined by the Society on a case-by-case basis.

7.2.5 Girder shear strength

The girder shear strength, in kN, is to be obtained from the following formulae:

- in way of the girder panel adjacent to the stool (or transverse bulkhead, if no stool is fitted):

$$S_{G1} = A_G \frac{\tau_A}{\eta_1} 10^{-3}$$

- in way of the largest opening in the outermost bay (i.e. that bay which is closer to the stool, or transverse bulkhead, if no stool is fitted):

$$S_{G2} = A_{G,H} \frac{\tau_A}{\eta_2} 10^{-3}$$

A_G : Sectional area, in mm^2, of the girder panel adjacent to the stool (or transverse bulkhead, if no stool is fitted)

$A_{G,H}$: Net sectional area, in mm^2, of the girder panel in way of the largest opening in the outermost bay (i.e. that bay which is closer to the stool, or transverse bulkhead, if no stool is fitted)

τ_A : Allowable shear stress, in N/mm^2, defined in [7.2.4], where t_N is the girder web net thickness

η_1 : Coefficient to be taken equal to 1,1

η_2 : Coefficient generally to be taken equal to 1,15; it may be reduced to 1,1 where appropriate reinforcements are fitted in way of the largest opening in the outermost bay, to be examined by the Society on a case-by-case basis.

7.2.6 Allowable hold loading

The allowable hold loading is to be obtained, in t, from the following formula:

$$W = \rho_B V \frac{1}{F}$$

where:

F : Coefficient to be taken equal to:

- F = 1,1 in general
- F = 1,05 for steel mill products

V : Volume, in m^3, occupied by cargo at a level h_B (see Fig 14)

h_B : Level of cargo, in m, to be obtained from the following formula:

$$h_B = \frac{X}{\rho_B g}$$

X : Pressure, in kN/m^2, to be obtained from the following formulae:

- for dry bulk cargoes, the lesser of:

$$X = \frac{Z + \rho g(z_F - 0{,}1D_1 - h_F)}{1 + \frac{\rho}{\rho_B}(perm - 1)}$$

$$X = Z + \rho g(z_F - 0{,}1D_1 - h_F perm)$$

- for steel mill products:

$$X = \frac{Z + \rho g(z_F - 0{,}1D_1 - h_F)}{1 - \frac{\rho}{\rho_B}}$$

perm : Permeability of cargo, which need not be taken greater than 0,3

Z : Pressure, in kN/m^2, to be taken as the lesser of:

$$Z = \frac{C_H}{A_{DB,H}}$$

$$Z = \frac{C_E}{A_{DB,E}}$$

C_H : Shear capacity of the double bottom, in kN, to be calculated according to [7.2.2], considering, for each floor, the lesser of the shear strengths S_{F1} and S_{F2} (see [7.2.4]) and, for each girder, the lesser of the shear strengths S_{G1} and S_{G2} (see [7.2.5])

C_E : Shear capacity of the double bottom, in kN, to be calculated according to [7.2.2], considering, for each floor, the shear strength S_{F1} (see [7.2.4]) and, for each girder, the lesser of the shear strengths S_{G1} and S_{G2} (see [7.2.5])

$$A_{DB,H} = \sum_{i=1}^{n} S_i B_{DB,i}$$

$$A_{DB,E} = \sum_{i=1}^{n} S_i (B_{DB} - s)$$

n : Number of floors between stools (or transverse bulkheads, if no stool is fitted)

S_i : Space of ith-floor, in m

$B_{DB,i}$: Length, in m, to be taken equal to :

- $B_{DB,i} = B_{DB} - s$ for floors for which $S_{F1} < S_{F2}$ (see [7.2.4])
- $B_{DB,i} = B_{DB,h}$ for floors for which $S_{F1} \geq S_{F2}$ (see [7.2.4])

B_{DB} : Breadth, in m, of double bottom between the hopper tanks (see Fig 16)

$B_{DB,h}$: Distance, in m, between the two openings considered (see Fig 16)

s : Spacing, in m, of inner bottom longitudinal ordinary stiffeners adjacent to the hopper tanks.

8 Fore part

8.1 Reinforcement of the flat bottom forward area

8.1.1 Minimum forward draught *(1/7/2003)*

The structures of the bottom forward are to be strengthened in accordance with the requirements in Pt B, Ch 9, Sec 1, [3] against dynamic pressures due to bottom impact for the condition specified in [4.3.2] at the minimum forward draught.

9 Hatch covers, hatch coamings and closing devices

9.1 Application

9.1.1 *(1/7/2024)*

Refer to the requirements for Type 2 ships in Pt B, Ch 9, Sec 7.

10 Hull outfitting

10.1 Forecastle

10.1.1 General *(1/1/2004)*

Ships with service notation **bulk carrier ESP** are to be fitted with an enclosed forecastle on the freeboard deck.

The required dimensions of the forecastle are defined in [10.1.2].

The structural arrangements and scantlings of the forecastle are to comply with the requirements in Pt B, Ch 10, Sec 2.

10.1.2 Dimensions *(1/1/2004)*

The forecastle is to be located on the freeboard deck with its aft bulkhead fitted in way or aft of the forward bulkhead of the foremost hold, as shown in Fig 17.

The forecastle height H_F above the main deck is to be not less than the greater of:

- the standard height of a superstructure, as specified in Pt B, Ch 1, Sec 2, Tab 2, or
- H_C + 0,5 m, where H_C is the height of the forward transverse hatch coaming of cargo hold No.1,

$$l_F \leq 5\sqrt{H_F - H_C}$$

All points of the aft edge of the forecastle deck are to be located at a distance from the hatch coaming plate in order to apply the reduced loading to the No.1 forward transverse hatch coaming and No.1 hatch cover in applying Pt B, Ch 9, Sec 7, [3.3.2] and Pt B, Ch 9, Sec 7, [7.2.3], respectively.

A breakwater may not be fitted on the forecastle deck with the purpose of protecting the hatch coaming or hatch covers. If fitted for other purposes, it is to be located such that its upper edge at centreline is not less than H_B / tan20° forward of the aft edge of the forecastle deck, where H_B is the height of the breakwater above the forecastle (see Fig 17).

Figure 15 : Double bottom structure

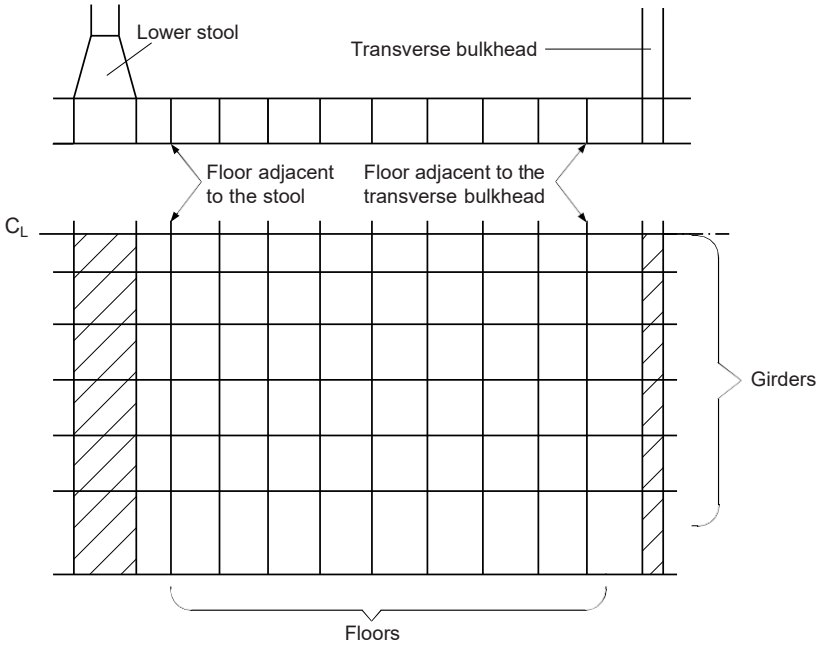


Figure 16 : Dimensions B_{DB} and $B_{DB,h}$

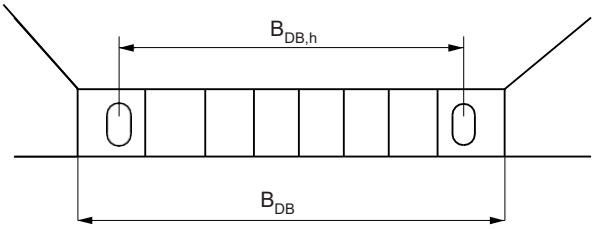
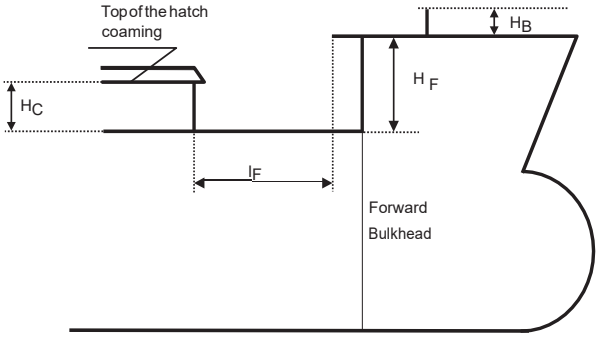


Figure 17 : Forecastle arrangement *(1/1/2004)*



11 Protection of hull metallic structures

11.1 Protection of sea water ballast tanks

11.1.1 *All dedicated seawater ballast tanks are to have an efficient corrosion prevention system, such as hard protective coatings or equivalent.*

The coatings are preferably to be of a light colour, i.e. a colour easily distinguishable from rust which facilitates inspection.

Where appropriate, sacrificial anodes may also be used.

11.2 Protection of cargo holds

11.2.1 Coating

It is the responsibility of the shipbuilder and of the Owner to choose coatings suitable for the intended cargoes, in particular for the compatibility with the cargo, and to see that they are applied in accordance with the Manufacturer's requirements.

11.2.2 Application

All internal and external surfaces of hatch coamings and hatch covers and all internal surfaces of cargo holds (side and transverse bulkheads) are to have an efficient protective coating, of an epoxy type or equivalent, applied in accordance with the Manufacturer’s recommendations.

The side (single and double skin) and transverse bulkhead areas to be coated are specified in [11.2.3] to [11.2.5].

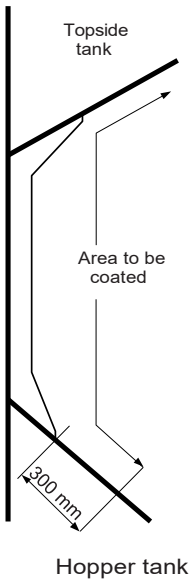
11.2.3 Single side areas to be coated

The areas to be coated are:

- the internal surfaces of the side plating
- the side frames with end brackets
- the internal surfaces of the topside tank sloping plates and, for a distance of 300 mm below, of the hopper tank sloping plates.

These areas are shown in Fig 18.

Figure 18 : Single side - Areas to be coated



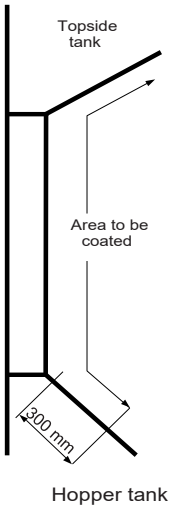
11.2.4 Double side areas to be coated

The areas to be coated are the internal surfaces of:

- the inner side plating
- the internal surfaces of the topside tank sloping plates and the hopper tank sloping plates for a distance of 300 mm below their upper ends.

These areas are shown in Fig 19.

Figure 19 : Double side - Areas to be coated



11.2.5 Transverse bulkhead areas to be coated

The areas to be coated are the upper parts down to 300 mm below the top of the lower stool. Where there is no lower stool, the area to be coated is the whole transverse bulkhead. These areas are shown in Fig 20.

12 Construction and testing

12.1 Welding and weld connections

12.1.1 The welding factors for some hull structural connections are specified in Tab 4. These welding factors are to be used, in lieu of the corresponding factors specified in Pt B, Ch 12, Sec 1, Tab 2, to calculate the throat thickness of fillet weld T connections according to Pt B, Ch 12, Sec 1, [2.3]. For the connections in Tab 4, continuous fillet welding is to be adopted.

12.2 Special structural details

12.2.1 The specific requirements in Pt B, Ch 12, Sec 2, [2.5] for ships with the service notation **bulk carrier ESP** are to be complied with.

Figure 20 : Transverse bulkheads - Areas to be coated

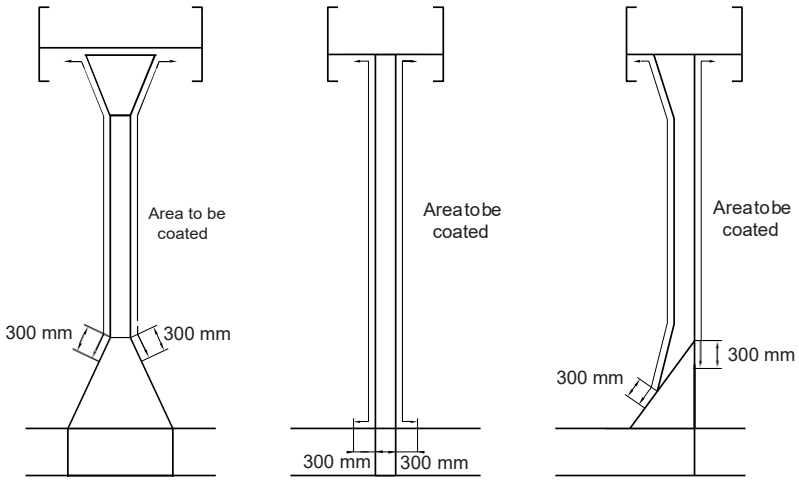


Figure 21 : Zones “a” and “b” of weld connections of side frames

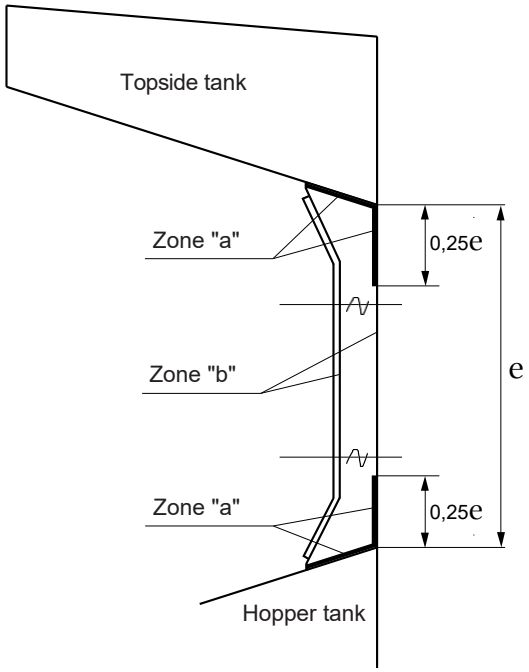


Table 4 : Welding factor w_F *(1/7/2002)*

Hull area	Connection			Welding factor w_F
	of	to		
Double bottom in way of cargo holds	girders	bottom and inner bottom plating		0,35
		floors (interrupted girders)		0,35
	floors	bottom and inner bottom plating		0,35
		inner bottom in way of bulkheads or their lower stools, in general		0,45
		inner bottom in way of corrugated watertight bulkheads or their lower stools		Full penetration or partial penetration welding
		girders (interrupted floors)		0,35
Bulkheads	structures of tank and watertight bulkheads	lower stool top plate or, if no lower stool is fitted, inner bottom and hopper tank sloping plates	plating and ordinary stiffeners (plane bulkheads)	0,45
			vertical corrugations (corrugated bulkheads)	Full penetration welding
		upper stool bottom plate or, if no upper stool is fitted, deck structures and topside tank sloping plates		0,45
		side structures		0,35
	lower stool structures	boundaries	plating of lower stools, in general	0,45
			plating of lower stools supporting corrugated watertight bulkheads	Full penetration or partial penetration welding
			ordinary stiffeners and diaphragms	0,45
	upper stool structures	boundaries		0,45
	effective shedder plates (see [3.5.7])	vertical corrugations and lower stool top plate		One side penetration welding or equivalent
	effective gusset plates (see [3.5.8])	lower stool top plate		Full penetration welding
		vertical corrugations and shedder plates		One side penetration welding or equivalent
Side	web of side frames and brackets	side plating, hopper and topside tank sloping plates, face plates	in zone “a” **(1)**	0,45 **(2)**
			in zone “b” **(1)**	0,40 **(2)**

(1) Zones “a” and “b” are defined in Fig 21.

(2) Where the hull form is such as to prohibit an effective fillet weld, the Society may require edge preparation of the web of side frame and bracket to be carried out in order to ensure the same efficiency as the required weld connections.

SECTION 4 MACHINERY

1 Draining and pumping forward spaces

1.1 Application

1.1.1 *(1/1/2005)*
This requirement applies to bulk carriers which are to comply with Regulation 13 of Chapter XII of SOLAS Convention.

1.2 Dewatering capacity

1.2.1 *(1/1/2005)*
The dewatering system for ballast tanks located forward of the collision bulkhead and for bilges of dry spaces any part of which extends forward of the foremost cargo hold is to be designed to remove water from the forward spaces at a rate of not less than 320A m^3/h, where A is the cross-sectional area in m^2 of the largest air pipe or ventilator pipe connected from the exposed deck to a closed forward space that is required to be dewatered by these arrangements.

APPENDIX 1 INTACT STABILITY CRITERIA FOR GRAIN LOADING

1 Calculation of assumed heeling moments due to cargo shifting

1.1 Stowage of bulk grain

1.1.1 General

All necessary and reasonable trimming is to be performed to level all free grain surfaces and to minimise the effect of grain shifting.

1.1.2 Filled compartment trimmed

In any filled compartment trimmed, as defined in Sec 3, [2.1.2], the bulk grain is to be trimmed so as to fill all spaces under the decks and hatch covers to the maximum extent possible.

1.1.3 Filled compartment untrimmed

In any filled compartment untrimmed, as defined in Sec 3, [2.1.3], the bulk grain is to be filled to the maximum extent possible in way of the hatch opening but may be at its natural angle of repose outside the periphery of the hatch opening. A filled compartment may qualify for this classification if it falls into one of the following categories:

a) the Society may, under [1.7], grant dispensation from trimming in those cases where the underdeck void geometry resulting from free flowing grain in a compartment, which may be provided with feeder ducts, perforated decks or other similar means, is taken into account when calculating the void depths, or

b) the compartment is "specially suitable" as defined in Sec 3, [2.1.6], in which case dispensation may be granted from trimming the ends of that compartment.

1.1.4 Grain in partially filled compartments

If there is no bulk grain or other cargo above a lower cargo space containing grain, the hatch covers are to be secured in an approved manner having regard to the mass and permanent arrangements provided for securing such covers.

When bulk grain is stowed on top of closed 'tweendeck hatch covers which are not grain-tight, such covers are to be made grain-tight by taping the joints, covering the entire hatchway with tarpaulins or separation cloths, or other suitable means.

After loading, all free grain surfaces in partly filled compartments are to be level.

1.1.5 Cargo securing

Unless account is taken of the adverse heeling effect due to the grain shift according to these Rules, the surface of the bulk grain in any partly filled compartment is to be secured so as to prevent a grain shift by overstowing as described in [1.9.1] to [1.9.3]. Alternatively, in partly filled compartments, the bulk grain surface may be secured by strapping or lashing as described in [1.9.4] or [1.9.5].

Lower cargo spaces and 'tweendeck spaces in way thereof may be loaded as one compartment provided that, in calculating transverse heeling moments, proper account is taken of the flow of grain into the lower spaces.

1.1.6 Longitudinal division

In filled compartments trimmed, filled compartments untrimmed and partly filled compartments, longitudinal divisions may be installed as a device to reduce the adverse heeling effect of grain shift provided that:

a) the division is grain-tight,

b) the construction meets the requirements in Part B for longitudinal bulkheads; if no particular requirement is foreseen see MSC Res. 23(59)sect 11-14); and

c) in 'tweendecks, if fitted, the division extends from deck to deck and in other cargo spaces the division extends downwards from the underside of the deck or hatch covers, as described in [1.3.2] a) (second bullet)*, Note 2, [1.3.2] b), Note 7, or [1.6.1] b), as applicable.*

1.2 General assumptions

1.2.1 Voids in spaces loaded with grain

For the purpose of calculating the adverse heeling moment due to a shift of cargo surface in ships carrying bulk grain it is to be assumed that:

a) in filled compartments which have been trimmed in accordance with [1.1.2], a void exists under all boundary surfaces having an inclination to the horizontal less than 30° and that void is parallel to the boundary surface having an average depth calculated according to the formula:

$$V_d = V_{d1} + 0{,}75(d - 600)$$

where:

V_d *: Average void depth, in mm*

V_{d1} *: Standard void depth, in mm, from Tab 1*

d *: Actual girder depth, in mm.*

In any case, V_d is to be assumed equal to or greater than 100 mm.

b) within filled hatchways and in addition to any open void within the hatch cover there is a void of average depth of 150 mm measured down to the grain surface from the lowest part of the hatch cover or the top of the hatch side coaming, whichever is the lower.

c) in a filled compartment untrimmed which is exempted from trimming outside the periphery of the hatchway by the provisions of [1.1.3] a), it is to be assumed that the surface of the grain after loading will slope into the void space underdeck, in all directions, at an angle of 30° to the horizontal from the edge of the opening which establishes the void.

d) In a filled compartment untrimmed which is exempted from trimming in the ends of the compartment under the provisions of [1.1.3] b), it is to be assumed that the surface of the grain after loading will slope in all directions away from the filling area at an angle of 30° from the lower edge of the hatch end beam. However, if feeding holes are provided in the hatch end beams in accordance with Tab 2, then the surface of the grain after loading is to be assumed to slope in all directions, at an angle of 30° from a line on the hatch end beam which is the mean of the peaks and valleys of the actual grain surface as shown in Fig 1.

The description of the pattern of grain surface behaviour to be assumed in partly filled compartments is contained in [1.6].

1.2.2 Assumptions in filled compartments trimmed

For the purpose of demonstrating compliance with the stability criteria specified in Sec 3, [2.2.3], the ship's stability calculations are normally to be based upon the assumption that the centre of gravity of cargo in a filled compartment trimmed is at the volumetric centre of the whole cargo space. In those cases where the Society authorises account to be taken of the effect of assumed underdeck voids on the vertical position of the centre of gravity of the cargo in filled compartments trimmed, it is necessary to compensate for the adverse effect of the vertical shift of grain surfaces by increasing the assumed heeling moment due to the transverse shift of grain as follows:

$$M_{H,T} = 1{,}06M_{H,C}$$

where:

$M_{H,T}$ *: Total heeling moment, in t.m*

$M_{H,C}$ *: Calculated transverse heeling moment, in t.m*

In all cases the weight of cargo in a filled compartment trimmed is to be the volume of the whole cargo space divided by the stowage factor.

1.2.3 Assumptions in filled compartments untrimmed

The centre of gravity of cargo in a filled compartment untrimmed is to be taken to be the volumetric centre of the whole cargo compartment with no account being allowed for voids. In all cases the weight of cargo is to be the volume of the cargo (resulting from the assumptions stated in [1.2.1] c) or [1.2.1] d)) divided by the stowage factor.

1.2.4 Assumptions in partially filled compartments

In partly filled compartments the adverse effect of the vertical shift of grain surfaces is to be taken into account as follows:

$$M_{H,T} = 1{,}12M_{H,C}$$

where $M_{H,T}$ and $M_{H,C}$ are defined in [1.2.2].

1.2.5 Equivalent methods

Any other equally effective method may be adopted to make the compensation required in [1.2.2] and [1.2.4].

Table 1 : Standard void depth

Distance, in m, from hatch end or hatch side to boundary of compartment	Standard void depth V_{d1} in mm
0,5	570
1,0	530
1,5	500
2,0	480
2,5	450
3,0	440
3,5	430
4,0	430
4,5	430
5,0	430
5,5	450
6,0	470
6,5	490
7,0	520
7,5	550
8,0	590

Note 1:
For boundary distances greater than 8,0 m, the standard void depth V_{d1} is to be linearly extrapolated with 80 mm increases for each 1,0 m increase in length.

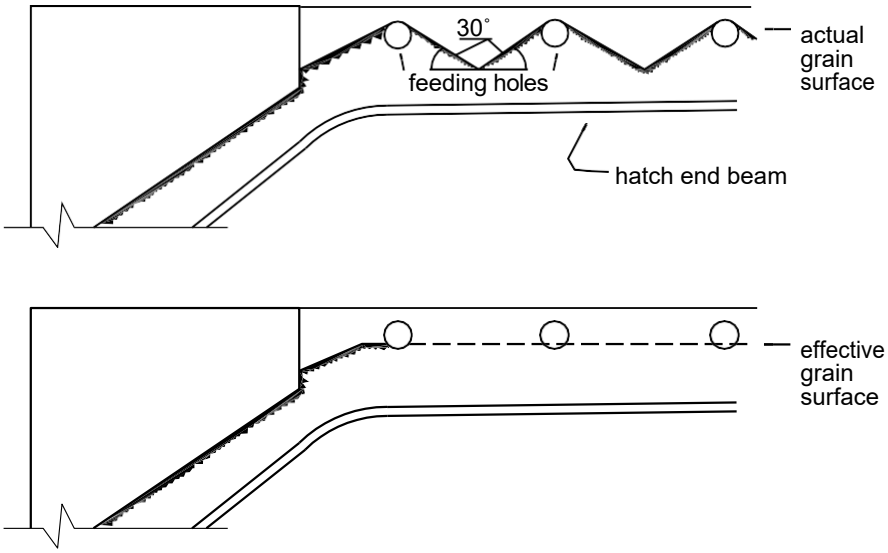
Note 2:
In the corner area of a compartment, the boundary distance is to be the perpendicular distance from the line of the hatch side girder or the line of the hatch end beam to the boundary of the compartment, whichever is the greater. The girder depth d is to be taken as the depth of the hatch side girder or the hatch end beam, whichever is the lesser.

Note 3:
Where there is a raised deck clear of the hatchway, the average void depth measured from the underside of the raised deck is to be calculated using the standard void depth in association with a girder depth of the hatch end beam plus the height of the raised deck.

Table 2 : Requirements for feeding holes

Minimum diameter, in mm	Area, in cm^2	Maximum spacing, in m
90	63,6	0,60
100	78,5	0,75
110	95,0	0,90
120	113,1	1,07
130	133,0	1,25
140	154,0	1,45
150	177,0	1,67
160	201,0	1,90
170 or above	227,0	2,00

Figure 1 : Effective grain surface to be assumed



1.3 Assumed volumetric heeling moment of a filled compartment trimmed

1.3.1 General

The pattern of grain surface movement relates to a transverse section across the portion of the compartment being considered and the resultant heeling moment is to be multiplied by the length to obtain the total moment for that portion. The assumed transverse heeling moment due to grain shifting is a consequence of final changes of shape and position of voids after grain has moved from the high side to the low side.

The resulting grain surface after shifting is to be assumed to be at 15° to the horizontal.

In calculating the maximum void area that can be formed against a longitudinal structural member, the effects of any horizontal surfaces, e.g. flanges or face bars, are to be ignored.

The total areas of the initial and final voids are to be equal.

Longitudinal structural members which are grain-tight may be considered effective over their full depth except where they are provided as a device to reduce the adverse effect of grain shift, in which case the provisions of [1.1.6] are to apply.

A discontinuous longitudinal division may be considered effective over its full length.

1.3.2 Assumptions

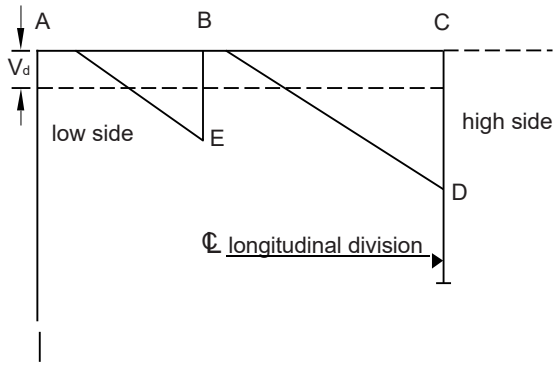
In the following paragraphs it is assumed that the total heeling moment for a compartment is obtained by adding the results of separate consideration of the following portions:

a) before and abaft hatchways:

- *if a compartment has two or more main hatchways through which loading may take place, the depth of the underdeck void for the portion or portions between such hatchways is to be determined using the fore and aft distance to the mid-point between the hatchways*
- *after the assumed shift of grain the final void pattern is to be as shown in Fig 2.*

b) In and abreast of hatchways without longitudinal division, after the assumed shift of grain the final void pattern is to be as shown in Fig 3 or Fig 4.

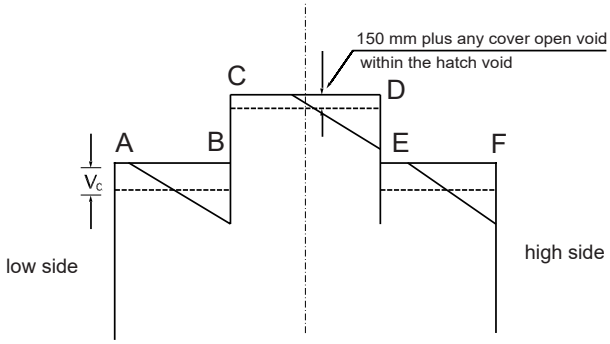
Figure 2 : Final void pattern



Note 1: If the maximum void area which can be formed against the girder at B is less than the initial area of the void under AB, i.e. AB.V_d the excess area is to be assumed to transfer to the final void on the high side.

Note 2: If, for example, the longitudinal division at C is one which has been provided in accordance with [1.1.6], it is to extend to at least 0,6 m below D or E, whichever gives the greater depth.

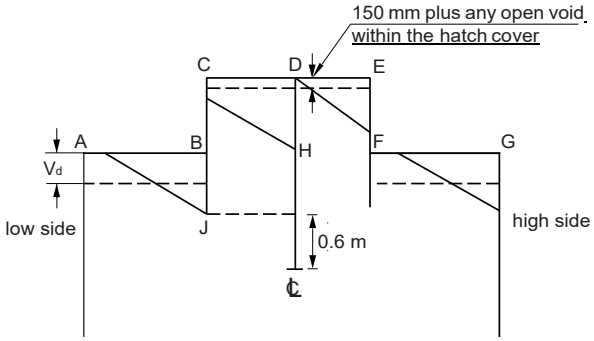
Figure 3 : Final void pattern



Note 3: AB: Any area in excess of that which can be formed against the girder at B is to transfer to the final void area in the hatchway.

Note 4: CD: Any area in excess of that which can be formed against the girder at E is to transfer to the final void area on the high side.

Figure 4 : Final void pattern



Note 5: The excess void area from AB is to transfer to the low side half of the hatchway in which two separate final void areas are formed: one against the centreline division and the other against the hatch side coaming and girder on the high side.

Note 6: If a bagged saucer or bulk bundle is formed in a hatchway it is to be assumed for the purpose of calculating the transverse heeling moment that such a device is at least equivalent to the centreline division.

Note 7: If the centreline division is one which has been provided in accordance with [1.1.6], it is to extend to at least 0,6 m below H or J, whichever gives the greater depth.

1.3.3 Compartment loaded in combination

The following paragraphs describe the patterns of void behaviour which are to be assumed when compartments are loaded in combination:

a) without effective centreline divisions:

- *under the upper deck:*

  as for the single deck arrangement described in [1.3.2] a) (second bullet) and [1.3.2] b)
- *under the second deck (if applicable):*

  the area of void available for transfer from the low side, i.e. original void area less area against the hatch side girder, is to be assumed to transfer as follows: one half to the upper deck hatchway and one quarter each to the high side under the upper and second deck
- *under the third and lower decks (if applicable):*

  the void areas available for transfer from the low side of each of these decks are to be assumed to transfer in equal quantities to all the voids under the decks on the high side and the void in the upper deck hatchway

b) with effective centreline divisions which extend into the upper deck hatchway:

- *at all deck levels abreast of the division the void areas available for transfer from the low side are to be assumed to transfer to the void under the low side half of the upper deck hatchway*
- *at the deck level immediately below the bottom of the division the void area available for transfer from the low side is to be assumed to transfer as follows: one half to the void under the low side half of the upper deck hatchway and the remainder in equal quantities to the voids under the decks on the high side*
- *at deck levels lower than those described above, the void area available for transfer from the low side of each of those decks is to be assumed to transfer in equal quantities to the voids in each of the two halves of the upper deck hatchway on each side of the division and the voids under the decks on the high side.*

c) with effective centreline divisions which do not extend into the upper deck hatchway:

Since no horizontal transfer of voids may be assumed to take place at the same deck level as the division, the void area available for transfer from the low side at this level is to be assumed to transfer above the division to voids on the high side in accordance with the principles of a) and b).

1.4 Assumed volumetric heeling moment of a filled compartment untrimmed

1.4.1 General

All the provisions for filled compartments trimmed set forth in [1.3] are to also apply to filled compartments untrimmed, except as reported in [1.4.2].

1.4.2 Additional requirements

In filled compartments untrimmed which are exempted from trimming outside the periphery of the hatchway under the provisions of [1.1.3] a), the following assumptions apply:

a) The resulting grain surface after shifting is to be assumed to be at an angle of 25° to the horizontal. However, if in any section of the compartment, forward, aft, or abreast of the hatchway the mean transverse area of the void in that section is equal to or less than the area which would be obtained by application of [1.2.1] a), then the angle of grain surface after shifting in that section is to be assumed to be 15° to the horizontal.

b) The void area at any transverse section of the compartment is to be assumed to be the same both before and after the grain shift, i.e. it is to be assumed that additional feeding does not occur at the time of the grain shift.

In filled compartments untrimmed which are exempted from trimming in the ends, forward and aft of the hatchway, under the provisions of [1.1.3] b), the following assumptions apply:

a) the resulting grain surface abreast of the hatchway after shifting is to be assumed to be at an angle of 15° to the horizontal

b) the resulting grain surface in the ends, forward and aft of the hatchway after shifting is to be assumed to be at an angle of 25° to the horizontal.

1.5 Assumed volumetric heeling moments in trunks

1.5.1 *After the assumed shift of grain the final void pattern is to be as shown in Fig 5.*

Note 1: If the wing spaces in way of the trunk cannot be properly trimmed in accordance with [1.1], it is to be assumed that a 25° surface shift takes place.

1.6 Assumed volumetric heeling moment of a partly filled compartment

1.6.1

a) When the free surface of the bulk grain has not been secured in accordance with [1.9.1] to [1.9.3], [1.9.4], or [1.9.5], it is to be assumed that the grain surface after shifting is at 25° to the horizontal.

b) In a partly filled compartment, a division, if fitted, is to extend from one eighth of the maximum breadth of the compartment above the level of the grain surface and to the same distance below the grain surface.

c) In a compartment in which the longitudinal divisions are not continuous between the transverse boundaries, the length over which any such divisions are effective as devices to prevent full width shifts of grain surfaces is to be taken to be the actual length of the portion of the division under consideration less two sevenths of the greater of the transverse distances between the division and its adjacent division or ship side. This correction does not apply in the lower compartments of any combination loading in which the upper compartment is either a filled compartment or a partly filled compartment.

1.7 Other assumptions

1.7.1 *The Society may authorise departure from the assumptions contained in these Rules in those cases where it considers this to be justified having regard to the provisions for loading or the structural arrangements, provided the stability criteria in Sec 3, [2.2.3] are met.*

Where such authorisation is granted under this regulation, particulars shall be included in the grain loading manual.

These particulars include the additional calculation of heeling moments for filled holds with untrimmed ends, an example of which is reported in [2.1].

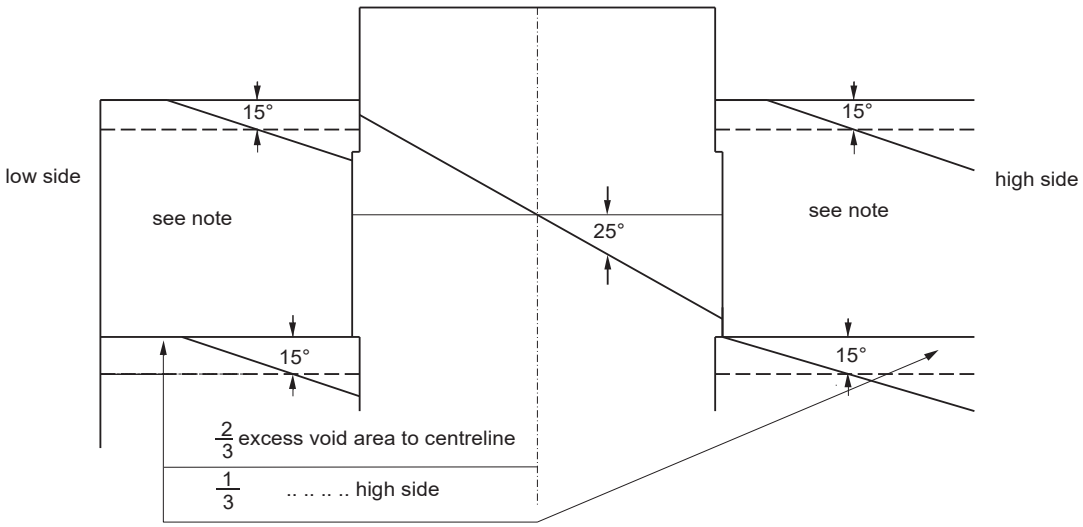
1.8 Saucers

1.8.1 *For the purpose of reducing the heeling moment a saucer may be used in place of a longitudinal division in way of a hatch opening only in a filled trimmed compartment as defined in Sec 3, [2.1.2], except in the case of linseed and other seeds having similar properties, where a saucer may not be substituted for a longitudinal division. If a longitudinal division is provided, it is to meet the requirements of [1.1.6].*

1.8.2 *The depth of the saucer, measured from the bottom of the saucer to the deck line, is to be as follows:*

- *for ships with a moulded breadth of up to 9,1 m, not less than 1,2 m*
- *for ships with a moulded breadth of 18,3 m or more, not less than 1,8 m*
- *for ships with a moulded breadth between 9,1 m and 18,3 m, the minimum depth of the saucer is to be calculated by interpolation.*

Figure 5 : Assumed volumetric heeling moment in trunks



1.8.3 *The top (mouth) of the saucer is to be formed by the underdeck structure in way of the hatchway, i.e. hatch side girders or coamings and hatch end beams. The saucer and hatchway above are to be completely filled with bagged grain or other suitable cargo laid down on a separation cloth or its equivalent and stowed tightly against adjacent*

structure so as to have a bearing contact with such structure to a depth equal to or greater than one half of the depth specified in [1.8.2].

If hull structure to provide such bearing surface is not available, the saucer is to be fixed in position by steel wire rope, chain, or double steel strapping as specified in [1.9.4] d) and spaced not more than 2,4 m apart.

1.8.4 *As an alternative to filling the saucer in a filled trimmed compartment with bagged grain or other suitable cargo, a bundle of bulk grain may be used provided that:*

a) the dimensions and means for securing the bundle in place are the same as specified for a saucer in [1.8.2] and [1.8.3]

b) the saucer is lined with a material acceptable to the Society having a tensile strength of not less than 2,687 N per 5 cm strip and which is provided with suitable means for securing at the top

c) as an alternative to b), a material acceptable to the Society having a tensile strength of not less than 1,344 N per 5 cm strip may be used if the saucer is constructed as follows:

- *athwartship lashings acceptable to the Society are to be placed inside the saucer formed in the bulk grain at intervals of not more than 2,4 m. These lashings are to be of sufficient length to permit being drawn up tight and secured at the top of the saucer.*
- *dunnage not less than 25 mm in thickness or other suitable material of equal strength and between 150 mm and 300 mm in width is to be placed fore and aft over these lashings to prevent the cutting or chafing of the material which is to be placed thereon to line the saucer*

d) the saucer is to be filled with bulk grain and secured at the top except that when using material approved under c) further dunnage is to be laid on top after lapping the material before the saucer is secured by setting up the lashings

e) if more than one sheet of material is used to line the saucer they are to be joined at the bottom either by sewing or by a double lap

f) the top of the saucer is to be coincidental with the bottom of the beams when these are in place and suitable general cargo or bulk grain may be placed between the beams on top of the saucer.

1.9 Overstowing arrangements and securing

1.9.1 Bagged grain

Where bagged grain or other suitable cargo is utilised for the purpose of securing partly filled compartments, the free grain surface is to be level and is to be covered with a separation cloth or equivalent or by a suitable platform. Such platform is to consist of bearers spaced not more than 1,2 m apart and 25 mm boards laid thereon spaced not more than 100 mm apart. Platforms may be constructed of other materials provided they are deemed by the Society to be equivalent.

1.9.2 Separating platform

The platform or separation cloth is be topped off with bagged grain tightly stowed and extending to a height of not less than one sixteenth of the maximum breadth of the free grain surface or 1,2 m, whichever is the greater.

1.9.3 Equivalent cargo

The bagged grain is to be carried in sound bags which are to be well filled and securely closed.

Instead of bagged grain, other suitable cargo tightly stowed and exerting at least the same pressure as bagged grain stowed in accordance with [1.9.2] may be used.

1.9.4 Strapping or lashing

When, in order to eliminate heeling moments in partly filled compartments, strapping or lashing is utilised, the securing is to be accomplished as follows:

a) the grain is to be trimmed and levelled to the extent that it is very slightly crowned and covered with burlap separation cloths, tarpaulins or the equivalent

b) the separation cloths and/or tarpaulins are to overlap by at least 1,8 m

c) two solid floors of rough 25 mm by 150 mm to 300 mm lumber are to be laid with the top floor running longitudinally and nailed to an athwartship bottom floor. Alternatively, one solid floor of 50 mm lumber, running longitudinally and nailed over the top of a 50 mm bottom bearer not less than 150 mm wide, may be used. The bottom bearers are to extend the full breadth of the compartment and are to be spaced not more than 2,4 m apart. Arrangements utilising other materials and deemed by the Society to be equivalent to the foregoing may be accepted.

d) Steel wire rope (19 mm diameter or equivalent), double steel strapping (50 mm x 1,3 mm and having a breaking load of at least 49 kN), or chain of equivalent strength, each of which is to be set tightly by means of a 32 mm turnbuckle,

may be used for lashings. A winch tightener, used in conjunction with a locking arm, may be substituted for the 32 mm turnbuckle when steel strapping is used, provided suitable wrenches are available for setting up as necessary.

When steel strapping is used, not less than three crimp seals are to be used for securing the ends. When wire is used, not less than four clips are to be used for forming eyes in the lashings.

e) Prior to the completion of loading the lashings are to be positively attached to the framing at a point approximately 450 mm below the anticipated final grain surface by means of either a 25 mm shackle or beam clamp of equivalent strength

f) the lashings are to be spaced not more than 2,4 m apart and each is to be supported by a bearer nailed over the top of the fore and aft floor. This bearer is to consist of lumber of not less than 25 mm by 150 mm or its equivalent and is to extend the full breadth of the compartment.

g) During the voyage the strapping is to be regularly inspected and set up where necessary.

1.9.5 Securing with wire mesh

When, in order to eliminate grain heeling moments in partly filled compartments, strapping or lashing is utilised, the securing may, as an alternative to the method described in [1.9.4], be accomplished as follows:

a) the grain is to be trimmed and levelled to the extent that it is very slightly crowned along the fore and aft centreline of the compartment

b) the entire surface of the grain is to be covered with burlap separation cloths, tarpaulins, or the equivalent. The covering material is to have a tensile strength of not less than 1,344 N per 5 cm strip.

c) Two layers of wire reinforcement mesh are to be laid on top of the burlap or other covering. The bottom layer is to be laid athwartship and the top layer is to be laid longitudinally. The lengths of wire mesh are to be overlapped at least 75 mm. The top layer of mesh is to be positioned over the bottom layer in such a manner that the squares formed by the alternate layer measure approximately 75 mm by 75 mm. The wire reinforcement mesh is the type used in reinforced concrete construction. It is fabricated of 3 mm diameter steel wire having a breaking strength of not less than 52 kN/cm^2, welded in 150 mm x 150 mm squares. Wire mesh having mill scale may be used but mesh having loose, flaking rust may not be used.

d) The boundaries of the wire mesh, at the port and starboard side of the compartment, are to be retained by wood planks 150 mm x 50 mm,

e) hold-down lashings, running from side to side across the compartment, are to be spaced not more than 2,4 m apart except that the first and the last lashing are not to be more than 300 mm from the forward or after bulkhead, respectively. Prior to the completion of the loading, each lashing is to be positively attached to the framing at a point approximately 450 mm below the anticipated final grain surface by means of either a 25 mm shackle or beam clamp of equivalent strength. The lashing is to be led from this point over the top of the boundary plank described in d), which has the function of distributing the downward pressure exerted by the lashing. Two layers of 150 mm x 25 mm planks are to be laid athwartship centred beneath each lashing and extending the full breadth of the compartment.

f) The hold-down lashings are to consist of steel wire rope (19 mm diameter or equivalent), double steel strapping (50 mm x 1,3 mm and having a breaking load of at least 49 kN), or chain of equivalent strength, each of which is to be set tight by means of a 32 mm turnbuckle. A winch tightener, used in conjunction with a locking arm, may be substituted for the 32 mm turnbuckle when steel strapping is used, provided suitable wrenches are available for setting up as necessary. When steel strapping is used, not less than three crimp seals are to be used for securing the ends. When wire rope is used, not less than four clips are to be used for forming eyes in the lashings.

g) During the voyage the hold-down lashings are to be regularly inspected and set up where necessary.

2 Dispensation from trimming ends of holds in certain ships

2.1 Calculation example

2.1.1 General

As a result of the provisions in [1.1.3] and [1.7.1]*, dispensation may be granted from trimming the ends of holds in specially suitable ships, when requested, provided that an additional entry of heeling moments for filled holds with untrimmed ends is approved and included in the* grain loading manual required in Sec 3, [2.2.2]. *Untrimmed ends are to be treated as partly filled spaces and, accordingly, the grain surface in these portions of the hold is to be assumed to shift to an angle of 25° from the horizontal.*

After taking into account the heeling moments due to the shift of grain in the untrimmed ends, dispensation may be granted provided the ship meets the stability criteria specified in Sec 3, [2.2.3].

This dispensation may be granted only to ships which are arranged with sloping bulkheads, port and starboard forming the longitudinal inner boundaries of topside tanks and which slope at an angle of 30° or more to the horizontal.

When calculating the geometry of the void beyond the hatch end, allowance may be made for feeding holes in the hatch end beam provided they meet the requirements reported in Tab 2.

The effective depth is to be taken as the distance from the underside of the deck to a horizontal line on the hatch end beam which is the mean between the peaks and valleys of the actual grain surface as shown in Fig 1.

2.1.2 Assumptions

In performing the calculation of the volumetric heeling moment, the grain in the hatchway is assumed to be filled to the maximum and the resulting surface shifted to an angle of 15° to the horizontal.

In the untrimmed end the surface of the grain will slope in all directions away from the filling area at an angle of 30° to the horizontal from the lower edge of the hatch end beam or, in certain cases from a higher level where feeding holes are provided.

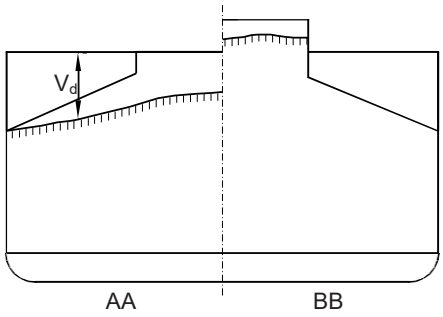
The sum of the moments calculated for the ends and the moments for the hatchway give the total volumetric heeling moment for the compartment "filled - ends not trimmed" and is to be listed for any such compartment in the grain loading manual.

The information concerning full holds assumed to be trimmed and partly filled holds is to remain the same as at present.

2.1.3 Calculation of void areas

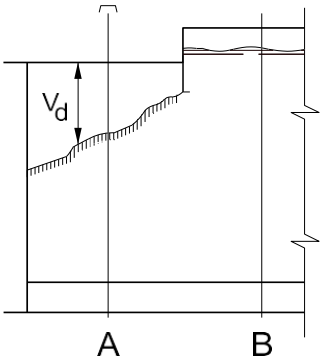
In ships having sloping topside tanks in each hold, the grain surface leans against topside tank bulkheads if its slope is equal to or greater than 30° to the horizontal; in this case no void occurs and the grain surface location is that illustrated in Fig 6.

Figure 6 : Void depth - Transverse section



In the zone forward and abaft the hatch, the grain surface is located so as that the standard void depth V_d increases with the distance from the hatch, as shown in Fig 7.

Figure 7 : Void depth - Longitudinal section



For the void depth calculation, three different transversal sections, AA, BB and CC are taken into account, and for each of these sections, three different points (A_1, A_2, A_3, B_1, B_2, B_3 and C_1, C_2, C_3) are to be considered, as illustrated in Fig 8.

The distance between the points C_3 and B_2, in m, is as follows:

$$C_3B_2 = \sqrt{(3^2 + 2^2)} = 3{,}61$$

and the void depth V_{d2}, in m, measured in B_2 is:

$$V_{d2} = 3{,}61 \tan 30^\circ + 0{,}60 = 2{,}68$$

The topside tank area A_W, in m², (I + II) is as follows:

$$A_W = (6 \cdot 0{,}60) + \frac{6(\tan 30^\circ)6}{2} = 13{,}99$$

The void depth V_{d3}, V_{d2}, V_{d1}, in m, relevant to points A_3, A_2, A_1 of section AA is:

$$V_{d3} = 4 \tan 30^\circ + 0{,}60 = 2{,}91$$

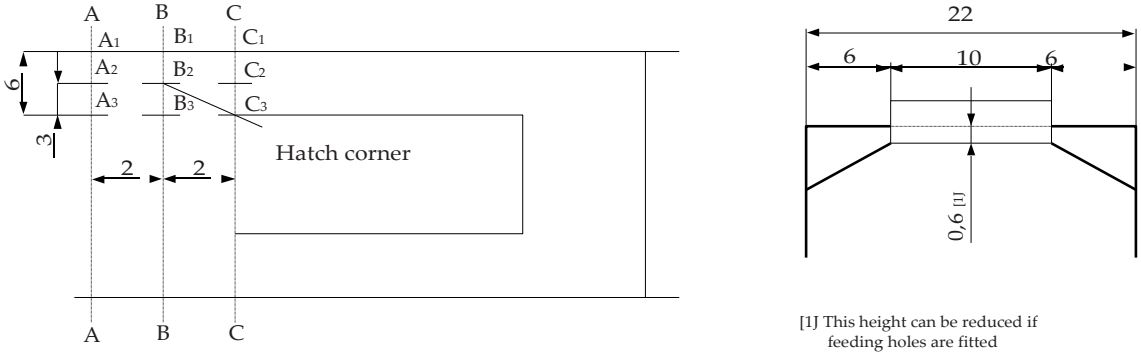
$$V_{d2} = (\sqrt{3^2 + 4^2}) \tan 30^\circ + 0{,}60 = 3{,}49$$

$$V_{d1} = (\sqrt{6^2 + 4^2}) \tan 30^\circ + 0{,}60 = 4{,}76$$

The area $A_{V,AA}$, in m², of the void in transversal section AA (calculated according to Simpson's integration rule) is as follows:

$$A_{V,AA} = \frac{A_1 A_-}{3} \cdot (V_{d3} + 4 \cdot V_{d2} + V_{d1}) = 21{,}63$$

Figure 8 : Geometry for void depth calculation



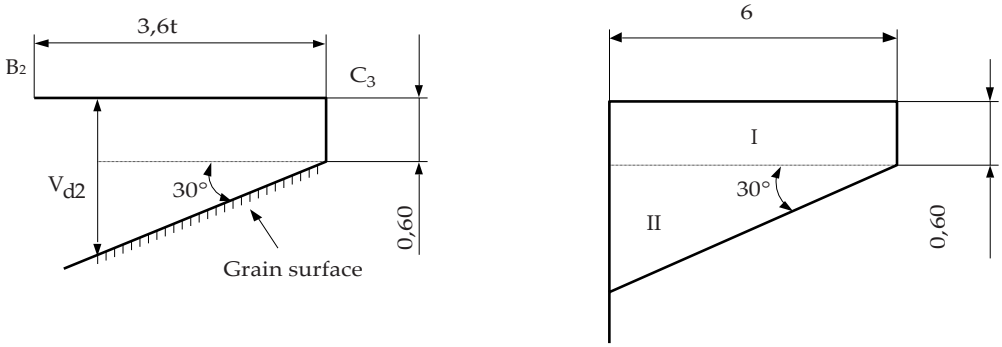


Figure 9 : Geometry for void depth calculation

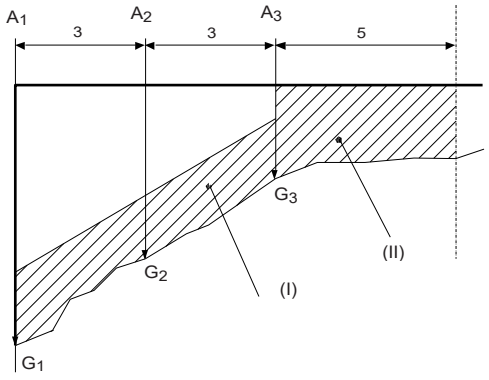
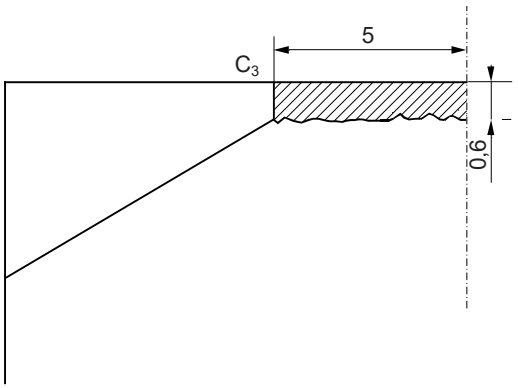


Figure 10 : Geometry for void depth calculation



With reference to Fig 9 and Fig 10 the following areas are calculated:

- area $A_1A_3G_1G_3$ (which is the area $A_{V,AA}$ calculated above), in m², equal to: 21,63
- topside tank area A_W, in m², equal to: 13,98
- area $A_{V,I}$, in m², relevant to void I, equal to:

  $A_{V,I} = 21,63 - 13,99 = 7,64$
- area $A_{V,II}$, in m², relevant to void II, equal to:

  $A_{V,II} = 5 \cdot 2,91 = 14,55$
- total area $A_{T,AA}$ of void, port and starboard, in m², in section AA, equal to:

  $A_{T,AA} = 2\ (7,64 + 14,55) = 44,38$

With the same procedure the void relevant to the BB section is calculated, as follows:

- total area $A_{T,BB}$ of void, port and starboard, in m², in section BB:

  $A_{T,BB} = 22,98$
- total area $A_{T,CC}$ of void, port and starboard, in m², in section CC:

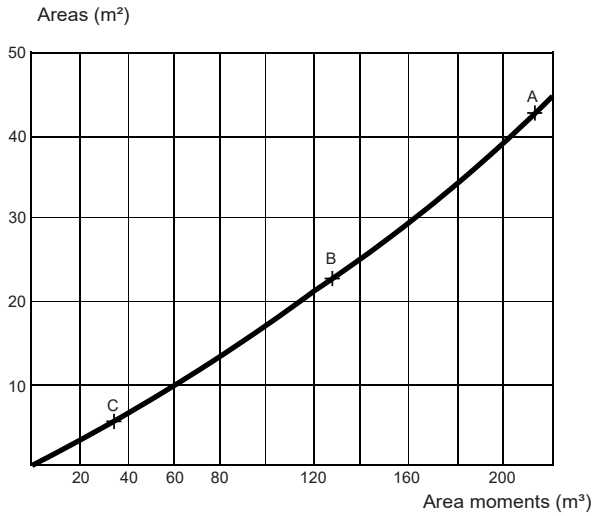
  $A_{T,CC} = 2\ (5 \cdot 0,60) = 6,00$

3.1.1 Calculation of areas and area moments

Finding the surface at each station after shift which establishes a void area exactly equal to that at the station before shift is a complicated calculation if done directly.

However, if the areas and corresponding area moments are calculated for random shifts from the horizontal to 25°, and a plot is made of areas versus area moments, then by entering the plot with the actual void area at any position before shift, a close approximation to the area moment after shift can be obtained. Such a plot is provided in Fig 11.

Figure 11 : Plot of areas versus area moments



Another advantage of this method lies in the fact that while the lengths of the end sections may vary, the cross-sectional dimensions are usually uniform throughout most of the ship. Therefore the same plot of areas versus area moments can be used for several locations.

With reference to Fig 12, the areas relevant to the zones 1, 2, 3 are as follows:

- area A_1, in m^2, relevant to zone 1:

$$A_1 = \frac{8,74(\tan 25^\circ)8,74}{2} - 3,99 = 3,82$$

- area A_2, in m^2, relevant to zone 2:

$$A_2 = \frac{13(\tan 25^\circ)13}{2} - 13,99 = 25,41$$

- area A_3, in m^2, relevant to zone 3:

$$A_3 = \frac{16(\tan 25^\circ)16}{2} - 13,99 = 45,70$$

The area moments M_1, M_2, M_3, in m^3 relevant to areas A_1, A_2, A_3, referred to the centreline are as follows:

- area moment M_1:

$$M_1 = 17,81\left(\frac{2}{3}.8,74 + 2,26\right) - 3,6(3+5) - 10,38\left(\frac{2}{3}.6 + 5\right) = 21,80$$

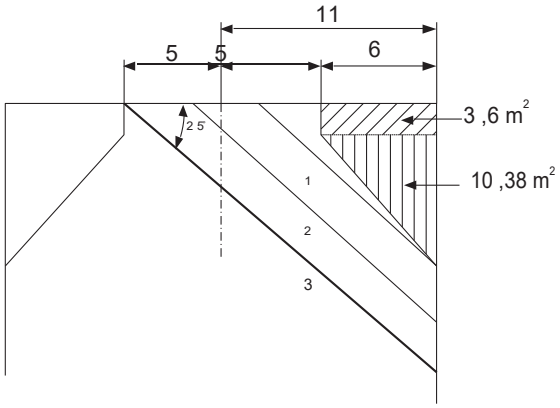
- area moment M_2:

$$M_2 = 39,39\left(\frac{2}{3}.13 - 2\right) - 3,6(3+5) - 10,38\left(\frac{2}{3}.6 + 5\right) = 140,38$$

- area moment M_3:

$$M_3 = 59,68\left(\frac{2}{3}.16 - 5\right) - 3,6(3+5) - 10,38\left(\frac{2}{3}.6 + 5\right) = 215,97$$

Figure 12 : Geometry for void depth calculation



A summary of the values obtained is reported in Tab 3.

Table 3 : Areas and area moments

Zone	Area, in m^2	Area moment in m^3
1	3,83	21,80
2	25,41	140,38
3	45,70	215,97

Table 4 : Total volumetric heeling moment in a hold, with untrimmed ends

Hold zone	Heeling moment, in m^4
Fore end	505,33
Hatch	236,25
Aft end	505,33
Total	1246,91

3.1.2 Calculation of volumetric heeling moment

a) Volumetric heeling moment in untrimmed end.

Tab 4 gives the values of areas and area moments derived from the plot in Fig 11.

Therefore, the longitudinal distance between points A, B, C being equal to 2 m, the volumetric heeling moment in the untrimmed end M^I, in m^4, is as follows:

$$M^I = \frac{2}{3}[1 \cdot 34 + 4 \cdot 128 + 1 \cdot 212] = 505,33$$

b) Volumetric heeling moment in hatch.

The following calculation is valid for void spaces within the hatch (see Fig 13).

- void area A_H, in m^2:

$$A_H = 10(0,4 + 0,15) = 5,5$$

- centre of gravity x, in m, relevant to A_H:

$$x = \sqrt{\frac{5,5 \cdot 2}{\tan 15^\circ}} = 6,41$$

- area moment M_H, in m^3:

$$M_H = 5,5\left(5 - \frac{6,41}{3}\right) = 15,75$$

Figure 13 : Volumetric heeling moment in hatch

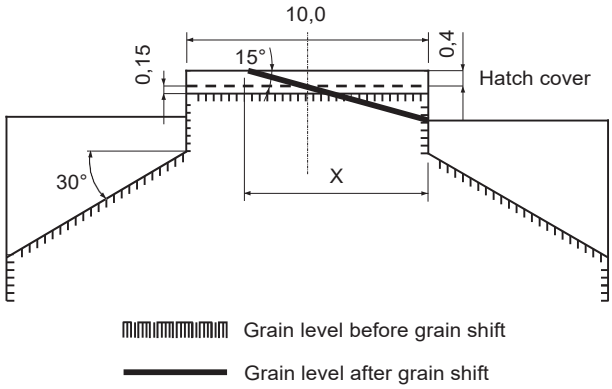
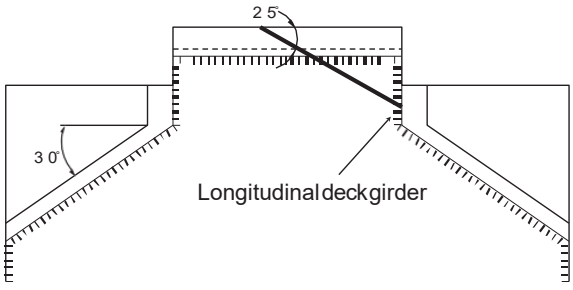


Figure 14 : Possible void relevant to a longitudinal deck girder



The hatch length being equal to 15 m, the volumetric heeling moment in hatch M^{II}, in m^4, is as follows:

$M^{II} = 15{,}75 \cdot 15 = 236{,}25$

In addition, the possible void relevant to a longitudinal deck girder as described in Fig 14, as well as the possible void relevant to the topside tank geometry as described in Fig 15, are to be taken into account; on the contrary, the possible void relevant to topside tank longitudinal stiffeners as described in Fig 16 may not be taken into account.

c) Volumetric heeling moment

The total volumetric heeling moment in a hold, as reported in Tab 4, is the sum of the contribution of a) and b) above.

Figure 15 : Possible void relevant to the topside tank geometry

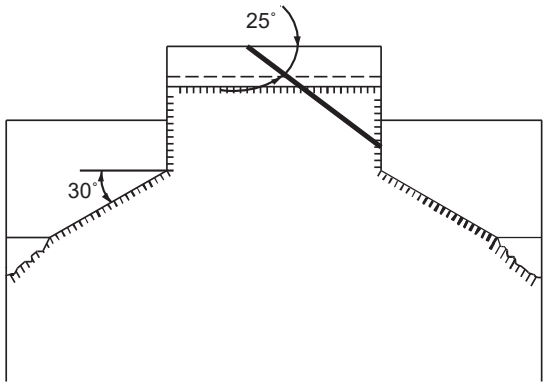
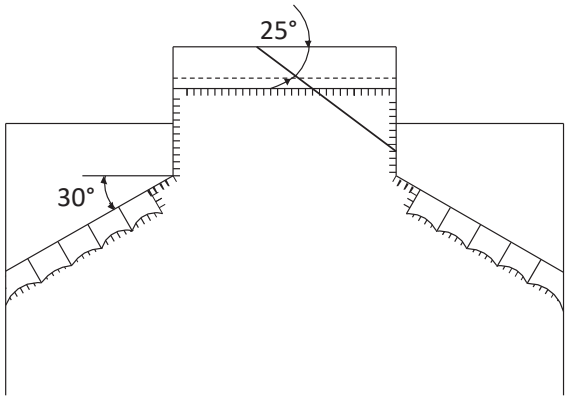


Figure 16 : Possible void relevant to topside tank longitudinal stiffeners



Chapter 5
ORE CARRIERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligilble for the assignment of the service notation **ore carrier**, as defined in Pt A, Ch 1, Sec 2, [4.3.5].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Part A, Part C and Part D of the Rules, as applicable, and with the requirements of this Chapter, which are specific to ore carriers.

1.2 Summary table

1.2.1 Tab 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to ore carriers.

Table 1

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery	**(1)**
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for ore carriers are given in this Chapter.	

SECTION 2 SHIP ARRANGEMENT

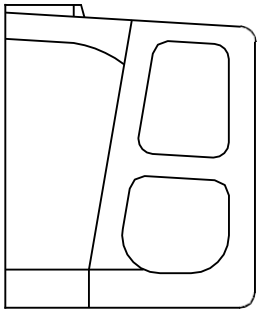
1 General

1.1 Application

1.1.1 The requirements of Sec 2 and Sec 3 apply to single deck ships with two longitudinal bulkheads and a double bottom throughout the cargo region and intended to carry dry cargoes in bulk, including ore cargo, in the centre holds only. A typical midship section is shown in Fig 1.

The application of these requirements to other ship types is to be considered by the Society on a case-by-case basis.

Figure 1 : Ore carrier



2 General arrangement design

2.1 Access arrangement to double bottom and pipe tunnel

2.1.1 Means of access

Adequate means of access to the double bottom and pipe tunnel are to be provided.

2.1.2 Manholes in the inner bottom, floors and girders

Manholes cut in the inner bottom are to be located at a minimum distance of one floor spacing from the lower stool.

The location and size of manholes in floors and girders are to be determined to facilitate the access to double bottom structures and their ventilation. However, they are to be avoided in the areas where high shear stresses may occur.

2.2 Access arrangement to cargo holds

2.2.1 Means of access

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

2.2.2 Hatches of large cargo holds

If separate hatches are used as access to the ladders as required in [2.2.3], each hatch is to have a clear opening of at least 600 mm x 600 mm.

When the access to the cargo hold is arranged through the cargo hatch, the top of the ladder is to be placed as close as possible to the hatch coaming.

Accesses and ladders are to be so arranged that personnel equipped with self-contained breathing apparatus may readily enter and leave the cargo hold.

Access hatch coamings having a height greater than 900 mm are also to have steps on the outside in conjunction with cargo hold ladders.

2.2.3 Ladders within large cargo holds

Each cargo hold is to be provided with at least two ladders as far apart as practicable longitudinally. If possible these ladders are to be arranged diagonally, e.g. one ladder near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side, from the ship's centreline.

Ladders are to be so designed and arranged that the risk of damage from the cargo handling gear is minimised.

Vertical ladders may be permitted provided they are arranged above each other in line with other ladders to which they form access and resting positions are provided at not more than 9 metres apart.

Tunnels passing through cargo holds are to be equipped with ladders or steps at each end of the hold so that personnel may get across such tunnels.

Where it may be necessary for work to be carried out within a cargo hold preparatory to loading, consideration is to be given to suitable arrangements for the safe handling of portable staging or movable platforms.

SECTION 3 HULL AND STABILITY

Symbols

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

E : Young's modulus, in N/mm^2, to be taken equal to:

- E = 2,06.10^5 N/mm^2 for steels in general
- E = 1,95.10^5 N/mm^2 for stainless steels.

1 General

1.1 Loading manual and loading instruments

1.1.1 The specific requirements in Pt B, Ch 11, Sec 2 for ships with the service notation **ore carrier ESP** and equal to or greater than 150 m in length are to be complied with.

2 Stability

2.1 Intact stability

2.1.1 General

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.5] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2. Where the ship is intended also for the carriage of grain, the requirements in Ch 4, Sec 3, [2.2.2] and Ch 4, Sec 3, [2.2.3] are to be complied with.

3 Design loads

3.1 Hull girder loads

3.1.1 Still water loads *(1/1/2022)*

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1.2], still water loads are to be calculated for the following loading conditions, subdivided into departure and arrival conditions as appropriate:

- alternate light and heavy cargo loading conditions at maximum draught
- homogeneous light and heavy cargo loading conditions at maximum draught

Figure 1 : Symmetrical gusset/shedder plates

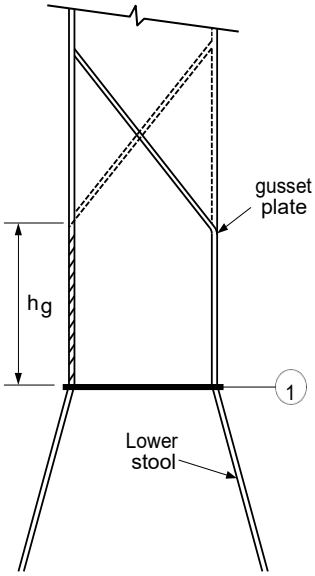
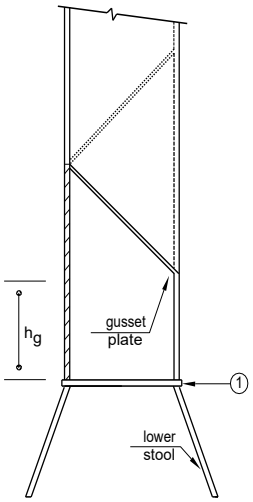
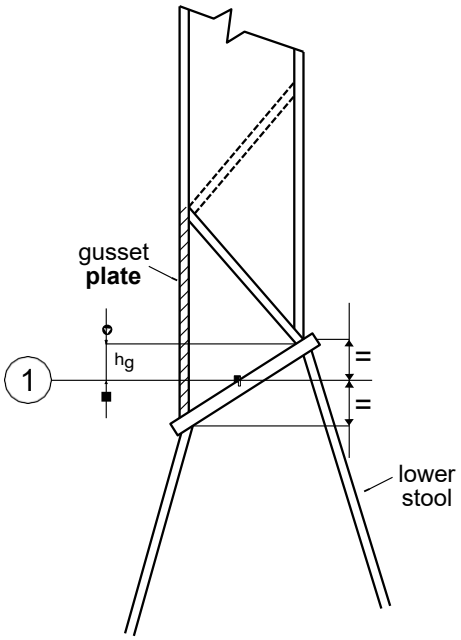


Figure 2 : Asymmetrical gusset/shedder plates



- ballast conditions; App 1 contains the guidance for partially filled ballast tanks in ballast loading conditions.
- short voyage conditions where the ship is to be loaded to maximum draught but with a limited amount of bunkers
- multiple port loading/unloading conditions
- deck cargo conditions, where applicable
- typical loading sequences where the ship is loaded from commencement of cargo loading to reaching full deadweight capacity, for homogeneous conditions, relevant part load conditions and alternate conditions where applicable. Typical unloading sequences for these conditions are also to be included. The typical loading/unloading sequences are also to be developed so as not to exceed applicable strength limitations. The typical loading sequences are also to be developed paying due attention to the loading rate and deballasting capability.
- typical sequences for change of ballast at sea, where applicable.

Figure 3 : Asymmetrical gusset/shedder plates - Sloping stool top plate



4 Structure design principles

4.1 Double bottom structure

4.1.1 The double bottom is to be longitudinally framed.

The girder spacing is to be not greater than 4 times the spacing of bottom or inner bottom ordinary stiffeners and the floor spacing is to be not greater than 3 frame spaces.

Solid floors are to be fitted in line with the transverse primary supporting members in wing tanks and intermediate floors are to be added at mid-span between primary supporting members.

4.1.2 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

4.1.3 Scarfing of the double bottom structure into the wing tanks is to be properly ensured. The inner bottom plating is generally to be prolonged within the wing tanks by adequately sized horizontal brackets in way of floors.

4.2 Side structure

4.2.1 In ships greater than 120 m in length, the side shell is to be longitudinally framed.

In general, the spacing of vertical primary supporting members is to be not greater than 6 times the frame spacing.

4.2.2 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo hold.

4.3 Deck structure

4.3.1 The deck outside the line of hatches is to be longitudinally framed.

4.3.2 The cross decks between hatches are generally to be transversely framed.

4.3.3 The connection of hatch end beams with deck structures is to be properly ensured by fitting inside the wing tanks additional web frames or brackets.

4.4 Longitudinal bulkhead structure

4.4.1 Longitudinals bulkheads are to be plane, but they may be knuckled in the upper and lower parts to form a hopper. In such cases, the design of the knuckles and the adjacent structures is to be considered by the Society on a case-by-case basis.

4.4.2 In ships greater than 120 m in length, longitudinal bulkheads are to be longitudinally framed.

4.4.3 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo hold.

4.5 Transverse bulkhead structure

4.5.1 Where the structural arrangement of transverse bulkheads in wing tanks is different from that in centre holds, arrangements are to be made to ensure continuity of the transverse strength through the longitudinal bulkheads.

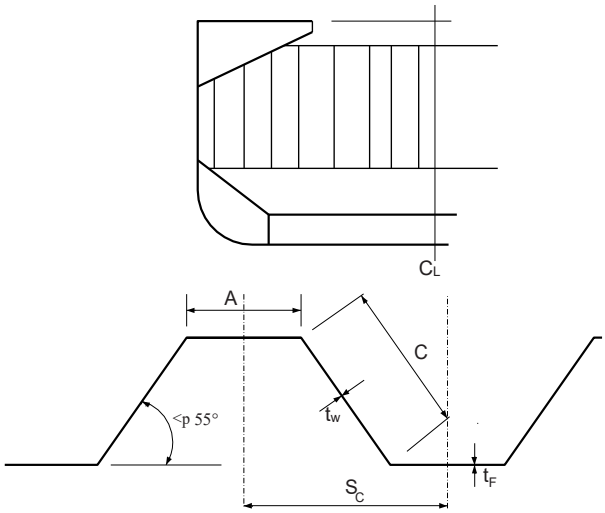
4.6 Transverse vertically corrugated watertight bulkheads

4.6.1 General

Transverse vertically corrugated watertight bulkheads are generally to be fitted with a lower stool and an upper stool below the deck.

The corrugation angle φ shown in Fig 4 is to be not less than 55°.

Figure 4 : Corrugation geometry

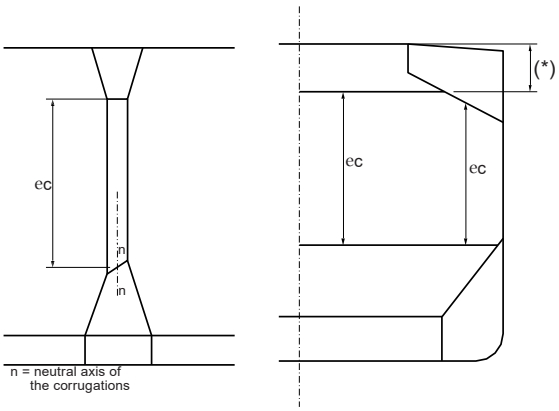


4.6.2 Span of corrugations

The span ℓ_C of the corrugations (to be used for carrying out the strength checks according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as the case may be) is to be taken as the distance shown in Fig 5. For the definition of ℓ_C, the internal end of the upper stool may not be taken at a distance from the deck at centreline greater than:

- 3 times the depth of corrugations, in general
- twice the depth of corrugations, for rectangular upper stools.

Figure 5 : Span of the corrugations



(*) See [4.6.2].

4.6.3 Lower stool *(1/7/2001)*

The lower stool is to have a height in general not less than 3 times the depth of the corrugations.

The thickness and material of the stool top plate are to be not less than those required for the bulkhead plating above. The thickness and material properties of the upper portion of vertical or sloping stool side plating within the depth equal to the corrugation flange width from the stool top are to be not less than the required flange plate thickness and material to meet the bulkhead stiffness requirement at the lower end of corrugation.

The ends of stool side ordinary stiffeners are to be attached to brackets at the upper and lower ends of the stool.

The distance from the edge of the stool top plate to the surface of the corrugation flange is to be in accordance with Fig 6 .

The stool bottom is to be installed in line with double bottom floors and is to have a width not less than 2,5 times the mean depth of the corrugation.

The stool is to be fitted with diaphragms in line with the longitudinal double bottom girders for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connections to the stool top plate are to be avoided.

Where corrugations are cut at the lower stool, the weld connections of corrugations and stool side plating to the stool top plate are to be in accordance with [9.1]. The weld connections of stool side plating and supporting floors to the inner bottom plating are to be in accordance with [9.1].

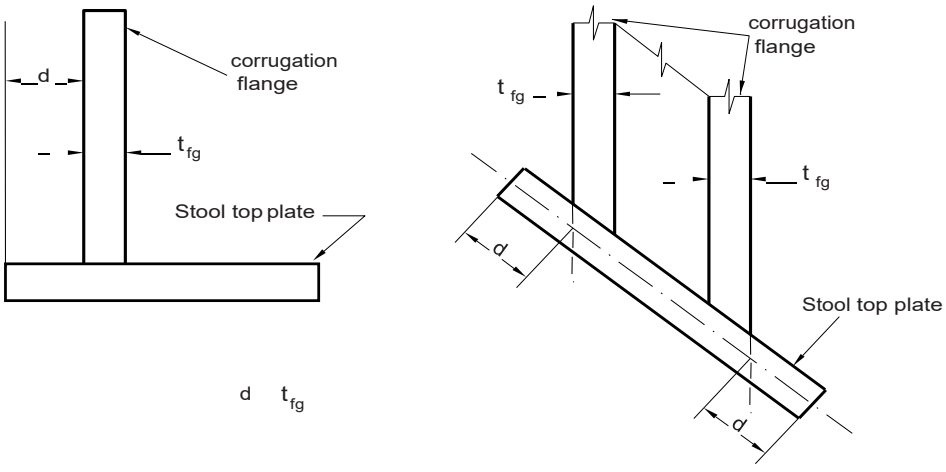
4.6.4 Upper stool

The upper stool is to have a height in general between 2 and 3 times the depth of corrugations. Rectangular stools are to have a height in general equal to twice the depth of corrugations, measured from the deck level and at the hatch side girder.

The upper stool is to be properly supported by deck girders or deep brackets between the adjacent hatch end beams.

The width of the upper stool bottom plate is generally to be the same as that of the lower stool top plate. The stool top of non-rectangular stools is to have a width not less than twice the depth of corrugations.

Figure 6 : Permitted distance, d, from the edge of the stool top plate to the surface of the corrugation flange



t_{fg} : as built flange thickness

The thickness and material of the stool bottom plate are to be the same as those of the bulkhead plating below. The thickness of the lower portion of stool side plating is to be not less than 80% of that required for the upper part of the bulkhead plating where the same material is used.

The ends of stool side ordinary stiffeners are to be attached to brackets at the upper and lower end of the stool.

The stool is to be fitted with diaphragms in line with and effectively attached to longitudinal deck girders extending to the hatch end coaming girders for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connection to the stool bottom plate are to be avoided.

4.6.5 Alignment

Stool side plating is to align with the corrugation flanges; lower stool side vertical stiffeners and their brackets in the stool are to align with the inner bottom longitudinals to provide appropriate load transmission between these stiffening members. Lower stool side plating may not be knuckled anywhere between the inner bottom plating and the stool top plate.

4.6.6 Effective width of the compression flange

The effective width of the corrugation flange to be considered for the strength check of the bulkhead is to be obtained, in m, from the following formula:

$b_{EF} = C_E A$

where:

C_E : Coefficient to be taken equal to:

$$C_E = \frac{2,25}{\beta} - \frac{1,25}{\beta^2} \quad \text{for } \beta > 1,25$$

$$C_E = 1,0 \quad \text{for } \beta \leq 1,25$$

β : Coefficient to be taken equal to:

$$\beta = 10^3 \frac{A}{t_f} \sqrt{\frac{R_{eH}}{E}}$$

A : Width, in m, of the corrugation flange (see Fig 4)

t_f : Net flange thickness, in mm

R_{eH} : Minimum yield stress, in N/mm^2, of the flange material, defined in Pt B, Ch 4, Sec 1, [2].

4.6.7 Effective shedder plates

Effective shedder plates are those which:

- are not knuckled
- are welded to the corrugations and the lower stool top plate according to [9.1]
- are fitted with a minimum slope of 45°, their lower edge being in line with the lower stool side plating
- have thickness not less than 75% of that required for the corrugation flanges
- have material properties not less than those required for the flanges.

4.6.8 Effective gusset plates

Effective gusset plates are those which:

- are in combination with shedder plates having thickness, material properties and welded connections according to [4.6.7]
- have a height not less than half of the flange width
- are fitted in line with the lower stool side plating
- are welded to the lower stool plate, corrugations and shedder plates according to [9.1]
- have thickness and material properties not less than those required for the flanges.

4.6.9 Section modulus at the lower end of corrugations

a) The section modulus at the lower end of corrugations (sections 1 in Fig 7 to Fig 3) is to be calculated with the compression flange having an effective flange width b_{ef} not larger than that indicated in [4.6.6].

b) Webs not supported by local brackets.

Except in case e), if the corrugation webs are not supported by local brackets below the stool top plate in the lower part, the section modulus of the corrugations is to be calculated considering the corrugation webs 30% effective.

c) Effective shedder plates.

Provided that effective shedder plates, as defined in [4.6.7], are fitted (see Fig 7 and Fig 8), when calculating the section modulus of corrugations at the lower end (sections 1 in Fig 7 and Fig 8), the area of flange plates may be increased by the value obtained, in cm^2, from the following formula:

$I_{SH} = 2,5A \sqrt{t_F t_{SH}}$

without being taken greater than $2,5At_F$,

where:

A : Width, in m, of the corrugation flange (see Fig 4)

t_{SH} : Net shedder plate thickness, in mm

t_F : Net flange thickness, in mm.

d) Effective gusset plates.

Provided that effective gusset plates, as defined in [4.6.8], are fitted (see Fig 1 to Fig 3), when calculating the section modulus of corrugations at the lower end (cross-sections 1 in Fig 1 to Fig 3), the area of flange plates may be increased by the value obtained, in cm^2, from the following formula:

$I_G = 7 h_G t_F$

where:

h_G : Height, in m, of gusset plates (see Fig 1 to Fig 3), to be taken not greater than $(10/7)S_{GU}$

S_{GU} : Width, in m, of gusset plates

t_F : Net flange thickness, in mm, based on the as-built condition.

e) Sloping stool top plate

If the corrugation webs are welded to a sloping stool top plate which has an angle not less than 45° with the horizontal plane, the section modulus of the corrugations may be calculated considering the corrugation webs fully effective. For angles less than 45°, the effectiveness of the web may be obtained by linear interpolation between 30% for 0° and 100% for 45°.

Where effective gusset plates are fitted, when calculating the section modulus of corrugations the area of flange plates may be increased as specified in d) above. No credit may be given to shedder plates only.

4.6.10 Section modulus at sections other than the lower end of corrugations

The section modulus is to be calculated with the corrugation webs considered effective and the compression flange having an effective flange width, b_{EF}, not larger than that obtained in [4.6.6].

4.6.11 Shear area

The shear area is to be reduced in order to account for possible non-perpendicularity between the corrugation webs and flanges. In general, the reduced shear area may be obtained by multiplying the web sectional area by (sin φ), φ being the angle between the web and the flange (see Fig 4).

Figure 7 : Symmetrical shedder plates

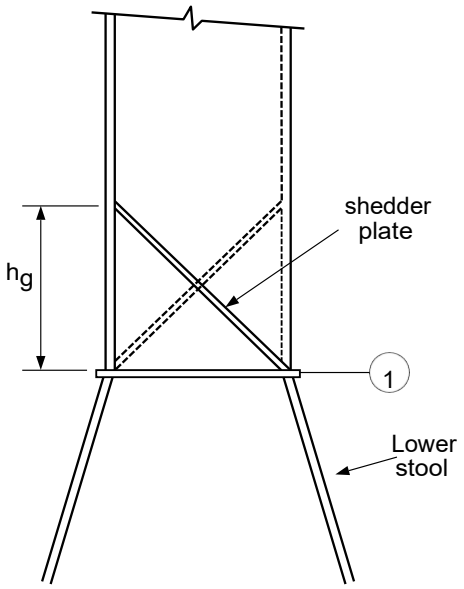
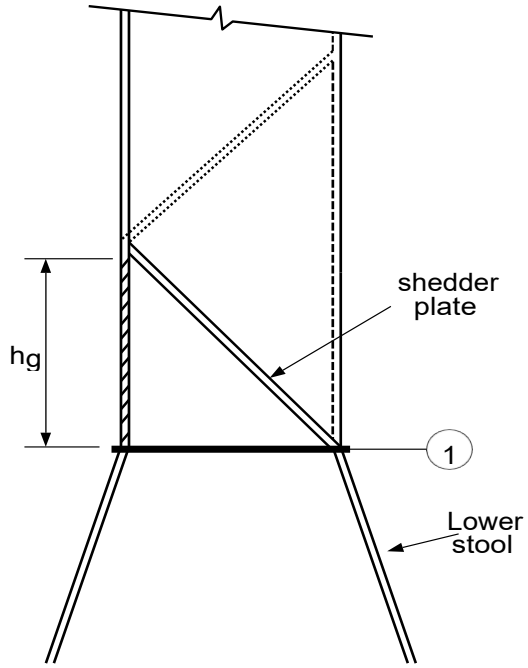


Figure 8 : Asymmetrical shedder plates



5 Hull scantlings

5.1 Additional requirements

5.1.1 Minimum net thicknesses of the inner bottom plating

The net thickness of the inner bottom plating in holds is to be not less than the value given in Tab 1.

Table 1 : Minimum net thickness of the inner bottom plating in holds

Plating	Minimum net thickness, in mm	
Inner bottom in holds	Longitudinal framing	$2,15\ (L^{1/3}\ k^{1/6}) + 4,5\ s$
	Transverse framing	$2,35\ (L^{1/3}\ k^{1/6}) + 4,5\ s$
Note 1: s : Length, in m, of the shorter side of the plate panel.		

5.2 Strength checks of cross-ties analysed through a three dimensional beam model

5.2.1 General

Cross-ties analysed through three dimensional beam model analyses according to Pt B, Ch 7, Sec 3 are to be considered, in the most general case, as being subjected to axial forces and bending moments around the neutral axis perpendicular to the cross-tie web. This axis is identified as the y axis, while the x axis is that in the web plane (see Figures in Tab 2).

The axial force may be either tensile or compression. Depending on this, two types of checks are to be carried out, according to [5.2.2] or [5.2.3], respectively.

5.2.2 Strength check of cross-ties subjected to axial tensile forces and bending moments

The net scantlings of cross-ties are to comply with the following formula:

$$10\frac{F_T}{A_{ct}} + 10^3\frac{M}{w_{yy}} \leq \frac{R_y}{\gamma_R\gamma_m}$$

where:

F_T : Axial tensile force, in kN, in the cross-ties, obtained from the structural analysis

A_{ct} : Net sectional area, in cm^2, of the cross-tie

M : Max ($|M_1|$, $|M_2|$)

M_1, M_2 : Algebraic bending moments, in kN.m, around the y axis at the ends of the cross-tie, obtained from the structural analysis,

w_{yy} : Net section modulus, in cm^3, of the cross-tie about the y axis

γ_R : Resistance partial safety factor:

$\gamma_R = 1,02$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

5.2.3 Strength check of cross-ties subjected to axial compressive forces and bending moments

The net scantlings of cross-ties are to comply with the following formula:

$$10F_C\left(\frac{1}{A_{ct}} + \frac{\Phi e}{w_{xx}}\right) \leq \frac{R_y}{\gamma_R\gamma_m}$$

$$10\frac{F_C}{A_{ct}} + 10^3\frac{M_{max}}{w_{yy}} \leq \frac{R_y}{\gamma_R\gamma_m}$$

where:

F_C : Axial compressive force, in kN, in the cross-ties, obtained from the structural analysis

A_{ct} : Net cross-sectional area, in cm^2, of the cross-tie

$$\Phi = \frac{1}{1 - \frac{F_C}{F_{EX}}}$$

F_{EX} : Euler load, in kN, for buckling around the x axis:

$$F_{EX} = \frac{\pi^2 E I_{xx}}{10^5 \ell^2}$$

I_{xx} : Net moment of inertia, in cm^4, of the cross-tie about the x axis

ℓ : Span, in m, of the cross-tie

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 2 for various types of profiles

w_{ww} : Net section modulus, in cm^3, of the cross-tie about the x axis

M_{max} : Max ($|M_0|$, $|M_1|$, $|M_2|$)

$$M_0 = \frac{\sqrt{1+t^2}(M_1+M_2)}{2\cos(u)}$$

$$t = \frac{1}{\tan(u)}\left(\frac{M_2 - M_1}{M_2 + M_1}\right)$$

$$u = \frac{\pi}{2}\sqrt{\frac{F_C}{F_{EY}}}$$

F_{EY} : Euler load, in kN, for buckling around the y axis:

$$F_{EY} = \frac{\pi^2 E I_{yy}}{10^5 \ell^2}$$

I_{yy} : Net moment of inertia, in cm^4, of the cross-tie about the y axis

M_1,M_2 : Algebraic bending moments, in kN.m, around the y axis at the ends of the cross-tie, obtained from the structural analysis

w_{yy} : Net section modulus, in cm^3, of the cross-tie about the y axis

γ_R : Resistance partial safety factor:

$\gamma_R = 1,02$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

5.3 Strength checks of cross-ties analysed through a three dimensional finite element model

5.3.1 In addition to the requirements in Pt B, Ch 7, Sec 3, [4] and Pt B, Ch 7, Sec 3, [6], the net scantlings of cross-ties subjected to compression axial stresses are to comply with the following formula:

$$|o| \leq \frac{\sigma_c}{\gamma_R \gamma_m}$$

where:

o : Compressive stress, in N/mm^2, obtained from a three dimensional finite element analysis, based on fine mesh modelling, according to Pt B, Ch 7, Sec 3 and Pt B, Ch 7, App 1

σ_c : Critical stress, in N/mm^2, defined in [5.3.2]

γ_R : Resistance partial safety factor:

$\gamma_R = 1,02$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

5.3.2 The critical buckling stress of cross-ties is to be obtained, in N/mm^2, from the following formulae:

$$\sigma_c = \sigma_E \quad \text{for } \sigma_E \leq \frac{R_y}{2}$$

$$\sigma_c = R_y\left(1 - \frac{R_y}{4\sigma_E}\right) \quad \text{for } \sigma_E > \frac{R_y}{2}$$

where:

σ_E = Min (σ_{E1}, σ_{E2}),

σ_{E1} : Euler flexural buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E1} = \frac{\pi^2 E I}{10^4 A_{ct}^2 \ell}$$

I : Min (I_{xx}, I_{yy})

I_{xx} : Net moment of inertia, in cm^4, of the cross-tie about the x axis defined in [5.2.1]

I_{yy} : Net moment of inertia, in cm^4, of the cross-tie about the y axis defined in [5.2.1]

A_{ct} : Net cross-sectional area, in cm^2, of the cross-tie

ℓ : Span, in m, of the cross-tie

σ_{E2} : Euler torsional buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E2} = \frac{\pi^2 E I_w}{10^4 I_o \ell^2} + 0,41E\frac{J}{I_o}$$

I_w : Net sectorial moment of inertia, in cm^4, of the cross-tie, specified in Tab 2 for various types of profiles

I_o : Net polar moment of inertia, in cm^4, of the cross-tie,

$I_o = I_{xx} + I_{yy} + A_{ct}(y_o + e)^2$

y_o : Distance, in cm, from the centre of torsion to the web of the cross-tie, specified in Tab 2 for various types of profiles

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 2 for various types of profiles

J : St. Venant's net moment of inertia, in cm^4, of the cross-tie, specified in Tab 2 for various types of profiles.

6 Hatch covers, hatch coamings and closing devices

6.1 Application

6.1.1 *(1/7/2024)*

Refer to the requirements for Type 2 ships in Pt B, Ch 9, Sec 7.

7 Hull outfitting

7.1 Forecastle

7.1.1 General *(1/1/2004)*

Ships with service notation **ore carrier ESP** are to be fitted with an enclosed forecastle on the freeboard deck.

The required dimensions of the forecastle are defined in [7.1.2].

The structural arrangements and scantlings of the forecastle are to comply with the requirements in Pt B, Ch 10, Sec 2.

7.1.2 Dimensions *(1/7/2006)*

The forecastle is to be located on the freeboard deck with its aft bulkhead fitted in way or aft of the forward bulkhead of the foremost hold, as shown in Fig 9.

However, if this requirement hinders hatch cover operation, the aft bulkhead of the forecastle may be fitted forward of the forward bulkhead of the foremost cargo hold provided that the forecastle length aft FE is not less than $0,07L_{LL}$, where:

FE : Fore end of the length L, as defined in Pt B, Ch 1, Sec 2, [3.3.1]

L_{LL} : Freeboard length, as defined in Pt B, Ch 1, Sec 2, [3.2]

The forecastle height H_F above the main deck is to be not less than the greater of:

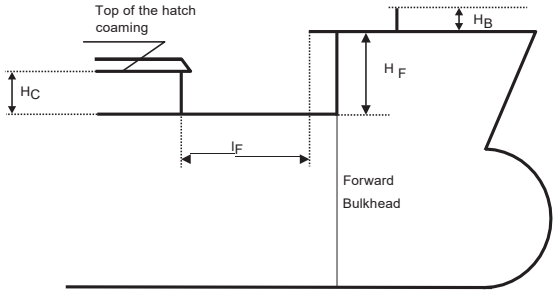
- the standard height of a superstructure, as specified in Pt B, Ch 1, Sec 2, Tab 2, or
- H_C + 0,5 m, where H_C is the height of the forward transverse hatch coaming of cargo hold No.1,

All points of the aft edge of the forecastle deck are to be located at a distance l_F, in compliance with the following formula, from the hatch coaming plate in order to apply the reduced loading to the No.1 forward transverse hatch coaming and No.1 hatch cover in applying Pt B, Ch 9, Sec 7, [3.3.2] and Pt B, Ch 9, Sec 7, [7.2.3], respectively:

$$l_F \leq 5\sqrt{H_F - H_C}$$

A breakwater may not be fitted on the forecastle deck with the purpose of protecting the hatch coaming or hatch covers. If fitted for other purposes, it is to be located such that its upper edge at centreline is not less than H_B / tan 20° forward of the aft edge of the forecastle deck, where H_B is the height of the breakwater above the forecastle (see Fig 9).

Figure 9 : Forecastle arrangement *(1/1/2004)*



8 Protection of hull metallic structures

8.1 Protection of sea water ballast tanks

8.1.1 *All dedicated seawater ballast tanks are to have an efficient corrosion prevention system, such as hard protective coatings or equivalent.*

The coatings are preferably to be of a light colour, i.e. a colour easily distinguishable from rust which facilitates inspection.

Where appropriate, sacrificial anodes may also be used.

9 Construction and testing

9.1 Welding and weld connections

9.1.1 The welding factors for some hull structural connections are specified in Tab 3. These welding factors are to be used, in lieu of the corresponding factors specified in Pt B, Ch 12, Sec 1, Tab 2, to calculate the throat thickness of fillet weld T connections according to Pt B, Ch 12, Sec 1, [2.3]. For the connections in Tab 3, continuous fillet welding is to be adopted.

9.2 Special structural details

9.2.1 The specific requirements in Pt B, Ch 12, Sec 2, [2.6] for ships with the service notation **ore carrier ESP** are to be complied with.

Table 2 : Calculation of cross-tie geometric properties

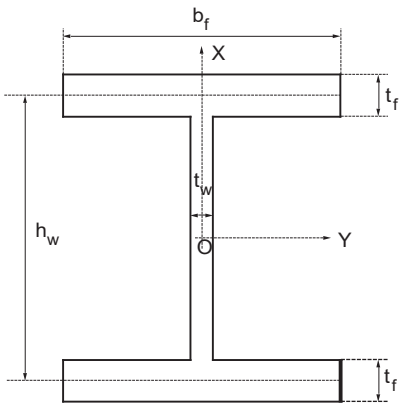
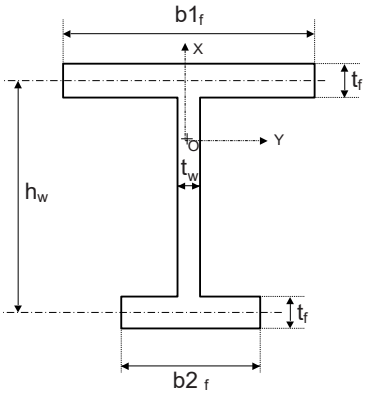
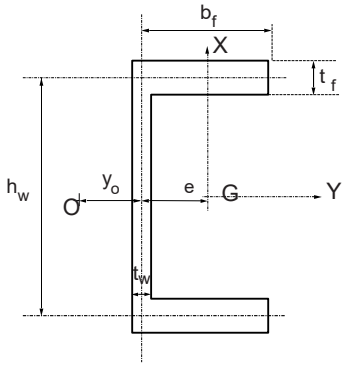
Cross-tie profile	e	y_0	J	I_W
T symmetrical 	0	0	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f h_w^2 b_f^3}{24}$
T non-symmetrical 	0	0	$\frac{1}{3}\lvert(b_{1f} + b_{2f})t_f^3 + h_w t_w^3\rvert$	$\frac{t_f h_w^2 b^3 b^3}{12(b_{1f}^3 + b_{2f}^3)}$
Non-symmetrical 	$\frac{b^2 t_f}{ht_w + 2bt_f}$	$\frac{3b^2 t}{6b_f t_f + h_w t_w}$	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f b^3 h^2 3b_f t_f + 2h_w t_w}{12 \quad 6b_f t_f + h_w t_w}$

Table 3 : Welding factor w_F *(1/7/2002)*

Hull area	Connection			Welding factor w_F
	of	to		
Double bottom in way of cargo holds	girders	bottom and inner bottom plating		0,35
		floors (interrupted girders)		0,35
	floors	bottom and inner bottom plating		0,35
		inner bottom in way of lower stools, in general		0,45
		inner bottom in way of corrugated watertight bulkhead lower stools		Full penetration or partial penetration welding
		girders (interrupted floors)		0,35
Bulkheads in cargo holds	structures of watertight bulkheads	lower stool top plate	plating and ordinary stiffeners (plane bulkheads)	0,45
			vertical corrugations (corrugated bulkheads)	Full penetration welding
		upper stool bottom plate		0,45
		longitudinal bulkheads		0,35
	lower stool structures	boundaries	plating of lower stools, in general	0,45
			plating of lower stools supporting corrugated watertight bulkheads	Full penetration or partial penetration welding
			ordinary stiffeners and diaphragms	0,45
	upper stool structures	boundaries		0,45
	effective shedder plates (see [4.6.7])	vertical corrugations and lower stool top plate		One side penetration welding or equivalent
	effective gusset plates (see [4.6.8])	lower stool top plate		Full penetration welding
		vertical corrugations and shedder plates		One side penetration welding or equivalent

APPENDIX 1 GUIDELINES FOR BALLAST LOADING CONDITIONS OF CARGO VESSELS INVOLVING PARTIALLY FILLED BALLAST TANKS

1 General guidance note

1.1 Introduction

1.1.1 *(1/1/2022)*

This Appendix is intended to provide guidance and interpretation of "Partially filled ballast tanks in ballast loading conditions" in Pt B, Ch 5, Sec 2, [2.1.2] b) and illustrates the conditions (C) necessary for checking longitudinal strength for a conventional ore carrier with two pairs of large wing water ballast tanks partly filled during the ballast voyage.

1.1.2 *(1/1/2022)*

In the Figures, the conditions only intended for strength verification (not operational) are marked with a star (*).

2 Conventional (with usual arrangement of WBT) ore carrier with two pairs of partially filled ballast water tanks

2.1 General

2.1.1 *(1/1/2022)*

Fig 1 show the operational loading conditions, departure condition (C1), four intermediate conditions (C2-C5) and arrival condition (C6), for a conventional (with usual arrangement of WBT) ore carrier with partial filling of both BW tank no.1 (P/S) and 7 (P/S) during voyage.

Table 1 : Filling level in partially filled BW tanks nos.1 (P/S) and 7 (P/S) for the operational conditions during ballast voyage *(1/1/2022)*

Loading condition	Consumables	Filling level, WBT 1(P/S)	Filling level, WBT 7(P/S)
C1 - Departure	100%	f_{1dep}%	f_{7dep}%
C2 – Intermediate 1	50% **(1)**	f_{1dep}%	f_{7dep}%
C3 – Intermediate 2	50% **(1)**	f_{1int}%	f_{7int}%
C4 – Intermediate 3	20% **(1)**	f_{1int}%	f_{7int}%
C5 – Intermediate 4	20% **(1)**	f_{1arr}%	f_{7arr}%
C6 - Arrival	10%	f_{1arr}%	f_{7arr}%
Note: **(1)** % consumables to be specified, indicated to 50% and 20 %			

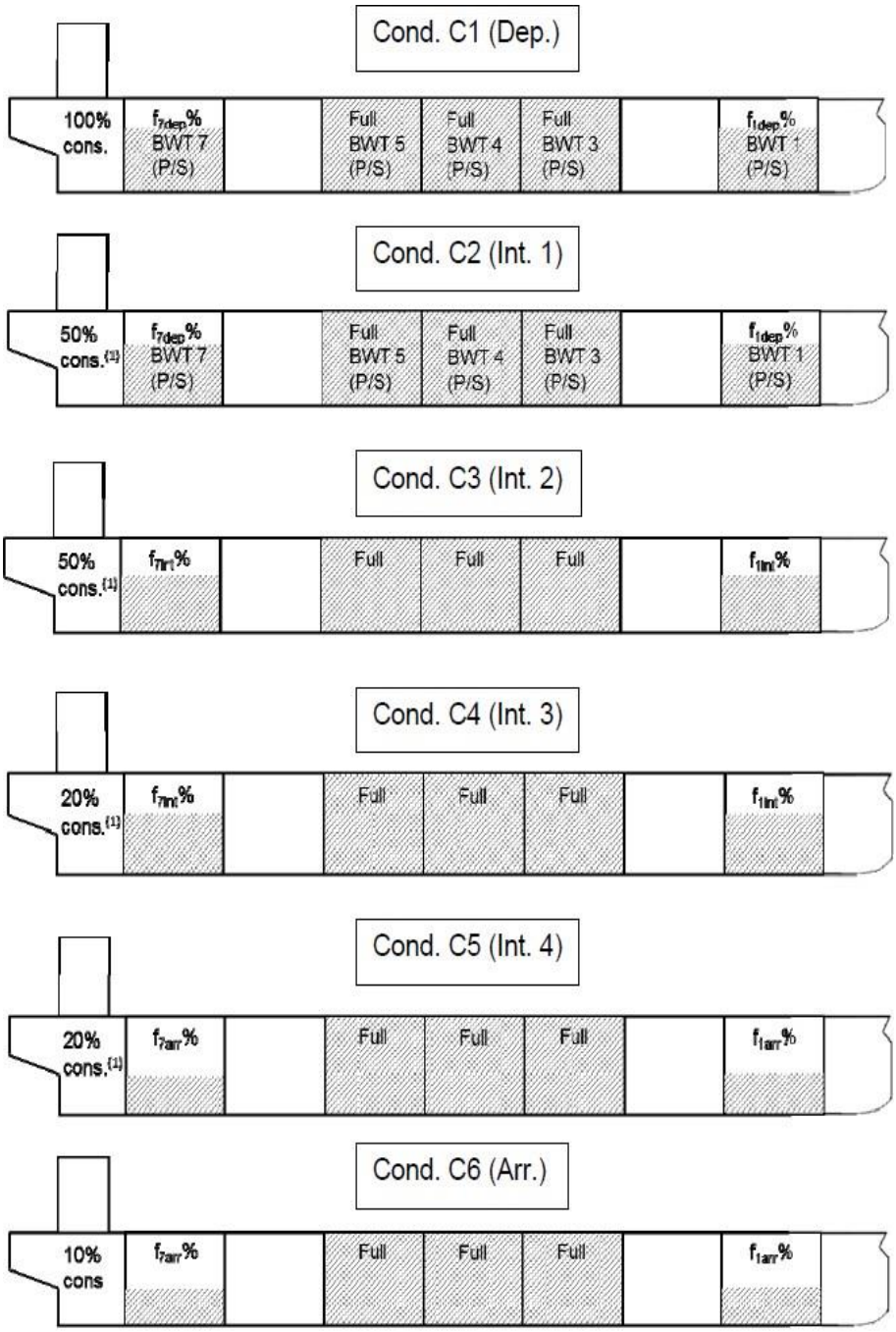
Fig 2 and Fig 3 show the additional twelve loading conditions (C1-1 ~ C1-12) which are to be added for longitudinal strength verification of the departure condition (C1).

Fig 4 and Fig 9 show the additional 32 loading conditions (C2-1 ~ C2-12, C3-1 ~ C3-4, C4-1 ~ C4-12 and C5-1 ~ C5-4) which are to be added for longitudinal strength verification of the intermediate conditions (C2 ~ C5).

Fig 10 and Fig 11 show the additional twelve loading conditions (C6-1 ~ C6-12) which are to be added for longitudinal strength verification of the arrival condition (C6).

For the additional loading conditions, the maximum and the minimum filling level of BW tank are according to trim and propeller immersion limitations given in Pt B, Ch 5, Sec 2, [2.1.2] b).

Figure 1 : *(1/1/2022)*



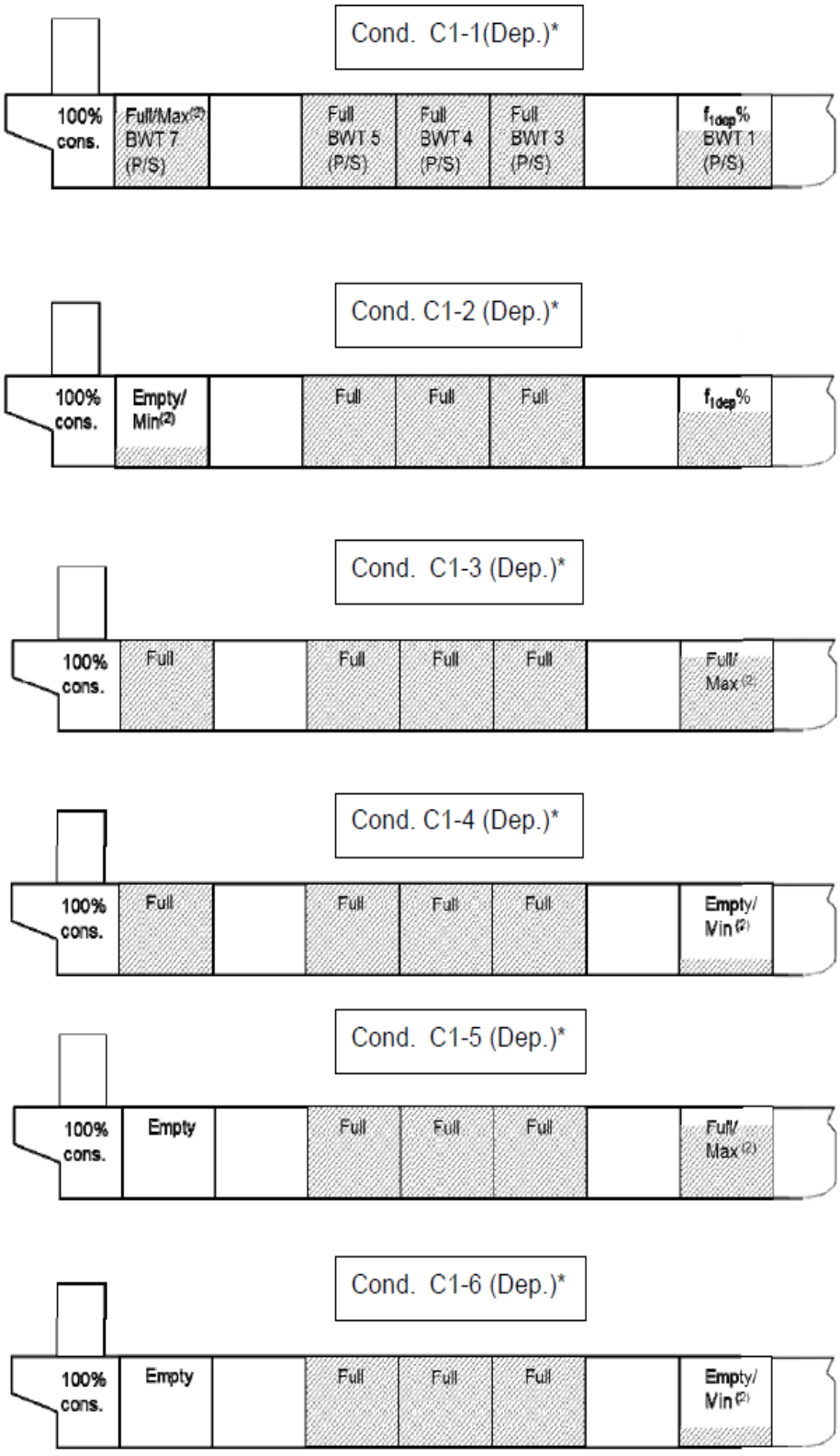
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during ballast voyage, operational conditions C1-C6.

Notes:

(1) The intermediate condition(s) to be specified incl.% consumables.

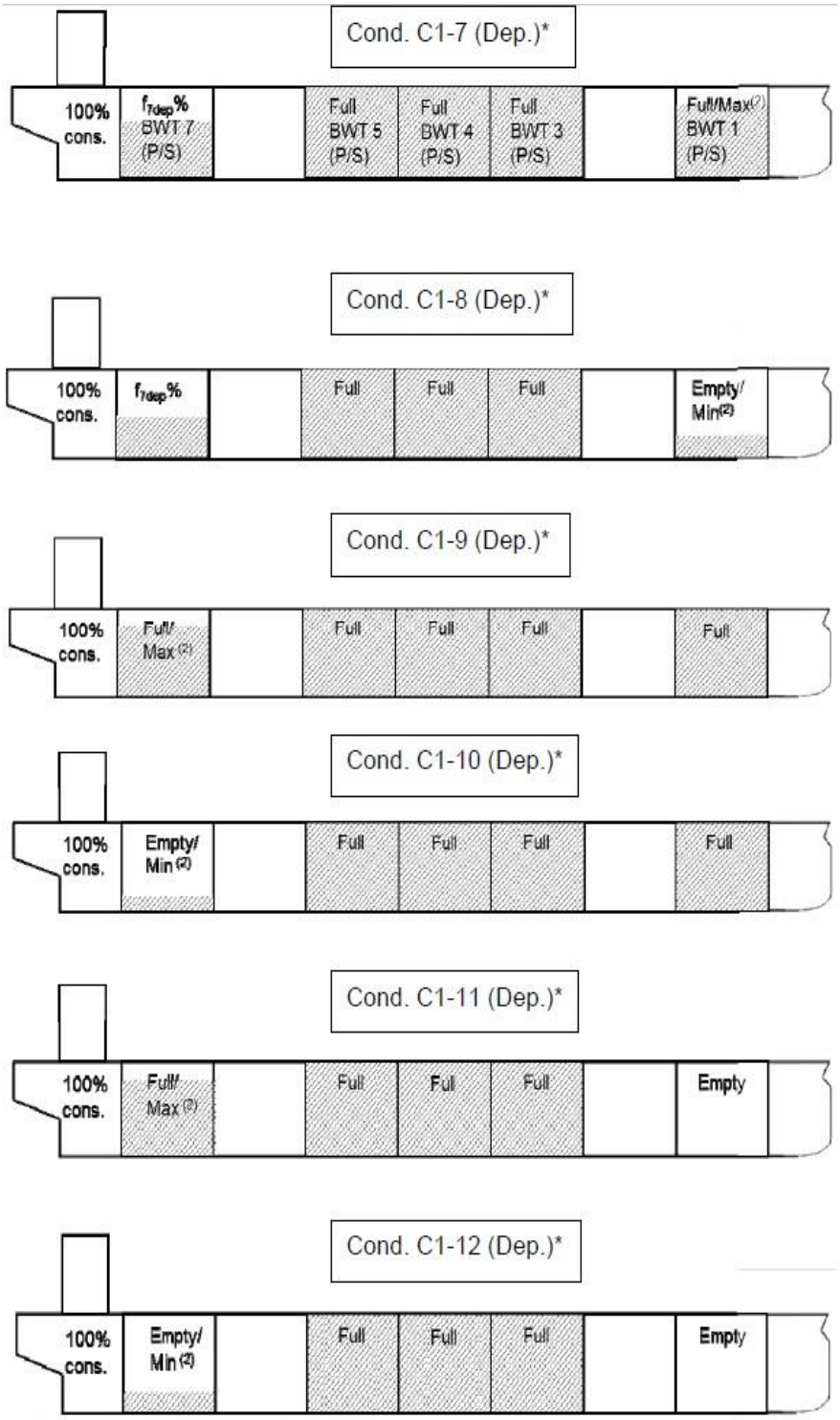
(2) Figures 2-11: Maximum and minimum filling level of BW tank according to trim and propeller immersion limitations given in Pt B, Ch 5, Sec 2, [2.1.2] b).

Figure 2 : *(1/1/2022)*



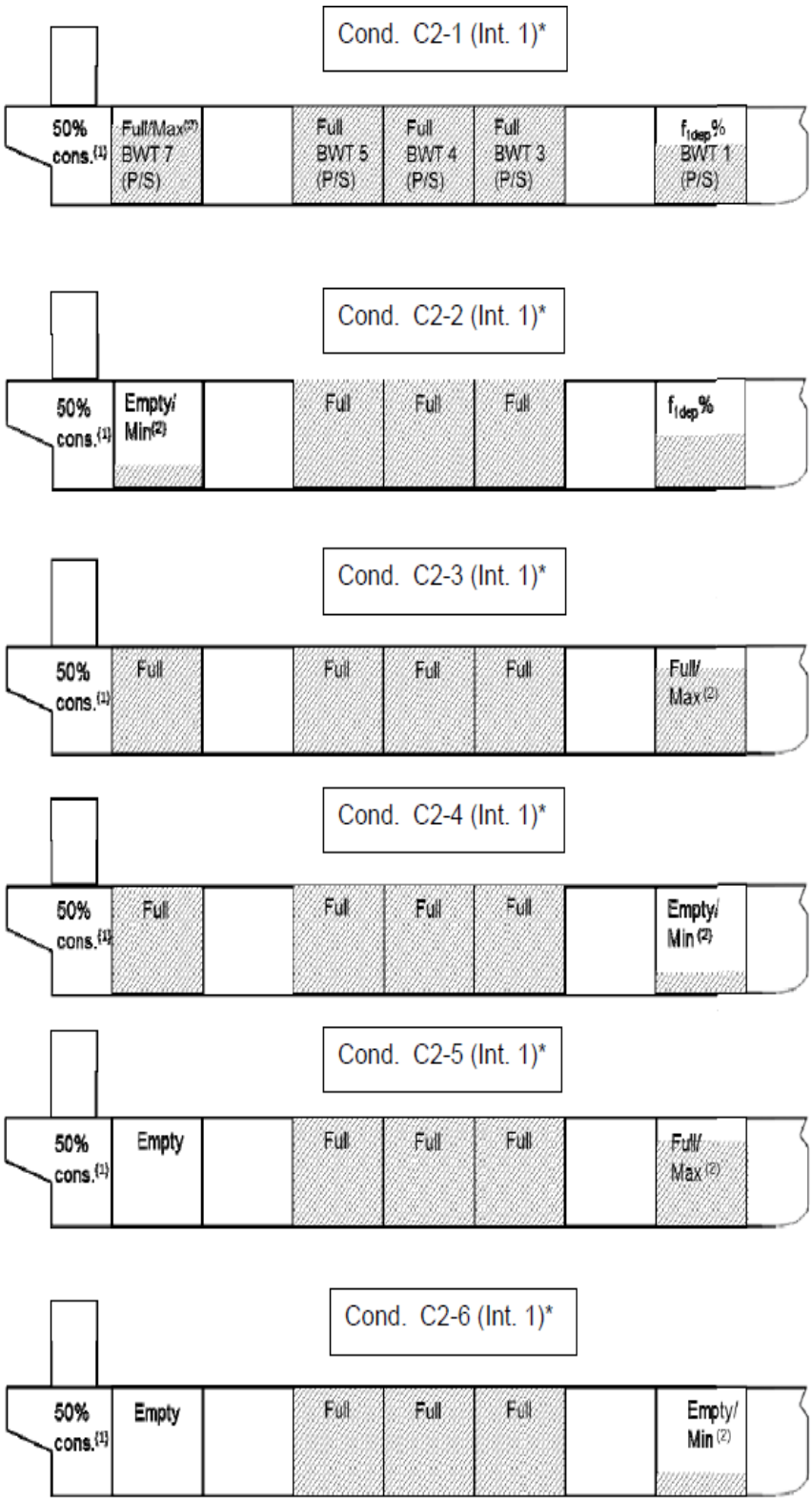
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Departure conditions C1-1~C1-6, only intended for strength verification (not operational) are marked: *

Figure 3 : *(1/1/2022)*



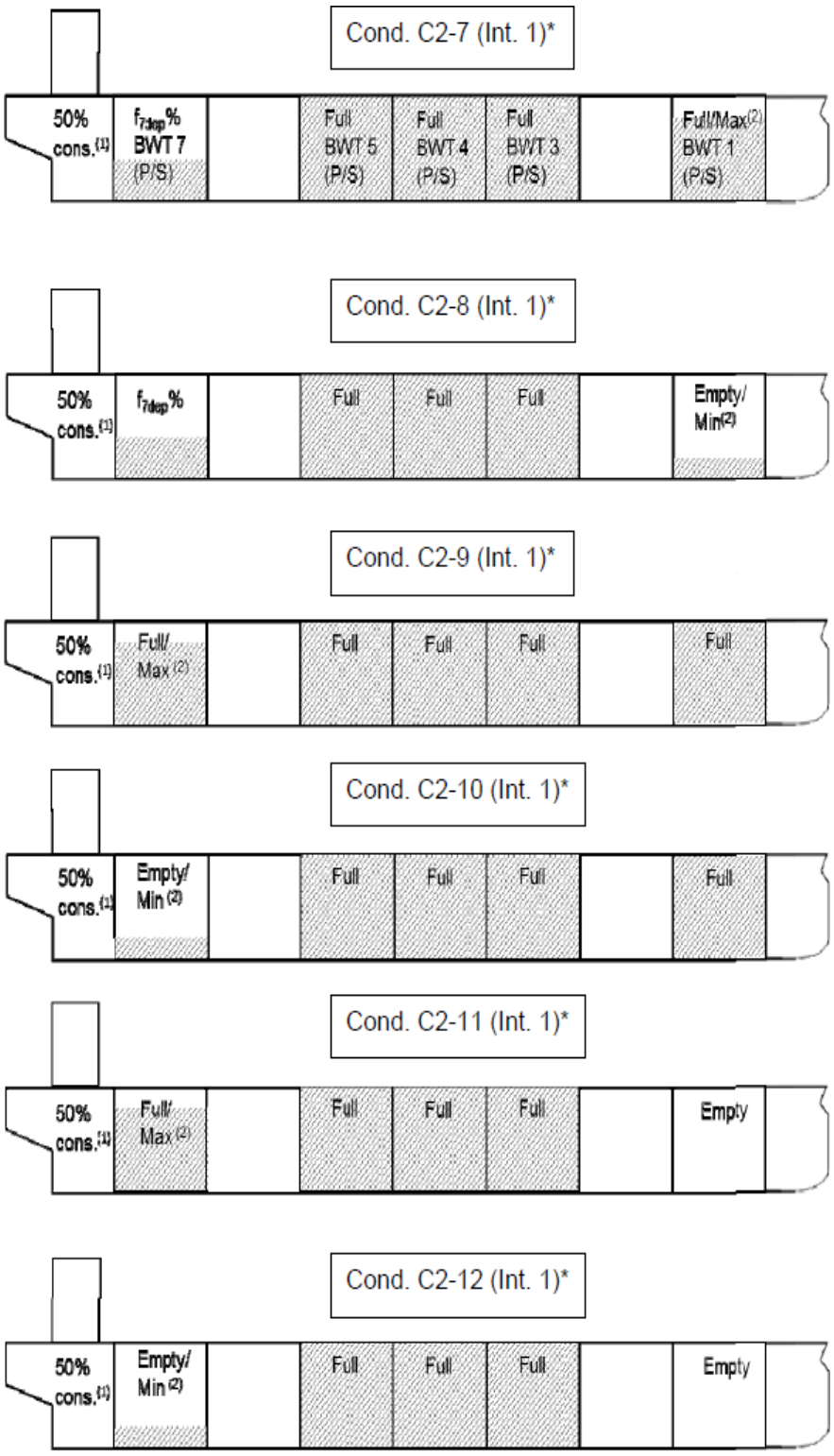
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Departure conditions CD1-7~C1-12, only intended for strength verification (not operational) are marked: *

Figure 4 : *(1/1/2022)*



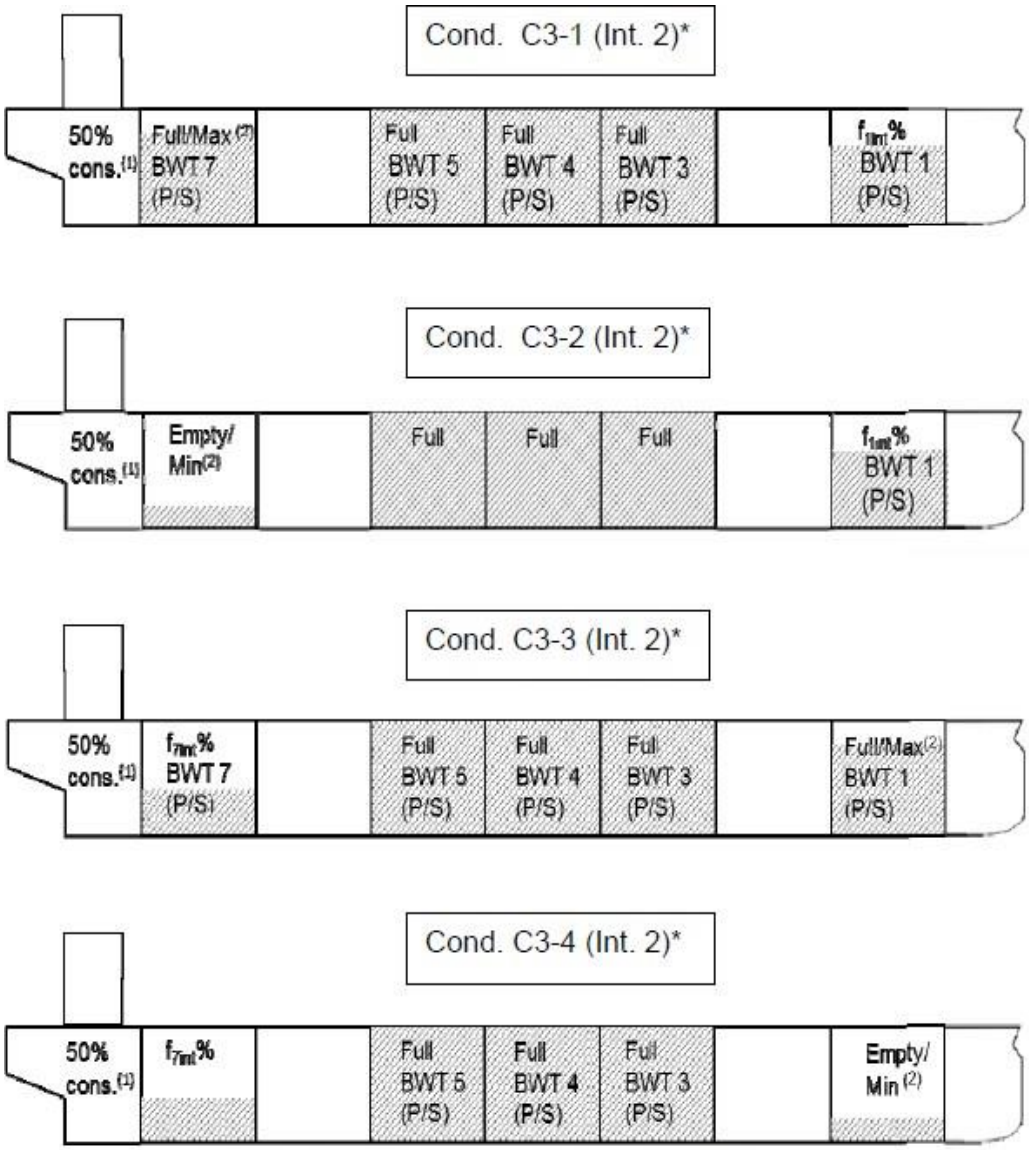
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C2-1~C2-6, only intended for strength verification (not operational) are marked: *

Figure 5 : *(1/1/2022)*



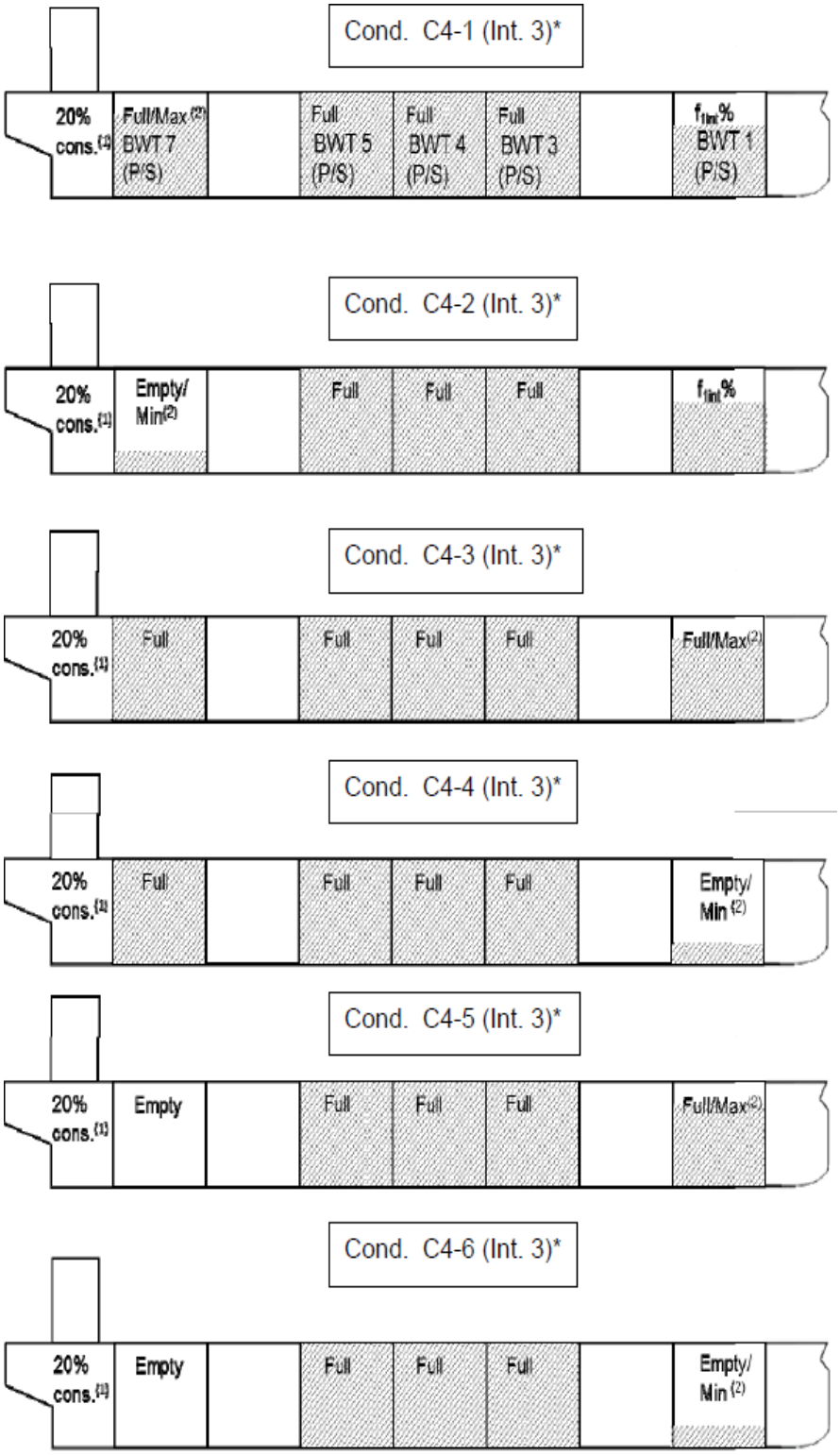
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C2-7~C2-12, only intended for strength verification (not operational) are marked: *

Figure 6 : *(1/1/2022)*



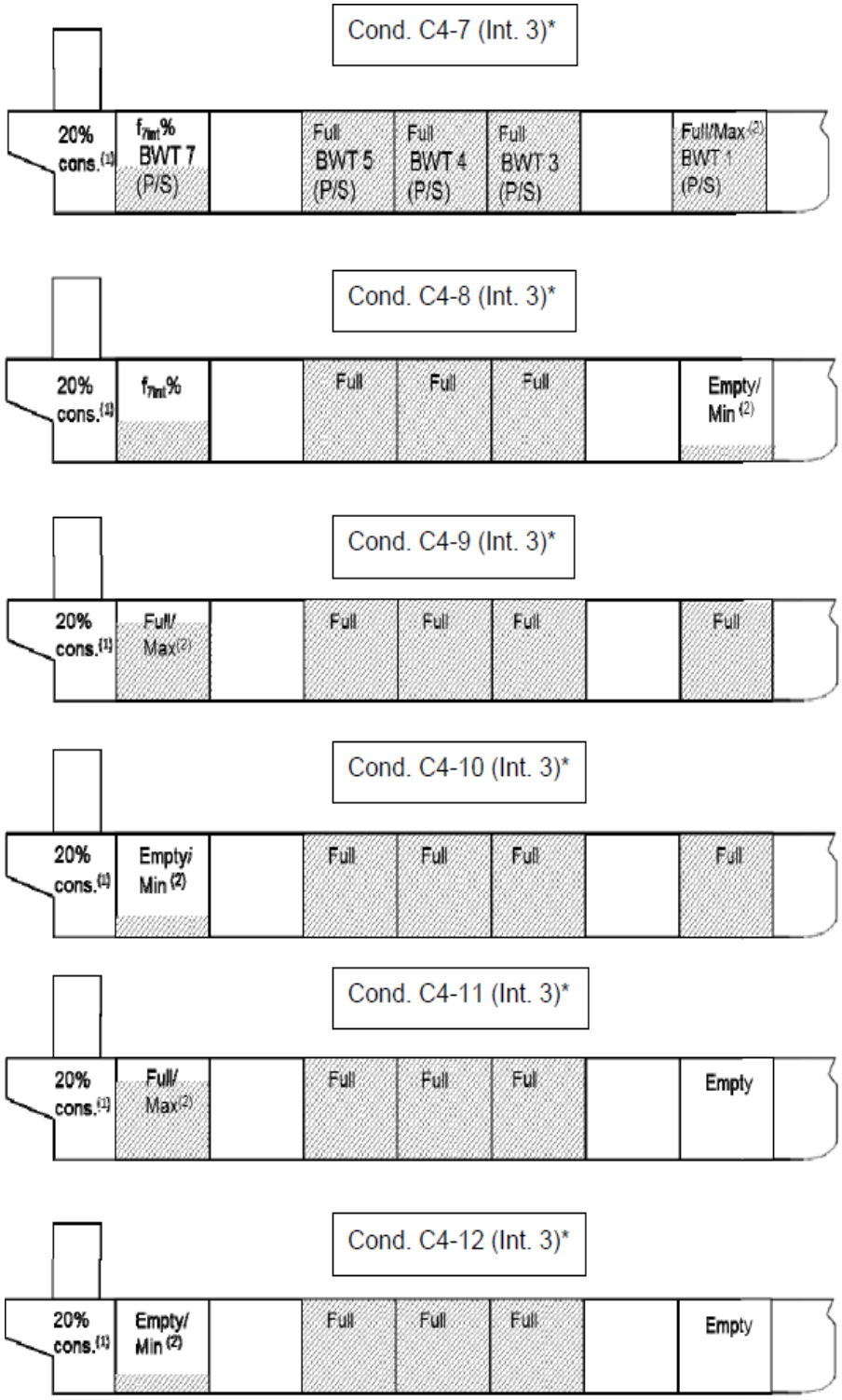
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C3-1~C3-4, only intended for strength verification (not operational) are marked: *

Figure 7 : *(1/1/2022)*



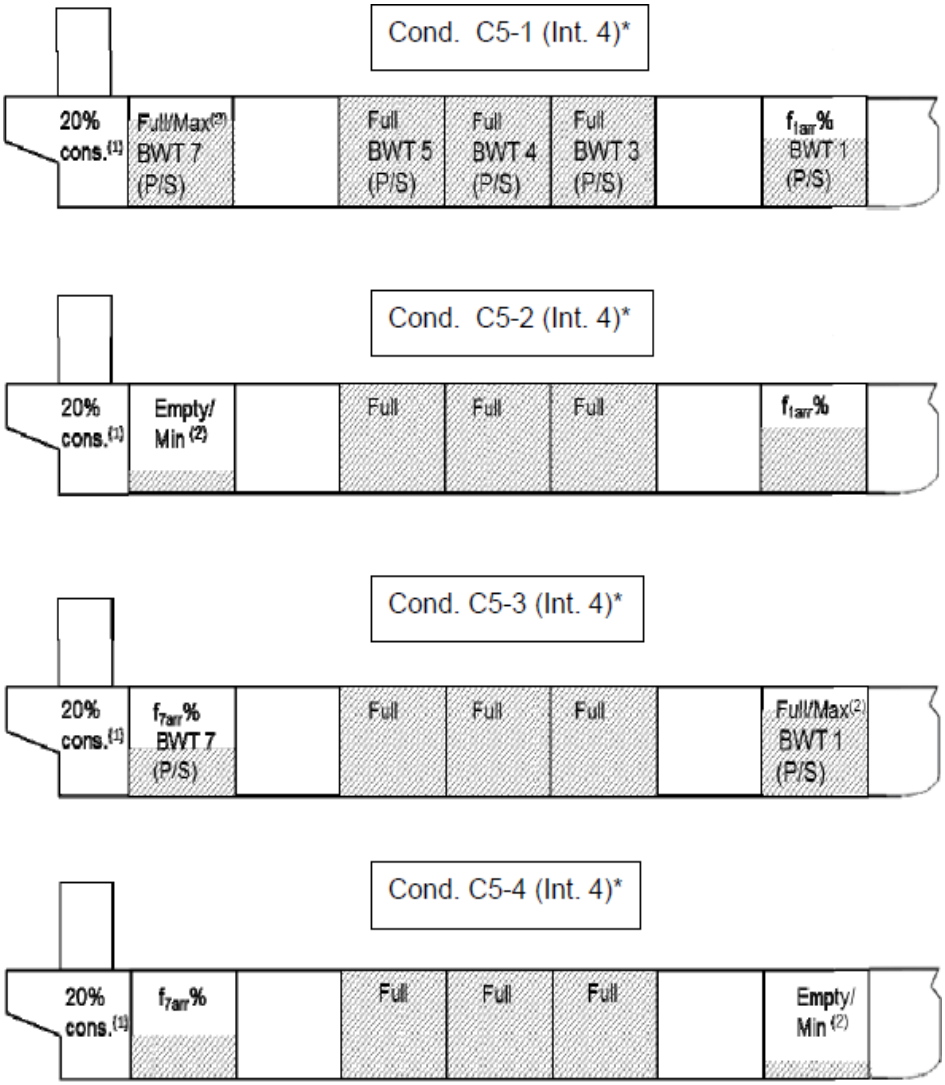
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C4-1~C4-6, only intended for strength verification (not operational) are marked: *

Figure 8 : *(1/1/2022)*



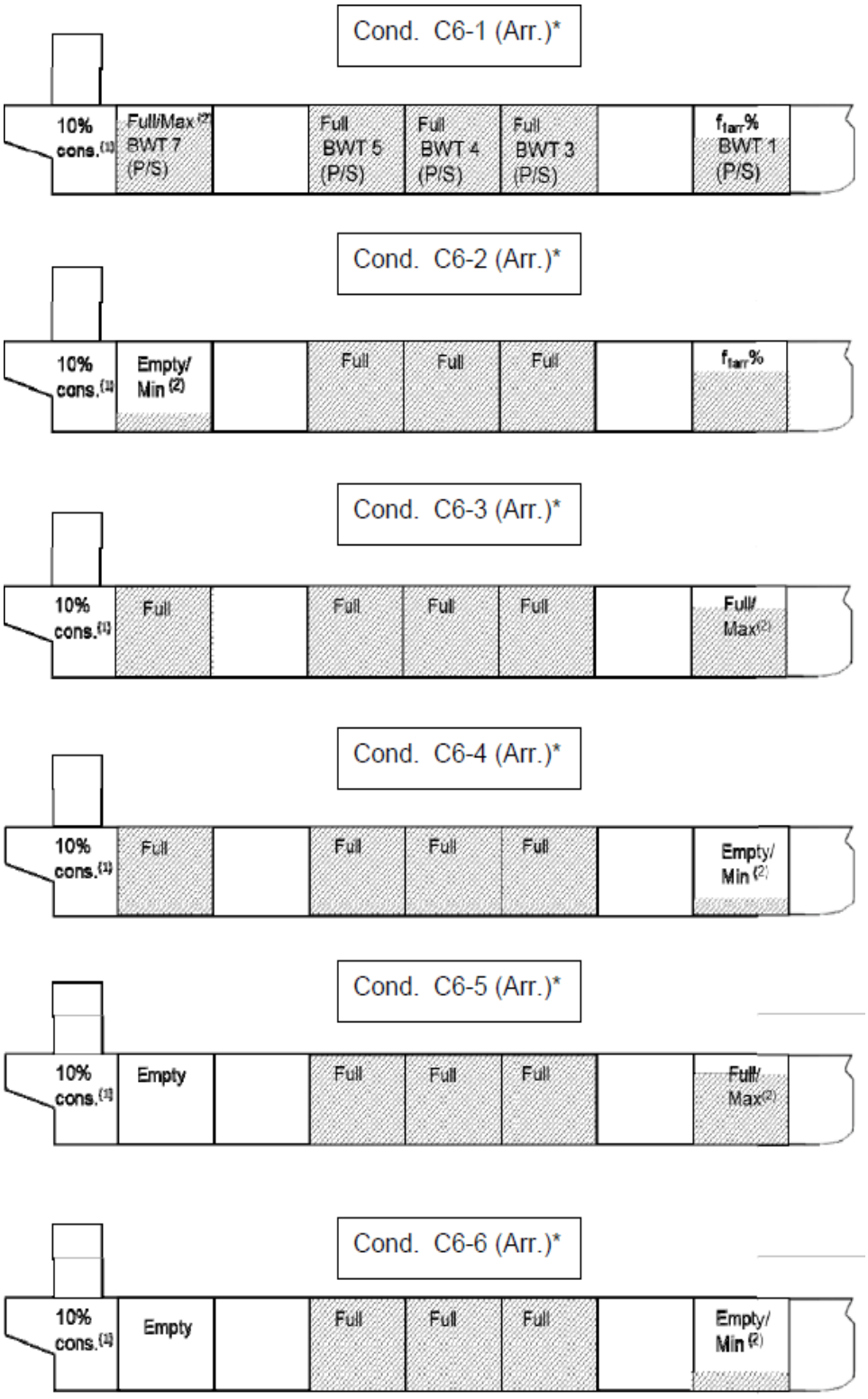
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C4-7~C4-12, only intended for strength verification (not operational) are marked: *

Figure 9 : *(1/1/2022)*



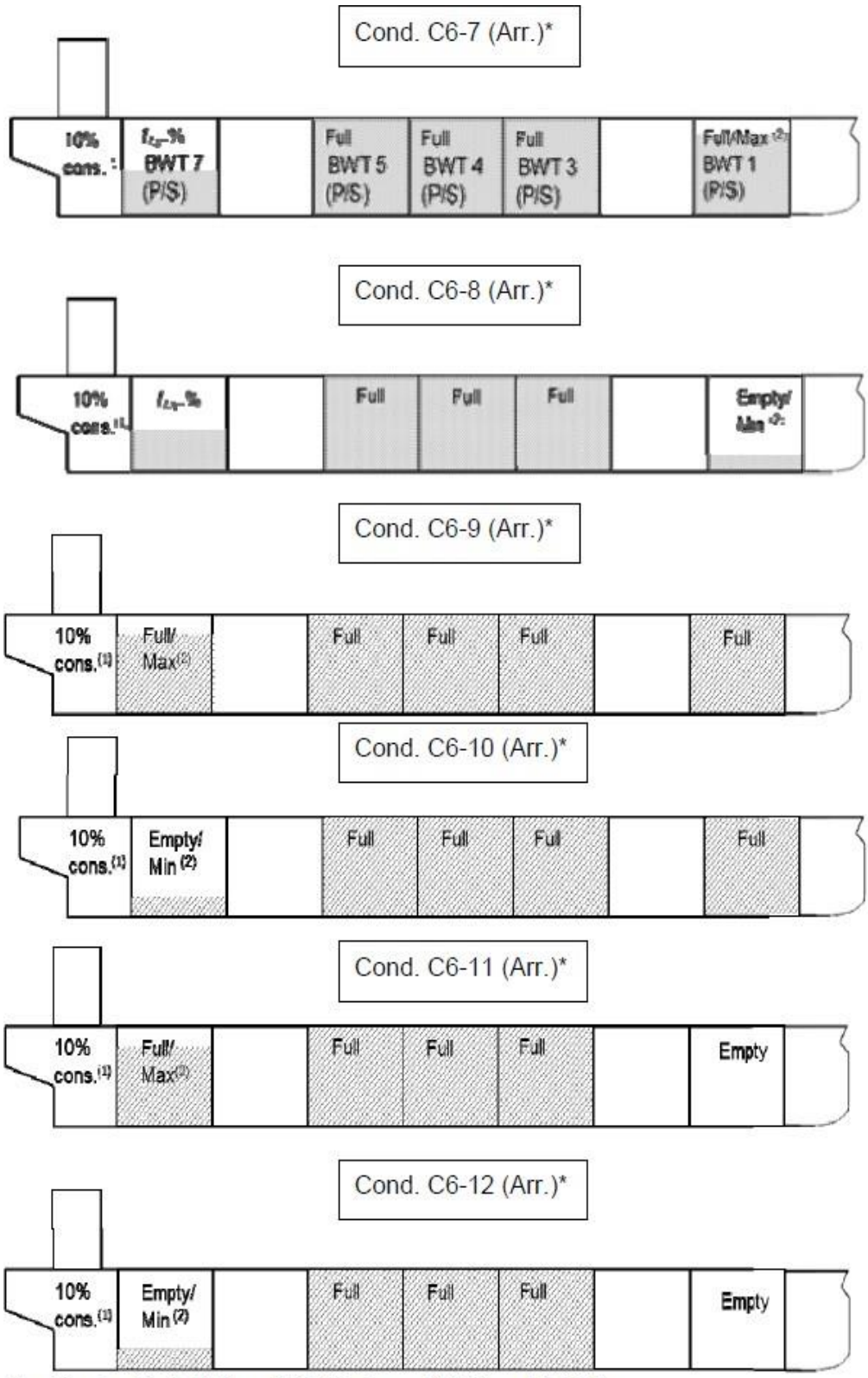
Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Intermediate conditions C5-1~C5-4, only intended for strength verification (not operational) are marked: *

Figure 10 : *(1/1/2022)*



Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 7 (P/S) during voyage. Arrival conditions C6-1~C6-6, only intended for strength verification (not operational) are marked: *

Figure 11 : *(1/1/2022)*



Ore Carrier. Partial filling of BW Tank no.1 (P/S) and 5 (P/S) during voyage. Arrival conditions C6-7~C6-12, only intended for strength verification (not operational) are marked: *

Chapter 6
COMBINATION CARRIERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **combination carrier**, as defined in Pt A, Ch 1, Sec 2, [4.3.6] and Pt A, Ch 1, Sec 2, [4.3.7].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Part A, Part B, Part C and Part D, as applicable, and with the requirements of this Chapter, which are specific to combination carriers.

1.2 Summary table

1.2.1 Tab 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to combination carriers.

Table 1

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery and cargo system	Sec 4
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(2)**

(1) No specific requirements for combination carriers are given in this Chapter.
(2) The specific requirements for combination carriers are given in Part C, Chapter 4.

SECTION 2 SHIP ARRANGEMENT

1 General

1.1 Application

1.1.1 The requirements in Sec 2 and Sec 3 apply to:

- single deck ships of double side skin construction, with a double bottom, hopper tanks and topside tanks and intended to carry dry cargoes in bulk, including ore cargo, or oil cargoes in bulk (ships with the service notation **combination carrier/OBO ESP**); a typical midship section is shown in Fig 1
- single deck ships with two longitudinal bulkheads and a double bottom throughout the cargo region and intended to carry dry cargoes in bulk, including ore cargo, or oil cargoes in the centre holds (ships with the service notation **combination carrier/OOC ESP**); typical midship sections are shown in Fig 2.

The application of these requirements to other ship types is to be considered by the Society on a case-by-case basis.

2 General arrangement design

2.1 General

2.1.1 Cofferdams

A cofferdam or similar compartment of width not less than 760 mm is to be provided at the aft end of the oil cargo tank area. Its bulkheads are to extend from keel to deck across the full breadth of the ship.

For the purpose of this requirement, the term “cofferdam” is intended to mean an isolating compartment between two adjacent steel bulkheads or decks. The minimum distance between the two bulkheads or decks is to be sufficient for safe access and inspection.

In order to meet the single failure principle, in the particular case when a corner-to-corner situation occurs, this principle may be met by welding a diagonal plate across the corner.

Cofferdams are also to be constructed so as to enable adequate ventilation.

2.1.2 Cargo segregation

Unless expressly provided otherwise, tanks containing oil cargoes or oil cargo residues are to be segregated from accommodation, service and machinery spaces, drinking water and stores for human consumption by means of a cofferdam, or any other similar compartment.

Where accommodation and service compartments are arranged immediately above the compartments containing flammable liquids, the cofferdam may be omitted only where the deck is not provided with access openings and is coated with a layer of material recognised as suitable by the Society. The cofferdam may also be omitted where such compartments are adjacent to a passageway, subject to the following conditions:

- the thicknesses of common boundary plates of adjacent tanks are increased with respect to those obtained from the applicable requirements in Pt B, Ch 6, Sec 2, by 2 mm in the case of tanks carrying fresh water or boiler feed water, and by 1 mm in all other cases
- the sum of the throats of the weld fillets at the edges of such plates is not less than the thickness of the plates themselves
- the hydrostatic test is carried out with a head increased by 1 m with respect to that required in Pt B, Ch 12, Sec 3.

Figure 1 : combination carrier/OBO

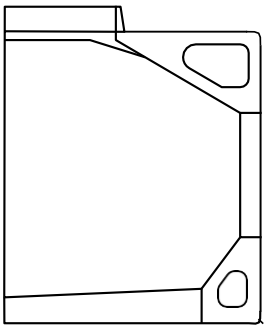
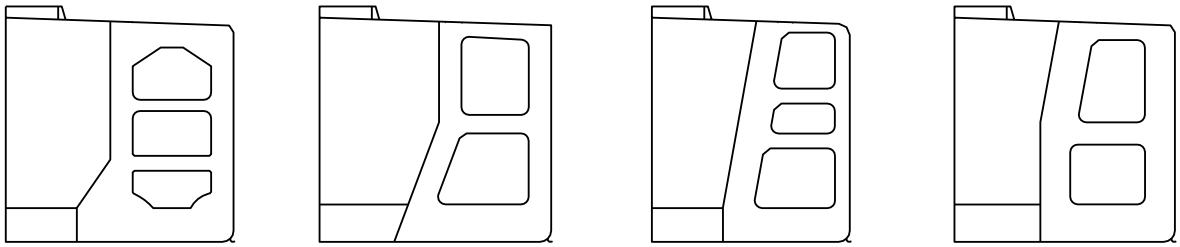


Figure 2 : combination carrier/OOC



Combination carriers of 600 t deadweight and above are not allowed to carry oil in any compartment extending forward of a collision bulkhead located in accordance with Pt B, Ch 2, Sec 1, [2].

2.1.3 Slop tanks

The slop tanks are to be surrounded by cofferdams except where the boundaries of the slop tanks where slop may be carried on dry cargo voyages are the hull, main cargo deck, cargo pump room bulkhead or fuel oil bunker tank. These cofferdams are to be not open to a double bottom, pipe tunnel, pump room or other enclosed space.

Means are to be provided for filling the cofferdams with water and for draining them.

Where the boundary of a slop tank is the cargo pump room bulkhead, the pump room is to be not open to the double bottom, pipe tunnel or other enclosed space; however, openings provided with gas-tight bolted covers may be permitted.

2.1.4 Deck spills

Means are to be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by providing a permanent continuous coaming of a suitable height extending from side to side.

Where gutter bars are installed on the weather decks of combination carriers in way of cargo manifolds and are extended aft as far as the aft bulkhead of superstructures for the purpose of containing cargo spills on deck during loading and discharge operations, the free surface effects caused by containment of a cargo spill during liquid transfer operations or of boarding seas while underway are to be considered with respect to the vessel's available margin of positive initial stability (GM_o).

Where the gutter bars installed are higher than 300 mm, they are to be treated as bulwarks with freeing ports arranged in accordance with Pt B, Ch 9, Sec 9, [5] and provided with effective closures for use during loading and discharge operations. Attached closures are to be arranged in such a way that jamming cannot occur while at sea, ensuring that the freeing ports will remain fully effective.

On ships without deck camber, or where the height of the installed gutter bars exceeds the camber, and for combination carriers having cargo tanks exceeding 60% of the vessel's maximum beam amidships regardless of gutter bar height, gutter bars may not be accepted without an assessment of the initial stability (GM_o) for compliance with the relevant intact stability requirements taking into account the free surface effect caused by liquids contained by the gutter bars.

2.1.5 Piping

Means are to be provided for isolating the piping connecting the pump room with the slop tanks. The means of isolation are to consist of a valve followed by a spectacle flange or a spool piece with appropriate blank flanges.

This arrangement is to be located adjacent to the slop tanks, but where this is unreasonable or impracticable it may be located within the pump room directly after the piping penetrates the bulkhead.

A separate pumping and piping arrangement is to be provided for discharging the contents of the slop tanks directly over the open deck when the ship is in the dry cargo mode.

Oil cargo lines below deck are to be placed in special ducts.

2.1.6 Opening in watertight bulkheads and decks

Openings intended to be used for dry cargo handling are not permitted in bulkheads and decks separating oil cargo tanks from other compartments not designed and equipped for the carriage of oil cargoes unless such openings are equipped with alternative means approved by the Society to ensure an equivalent integrity.

2.1.7 Tank cleaning openings

Hatches and tank cleaning openings to slop tanks are only permitted on the open deck and are to be fitted with closing arrangements.

Except where they consist of bolted plates with bolts at watertight spacing, these closing arrangements are to be provided with locking arrangements which are to be under the control of the responsible ship's officer.

2.2 Double bottom tanks or compartments

2.2.1 General

Double bottom tanks adjacent to cargo tanks may not be used as fuel oil tanks.

2.2.2 Combination carriers of 5000 t deadweight and above *(1/7/2007)*

At any cross-section, the depth of each double bottom tank or compartment is to be such that the distance h between the bottom of the cargo tanks and the moulded line of the bottom shell plating measured at right angles to the bottom shell plating, as shown in Fig 3, is not less than B/15, in m, or 2,0 m, whichever is the lesser. h is to be not less than 1,0 m.

Any horizontal partition necessary to fulfil the above requirements is to be located at a height not less than B/6 or 6 m, whichever is the lesser, but not more than 0,6D, above the baseline where D is the moulded depth amidships.

2.2.3 Combination carriers of less than 5000 t but at least 600 t deadweight

At any cross-section, the depth of each double bottom tank or compartment is to be such that the distance h between the bottom of the cargo tanks and the moulded line of the bottom shell plating measured at right angles to the bottom shell is not less than B/15, in m, with a minimum value of 0,76 m.

In the turn of the bilge area and at locations without a clearly defined turn of the bilge, the cargo tank boundary line is to run parallel to the line of the midship flat bottom as shown in Fig 4.

Figure 3 : Cargo tank boundary lines

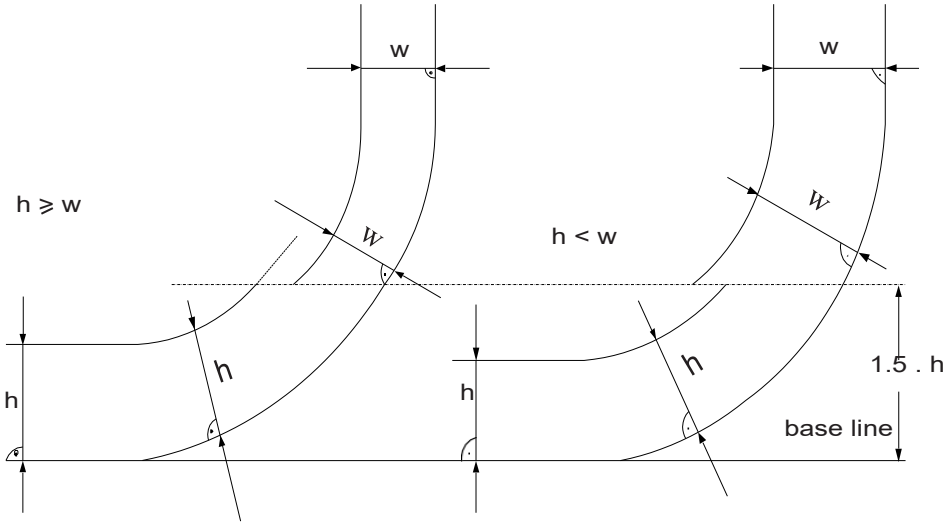
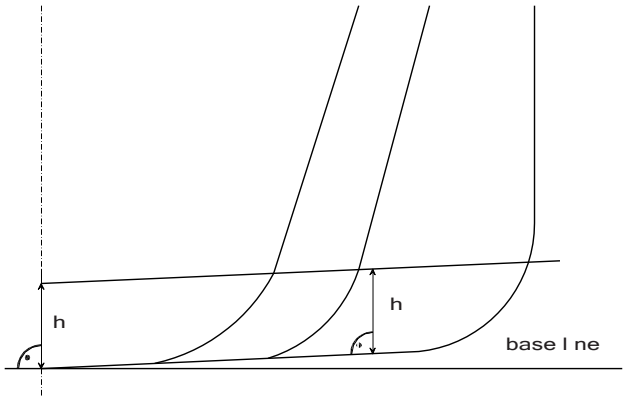


Figure 4 : Cargo tank boundary lines



2.3 Navigation position

2.3.1 When it is proven necessary to provide a navigation station above the cargo area, such station is to be for navigation purposes only and is to be separated from the cargo tank deck by an open space of at least 2 m in height.

3 Size and arrangement of cargo tanks and slop tanks

3.1 Cargo tanks

3.1.1 Combination carriers of 5000 t deadweight and above *(1/7/2007)*

Combination carriers of 5000 t deadweight and above are to comply with the requirements in [3.2].

3.1.2 Combination carriers of less than 5000 t but at least 600 t deadweight *(1/7/2007)*

The length of each cargo tank is not to exceed 10 metres or one of the values of Tab 1, as applicable, whichever is the greater.

3.1.3 Piping through cargo tanks *(1/7/2007)*

Lines of piping which run through oil cargo tanks in a position less than 0,30 B_S from the ship side or less than 0,30 D_S from the ship's bottom are to be fitted with valves or similar closing devices at the point at which they open into any cargo tank. These valves are to be kept closed at sea at any time when the tanks contain cargo oil, except that they may be opened only for cargo transfer needed for essential operations.

Table 1 : Length of cargo tanks

Longitudinal bulkhead arrangement	Condition **(1)**	Length of cargo tanks, in m
No bulkhead (**combination carrier/OBO ESP**)	-	(0,5 b_i / B + 0,1) L **(2)**
Two bulkheads (**combination carrier/OOC ESP**)	b_i / B ≥ 1/5	0,2 L
	b_i / B < 1/5	(0,5 b_i / B + 0,1) L

(1) b_i is the minimum distance from the ship side to the outer longitudinal bulkhead of the i-th tank, measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.

(2) Not to exceed 0,2 L.

3.1.4 Suction wells in cargo tanks

Suction wells in cargo tanks may protrude into the double bottom below the boundary line defined by the distance h in [2.2.2] or [2.2.3], as applicable, provided that such wells are as small as practicable and the distance between the well bottom and bottom shell plating is not less than 0,5 h.

3.2 Oil outflow

3.2.1 Definitions *(1/7/2007)*

- *Load line draught d_S, in m*

Vertical distance, in metres, from the moulded baseline at mid-length to the waterline corresponding to the summer freeboard to be assigned to the ship. Calculations pertaining to this requirement are to be based on draught d_S, notwithstanding assigned draughts that may exceed d_S, such as the tropical load line.

- *Waterline d_B, in m*

  Vertical distance, in metres, from the moulded baseline at mid-length to the waterline corresponding to 30% of the depth D_S.
- *Breadth B_S, in m*

  Greatest moulded breadth of the ship, in metres, at or below the deepest load line d_S.
- *Breadth B_B, in m*

  Greatest moulded breadth of the ship, in metres, at or below the waterline d_B.
- *Depth D_S, in m*

  Moulded depth measured at mid-length to the upper deck at side.

In calculating the hypothetical oil outflows, the following is to be considered:

- *the volume of an oil cargo tank is to include the volume of the hatchway up to the top of the hatchway coamings, regardless of the construction of the hatch, but may not include the volume of any hatch cover; and*
- *for the measurement of the volume to moulded lines, no deduction is to be made for the volume of internal structures.*

3.2.2 Oil outflow requirements *(1/7/2007)*

To provide adequate protection against oil pollution in the event of collision or stranding, the following is to be complied with:

a) for oil tankers of 5000 tonnes deadweight (DW) and above, the mean oil outflow parameter is to be as follows:

$O_M \leq 0{,}015$ *for* $C \leq 200000\ m^3$

$O_M \leq 0{,}012 + (0{,}003/200000)\ (400000\text{-}C)$ *for* $200000\ m^3 < C < 400000\ m^3$

$O_M \leq 0{,}012$ *for* $C \geq 400000\ m^3$

b) for combination carriers between 5000 tonnes deadweight (DW) and 200000 m^3 capacity, the mean oil outflow parameter may be applied, provided calculations are submitted to the satisfaction of the Society, demonstrating that after accounting for its increased structural strength, the combination carrier has at least equivalent oil outflow performance to a standard double hull tanker of the same size having a $O_M \leq 0{,}015$.

$O_M \leq 0{,}021$ *for* $C \leq 100000\ m^3$

$O_M \leq 0{,}015 + (0{,}006/100000)\ (200000\text{-}C)$ *for* $100000\ m^3 < C \leq 200000\ m^3$

where:

O_M *: mean oil outflow parameter.*

C *: total volume of cargo oil, in m^3, at 98% tank filling.*

3.2.3 General assumptions for calculation of oil outflow parameter *(1/7/2007)*

The following general assumptions are to be applied when calculating the mean oil outflow parameter:

a) The cargo block length extends between the forward and aft extremities of all tanks arranged for the carriage of cargo oil, including slop tanks.

b) Where this requirement refers to cargo tanks, it is to be understood to include all cargo tanks, slop tanks and fuel tanks located within the cargo block length.

c) The ship is to be assumed loaded to the load line draught d_S without trim or heel.

d) All cargo oil tanks are to be assumed loaded to 98% of their volumetric capacity.

e) The nominal density of the cargo oil ρ_n, in kg/m^3, is to be calculated as follows:

$\rho_n = 1000\ DW / C$

where DW is deadweight, in t.

f) For the purposes of these outflow calculations, the permeability of each space within the cargo block, including cargo tanks, ballast tanks and other non-oil spaces, is to be taken as 0,99, unless proven otherwise.

g) Suction wells may be neglected in the determination of tank location provided that such wells are as small as practicable and the distance between the well bottom and bottom shell plating is not less than 0,5 h, where h is the height as defined in [2.2.2].

3.2.4 General assumptions for combination of oil outflow parameters *(1/7/2007)*

The following assumptions are to be used when combining the oil outflow parameters.

The mean oil outflow is to be calculated independently for side damage and for bottom damage and then combined into the non-dimensional oil outflow parameter O_M, as follows:

$O_M = (0,4\ O_{MS} + 0,6\ O_{MB}) / C$

where:

O_{MS} : *mean outflow for side damage, in m^3;*

O_{MB} : *mean outflow for bottom damage, in m^3.*

For bottom damage, independent calculations for mean outflow are to be done for 0 m and minus 2,5 m tide conditions, and then combined as follows:

$O_{MB} = 0,7\ O_{MB(0)} + 0,3\ O_{MB(2,5)}$

where:

$O_{MB(0)}$: *mean outflow for 0 m tide condition, in m^3; and*

$O_{MB(2,5)}$: *mean outflow for minus 2,5 m tide condition, in m^3.*

3.2.5 Calculation of side damage outflow *(1/7/2007)*

The mean outflow for side damage O_{MS}, in m^3, is to be calculated as follows:

$$O_{MS} = C_3 \sum_{i}^{n} P_{s(i)} O_{s(i)}$$

where:

i : *represents each cargo tank under consideration;*

n : *total number of cargo tanks;*

$P_{S(i)}$: *the probability of penetrating cargo tank i from side damage, calculated in accordance with [3.2.7];*

$O_{S(i)}$: *the outflow, in m^3, from side damage to cargo tank i, which is assumed equal to the total volume in cargo tank i at 98% filling, unless it is proven through the application of the IMO Resolution referred to in [4.2.5] that any significant cargo volume will be retained;*

C_3 : *0,77 for ships having two longitudinal bulkheads inside the cargo tanks, provided these bulkheads are continuous over the cargo block and $P_{s(i)}$ is developed in accordance with this requirement. C_3 equals 1,0 for all other ships or when $P_{s(i)}$ is developed in accordance with [3.2.7].*

3.2.6 Calculation of bottom damage outflow *(1/7/2007)*

The mean outflow for bottom damage, in m^3, is to be calculated for each tidal condition as follows:

a)

$$O_{MB(0)} = \sum_{i}^{n} P_{B(i)} O_{B(i)} C_{DB(i)}$$

where:

i : *represents each cargo tank under consideration;*

n : *total number of cargo tanks;*

$P_{B(i)}$: *the probability of penetrating cargo tank i from bottom damage, calculated in accordance with [3.2.8];*

$O_{B(i)}$: *the outflow from cargo tank i, in m^3, calculated in accordance with c);*

$C_{DB(i)}$: *factor to account for oil capture as defined in d).*

b)

$$O_{MB(2,5)} = \sum_{i}^{n} P_{B(i)} O_{B(i)} C_{DB(i)}$$

where:

i, n, $P_{B(i)}$ and $C_{DB(i)}$ as defined above;

$O_{B(i)}$: *the outflow from cargo tank i, in m^3, after tidal change.*

c) *The oil outflow $O_{B(i)}$ for each cargo oil tank is to be calculated based on pressure balance principles, in accordance with the following assumptions:*

- *The ship is to be assumed stranded with zero trim and heel, with the stranded draught prior to tidal change equal to the load line draught d_s.*
- *The cargo level after damage is to be calculated as follows:*

  $h_c = [(d_s + t_c - Z_l)(\rho_s) - (1000\ p) / g] / \rho_n$

  where:

  h_c : *the height of the cargo oil above Z_l, in metres;*

  t_c : *the tidal change, in m. Reductions in tide are to be expressed as negative values;*

  Z_l : *the height of the lowest point in the cargo tank above the baseline, in m;*

  ρ_s : *density of seawater, to be taken as 1025 kg/m^3;*

  p : *if an inert gas system is fitted, the normal overpressure, in kPa, to be taken not less than 5 kPa; if an inert gas system is not fitted, the overpressure may be taken as 0;*

  g : *the acceleration of gravity, to be taken as 9,81 m/s^2;*

  ρ_n : *nominal density of cargo oil, calculated in accordance with [3.2.3].*
- *For cargo tanks bounded by the bottom shell, unless proven otherwise, oil outflow $O_{B(i)}$ is to be taken not less than 1% of the total volume of cargo oil loaded in cargo tank i, to account for initial exchange losses and dynamic effects due to current and waves.*

d) *In the case of bottom damage, a portion from the outflow from a cargo tank may be captured by non-oil compartments. This effect is approximated by application of the factor $C_{DB(i)}$ for each tank, which is to be taken as follows:*

$C_{DB(i)}$: 0,6 for cargo tanks bounded from below by non-oil compartments;

$C_{DB(i)}$: 1,0 for cargo tanks bounded by the bottom shell.

3.2.7 Calculation of probability for side damage *(1/7/2007)*

The probability P_S of breaching a compartment from side damage is to be calculated as follows:

a) $P_S = P_{SL}\ P_{SV}\ P_{ST}$

where:

$P_{SL} = 1 - P_{Sf} - P_{Sa}$ = *probability the damage will extend into the longitudinal zone bounded by X_a and X_f;*

$P_{SV} = 1 - P_{Su} - P_{Sl}$ = *probability the damage will extend into the vertical zone bounded by Z_l and Z_u; and*

$P_{ST} = 1 - P_{Sy}$ = *probability the damage will extend transversely beyond the boundary defined by y.*

b) *P_{Sa}, P_{Sf}, P_{Sl}, P_{Su} and P_{Sy} are to be determined by linear interpolation from the table of probabilities for side damage provided in Tab 2,*

where:

P_{Sa} : *the probability the damage will lie entirely aft of location X_a/L;*

P_{Sf} : *the probability the damage will lie entirely forward of location X_f/L;*

P_{Sl} : *the probability the damage will lie entirely below the tank;*

P_{Su} : *the probability the damage will lie entirely above the tank; and*

P_{Sy} : *the probability the damage will lie entirely outboard of the tank.*

Compartment boundaries X_a, X_f, Z_l, Z_u and y are to be developed as follows:

X_a : *the longitudinal distance from the aft terminal of L to the aftmost point on the compartment being considered, in m;*

X_f : *the longitudinal distance from the aft terminal of L to the foremost point on the compartment being considered, in m;*

Z_l : *the vertical distance from the moulded baseline to the lowest point on the compartment being considered, in m;*

Z_u : *the vertical distance from the moulded baseline to the highest point on the compartment being considered, in m. Z_u is not to be taken greater than D_s;*

y : *the minimum horizontal distance measured at right angles to the centreline between the compartment under consideration and the side shell in m;*

c) *P_{Sy} is to be calculated as follows:*

$P_{Sy} = (24{,}96 - 199{,}6\ y/B_S)(y/B_S)$ *for* $y/B_S \leq 0{,}05$

P_{Sy} = 0,749 + [5 - 44,4 (y/B_S - 0,05)] (y/B_S - 0,05) for 0,05 < y/B_S < 0,1

P_{Sy} = 0,888 + 0,56 (y/B_S - 0,1) for y/B_S > 0,1

P_{Sy} is not to be taken greater than 1.

Table 2 : Probabilities for side damage *(1/7/2007)*

X_a/L	P_{Sa}	X_f/L	P_{Sf}	Z_l/D_S	P_{Sl}	Z_u/D_S	P_{Su}
0,00	0,000	0,00	0,967	0,00	0,000	0,00	0,968
0,05	0,023	0,05	0,917	0,05	0,000	0,05	0,952
0,10	0,068	0,10	0,867	0,10	0,001	0,10	0,931
0,15	0,117	0,15	0,817	0,15	0,003	0,15	0,905
0,20	0,167	0,20	0,767	0,20	0,007	0,20	0,873
0,25	0,217	0,25	0,717	0,25	0,013	0,25	0,836
0,30	0,267	0,30	0,667	0,30	0,021	0,30	0,789
0,35	0,317	0,35	0,617	0,35	0,034	0,35	0,733
0,40	0,367	0,40	0,567	0,40	0,055	0,40	0,670
0,45	0,417	0,45	0,517	0,45	0,085	0,45	0,599
0,50	0,467	0,50	0,467	0,50	0,123	0,50	0,525
0,55	0,517	0,55	0,417	0,55	0,172	0,55	0,452
0,60	0,567	0,60	0,367	0,60	0,226	0,60	0,383
0,65	0,617	0,65	0,317	0,65	0,285	0,65	0,317
0,70	0,667	0,70	0,267	0,70	0,347	0,70	0,255
0,75	0,717	0,75	0,217	0,75	0,413	0,75	0,197
0,80	0,767	0,80	0,167	0,80	0,482	0,80	0,143
0,85	0,817	0,85	0,117	0,85	0,553	0,85	0,092
0,90	0,867	0,90	0,068	0,90	0,626	0,90	0,046
0,95	0,917	0,95	0,023	0,95	0,700	0,95	0,013
1,00	0,967	1,00	0,000	1,00	0,775	1,00	0,000

3.2.8 Calculation of probability for bottom damage *(1/7/2007)*

a) *The probability P_B of breaching a compartment from bottom damage is to be calculated as follows:*

$P_B = P_{BL} P_{BT} P_{BV}$

where:

P_{BL} = 1 - P_{Bf} - P_{Ba} = *probability the damage will extend into the longitudinal zone bounded by* X_a *and* X_f

P_{BT} = 1 - P_{Bp} - P_{Bs} = *probability the damage will extend into the transverse zone bounded by* Y_p *and* Y_s

P_{BV} = 1 - P_{Bz} = *probability the damage will extend vertically above the boundary defined by z*

b) P_{Ba}, P_{Bf}, P_{Bp}, P_{Bs}, *and* P_{Bz} *are to be determined by linear interpolation from the table of probabilities for bottom damage provided in Tab 3, where:*

P_{Ba} *: the probability the damage will lie entirely aft of location* X_a/L;

P_{Bf} *: the probability the damage will lie entirely forward of location* X_f/L;

P_{Bp} *: the probability the damage will lie entirely to port of the tank;*

P_{Bs} *: the probability the damage will lie entirely to starboard of the tank;*

P_{Bz} *: the probability the damage will lie entirely below the tank.*

Compartment boundaries X_a, X_f, Y_p, Y_s, *and z are to be developed as follows:*

X_a *and* X_f *are as defined in [3.2.7];*

Y_p *: the transverse distance from the port-most point on the compartment located at or below the waterline* d_B, *to a vertical plane located* B_B /2 *to starboard of the ship's centreline, in metres;*

Y_s : the transverse distance from the starboard-most point on the compartment located at or below the waterline d_B, to a vertical plane located B_B /2 to starboard of the ship's centreline, in metres;

z : the minimum value of z over the length of the compartment, where, at any given longitudinal location, z is the vertical distance from the lower point of the bottom shell at that longitudinal location to the lower point of the compartment at that longitudinal location, in metres.

c) P_{Bz} is to be calculated as follows:

$P_{Bz} = (14,5 - 67\ z/D_S)\ (z/D_S)$ for $z/D_S \leq 0,1$

$P_{Bz} = 0,78 + 1,1\ (z/D_S - 0,1)$ for $z/D_S > 0,1$

P_{Bz} is not to be taken greater than 1.

***Table 3 : Probabilities for bottom damage** (1/7/2007)*

X_a/L	P_{Ba}	X_f/L	P_{Bf}	Y_p/B_B	P_{Bp}	Y_s/B_B	P_{Bs}
0,00	0,000	0,00	0,969	0,00	0,844	0,00	0,000
0,05	0,002	0,05	0,953	0,05	0,794	0,05	0,009
0,10	0,008	0,10	0,936	0,10	0,744	0,10	0,032
0,15	0,017	0,15	0,916	0,15	0,694	0,15	0,063
0,20	0,029	0,20	0,894	0,20	0,644	0,20	0,097
0,25	0,042	0,25	0,870	0,25	0,594	0,25	0,133
0,30	0,058	0,30	0,842	0,30	0,544	0,30	0,171
0,35	0,076	0,35	0,810	0,35	0,494	0,35	0,211
0,40	0,096	0,40	0,775	0,40	0,444	0,40	0,253
0,45	0,119	0,45	0,734	0,45	0,394	0,45	0,297
0,50	0,143	0,50	0,687	0,50	0,344	0,50	0,344
0,55	0,171	0,55	0,630	0,55	0,297	0,55	0,394
0,60	0,203	0,60	0,563	0,60	0,253	0,60	0,444
0,65	0,242	0,65	0,489	0,65	0,211	0,65	0,494
0,70	0,289	0,70	0,413	0,70	0,171	0,70	0,544
0,75	0,344	0,75	0,333	0,75	0,133	0,75	0,594
0,80	0,409	0,80	0,252	0,80	0,097	0,80	0,644
0,85	0,482	0,85	0,170	0,85	0,063	0,85	0,694
0,90	0,565	0,90	0,089	0,90	0,032	0,90	0,744
0,95	0,658	0,95	0,026	0,95	0,009	0,95	0,794
1,00	0,761	1,00	0,000	1,00	0,000	1,00	0,844

3.2.9 Alternative calculation procedures *(1/7/2007)*

This requirement uses a simplified probabilistic approach where a summation is carried out over the contributions to the mean outflow from each cargo tank. For certain designs such as those characterised by the occurrence of steps/recesses in bulkheads/decks and for sloping bulkheads and/or a pronounced hull curvature, more rigorous calculations may be appropriate. In such cases one of the following calculation procedures may be applied:

- *The probabilities referred to in [3.2.7] and [3.2.8] may be calculated with more precision through application of hypothetical sub-compartments (see Note 1).*
- *The probabilities referred to in [3.2.7] and [3.2.8] may be calculated through direct application of the probability density functions contained in the IMO Resolutions referred to in [4.2.5].*
- *The oil outflow performance may be evaluated in accordance with the method described in the IMO Resolutions referred to in [4.2.5].*

Note 1: Refer to the "Explanatory Notes on matters related to the accidental oil outflow performance" adopted by IMO Resolution MEPC.122(52).

3.2.10 **Credit for reducing oil outflow** *(1/7/2007)*

Credit for reducing oil outflow through the use of an emergency rapid cargo transfer system or other system arranged to mitigate oil outflow in the event of an accident may be taken into account only after the effectiveness and safety aspects of the system are approved by the Society. Submittal for approval is to be made in accordance with the provisions of the IMO Resolutions referred to in [4.2.5].

3.3 Slop tanks

3.3.1 Combination carriers of 150 gross tonnage and above

The arrangements of the slop tank or combination of slop tanks are to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is to be not less than 3 per cent of the oil carrying capacity of the ships, except that the Society may accept:

- *2% for such combination carriers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system*
- *2% where segregated ballast tanks are provided in accordance with [5]. This capacity may be further reduced to 1,5% for such combination carriers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system.*
- *1% for combination carriers where oil cargo is only carried in tanks with smooth walls. This capacity may be further reduced to 0,8% where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system.*

  The term "tanks with smooth walls" includes the main oil cargo tanks of combination carriers which may be constructed with vertical framing of a small depth. Vertically corrugated bulkheads are considered smooth walls.

3.3.2 Combination carriers of 70000 t deadweight and above

Combination carriers of 70000 t deadweight and above are to be provided with at least two slop tanks.

4 Size and arrangement of protective ballast tanks or compartments

4.1 General

4.1.1 This requirement applies to combination carriers of 600 t deadweight and above.

4.2 Size and arrangement of ballast tanks or compartments

4.2.1 General

The entire oil cargo tank length is to be protected by ballast tanks or compartments other than oil cargo and fuel oil tanks as indicated in [4.2.2] to [4.2.5] for combination carriers of 5000 t deadweight and above, or [4.2.6] for combination carriers less than 5000 t deadweight.

4.2.2 Wing tanks or compartments

Wing tanks or compartments are to extend either for the full depth of the ship side or from the top of the double bottom to the uppermost deck, disregarding a rounded gunwale where fitted. They are to be arranged such that the oil cargo tanks are located inboard of the moulded line of the side shell plating, nowhere less than the distance w which, as shown in Fig 3, is measured at any cross-section at right angles to the side shell, as specified below:

- *w = 0,5 + DW / 20000, or*
- *w = 2,0 m*

whichever is the lesser.

The value of w is to be at least 1,0 m.

4.2.3 Double bottom tanks or compartments

The requirements of [2.2.1] and [2.2.2] apply.

4.2.4 Aggregate capacity of ballast tanks

On combination carriers of 20000 t deadweight and above and product carriers of 30000 t deadweight and above, the aggregate capacity of wing tanks, double bottom tanks, fore peak tanks and after peak tanks is to be not less than the capacity of segregated ballast tanks necessary to meet the requirements of [5]. Wing tanks or compartments and

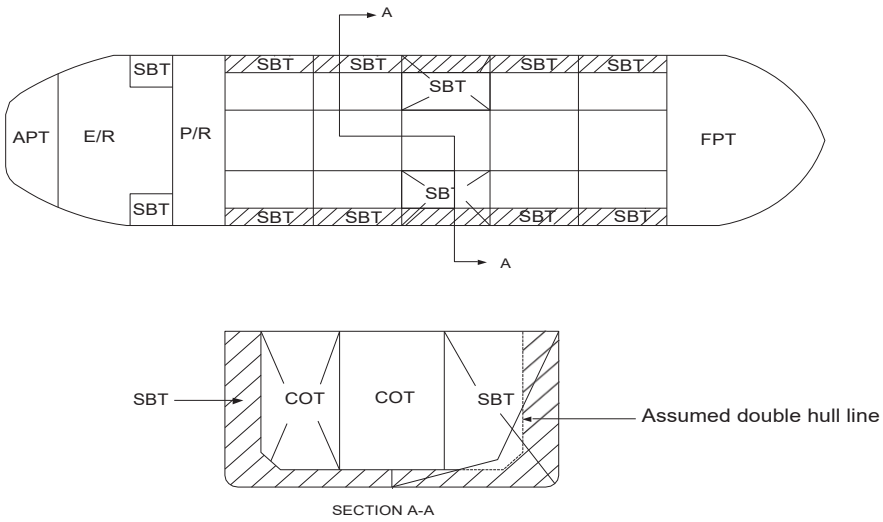
double bottom tanks used to meet the requirements of [5] are to be located as uniformly as practicable along the oil cargo tank length. Additional segregated ballast capacity provided for reducing longitudinal hull girder bending stress, trim, etc., may be located anywhere within the ship.

In calculating the aggregate capacity, the following is to be taken into account:

- *the capacity of engine room ballast tanks is to be excluded from the aggregate capacity of ballast tanks*
- *the capacity of ballast tanks located inboard of double hull is to be excluded from the aggregate capacity of ballast tanks (see Fig 5).*

Any ballast carried in localised inboard extensions, indentation or recesses of the double hull, such as bulkhead stools, may be considered as *excess ballast above the minimum requirement for segregated ballast capacity according to [5].*

Figure 5 : Segregated ballast tanks located inboard of double hull



4.2.5 Alternative methods of design and construction *(1/7/2007)*

Other methods of design and construction of combination carriers may also be accepted as alternatives to the requirements prescribed in [4.2.2] to [4.2.4], provided that such methods ensure at least the same level of protection against oil pollution in the event of collision or stranding. Such methods are to be acceptable to the Society.

Note 1: The Society considers the method described in IMO Resolution MEPC.110(49) as being acceptable.

4.2.6 Combination carriers of less than 5000 t deadweight

Combination carriers of less than 5000 t deadweight are to comply with [2.2.3].

5 Size and arrangement of segregated ballast tanks (SBT)

5.1 General

5.1.1 *Every combination carrier of 20000 t deadweight and above and every product carrier of 30000 t deadweight and above is to be provided with segregated ballast tanks and to comply with [5.2].*

5.2 Capacity of SBT

5.2.1 Combination carriers equal to or greater than 150 m in length

The capacity of the segregated ballast tanks is to be so determined that the ship may operate safely on ballast voyages without recourse to the use of oil cargo tanks for water ballast. In all cases, however, the capacity of segregated ballast tanks is to be at least such that, in any ballast condition at any part of the voyage, including the conditions consisting of lightweight plus segregated ballast only, the ship's draughts and trim can meet each of the following requirements:

- *the moulded draught amidships, d_m in metres (without taking into account any ship's deformation), is to be not less than 2,0 + 0,02 L*
- *the draughts at the forward and after perpendicular are to correspond to those determined by the draught amidships d_m as specified above, in association with the trim by the stern of not greater than 0,015L*

- *in any case the draught at the after perpendicular is to be not less than that which is necessary to obtain full immersion of the propeller(s)*
- *in no case is ballast water to be carried in oil cargo tanks, except:*
  - *on those rare voyages when weather conditions are so severe that, in the opinion of the Master, it is necessary to carry additional ballast water in oil cargo tanks for the safety of the ship*
  - *in exceptional cases where the particular character of the operation of a combination carrier renders it necessary to carry ballast water in excess of the quantity required to comply with the requirements above, provided that such operation of the combination carrier falls under the category of exceptional cases.*

5.2.2 Combination carriers less than 150 m in length

The capacity of the segregated ballast tanks is to be considered by the Society on a case-by-case basis.

6 Access arrangement

6.1 Access to double bottom and pipe tunnel

6.1.1 Means of access

Adequate means of access to the double bottom and the pipe tunnel are to be provided.

6.1.2 Manholes in the inner bottom, floors and girders

Manholes may not be cut in the inner bottom in way of oil cargo holds; access to the double bottom is, in general, to be provided by trunks leading to the upper deck.

The location and size of manholes in longitudinal girders and floors are to be determined to facilitate the access to double bottom structures and their ventilation. However, they are to be avoided in the areas where high shear stresses may occur.

6.1.3 Access to pipe tunnels under oil cargo tanks

The pipe tunnel in the double bottom under oil cargo tanks is to comply with the following requirements:

- it may not communicate with the engine room
- provision is to be made for at least two exits to the open deck arranged at a maximum distance from each other. One of these exits fitted with a watertight closure may lead to the cargo pump room.

6.1.4 Doors between pipe tunnel and main pump room

Where there is a permanent access from a pipe tunnel to the main pump room, a watertight door is to be fitted complying with the requirements in Pt B, Ch 2, Sec 1, [6.2.1] for watertight doors open at sea and located below the freeboard deck. In addition the following is to be complied with:

- *in addition to bridge operation, the watertight door is to be capable of being manually closed from outside the main pump room entrance*
- *the watertight door is to be kept closed during normal operations of the ship except when access to the pipe tunnel is required.* A notice is to be affixed to the door to the effect that it may not be left open.

6.2 Access to dry cargo holds

6.2.1 Means of access

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of dry cargo holds.

6.2.2 Hatches of large cargo holds

When the access to the dry cargo hold is arranged through the cargo hatch, the top of the ladder, as required in [6.2.3], is to be placed as close as possible to the hatch coaming.

Accesses and ladders are to be so arranged that personnel equipped with self-contained breathing apparatus may readily enter and leave the dry cargo hold.

Access hatch coamings having a height greater than 900 mm are also to have steps on the outside in conjunction with dry cargo hold ladders.

6.2.3 Ladders within large cargo holds

Each dry cargo hold is to be provided with at least two ladders as far apart as practicable longitudinally. If possible these ladders are to be arranged diagonally, e.g. one ladder near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side, from the ship's centreline.

Ladders are to be so designed and arranged that the risk of damage from the cargo handling gear is minimised.
Vertical ladders may be permitted provided they are arranged above each other in line with other ladders to which they form access and resting positions are provided at not more than 9 metres apart.
Tunnels passing through dry cargo holds are to be equipped with ladders or steps at each end of the hold so that personnel may get across such tunnels.
Where it may be necessary for work to be carried out within a dry cargo hold preparatory to loading, consideration is to be given to suitable arrangements for the safe handling of portable staging or movable platforms.

6.3 Access to compartments in the oil cargo area

6.3.1 General

Access to cofferdams, ballast tanks, dry cargo holds, oil cargo tanks and other compartments in the oil cargo area is to be direct from the open deck and such as to ensure their complete inspection.

6.3.2 Access to the fore peak tank *(1/1/2026)*

The requirements for access to the fore peak tank in Ch 7, Sec 2, [7.2] and [7.3] apply.

6.3.3 Access through horizontal openings

For access through horizontal openings the dimensions are to be sufficient to allow a person wearing a self-contained, air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the compartment. The minimum clear opening is to be not less than 600 mm by 600 mm.

6.3.4 Access through vertical openings

For access through vertical openings the minimum clear opening is to be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

6.4 Access to the bow

6.4.1 *(1/7/2008)*

This item [6.4] applies to ships subject to the International Load Line Convention 1966, as amended.

6.4.2 *Combination carriers are to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means are to be accepted by the Society.*

Note 1: The Society considers means in compliance with the Guidelines adopted by the Maritime Safety Committee of IMO with Resolution MSC.62(67) on 5/12/1996 as being acceptable.

SECTION 3 HULL AND STABILITY

Symbols

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

E : Young's modulus, in N/mm^2, to be taken equal to:

- E = 2,06.10^5 N/mm^2, for steels in general
- E = 1,95.10^5 N/mm^2, for stainless steels.

1 General

1.1 Loading manual and loading instrument

1.1.1 The specific requirements in Pt B, Ch 11, Sec 2 for ships with either of the service notations **combination carrier/OBO ESP** or **combination carrier/OOC ESP** and equal to or greater than 150 m in length are to be complied with.

2 Stability

2.1 Intact stability

2.1.1 General

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.5] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2. Where the ship is intended also for the carriage of grain, the requirements in Ch 4, Sec 3, [2.2.2] and Ch 4, Sec 3, [2.2.3] are to be complied with.

In addition, for the carriage of liquids, the requirements in [2.1.3] are to be complied with.

2.1.2 Liquid transfer operations

Ships with certain internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling, the design of oil tankers of 5000 t deadweight and above is to be such that the following criteria are complied with*:*

a) The intact stability criteria reported in b) are to be complied with for the worst possible condition of loading and ballasting as defined in c)*, consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.*

b) The initial metacentric height GM_o, in m, corrected for free surface measured at 0° heel, is to be not less than 0,15. For the purpose of calculating GM_o, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.

c) The vessel is to be loaded with:

- *all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank*
- *cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value*
- *full departure consumable*
- *1% of the total water ballast capacity. The maximum free surface moment is to be assumed in all ballast tanks.*

2.1.3 Alternative requirements for liquid transfer operation

As an alternative to the requirements in [2.1.2], simple supplementary operational procedures are to be followed when the ship is carrying oil cargoes or during liquid transfer operations.

Simple supplementary operational procedures for liquid transfer operations means written procedures made available to the Master which:

- *are approved by the Society,*

- *indicate those cargo and ballast tanks which may, under any specific condition of liquid transfer and possible range of cargo densities, be slack and still allow the stability criteria to be met. The slack tanks may vary during the liquid transfer operations and be of any combination provided they satisfy the criteria.*
- *are to be readily understandable to the officer-in-charge of liquid transfer operations,*
- *provide for planned sequences of cargo/ballast transfer operations,*
- *allow comparisons of attained and required stability using stability performance criteria in graphical or tabular form,*
- *require no extensive mathematical calculations by the officer-in-charge,*
- *provide for corrective actions to be taken by the officer-in-charge in the event of departure from the recommended values and in case of emergency situations, and,*
- *are prominently displayed in the approved trim and stability booklet and at the cargo/ballast transfer control station and in any computer software by which stability calculations are performed.*

3 Structure design principles of ships with the service notation combination carrier/OBO ESP

3.1 Double bottom structure

3.1.1 Longitudinally framed double bottom

In ships greater than 120 m in length, the double bottom and the sloped bulkheads of hopper tanks are to be longitudinally framed.

The girder spacing is to be not greater than 4 times the spacing of bottom or inner bottom ordinary stiffeners and the floor spacing is to be not greater than 3 frame spaces.

Greater spacing may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

3.1.2 Transversely framed double bottom

The double bottom and the sloped bulkheads of hopper tanks may be transversely framed in ships less than or equal to 120 m in length, when this is deemed acceptable by the Society on a case-by-case basis. In this case, however, the floor spacing is to be not greater than 2 frame spaces.

3.1.3 Floors in way of transverse bulkheads

The thickness and material properties of the supporting floors and pipe tunnel beams are to be not less than those required for the bulkhead plating or, when a stool is fitted, of the stool side plating.

3.2 Double side structure

3.2.1 General

The side within the hopper and topside tanks is, in general, to be longitudinally framed. It may be transversely framed when this is accepted for the double bottom and the deck according to [3.1.2] and [3.3.1], respectively.

3.2.2 Side primary supporting members

The spacing of transverse side primary supporting members is to be not greater than 3 frame spaces.

Greater spacing may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

In any case, transverse side primary supporting members are to be fitted in line with transverse primary supporting members in hopper and topside tanks.

3.3 Deck structure

3.3.1 Deck outside the line of hatches and topside tank sloping plates

In ships greater than 120 m in length, the deck outside the line of hatches and the topside tank sloping plates are to be longitudinally framed.

The spacing of transverse primary supporting members in topside tanks is to be not greater than 6 frame spaces.

Greater spacing may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

3.3.2 Deck between hatches

The cross decks between hatches are generally to be transversely framed.

3.3.3 Connection of hatch end beams with deck structures

The connection of hatch end beams with deck structures is to be properly ensured by fitting inside the topside tanks additional web frames or brackets.

3.3.4 Topside tank structure

Topside tank structures are to extend as far as possible within the machinery space and are to be adequately tapered.

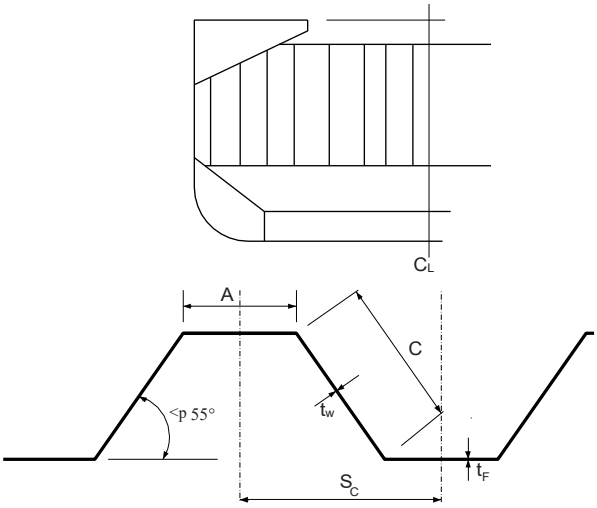
3.4 Transverse vertically corrugated watertight bulkhead

3.4.1 General *(1/7/2004)*

In ships equal to or greater than 190 m in length, transverse vertically corrugated watertight bulkheads are to be fitted with a lower stool and, in general, with an upper stool below the deck. In smaller ships, corrugations may extend from the inner bottom to the deck; if the stool is fitted, it is to comply with the requirements in [3.4.1] to [3.4.5].

The corrugation angle φ shown in Fig 1 is to be not less than 55°.

Figure 1 : Corrugation geometry

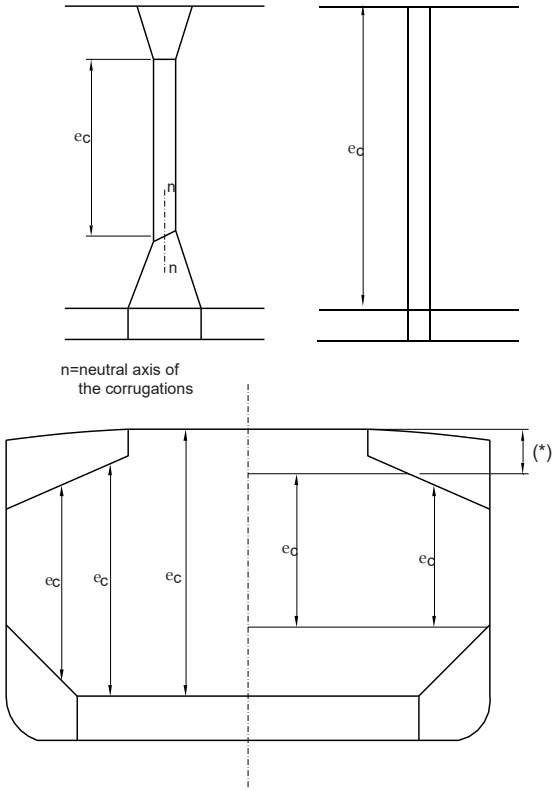


3.4.2 Span of corrugations

The span ℓ_C of the corrugations (to be used for carrying out the strength checks according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as the case may be) is to be taken as the distance shown in Fig 2. For the definition of ℓ_C, the internal end of the upper stool may not be taken at a distance from the deck at centreline greater than:

- 3 times the depth of corrugations, in general
- twice the depth of corrugations, for rectangular upper stools.

Figure 2 : Span of the corrugations



(*) See [3.4.2].

3.4.3 Lower stool *(1/7/2001)*

The lower stool, when fitted, is to have a height in general not less than 3 times the depth of the corrugations.

The thickness and material of the stool top plate is to be not less than those required for the bulkhead plating above. The thickness and material properties of the upper portion of vertical or sloping stool side plating within the depth equal to the corrugation flange width from the stool top are to be not less than the required flange plate thickness and material to meet the bulkhead stiffness requirement at the lower end of corrugation.

The ends of stool side ordinary stiffeners are to be attached to brackets at the upper and lower ends of the stool.

The distance from the edge of the stool top plate to the surface of the corrugation flange is to be in accordance with Fig 3.

The stool bottom is to be installed in line with double bottom floors and is to have a width not less than 2,5 times the mean depth of the corrugation.

The stool is to be fitted with diaphragms in line with the longitudinal double bottom girders for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connections to the stool top plate are to be avoided.

Where corrugations are cut at the lower stool, the weld connections of corrugations and stool side plating to the stool top plate are to be in accordance with [13.1]. The weld connections of stool side plating and supporting floors to the inner bottom plating are to be in accordance with [13.1].

3.4.4 Upper stool

The upper stool, when fitted, is to have a height in general between 2 and 3 times the depth of corrugations. Rectangular stools are to have a height in general equal to twice the depth of corrugations, measured from the deck level and at the hatch side girder.

The upper stool is to be properly supported by deck girders or deep brackets between the adjacent hatch end beams.

The width of the upper stool bottom plate is generally to be the same as that of the lower stool top plate. The stool top of non-rectangular stools is to have a width not less then twice the depth of corrugations.

The thickness and material of the stool bottom plate are to be the same as those of the bulkhead plating below. The thickness of the lower portion of stool side plating is to be not less than 80% of that required for the upper part of the bulkhead plating where the same material is used.

The ends of stool side ordinary stiffeners are to be attached to brackets at the upper and lower end of the stool.

The stool is to be fitted with diaphragms in line with and effectively attached to longitudinal deck girders extending to the hatch end coaming girders for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connection to the stool bottom plate are to be avoided.

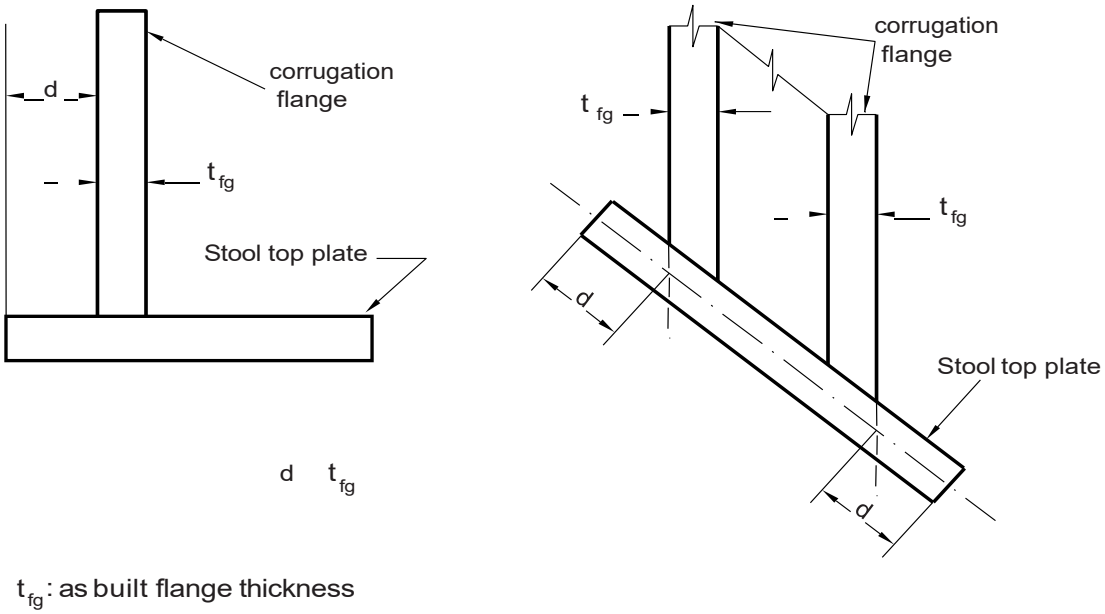
3.4.5 Alignment

At deck, if no upper stool is fitted, two transverse reinforced beams are to be fitted in line with the corrugation flanges.

At bottom, if no lower stool is fitted, the corrugation flanges are to be in line with the supporting floors. The weld connections of corrugations and floors to the inner bottom plating are to be in accordance with [12.1]. The thickness and material properties of the supporting floors are to be not less than those of the corrugation flanges. Moreover, the cut-outs for connections of the inner bottom longitudinals to double bottom floors are to be closed by collar plates. The supporting floors are to be connected to each other by suitably designed shear plates.

Stool side plating is to align with the corrugation flanges; lower stool side vertical stiffeners and their brackets in the stool are to align with the inner bottom longitudinals to provide appropriate load transmission between these stiffening members. Lower stool side plating may not be knuckled anywhere between the inner bottom plating and the stool top plate.

Figure 3 : Permitted distance, d, from the edge of the stool top plate to the surface of the corrugation flange



d t_{fg}

t_{fg}: as built flange thickness

3.4.6 Effective width of the compression flange

The effective width of the corrugation flange to be considered for the strength check of the bulkhead is to be obtained, in m, from the following formula:

$b_{EF} = C_E A$

where:

C_E : Coefficient to be taken equal to:

$$C_E = \frac{2,25}{\beta} - \frac{1,25}{\beta^2} \quad \text{for } \beta > 1,25$$

$$C_E = 1,0 \quad \text{for } \beta \leq 1,25$$

β : Coefficient to be taken equal to:

$$\beta = 10^3 \frac{A}{t_f} \sqrt{\frac{R_{eH}}{E}}$$

A : Width, in m, of the corrugation flange (see Fig 1)

t_f : Net flange thickness, in mm

R_{eH} : Minimum yield stress, in N/mm^2, of the flange material, defined in Pt B, Ch 4, Sec 1, [2].

3.4.7 Effective shedder plates

Effective shedder plates are those which:

- are not knuckled

- are welded to the corrugations and the lower stool top plate according to [13.1]
- are fitted with a minimum slope of 45°, their lower edge being in line with the lower stool side plating
- have thickness not less than 75% of that required for the corrugation flanges
- have material properties not less than those required for the flanges.

3.4.8 Effective gusset plates

Effective gusset plates are those which:

- are in combination with shedder plates having thickness, material properties and welded connections according to [3.4.7]
- have a height not less than half of the flange width
- are fitted in line with the lower stool side plating
- are welded to the lower stool plate, corrugations and shedder plates according to [13.1]
- have thickness and material properties not less than those required for the flanges.

3.4.9 Section modulus at the lower end of corrugations

a) The section modulus at the lower end of corrugations (sections 1 in Fig 4 to Fig 8) is to be calculated with the compression flange having an effective flange width b_{ef} , not larger than that indicated in [3.4.6].

b) Webs not supported by local brackets.

Except in case e), if the corrugation webs are not supported by local brackets below the stool top plate (or below the inner bottom) in the lower part, the section modulus of the corrugations is to be calculated considering the corrugation webs 30% effective.

c) Effective shedder plates.

Provided that effective shedder plates, as defined in [3.4.7], are fitted (see Fig 4 and Fig 5), when calculating the section modulus of corrugations at the lower end (sections 1 in Fig 4 and Fig 5), the area of flange plates may be increased by the value obtained, in cm^2, from the following formula:

$$I_{SH} = 2{,}5A \sqrt{t_F t_{SH}}$$

without being taken greater than $2{,}5At_F$,

where:

A : Width, in m, of the corrugation flange (see Fig 1)

t_{SH} : Net shedder plate thickness, in mm

t_F : Net flange thickness, in mm.

d) Effective gusset plates.

Provided that effective gusset plates, as defined in [3.4.8], are fitted (see Fig 6 to Fig 8), when calculating the section modulus of corrugations at the lower end (cross-sections 1 in Fig 6 to Fig 8), the area of flange plates may be increased by the value obtained, in cm^2, from the following formula:

$$I_G = 7h_G t_F$$

where:

h_G : Height, in m, of gusset plate (see Fig 6 to Fig 8), to be taken not greater than $(10/7)S_{GU}$,

S_{GU} : Width, in m, of the gusset plates

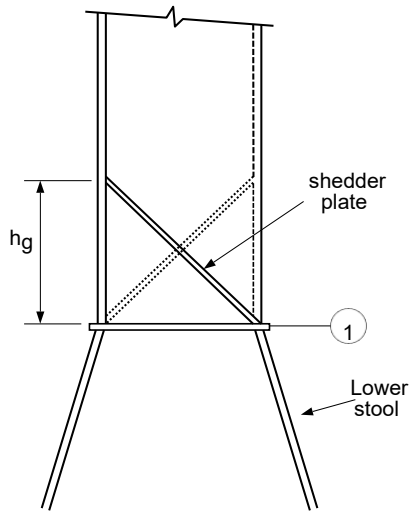
t_F : Net flange thickness, in mm, based on the as-built condition.

e) Sloping stool top plate

If the corrugation webs are welded to a sloping stool top plate which has an angle not less than 45° with the horizontal plane, the section modulus of the corrugations may be calculated considering the corrugation webs fully effective. For angles less than 45°, the effectiveness of the web may be obtained by linear interpolation between 30% for 0° and 100% for 45°.

Where effective gusset plates are fitted, when calculating the section modulus of corrugations the area of flange plates may be increased as specified in d) above. No credit may be given to shedder plates only.

Figure 4 : Symmetrical shedder plates



3.4.10 Section modulus at sections other than the lower end of corrugations

The section modulus is to be calculated with the corrugation webs considered effective and the compression flange having an effective flange width, b_{EF}, not larger than that obtained in [3.4.6].

3.4.11 Shear area

The shear area is to be reduced in order to account for possible non-perpendicularity between the corrugation webs and flanges. In general, the reduced shear area may be obtained by multiplying the web sectional area by (sin φ), φ being the angle between the web and the flange (see Fig 1).

Figure 5 : Asymmetrical shedder plates

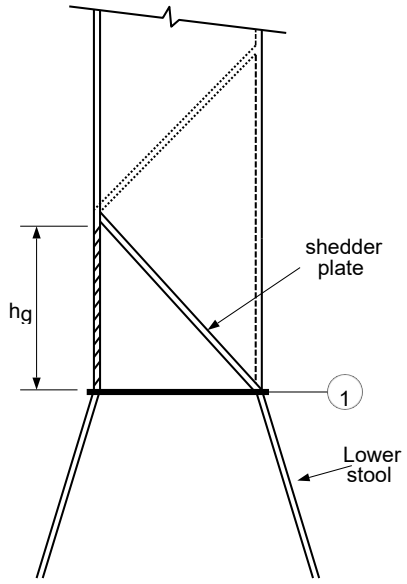


Figure 6 : Symmetrical gusset/shedder plates

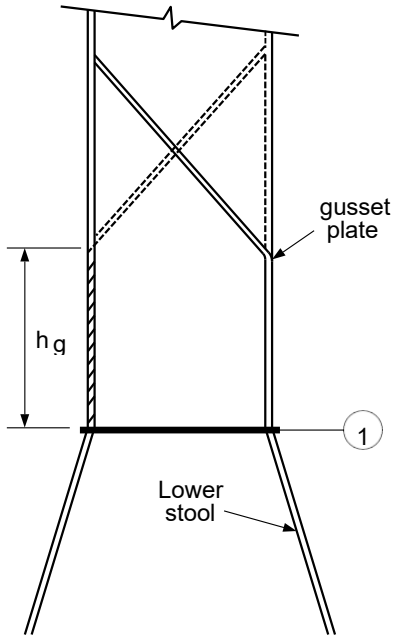


Figure 7 : Asymmetrical gusset/shedder plates

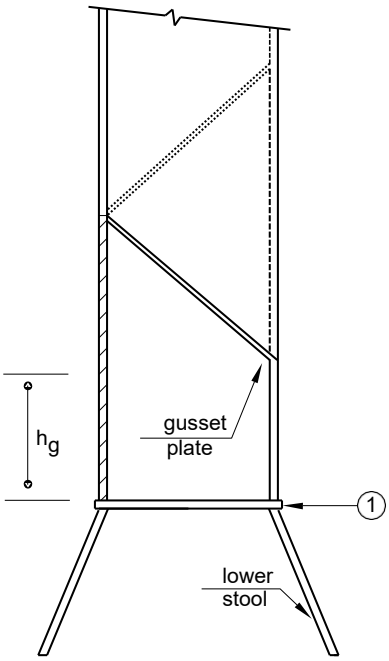
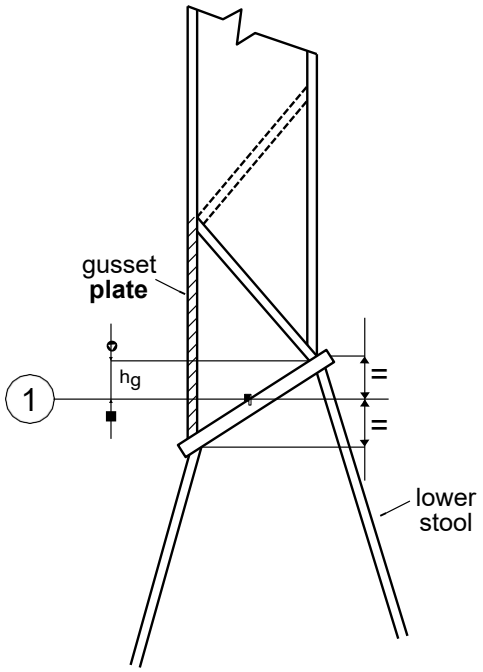


Figure 8 : Asymmetrical gusset/shedder plates - Sloping stool top plate



4 Structure design principles of ships with the service notation combination carrier/OOC ESP

4.1 Double bottom structure

4.1.1 The double bottom is to be longitudinally framed.

The girder spacing is to be not greater than 4 times the spacing of bottom or inner bottom ordinary stiffeners and the floor spacing is to be not greater than 3 frame spaces.

Solid floors are to be fitted in line with the transverse primary supporting members in wing tanks and intermediate floors are to be added at mid-span between primary supporting members.

4.1.2 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo holds.

4.1.3 Scarfing of the double bottom structure into the wing tanks is to be properly ensured. The inner bottom plating is generally to be prolonged within the wing tanks by adequately sized horizontal brackets in way of floors.

4.2 Side structure

4.2.1 In ships greater than 120 m in length, the side shell is to be longitudinally framed.

In general, the spacing of vertical primary supporting members is to be not greater than 6 times the frame spacing.

4.2.2 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo hold.

4.3 Deck structure

4.3.1 The deck outside the line of hatches is to be longitudinally framed.

4.3.2 The cross decks between hatches are generally to be transversely framed.

4.3.3 The connection of hatch end beams with deck structures is to be properly ensured by fitting inside the wing tanks additional web frames or brackets.

4.4 Longitudinal bulkhead structure

4.4.1 Longitudinals bulkheads are to be plane, but they may be knuckled in the upper part and in the lower part to form a hopper. In these cases, the design of the knuckles and the adjacent structures is to be considered by the Society on a case-by-case basis.

4.4.2 In ships greater than 120 m in length, longitudinal bulkheads are to be longitudinally framed.

4.4.3 Other arrangements may be accepted by the Society, on a case-by-case basis, depending on the results of the analysis carried out according to Pt B, Ch 7, App 1 for the primary supporting members in the cargo hold.

4.5 Transverse bulkhead structure

4.5.1 Where the structural arrangement of transverse bulkheads in wing tanks is different from that in centre holds, arrangements are to be made to ensure continuity of the transverse strength through the longitudinal bulkheads.

4.6 Transverse vertically corrugated watertight bulkheads

4.6.1 The requirements in [3.4] apply, with the exception that lower and upper stools are generally required, irrespective of the ship's length (see [3.4.1]).

5 Design loads

5.1 Hull girder loads

5.1.1 Still water loads *(1/7/2002)*

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1.2], still water loads are to be calculated for the following loading conditions, subdivided into departure and arrival conditions as appropriate:

- alternate light and heavy cargo (dry or oil) loading conditions at maximum draught, where applicable
- homogeneous light and heavy cargo (dry or oil) loading conditions at maximum draught
- ballast conditions. For ships having ballast holds adjacent to topside wing, hopper and double bottom tanks, it may be acceptable in terms of strength that the ballast holds are filled when the topside wing, hopper and double bottom tanks are empty.
- short voyage conditions where the ship is to be loaded to maximum draught but with a limited amount of bunkers
- multiple port loading/unloading conditions
- deck cargo conditions, where applicable
- typical loading sequences where the ship is loaded from commencement of cargo loading to reaching full deadweight capacity, for homogeneous conditions, relevant part load conditions and alternate conditions where applicable. Typical unloading sequences for these conditions are also to be included. The typical loading/unloading sequences are also to be developed so as not to exceed applicable strength limitations. The typical loading sequences are also to be developed paying due attention to the loading rate and deballasting capability
- typical sequences for change of ballast at sea, where applicable.

5.2 Local loads

5.2.1 Bottom impact pressure

For combination carriers of 20000 t deadweight and above, the draught T_F, to be considered in the calculation of the bottom impact pressure according to Pt B, Ch 9, Sec 1, [3.2], is that calculated by using the segregated ballast tanks only.

5.2.2 Oil cargo mass density

In the absence of more precise values, an oil cargo mass density of 0,9 t/m^3 is to be considered for calculating the internal pressures and forces in cargo tanks according to Pt B, Ch 5, Sec 6.

6 Hull scantlings

6.1 Plating

6.1.1 Minimum net thicknesses *(1/7/2002)*

The net thickness of the plating of the inner bottom in holds intended to carry ore, of the strength deck and of bulkheads within or bounding the longitudinal extension of the cargo area is to be not less than the values given in Tab 1.

Table 1 : Minimum net thickness of the plating of the inner bottom in holds intended to carry ore, of the strength deck and of bulkheads

Plating	Minimum net thickness, in mm	
Inner bottom in holds intended to carry ore	Longitudinal framing	2,15 ($L^{1/3}\,k^{1/6}$) + 4,5 s
	Transverse framing	2,35 ($L^{1/3}\,k^{1/6}$) + 4,5 s
Strength deck	(5,5 + 0,02 L) $k^{1/2}$ (8 + 0,0085 L) $k^{1/2}$	for L < 200 m for L ≥ 200 m
Tank bulkhead	$L^{1/3}\,k^{1/6}$ + 4,5 s 1,5 $k^{1/2}$ + 8,2 + s	for L < 275 m for L ≥ 275 m
Watertight bulkhead	0,85 $L^{1/3}\,k^{1/6}$ + 4,5 s 1,5 $k^{1/2}$ + 7,5 + s	for L < 275 m for L ≥ 275 m
Wash bulkhead	0,8 + 0,013 L $k^{1/2}$ + 4,5 s 3,0 $k^{1/2}$ + 4,5 + s	for L < 275 m for L ≥ 275 m
Note 1: s : Length, in m, of the shorter side of the plate panel.		

6.2 Ordinary stiffeners

6.2.1 Minimum net thicknesses

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

t_{MIN} = 0,75 $L^{1/3}\,k^{1/6}$ + 4,5 s for L < 275 m

t_{MIN} = 1,5 $k^{1/2}$ + 7,0 + s for L ≥ 275 m

where s is the spacing, in m, of ordinary stiffeners.

6.3 Primary supporting members

6.3.1 Minimum net thicknesses

The net thickness of plating which forms the webs of primary supporting members is to be not less than the value obtained, in mm, from the following formula:

t_{MIN} = 1,45 $L^{1/3}\,k^{1/6}$

6.3.2 Strength check of floors of cargo tank structure with hopper tank analysed through a three dimensional beam model

Where the cargo tank structure with hopper tank is analysed through a three dimensional beam model, to be carried out according to Pt B, Ch 7, App 1, the net shear sectional area of floors within 0,1 ℓ from the floor ends (see Fig 9 for the definition of ℓ) is to be not less than the value obtained, in cm^2, from the following formula:

$$A_{Sh} = 2\frac{Q}{\gamma_R \gamma_m R}$$

where:

Q : Shear force, in kN, in the floors at the ends of ℓ, obtained from the structural analysis

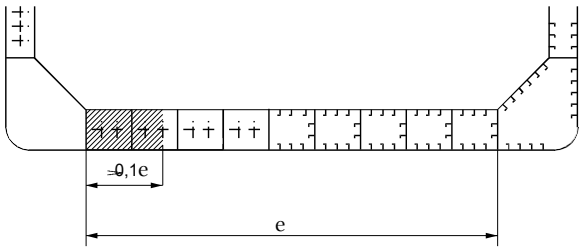
γ_R : Resistance partial safety factor:

γ_R = 1,2

γ_m : Material partial safety factor:

γ_m = 1,02

Figure 9 : End area of floors



6.3.3 Strength checks of cross-ties analysed through a three dimensional beam model

a) Cross-ties analysed through three dimensional beam model analyses according to Pt B, Ch 7, Sec 3 are to be considered, in the most general case, as being subjected to axial forces and bending moments around the neutral axis perpendicular to the cross-tie web. This axis is identified as the y axis, while the x axis is that in the web plane (see Figures in Tab 2).

The axial force may be either tensile or compression. Depending on this, two types of checks are to be carried out, according to b) or c), respectively.

b) Strength check of cross-ties subjected to axial tensile forces and bending moments.

The net scantlings of cross-ties are to comply with the following formula:

$$10\frac{F_T}{A_{ct}} + 10^3\frac{M}{w_{yy}} \leq \frac{R_y}{\gamma_R\gamma_m}$$

where:

F_T : Axial tensile force, in kN, in the cross-ties, obtained from the structural analysis

A_{ct} : Net sectional area, in cm^2, of the cross-tie

M : Max ($|M_1|$, $|M_2|$)

M_1, M_2 : Algebraic bending moments, in kN.m, around the y axis at the ends of the cross-tie, obtained from the structural analysis

w_{yy} : Net section modulus, in cm^3, of the cross-tie about the y axis

γ_R : Resistance partial safety factor:

$\gamma_R = 1,02$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

c) Strength check of cross-ties subjected to axial compressive forces and bending moments.

The net scantlings of cross-ties are to comply with the following formulae:

$$10F_C\left(\frac{1}{A_{ct}} + \frac{\Phi e}{w_{xx}}\right) \leq \frac{R_y}{\gamma_R\gamma_m}$$

$$10\frac{F_C}{A_{ct}} + 10^3\frac{M_{max}}{w_{yy}} \leq \frac{R_y}{\gamma_R\gamma_m}$$

where:

F_C : Axial compressive force, in kN, in the cross-ties, obtained from the structural analysis

A_{ct} : Net cross-sectional area, in cm^2, of the cross-tie

$$\Phi = \frac{1}{1 - \frac{F_C}{F_{EX}}}$$

F_{EX} : Euler load, in kN, for buckling around the x axis:

$$F_{EX} = \frac{\pi^2 E I_{xx}}{10^5 \ell^2}$$

I_{xx} : Net moment of inertia, in cm^4, of the cross-tie about the x axis

ℓ : Span, in m, of the cross-tie

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 2 for various types of profiles

w_{ww} : Net section modulus, in cm^3, of the cross-tie about the x axis

M_{max} : Max ($|M_0|$, $|M_1|$, $|M_2|$)

$$M_0 = \frac{\sqrt{1+t^2}(M_1+M_2)}{2\cos(u)}$$

$$t = \frac{1}{\tan(u)}\left(\frac{M_2-M_1}{M_2+M_1}\right)$$

$$u = \frac{\pi}{2}\sqrt{\frac{F_C}{F_{EY}}}$$

F_{EY} : Euler load, in kN, for buckling around the y axis:

$$F_{EY} = \frac{\pi^2 E I_{yy}}{10^5 \ell^2}$$

I_{yy} : Net moment of inertia, in cm^4, of the cross-tie about the y axis

M_1,M_2 : Algebraic bending moments, in kN.m, around the y axis at the ends of the cross-tie, obtained from the structural analysis

w_{yy} : Net section modulus, in cm^3, of the cross-tie about the y axis

γ_R : Resistance partial safety factor:

γ_R = 1,02

γ_m : Material partial safety factor:

γ_m = 1,02

6.3.4 Strength checks of cross-ties analysed through a three dimensional finite element model

a) In addition to the requirements in Pt B, Ch 7, Sec 3, [4] and Pt B, Ch 7, Sec 3, [6], the net scantlings of cross-ties subjected to compression axial stresses are to comply with the following formula:

$$|o| \le \frac{\sigma_C}{\gamma_R \gamma_m}$$

where:

o : Compressive stress, in N/mm^2, obtained from a three dimensional finite element analysis, based on fine mesh modelling, according to Pt B, Ch 7, Sec 3 and Pt B, Ch 7, App 1

σ_c : Critical stress, in N/mm^2, defined in b) below

γ_R : Resistance partial safety factor:

γ_R = 1,02

γ_m : Material partial safety factor:

γ_m = 1,02

b) The critical buckling stress of cross-ties is to be obtained, in N/mm^2, from the following formulae:

$$\sigma_c = \sigma_E \quad \text{for } \sigma_E \le \frac{R_y}{2}$$

$$\sigma_c = R_y\left(1 - \frac{R_y}{4\sigma_E}\right) \quad \text{for } \sigma_E > \frac{R_y}{2}$$

where:

σ_E = Min (σ_{E1}, σ_{E2}),

σ_{E1} : Euler flexural buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E1} = \frac{\pi^2 E I}{10^4 A_{ct}^2 \ell}$$

I : Min (I_{xx}, I_{yy}),

I_{xx} : Net moment of inertia, in cm^4, of the cross-tie about the x axis defined in [6.3.3] a)

I_{yy} : Net moment of inertia, in cm^4, of the cross-tie about the y axis defined in [6.3.3] a)

A_{ct} : Net cross-sectional area, in cm^2, of the cross-tie,

ℓ : Span, in m, of the cross-tie

σ_{E2} : Euler torsional buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E2} = \frac{\pi^2 E I_w}{10^4 I_o \ell^2} + 0{,}41E\frac{J}{I_o}$$

I_w : Net sectorial moment of inertia, in cm^6, of the cross-tie, specified in Tab 2 for various types of profiles

I_o : Net polar moment of inertia, in cm^4, of the cross-tie,

$$I_o = I_{xx} + I_{yy} + A_{ct}(y_o + e)^2$$

y_o : Distance, in cm, from the centre of torsion to the web of the cross-tie, specified in Tab 2 for various types of profiles

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 2 for various types of profiles

J : St. Venant's net moment of inertia, in cm^4, of the cross-tie, specified in Tab 2 for various types of profiles.

6.4 Strength check with respect to stresses due to the temperature gradient

6.4.1 *(1/7/2018)*

Direct calculations of stresses induced in the hull structures by the temperature gradient are to be performed for ships intended to carry cargoes at temperatures exceeding 90°C. In these calculations, the water temperature is to be assumed equal to 0°C.

The calculations are to be submitted to the Society for review.

6.4.2 The stresses induced in the hull structures by the temperature gradient are to comply with the checking criteria in Pt B, Ch 7, Sec 3, [4.3].

7 Forecastle

7.1 General

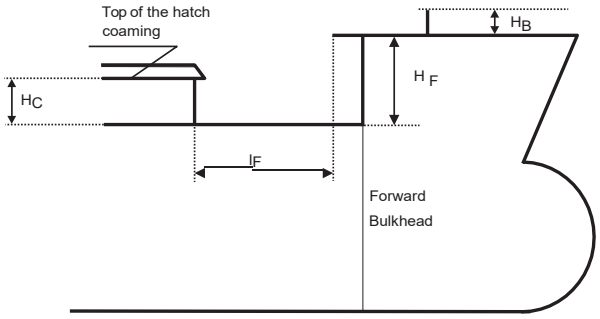
7.1.1 *(1/1/2004)*

Ships with service notation **combination carrier ESP** are to be fitted with an enclosed forecastle on the freeboard deck.

The required dimensions of the forecastle are defined in [7.2].

The structural arrangements and scantlings of the forecastle are to comply with the requirements in Pt B, Ch 10, Sec 2.

Figure 10 : Forecastle arrangement *(1/1/2004)*



7.2 Dimensions

7.2.1 *(1/7/2006)*

The forecastle is to be located on the freeboard deck with its aft bulkhead fitted in way or aft of the forward bulkhead of the foremost hold, as shown in Fig 10.

However, if this requirement hinders hatch cover operation, the aft bulkhead of the forecastle may be fitted forward of the forward bulkhead of the foremost cargo hold provided that the forecastle length aft FE is not less than $0,07L_{LL}$, where:

FE : Fore end of the length L, as defined in Pt B, Ch 1, Sec 2, [3.3.1]

L_{LL} : Freeboard length, as defined in Pt B, Ch 1, Sec 2, [3.2]

The forecastle height H_F above the main deck is to be not less than the greater of:

- the standard height of a superstructure, as specified in Pt B, Ch 1, Sec 2, Tab 2, or
- H_C + 0,5 m, where H_C is the height of the forward transverse hatch coaming of cargo hold No.1.

All points of the aft edge of the forecastle deck are to be located at a distance l_F, in compliance with the following formula, from the hatch coaming plate in order to apply the reduced loading to the No.1 forward transverse hatch coaming and No.1 hatch cover in applying Pt B, Ch 9, Sec 7, [3.3.2] and Pt B, Ch 9, Sec 7, [7.2.3], respectively:

$$l_F \leq 5\sqrt{H_F - H_C}$$

A breakwater may not be fitted on the forecastle deck with the purpose of protecting the hatch coaming or hatch covers. If fitted for other purposes, it is to be located such that its upper edge at centreline is not less than H_B / tan20° forward of the aft edge of the forecastle deck, where H_B is the height of the breakwater above the forecastle (see Fig 10).

8 Machinery space

8.1 Extension of hull structures within the machinery space

8.1.1 Longitudinal bulkheads or inner side, as applicable, carried through cofferdams are to continue within the machinery space and are to be used preferably as longitudinal bulkheads for liquid cargo tanks. In any case, such extension is to be compatible with the shape of the structures of the double bottom, deck and platforms of the machinery space.

Where topside tanks are fitted, their structures are to extend as far as possible within the machinery space and to be adequately tapered.

9 Hatch covers, hatch coamings and closing devices

9.1 Application

9.1.1 *(1/7/2024)*

Refer to the requirements for Type 2 ships in Pt B, Ch 9, Sec 7.

10 Opening arrangement

10.1 Tanks covers

10.1.1 Covers fitted on all cargo tank openings are to be of sturdy construction, and to ensure tightness for hydrocarbon and water.

Aluminium is not permitted for the construction of tank covers. The use of reinforced fibreglass covers is to be specially examined by the Society.

11 Hull outfitting

11.1 Equipment

11.1.1 Emergency towing arrangement

The specific requirements in Pt B, Ch 10, Sec 4, [4] for ships with either of the service notations **combination carrier/OBO ESP** or **combination carrier/OOC ESP** and of 20000 t deadweight and above are to be complied with.

12 Protection of hull metallic structures

12.1 Protection of sea water ballast tanks

12.1.1 *All dedicated seawater ballast tanks are to have an efficient corrosion prevention system, such as hard protective coatings or equivalent.*

The coatings are preferably to be of a light colour, i.e. a colour easily distinguishable from rust which facilitates inspection.

Where appropriate, sacrificial anodes may also be used.

12.2 Protection by aluminium coatings

12.2.1 *(1/1/2014)*
The use of aluminium coatings containing more than 10 percent aluminium by weight in the dry film is prohibited in cargo tanks, the cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

13 Construction and testing

13.1 Welding and weld connections

13.1.1 The welding factors for some hull structural connections are specified in Tab 3. These welding factors are to be used, in lieu of the corresponding factors specified in Pt B, Ch 12, Sec 1, Tab 2, to calculate the throat thickness of fillet weld T connections according to Pt B, Ch 12, Sec 1, [2.3]. For the connections in Tab 3, continuous fillet welding is to be adopted.

13.2 Special structural details

13.2.1 The specific requirements in Pt B, Ch 12, Sec 2, [2.6] for ships with either of the service notations **combination carrier/OBO ESP** or **combination carrier/OOC ESP** are to be complied with.

Table 2 : Calculation of cross-tie geometric properties

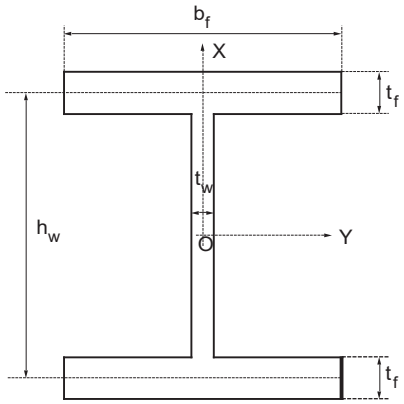
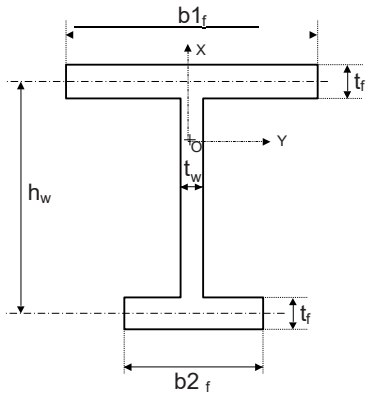
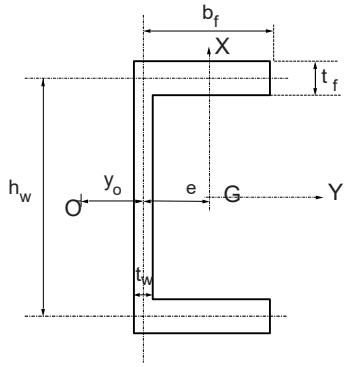
Cross-tie profile	e	y_0	J	I_W
T symmetrical 	0	0	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f h_w^2 b_f^3}{24}$
T non-symmetrical 	0	0	$\frac{1}{3}\lvert(b_{1f} + b_{2f})t_f^3 + h_w t_w^3\rvert$	$\frac{t_f h_w^2 b_{1f}^3 b_{2f}^3}{12(b_{1f}^3 + b_{2f}^3)}$
Non-symmetrical 	$\frac{b^2 t_f}{ht_w + 2bt_f}$	$\frac{3b^2 t_f}{6b_f t_f + h_w t_w}$	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f b_f^3 h^2 3b_f t_f + 2h_w t_w}{12 \quad 6b_f t_f + h_w t_w}$

Table 3 : Welding factor w_F

Hull area	Connection		Welding factor w_F
	of	to	
Double bottom in way of cargo holds and tanks	girders	bottom and inner bottom plating	0,35
		floors (interrupted girders)	0,35
	floors	bottom and inner bottom plating	0,35
		inner bottom in way of lower stools, in general	0,45
		girders (interrupted floors)	0,35
Bulkheads in dry cargo holds	lower and upper stool structures	boundaries	0,45
	effective shedder plates (see [3.4.7])	vertical corrugations and lower stool top plate	One side penetration welding or equivalent
	effective gusset plates (see [3.4.8])	lower stool top plate	Full penetration welding
		vertical corrugations and shedder plates	One side penetration welding or equivalent
Bulkheads in oil cargo tanks	ordinary stiffeners	bulkhead plating	0,35

SECTION 4 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Application

1.1.1 Ships having the service notation **combination carrier** are to comply with the requirements of Ch 7, Sec 4 applicable to oil tankers or oil tankers flashpoint > 60°C, as appropriate.

In addition, they are to comply with the provisions of this Section.

1.2 Documents

1.2.1 Documents to be submitted

In addition to those listed in Ch 7, Sec 4, Tab 2 the following documents are to be submitted for approval.

Table 1 : Documents to be submitted

Item N°	Description of the document **(1)**
1	Diagram of the ventilation systems serving cargo spaces and enclosed spaces adjacent to cargo spaces
2	Diagram of the gas measurement system for cargo pump rooms, pipe ducts and cofferdams adjacent to slop tanks
3	Diagram of water filling and draining systems for cofferdams
4	Diagram of discharge pumping and piping systems for slop tanks
(1) Diagrams are also to include, where applicable: • the (local and remote) control and monitoring systems and automation systems • the instructions for the operation and maintenance of the piping system concerned (for information).	

1.2.2 Instruction manual

A manual is to be kept on board giving all instructions for safe carriage of contaminated sludge in slop tanks when the ship is in the dry cargo mode.

2 General requirements

2.1 Ventilation and gas detection

2.1.1 Ventilation *(1/1/2007)*

All cargo spaces and any enclosed spaces adjacent to cargo spaces are to be capable of being mechanically ventilated. The mechanical ventilation may be provided by portable fans. See also Pt C, Ch 4, Sec 1, [5.2.2].

2.1.2 Gas detection *(1/1/2007)*

a) Arrangements for gas detection are to comply with the relevant provisions of Pt C, Ch 4, Sec 1, [5.2.4].

b) Audible and visual alarms for the gas detection equipment are to be located on the bridge or in other suitable continually manned spaces.

2.2 Arrangement of cargo lines

2.2.1 *(1/1/2007)*

a) Where cargo wing tanks are provided, cargo oil lines below deck are to be installed inside these tanks. However, the Society may permit cargo oil lines to be placed in special ducts which are to be capable of being adequately cleaned and ventilated and to the satisfaction of the Society.

If connected to a cargo pump room, such ducts are to be considered as cargo pump rooms for the purposes of safety.

b) Where cargo wing tanks are not provided, cargo oil lines below deck are to be placed in special ducts.

2.3 Cargo openings

2.3.1 Openings which may be used for cargo operations are not permitted in bulkheads and decks separating oil cargo spaces from other spaces not designed and equipped for the carriage of oil cargoes unless alternative approved means are provided to ensure equivalent integrity.

2.4 Cofferdam filling and draining

2.4.1 Means are to be provided for filling the cofferdams surrounding the slop tanks with water and for draining them. See Sec 2, [2.1.3].

3 Slop tanks

3.1 Segregation of piping systems

3.1.1 *(1/1/2007)*

a) Pipes serving the slop tanks are to be segregated from other parts of the cargo pumping and piping system by means of isolation complying with b) or c) below.

b) Arrangements to isolate slop tanks containing oil or oil residues from other cargo tanks are to consist of blank flanges which are to remain in position at all times when cargoes other than oil products having a flashpoint not exceeding 60°C are carried.

c) Means are to be provided for isolating the piping connecting the pump room with the slop tanks. The means of isolation are to consist of a valve followed by a spectacle flange or a spool piece with appropriate blank flanges. This arrangement is to be located adjacent to the slop tanks, but where this is unreasonable or impracticable, it may be located within the pump room directly after the piping penetrates the bulkhead.

3.2 Venting system

3.2.1 Slop tanks are to be provided with a separate venting system complying with the provisions of Ch 7, Sec 4, [4.2].

3.3 Discharge pumping and piping arrangement

3.3.1 *(1/1/2007)*

A separate pumping and piping arrangement incorporating a manifold is to be provided for discharging the contents of the slop tanks directly to the open deck for disposal to shore reception facilities when the ship is in the dry cargo mode.

Chapter 7

OIL TANKERS AND FLS TANKERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Service notation oil tanker *(1/7/2011)*

a) The requirements of this Chapter apply to ships having the service notations **oil tanker** or **oil tanker ESP**, as defined in Pt A, Ch 1, Sec 2, [4.5.2] and **oil tanker ESP CSR**, as defined in Pt A, Ch 1, Sec 2, [4.5.3] and **asphalt tanker**, as defined in Pt A, Ch 1, Sec 2, [4.5.8] or **asphalt tanker ESP** as defined in Pt A, Ch 1, Sec 2, [4.5.9]. They also apply to ships having the additional service feature **flash point > 60°C**, taking into account the departures given in the different Sections.

Note 1: The departures referred to in a) above do not apply to ships intended for the carriage of bulk cargoes at a temperature above the flashpoint of the product carried.

b) Additional departures are given for ships that have the service notation **oil tanker, flashpoint > 60°C** or **oil tanker ESP, flash point > 60°C** or **oil tanker ESP CSR, flash point > 60°C** and are intended only for the carriage of bulk cargoes:

- at a temperature below and not within 15°C of their flashpoint, or
- having a flashpoint above 100°C.

c) Sec 4, [8] provides additional requirements for ships having the service notation **asphalt tanker** or **asphalt tanker ESP**.

d) The list of substances the carriage in bulk of which is covered by the service notations

- **oil tanker**
- **oil tanker, flashpoint > 60°C**
- **oil tanker ESP**
- **oil tanker ESP CSR**
- **oil tanker ESP, flashpoint > 60°C**
- **oil tanker ESP CSR, flashpoint > 60°C**
- **asphalt tanker**
- **asphalt tanker ESP**

is given in App 3.

1.1.2 Service notation FLS tanker

a) The requirements of this Chapter apply to ships having the service notation **FLS tanker**, as defined in Pt A, Ch 1, Sec 2, [4.5.6]. They also apply to ships having the additional service feature **flash point > 60°C**, taking into account the departures given in Sec 4.

Note 1: The departures referred to in a) above do not apply to ships intended for the carriage of bulk cargoes at a temperature above the flashpoint of the product carried.

b) Sec 4, [8] provides additional requirements for ships having the service notations **FLS tanker** and **FLS tanker, flash point > 60°C** in the case of carriage of pollution category Z products.

c) The list of substances the carriage in bulk of which is covered by the service notations **FLS tanker** and **FLS tanker, flash point > 60°C** is given in App 4.

Note 2: The service notation **FLS tanker** does not cover cargoes containing 10% of benzene or more. Ships carrying such cargoes are to comply with the relevant requirements of Chapter 8.

Note 3: Where the provisions of this Chapter applicable to the service notation **oil tanker** and those applicable to the service notation **FLS tanker** are simultaneously complied with, a ship may be granted both service notations **oil tanker - FLS tanker** or **oil tanker - FLS tanker, flash point > 60°C**, as applicable.

1.2 Summary tables

1.2.1 *(1/7/2011)*

Tab 1 indicates, for easy reference, the Sections or Appendixes of this Chapter dealing with requirements applicable to ships having the following service notations:

- **oil tanker**
- **oil tanker, flashpoint > 60°C**
- **oil tanker ESP**
- **oil tanker ESP, flashpoint > 60°C**
- **FLS tanker**
- **FLS tanker, flashpoint > 60°C**
- **asphalt tanker**
- **asphalt tanker ESP**.

1.2.2 *(1/4/2006)*

Tab 2 indicates, for easy reference, the Sections or Appendixes of this Chapter dealing with requirements applicable to ships having the following service notations:

- **oil tanker ESP CSR**
- **oil tanker ESP CSR, flash point > 60°C**

Table 1 : Sections or Appendixes with requirements applicable to ships having the Service Notations indicated in [1.2.1] *(1/7/2011)*

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery and cargo system	Sec 4 and Sec 5
Electrical installations	Sec 6
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
Devices to prevent the passage of flames into cargo tanks	App 1
Crude oil washing system	App 2
List of oils	App 3
List of easy chemicals	App 4
(1) No specific requirements are given in this Chapter.	

Table 2 : Sections or Appendixes with requirements applicable to ships having the Service Notations indicated in [1.2.2] *(1/7/2011)*

Main subject	Reference
Ship arrangement	Sec 2
Hull	**(1)**
Stability	Sec 3, [1]
Machinery and cargo system	Sec 4 and Sec 5
Electrical installations	Sec 6
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
Devices to prevent the passage of flames into cargo tanks	App 1
(1) No specific requirement are given in this Chapter.	

Main subject	Reference
Crude oil washing system	App 2
List of oils	App 3
(1) No specific requirement are given in this Chapter.	

1.3 Definitions

1.3.1 Cargo area

The cargo area is that part of the ship that contains cargo tanks as well as slop tanks, cargo pump rooms including pump rooms, cofferdams, ballast or void spaces adjacent to cargo tanks or slop tanks as well as deck areas throughout the entire length and breadth of the part of the ship above these spaces.

When independent tanks are installed in hold spaces, the cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space are excluded from the cargo area.

1.3.2 Cargo pump room

Cargo pump room is a space containing pumps and their accessories for the handling of products covered by the service notation granted to the ship.

1.3.3 Cargo service spaces

Cargo service spaces are spaces within the cargo area used for workshops, lockers and storerooms of more than 2 m^2 in area, intended for cargo handling equipment.

1.3.4 Cargo tank block *(1/7/2017)*

Cargo tank block is the part of the ship as indicated in Fig 1, extending from the aft bulkhead of the aftmost cargo or slop tank to the forward bulkhead of the forward most cargo or slop tank, extending to the full depth and beam of the ship, but not including the area above the deck of the cargo or slop tank.

1.3.5 Clean ballast

Clean ballast means the ballast in a tank which since oil was last carried therein, has been so cleaned that the effluent therefrom if it were discharged from a ship which is stationary into clean calm water on a clear day would not produce visible traces of oil on the surface of the water or on adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. If the ballast is discharged through an oil discharge monitoring and control system approved by the Society, evidence based on such a system to the effect that the oil content of the effluent did not exceed 15 parts per million is to be determinative that the ballast was clean, notwithstanding the presence of visible traces.

1.3.6 Crude oil

Crude oil means any liquid hydrocarbon mixture occurring naturally in the earth whether or not treated to render it suitable for transportation and includes:

a) crude oil from which certain distillate fractions have been removed, and

b) crude oil to which certain distillate fractions may have been added.

1.3.7 Crude oil tanker

Crude oil tanker means an oil tanker engaged in the trade of carrying crude oil.

1.3.8 Hold space

Hold space is the space enclosed by the ship’s structure in which an independent cargo tank is fitted

1.3.9 Fuel oil

Fuel oil means any oil used as fuel in connection with the propulsion and auxiliary machinery of the ship on which such oil is carried.

1.3.10 Integrated cargo and ballast system *(1/1/2004)*

Integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps (including active control and safety systems and excluding passive components, e.g. piping).

1.3.11 Oil mixture

Oil mixture means a mixture with any oil content.

1.3.12 Product carrier

Product carrier means an oil tanker engaged in the trade of carrying oil other than crude oil.

1.3.13 Pump room

Pump room is a space, located in the cargo area, containing pumps and their accessories for the handling of ballast and fuel oil, or cargoes other than those covered by the service notation granted to the ship.

1.3.14 Segregated ballast

Segregated ballast means the ballast water introduced into a tank which is completely separated from the cargo oil and fuel oil system and which is permanently allocated to the carriage of ballast or to the carriage of ballast or cargoes other than oil or noxious substances as variously defined in Chapter 7 and Chapter 8.

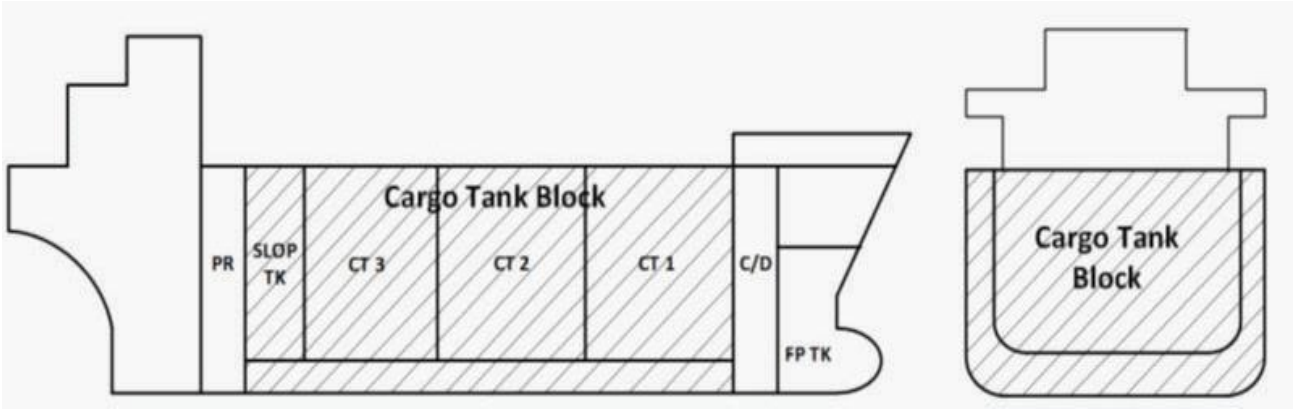
1.3.15 Slop tank

Slop tank means a tank specifically designated for the collection of tank draining, tank washings and other oily mixtures.

1.3.16 Void space

Void space is an enclosed space in the cargo area external to a cargo tank, except for a hold space, ballast space, fuel oil tank, cargo pump room, pump room, or any space normally used by personnel.

Figure 1 : Cargo tank block *(1/7/2017)*



SECTION 2 SHIP ARRANGEMENT

1 General

1.1 Application

1.1.1 *(1/7/2011)*

The requirements in Sec 2 apply to single deck ships, with machinery aft, double bottom throughout the cargo tank area, double side skin and possible longitudinal bulkheads, or single side skin and one or more longitudinal bulkheads throughout the cargo tank area. The deck may be single or double skin, with or without a trunk.

The application of these requirements to other ship types is to be considered by the Society on a case-by-case basis.

1.1.2 Deviations *(1/7/2011)*

The requirements in [2.1.2] to [2.1.4], apply only to ships with the service notations:

- **oil tanker ESP**
- **oil tanker ESP CSR**
- **FLS tanker**.

The requirements in [2.2], [3], [4] and [5] apply only to ships with the service notations:

- **oil tanker ESP**
- **oil tanker ESP CSR**
- **oil tanker ESP, flashpoint > 60°C**
- **oil tanker ESP CSR, flashpoint > 60°C**
- **asphalt tanker**
- **asphalt tanker ESP.**

The requirements in [6] apply only to ships with the service notations:

- **oil tanker ESP**
- **oil tanker ESP CSR**
- **oil tanker ESP, flashpoint > 60°C**
- **oil tanker ESP CSR, flashpoint > 60°C**
- **asphalt tanker**
- **asphalt tanker ESP**

apart from [6.2.2], which applies also to ships having the service notation **FLS tanker**.

2 General arrangement design

2.1 General

2.1.1 Specification

The requirements in [2.1.2] to [2.1.4] apply also to ships with the service notation **FLS tanker**.

2.1.2 Cofferdams

A cofferdam or similar compartment of width not less than 760 mm is to be provided at the aft end of the cargo tank area. Its bulkheads are to extend from keel to deck across the full breadth of the ship.

For the purpose of this requirement, the term “cofferdam” is intended to mean an isolating compartment between two adjacent steel bulkheads or decks. The minimum distance between the two bulkheads or decks is to be sufficient for safe access and inspection.

In order to meet the single failure principle, in the particular case when a corner-to-corner situation occurs, this principle may be met by welding a diagonal plate across the corner.

The cofferdams are also to be constructed so as to enable adequate ventilation.

2.1.3 Cargo segregation

Unless expressly provided otherwise, tanks containing cargo or cargo residues are to be segregated from accommodation, service and machinery spaces, drinking water and stores for human consumption by means of a cofferdam, or any other similar compartment.

Where accommodation and service compartments are arranged immediately above the compartments containing flammable liquids, the cofferdam may be omitted only where the deck is not provided with access openings and is coated with a layer of material recognised as suitable by the Society. The cofferdam may also be omitted where such compartments are adjacent to a passageway, subject to the following conditions:

- the thicknesses of common boundary plates of adjacent tanks are increased, with respect to those obtained from the applicable requirements in Part B and Sec 3, by 2 mm in the case of tanks carrying fresh water or boiler feed water, and by 1 mm in all other cases
- the sum of the throats of the weld fillets at the edges of such plates is not less than the thickness of the plates themselves
- the hydrostatic test is carried out with a head increased by 1 m with respect to that required in Pt B, Ch 12, Sec 3.

2.1.4 Deck spills

Means are to be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by providing a permanent continuous coaming of a suitable height extending from side to side.

Where gutter bars are installed on the weather decks of oil tankers in way of cargo manifolds and are extended aft as far as the aft bulkhead of superstructures for the purpose of containing cargo spills on deck during loading and discharge operations, the free surface effects caused by containment of a cargo spill during liquid transfer operations or of boarding seas while underway are to be considered with respect to the vessel's available margin of positive initial stability (GM_o).

Where the gutter bars installed are higher than 300 mm, they are to be treated as bulwarks with freeing ports arranged in accordance with Pt B, Ch 9, Sec 9, [5] and effective closures provided for use during loading and discharge operations. Attached closures are to be arranged in such a way that jamming cannot occur while at sea, ensuring that the freeing ports will remain fully effective.

On ships without deck camber, or where the height of the installed gutter bars exceeds the camber, and for oil tankers having cargo tanks exceeding 60% of the vessel's maximum beam amidships regardless of gutter bar height, gutter bars may not be accepted without an assessment of the initial stability (GM_o) for compliance with the relevant intact stability requirements taking into account the free surface effect caused by liquids contained by the gutter bars.

2.1.5 Location of fuel tanks in cargo area *(1/7/2019)*

a) These requirements apply to oil tankers carrying liquid cargoes having a flashpoint not exceeding 60°C.

b) Fuel tanks located with a common boundary to cargo or slop tanks shall not be situated within nor extend partly into the cargo tank block. Such tanks may, however, be situated aft and/or forward of the cargo tank block.

c) They may be accepted when located as independent tanks on open deck in the cargo area subject to spill and fire safety considerations.

d) The arrangement of independent fuel tanks and associated fuel piping systems, including the pumps, can be as for fuel tanks and associated fuel piping systems located in the machinery spaces. For electrical equipment, requirements to hazardous area classification must however be met.

2.2 Double bottom tanks or compartments

2.2.1 General

Double bottom tanks adjacent to cargo tanks may not be used as fuel oil tanks.

2.2.2 Oil tankers of 5000 t deadweight and above *(1/7/2007)*

a) At any cross-section, the depth of each double bottom tank or compartment is to be such that the distance h between the bottom of the cargo tanks and the moulded line of the bottom shell plating measured at right angles to the bottom shell plating, as shown in Fig 1, is not less than B/15, in m, or 2,0 m, whichever is the lesser. h is to be not less than 1,0 m.

b) Double bottom tanks or compartments as required by a) may be dispensed with, provided that the design of the tanker is such that the cargo and vapour pressure exerted on the bottom shell plating forming a single boundary between the cargo and the sea does not exceed the external hydrostatic water pressure, as expressed by the following formula:

$$fh_c\rho_c g + 1000\Delta p \leq T_1\rho g$$

where:

f : *Safety factor equal to 1,1*

h_c : *Height, in m, of cargo in contact with the bottom plating*

ρ_c : *Maximum cargo density, in t/m³*

g : *Standard acceleration of gravity equal to 9,81 m/s²*

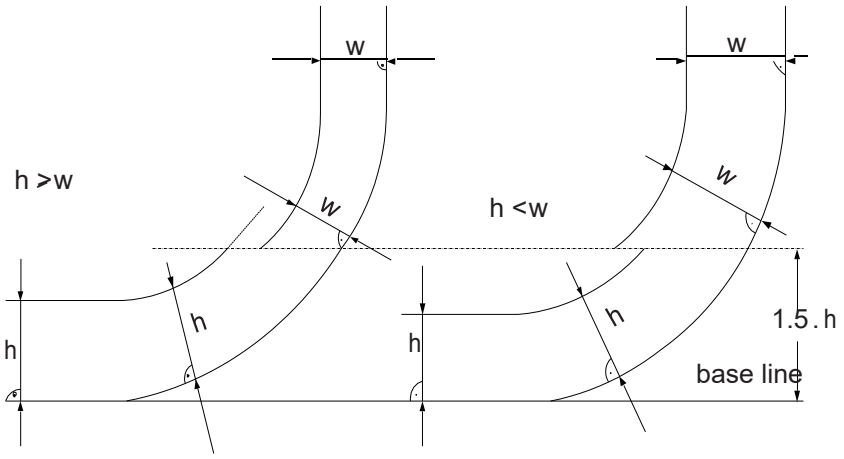
Δp : *Maximum set pressure, in MPa, of pressure/vacuum valve provided for the cargo tank*

T_1 : *Minimum operating draught, in m, under any expected loading condition*

ρ : *Density of sea water, in t/m³.*

c) Any horizontal partition necessary to fulfil the above requirements is to be located at a height not less than B/6 or 6 m, whichever is the lesser, but not more than 0,6D, above the baseline where D is the moulded depth amidships.

Figure 1 : Cargo tank boundary lines

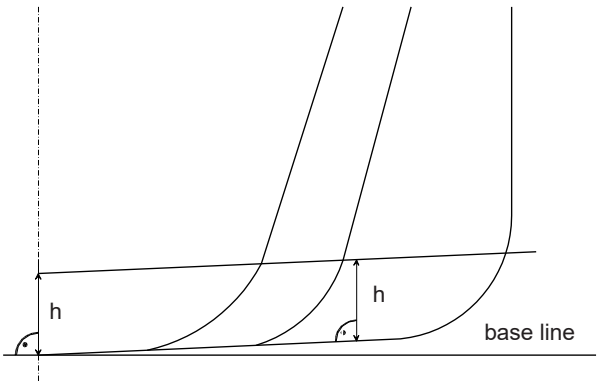


2.2.3 Oil tankers of less than 5000 t but at least 600 t deadweight

At any cross-section, the depth of each double bottom tank or compartment is to be such that the distance h between the bottom of the cargo tanks and the moulded line of the bottom shell plating measured at right angles to the bottom shell is not less than B/15, in m, with a minimum value of 0,76 m.

In the turn of the bilge area and at locations without a clearly defined turn of the bilge, the cargo tank boundary line is to run parallel to the line of the midship flat bottom as shown in Fig 2.

Figure 2 : Cargo tank boundary lines



2.3 Navigation position

2.3.1 When it is proven necessary to provide a navigation station above the cargo area, such station is to be for navigation purposes only and is to be separated from the cargo tank deck by an open space of at least 2 m in height.

3 Size and arrangement of cargo tanks and slop tanks

3.1 Cargo tanks

3.1.1 General

Oil tankers of 600 t deadweight and above are not allowed to carry oil in any compartment extending forward of a collision bulkhead located in accordance with Pt B, Ch 2, Sec 1, [2].

3.1.2 Oil tankers of 5000 t deadweight and above *(1/7/2007)*

Oil tankers of 5000 t deadweight and above are to comply with the requirements in [3.2].

3.1.3 Oil tankers of less than 5000 t *(1/7/2007)*

The length of each cargo tank is not to exceed 10 metres or one of the values of Tab 1, as applicable, whichever is the greater.

Oil tankers of less than 5000 t but at least 600 t deadweight are to be provided with cargo tanks so arranged that the capacity of each cargo tank does not exceed 700 m^3 unless wing tanks or compartments are arranged in accordance with [4.2.2] complying with the following:

$$w = 0,4 + \frac{2,4DW}{20000}$$ with a minimum value of 0,76 m

where w is the distance, in m, as described in Fig 1 and DW is the deadweight, in t.

3.1.4 Piping through cargo tanks *(1/7/2007)*

Lines of piping which run through cargo tanks in a position less than 0,30 B_s from the ship's side or less than 0,30 D_s from the ship's bottom are to be fitted with valves or similar closing devices at the point at which they open into any cargo tank. These valves are to be kept closed at sea at any time when the tanks contain cargo oil, except that they may be opened only for cargo transfer needed for essential operations.

3.1.5 Suction wells in cargo tanks *(1/7/2007)*

Suction wells in cargo tanks may protrude into the double bottom below the boundary line defined by the distance h in [2.2.2] or [2.2.3], as applicable, provided that such wells are as small as practicable and the distance between the well bottom and bottom shell plating is not less than 0,5 h.

3.2 Oil outflow

3.2.1 Definitions *(1/7/2007)*

- *Load line draught d_S, in m*

  Vertical distance, in metres, from the moulded baseline at mid-length to the waterline corresponding to the summer freeboard to be assigned to the ship. Calculations pertaining to this requirement are to be based on draught d_S, notwithstanding assigned draughts that may exceed d_S, such as the tropical load line.

- *Waterline d_B, in m*

  Vertical distance, in metres, from the moulded baseline at mid-length to the waterline corresponding to 30% of the depth D_S.

- *Breadth B_S, in m*

  Greatest moulded breadth of the ship, in metres, at or below the deepest load line d_S.

- *Breadth B_B in m*

  Greatest moulded breadth of the ship, in metres, at or below the waterline d_B.

- *Depth D_S in m*

  Moulded depth measured at mid-length to the upper deck at side.

Table 1 : Length of cargo tanks

Longitudinal bulkhead arrangement	Cargo tank	Condition **(1)**	Centreline bulkhead arrangement	Length of cargo tanks, in m
No bulkhead	-	-	-	$(0,5\ b_i / B + 0,1)\ L$ **(2)**
Centreline bulkhead	-	-	-	$(0,25\ b_i / B + 0,15)\ L$
Two or more bulkheads	Wing cargo tank	-	-	0,2 L
	Centre cargo tank	$b_i / B \geq 1/5$	-	0,2 L
		$b_i / B < 1/5$	No	$(0,5\ b_i / B + 0,1)\ L$
			Yes	$(0,25\ b_i / B + 0,15)\ L$

(1) b_i is the minimum distance from the ship side to the outer longitudinal bulkhead of the i-th tank, measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.

(2) Not to exceed 0,2 L

3.2.2 Oil outflow requirements *(1/7/2007)*

To provide adequate protection against oil pollution in the event of collision or stranding. the following is to be complied with:

a) for oil tankers of 5000 tonnes deadweight (DW) and above, the mean oil outflow parameter is to be as follows:

$O_M \leq 0,015$ *for* $C \leq 200000\ m^3$

$O_M \leq 0,012 + (0,003/200000)\ (400000-C)$ *for* $200000\ m^3 < C < 400000\ m^3$

$O_M \leq 0,012$ *for* $C \geq 400000\ m^3$

b) for combination carriers between 5000 tonnes deadweight (DW) and 200000 m^3 capacity, the mean oil outflow parameter may be applied, provided calculations are submitted to the satisfaction of the Society, demonstrating that after accounting for its increased structural strength, the combination carrier has at least equivalent oil outflow performance to a standard double hull tanker of the same size having a $O_M \leq 0,015$.

$O_M \leq 0,021$ *for* $C \leq 100000\ m^3$

$O_M \leq 0,015 + (0,006/100000)\ (200000-C)$ *for* $100000\ m^3 < C \leq 200000\ m^3$

where:

O_M *: mean oil outflow parameter.*

C *: total volume of cargo oil, in m^3, at 98% tank filling.*

3.2.3 General assumptions for calculation of oil outflow parameter *(1/7/2007)*

The following general assumptions are to be applied when calculating the mean oil outflow parameter:

a) The cargo block length extends between the forward and aft extremities of all tanks arranged for the carriage of cargo oil, including slop tanks.

b) Where this requirement refers to cargo tanks, it is to be understood to include all cargo tanks, slop tanks and fuel tanks located within the cargo block length.

c) The ship is to be assumed loaded to the load line draught d_S without trim or heel.

d) All cargo oil tanks are to be assumed loaded to 98% of their volumetric capacity.

e) The nominal density of the cargo oil (ρ_n) is to be calculated as follows:

$\rho_n = 1000\ DW/C$, *where DW is the deadweight, in tonnes*

f) For the purposes of these outflow calculations, the permeability of each space within the cargo block, including cargo tanks, ballast tanks and other non-oil spaces, is to be taken as 0,99, unless proven otherwise.

g) Suction wells may be neglected in the determination of tank location provided that such wells are as small as practicable and the distance between the well bottom and bottom shell plating is not less than 0,5 h, where h is the height as defined in [2.2.2].

3.2.4 General assumptions for combination of oil outflow parameters *(1/7/2007)*

The following assumptions are to be used when combining the oil outflow parameters:

The mean oil outflow is to be calculated independently for side damage and for bottom damage and then combined into the non-dimensional oil outflow parameter O_M, as follows:

$O_M = (0,4\ O_{MS} + 0,6\ O_{MB}) / C$

where:

O_{MS} *: mean outflow for side damage, in* m^3*;*

O_{MB} *: mean outflow for bottom damage, in* m^3*.*

For bottom damage, independent calculations for mean outflow are to be done for 0 m and minus 2,5 m tide conditions, and then combined as follows:

$O_{MB} = 0,7\ O_{MB(0)} + 0,3\ O_{MB(2,5)}$

where:

$O_{MB(0)}$ *: mean outflow for 0 m tide condition, in* m^3

$O_{MB(2,5)}$ *: mean outflow for minus 2,5 m tide condition, in* m^3*.*

3.2.5 Calculation of side damage outflow *(1/7/2007)*

The mean outflow for side damage O_{MS}*, in* m^3*, is to be calculated as follows:*

$$O_{MS} = C_3 \sum_{i}^{n} P_{s(i)} O_{s(i)}$$

where:

i : *represents each cargo tank under consideration;*

n : *total number of cargo tanks;*

$P_{s(i)}$: *the probability of penetrating cargo tank i from side damage, calculated in accordance with [3.2.7];*

$O_{s(i)}$: *the outflow, in* m^3*, from side damage to cargo tank i, which is assumed equal to the total volume in cargo tank i at 98% filling, unless it is proven through the application of the IMO Resolution referred to in [4.2.6] that any significant cargo volume will be retained;*

C_3 : *0,77 for ships having two longitudinal bulkheads inside the cargo tanks, provided these bulkheads are continuous over the cargo block and* $P_{s(i)}$ *is developed in accordance with this requirement.* C_3 *equals 1,0 for all other ships or when* $P_{s(i)}$ *is developed in accordance with [3.2.7].*

3.2.6 Calculation of bottom damage outflow *(1/7/2017)*

The mean outflow for bottom damage, in m^3*, is to be calculated for each tidal condition as follows:*

a)

$$O_{MB(0)} = \sum_{i}^{n} P_{B(i)} O_{B(i)} C_{DB(i)}$$

where:

i : *represents each cargo tank under consideration;*

n : *total number of cargo tanks;*

$P_{B(i)}$: *the probability of penetrating cargo tank i from bottom damage, calculated in accordance with [3.2.8];*

$O_{B(i)}$: *the outflow from cargo tank i, in* m^3*, calculated in accordance with c);*

$C_{DB(i)}$: *factor to account for oil capture as defined in d)*

b)

$$O_{MB(2,5)} = \sum_{i}^{n} P_{B(i)} O_{B(i)} C_{DB(i)}$$

where:

i, n, $P_{B(i)}$ *and* $C_{DB(i)}$ *as defined above;*

$O_{B(i)}$ *= the outflow from cargo tank i, in* m^3*, after tidal change.*

c) The oil outflow $O_{B(i)}$ *for each cargo oil tank is to be calculated based on pressure balance principles, in accordance with the following assumptions:*

- *The ship is to be assumed stranded with zero trim and heel, with the stranded draught prior to tidal change equal to the load line draught* d_s*.*
- *The cargo level after damage is to be calculated as follows:*

  $h_c = [(d_s + t_c - Z_l)\ (\rho_s) - (1000\ P\ ) / g] / \rho_n$

  where:

h_c : the height of the cargo oil above Z_l, in m;

t_c : the tidal change, in m. Reductions in tide are to be expressed as negative values;

Z_l : the height of the lowest point in the cargo tank above the baseline, in m;

ρ_s : density of seawater, to be taken as 1025 kg/m^3;

P : if an inert gas system is fitted, the normal overpressure, in kPa, is to be taken as 5 kPa; if an inert gas system is not fitted, the overpressure may be taken as 0;

g : the acceleration of gravity, to be taken as 9,81 m/s^2;

ρ_n : nominal density of cargo oil, calculated in accordance with [3.2.3].

- For cargo tanks bounded by the bottom shell, unless proven otherwise, oil outflow $O_{B(i)}$ is to be taken not less than 1% of the total volume of cargo oil loaded in cargo tank i, to account for initial exchange losses and dynamic effects due to current and waves.

d) In the case of bottom damage, a portion from the outflow from a cargo tank may be captured by non-oil compartments. This effect is approximated by application of the factor $C_{DB(i)}$ for each tank, which is to be taken as follows:

$C_{DB(i)}$: 0,6 for cargo tanks bounded from below by non-oil compartments;

$C_{DB(i)}$: 1,0 for cargo tanks bounded by the bottom shell.

3.2.7 Calculation of probability for side damage *(1/7/2007)*

The probability P_S of breaching a compartment from side damage is to be calculated as follows:

a) $P_S = P_{SL} P_{SV} P_{ST}$

where:

P_{SL} =1 - P_{Sf} - P_{Sa} = probability the damage will extend into the longitudinal zone bounded by X_a and X_f;

P_{SV} = 1 - P_{Su} - P_{Sl} = probability the damage will extend into the vertical zone bounded by Z_l and Z_u; and

P_{ST} = 1 - P_{Sy} = probability the damage will extend transversely beyond the boundary defined by y.

b) P_{Sa}, P_{Sf}, P_{Sl}, P_{Su} and P_{Sy} are to be determined by linear interpolation from the table of probabilities for side damage provided in Tab 2,

where:

P_{Sa} : the probability the damage will lie entirely aft of location X_a/L;

P_{Sf} : the probability the damage will lie entirely forward of location X_f/L;

P_{Sl} : the probability the damage will lie entirely below the tank;

P_{Su} : the probability the damage will lie entirely above the tank; and

P_{Sy} : the probability the damage will lie entirely outboard of the tank.

Compartment boundaries X_a, X_f, Z_l, Z_u and y are to be developed as follows:

X_a : the longitudinal distance from the aft terminal of L to the aftmost point on the compartment being considered, in m;

X_f : the longitudinal distance from the aft terminal of L to the foremost point on the compartment being considered, in m;

Z_l : the vertical distance from the moulded baseline to the lowest point on the compartment being considered, in m;

Z_u : the vertical distance from the moulded baseline to the highest point on the compartment being considered, in m. Z_u is not to be taken greater than D_s;

y : the minimum horizontal distance measured at right angles to the centreline between the compartment under consideration and the side shell in m;

c) P_{Sy} is to be calculated as follows:

$P_{Sy} = (24,96 - 199,6\ y/B_S)\ (y/B_S)$ for $y/B_S \leq 0,05$

$P_{Sy} = 0,749 + [5 - 44,4\ (y/B_S - 0,05)]\ (y/B_S - 0,05)$ for $0,05 < y/B_S < 0,1$

$P_{Sy} = 0,888 + 0,56\ (y/B_S - 0,1)$ for $y/B_S \geq 0,1$

P_{Sy} is not to be taken greater than 1.

Table 2 : Probabilities for side damage *(1/7/2007)*

X_a/L	P_{Sa}	X_f/L	P_{Sf}	Z_l/D_S	P_{Sl}	Z_u/D_S	P_{Su}
0,00	0,000	0,00	0,967	0,00	0,000	0,00	0,968
0,05	0,023	0,05	0,917	0,05	0,000	0,05	0,952
0,10	0,068	0,10	0,867	0,10	0,001	0,10	0,931
0,15	0,117	0,15	0,817	0,15	0,003	0,15	0,905
0,20	0,167	0,20	0,767	0,20	0,007	0,20	0,873
0,25	0,217	0,25	0,717	0,25	0,013	0,25	0,836
0,30	0,267	0,30	0,667	0,30	0,021	0,30	0,789
0,35	0,317	0,35	0,617	0,35	0,034	0,35	0,733
0,40	0,367	0,40	0,567	0,40	0,055	0,40	0,670
0,45	0,417	0,45	0,517	0,45	0,085	0,45	0,599
0,50	0,467	0,50	0,467	0,50	0,123	0,50	0,525
0,55	0,517	0,55	0,417	0,55	0,172	0,55	0,452
0,60	0,567	0,60	0,367	0,60	0,226	0,60	0,383
0,65	0,617	0,65	0,317	0,65	0,285	0,65	0,317
0,70	0,667	0,70	0,267	0,70	0,347	0,70	0,255
0,75	0,717	0,75	0,217	0,75	0,413	0,75	0,197
0,80	0,767	0,80	0,167	0,80	0,482	0,80	0,143
0,85	0,817	0,85	0,117	0,85	0,553	0,85	0,092
0,90	0,867	0,90	0,068	0,90	0,626	0,90	0,046
0,95	0,917	0,95	0,023	0,95	0,700	0,95	0,013
1,00	0,967	1,00	0,000	1,00	0,775	1,00	0,000

3.2.8 Calculation of probability for bottom damage *(1/7/2007)*

a) The probability P_B of breaching a compartment from bottom damage is to be calculated as follows:

$$P_B = P_{BL} P_{BT} P_{BV}$$

where:

$P_{BL} = 1 - P_{Bf} - P_{Ba}$ *= probability the damage will extend into the longitudinal zone bounded by X_a and X_f*

$P_{BT} = 1 - P_{Bp} - P_{Bs}$ *= probability the damage will extend into the transverse zone bounded by Y_p and Y_s*

$P_{BV} = 1 - P_{Bz}$ *= probability the damage will extend vertically above the boundary defined by z*

b) P_{Ba}, P_{Bf}, P_{Bp}, P_{Bs}, and P_{Bz} are to be determined by linear interpolation from the table of probabilities for bottom damage provided in Tab 3, where:

P_{Ba} *: the probability the damage will lie entirely aft of location X_a/L;*

P_{Bf} *: the probability the damage will lie entirely forward of location X_f/L;*

P_{Bp} *: the probability the damage will lie entirely to port of the tank;*

P_{Bs} *: the probability the damage will lie entirely to starboard of the tank;*

P_{Bz} *: the probability the damage will lie entirely below the tank.*

Compartment boundaries X_a, X_f, Y_p, Y_s, and z are to be developed as follows:

X_a and X_f are as defined in [3.2.7];

Y_p *: the transverse distance from the port-most point on the compartment located at or below the waterline d_B, to a vertical plane located $B_B/2$ to starboard of the ship's centreline, in metres;*

Y_s *: the transverse distance from the starboard-most point on the compartment located at or below the waterline d_B, to a vertical plane located $B_B/2$ to starboard of the ship's centreline, in metres;*

z : the minimum value of z over the length of the compartment, where, at any given longitudinal location, z is the vertical distance from the lower point of the bottom shell at that longitudinal location to the lower point of the compartment at that longitudinal location, in metres.

Table 3 : Probabilities for bottom damage *(1/7/2007)*

X_a/L	P_{Ba}	X_f/L	P_{Bf}	Y_p/B_B	P_{Bp}	Y_s/B_B	P_{Bs}
0,00	0,000	0,00	0,969	0,00	0,844	0,00	0,000
0,05	0,002	0,05	0,953	0,05	0,794	0,05	0,009
0,10	0,008	0,10	0,936	0,10	0,744	0,10	0,032
0,15	0,017	0,15	0,916	0,15	0,694	0,15	0,063
0,20	0,029	0,20	0,894	0,20	0,644	0,20	0,097
0,25	0,042	0,25	0,870	0,25	0,594	0,25	0,133
0,30	0,058	0,30	0,842	0,30	0,544	0,30	0,171
0,35	0,076	0,35	0,810	0,35	0,494	0,35	0,211
0,40	0,096	0,40	0,775	0,40	0,444	0,40	0,253
0,45	0,119	0,45	0,734	0,45	0,394	0,45	0,297
0,50	0,143	0,50	0,687	0,50	0,344	0,50	0,344
0,55	0,171	0,55	0,630	0,55	0,297	0,55	0,394
0,60	0,203	0,60	0,563	0,60	0,253	0,60	0,444
0,65	0,242	0,65	0,489	0,65	0,211	0,65	0,494
0,70	0,289	0,70	0,413	0,70	0,171	0,70	0,544
0,75	0,344	0,75	0,333	0,75	0,133	0,75	0,594
0,80	0,409	0,80	0,252	0,80	0,097	0,80	0,644
0,85	0,482	0,85	0,170	0,85	0,063	0,85	0,694
0,90	0,565	0,90	0,089	0,90	0,032	0,90	0,744
0,95	0,658	0,95	0,026	0,95	0,009	0,95	0,794
1,00	0,761	1,00	0,000	1,00	0,000	1,00	0,844

c) P_{Bz} is to be calculated as follows:

$P_{Bz} = (14,5 - 67\ z/D_S)\ (z/D_S)$ for $z/D_S \leq 0,1$

$P_{Bz} = 0,78 + 1,1\ (z/D_S - 0,1)$ for $z/D_S > 0,1$

P_{Bz} is not to be taken greater than 1.

3.2.9 Alternative calculation procedures *(1/7/2007)*

This requirement uses a simplified probabilistic approach where a summation is carried out over the contributions to the mean outflow from each cargo tank. For certain designs such as those characterised by the occurrence of steps/recesses in bulkheads/decks and for sloping bulkheads and/or a pronounced hull curvature, more rigorous calculations may be appropriate. In such cases one of the following calculation procedures may be applied:

- *The probabilities referred to in [3.2.7] and [3.2.8] may be calculated with more precision through application of hypothetical sub-compartments.*
- *The probabilities referred to in [3.2.7] and [3.2.8] may be calculated through direct application of the probability density functions contained in the IMO Resolutions referred to in [4.2.6].*
- *The oil outflow performance may be evaluated in accordance with the method described in the IMO Resolutions referred to in [4.2.6].*

3.2.10 Credit for reducing oil outflow *(1/7/2007)*

Credit for reducing oil outflow through the use of an emergency rapid cargo transfer system or other system arranged to mitigate oil outflow in the event of an accident may be taken into account only after the effectiveness and safety aspects

of the system are approved by the Society. Submittal for approval is to be made in accordance with the provisions of the IMO Resolutions referred to in [4.2.6].

3.3 Slop tanks

3.3.1 Oil tankers of 150 gross tonnage and above

The arrangements of the slop tank or combination of slop tanks are to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is to be not less than 3 per cent of the oil carrying capacity of the ships, except that the Society may accept:

- *2% for such oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system*
- *2% where segregated ballast tanks are provided in accordance with [5]. This capacity may be further reduced to 1,5% for such oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system.*

3.3.2 Oil tankers of 70000 t deadweight and above

Oil tankers of 70000 t deadweight and above are to be provided with at least two slop tanks.

4 Size and arrangement of protective ballast tanks or compartments

4.1 General

4.1.1 This requirement applies to oil tankers of 600 t deadweight and above.

4.2 Size and arrangement of ballast tanks or compartments

4.2.1 General

The entire cargo tank length is to be protected by ballast tanks or compartments other than cargo and fuel oil tanks as indicated in [4.2.2] to [4.2.6] for oil tankers of 5000 t deadweight and above, or [4.2.7] for oil tankers less than 5000 t deadweight.

4.2.2 Wing tanks or compartments

Wing tanks or compartments are to extend either for the full depth of the ship side or from the top of the double bottom to the uppermost deck, disregarding a rounded gunwale where fitted. They are to be arranged such that the cargo tanks are located inboard of the moulded line of the side shell plating, nowhere less than the distance w which, as shown in Fig 1, is measured at any cross-section at right angles to the side shell, as specified below:

- *w = 0,5 + DW / 20000, or*
- *w = 2,0 m*

whichever is the lesser.

The value of w is to be at least 1,0 m.

4.2.3 Wing tanks or compartments of oil tankers complying with 2.2.2 b)

The location of wing tanks or compartments of oil tankers of 5000 t deadweight and above which are exempted from the requirements of [2.2.2] a) is to be as defined in [4.2.2], except that, below a level 1,5 h above the baseline where h is as defined in [2.2.2] a), the cargo tank boundary line may be vertical down to the bottom plating, as shown in Fig 3.

Such wing tanks or compartments may not contain cargo or fuel oil.

4.2.4 Double bottom tanks or compartments

The requirements of [2.2.1] and [2.2.2] apply.

4.2.5 Aggregate capacity of ballast tanks

On crude oil tankers of 20000 t deadweight and above and product carriers of 30000 t deadweight and above, the aggregate capacity of wing tanks, double bottom tanks, forepeak tanks and afterpeak tanks is to be not less than the capacity of segregated ballast tanks necessary to meet the requirements of [5]. Wing tanks or compartments and double bottom tanks used to meet the requirements of [5] are to be located as uniformly as practicable along the cargo tank length. Additional segregated ballast capacity provided for reducing longitudinal hull girder bending stress, trim, etc., may be located anywhere within the ship.

In calculating the aggregate capacity, the following is to be taken into account:

- *the capacity of engine room ballast tanks is to be excluded from the aggregate capacity of ballast tanks*
- *the capacity of ballast tanks located inboard of double hull is to be excluded from the aggregate capacity of ballast tanks (see Fig 4).*

Any ballast carried in localised inboard extensions, indentation or recesses of the double hull, such as bulkhead stools, may be considered as *excess ballast above the minimum requirement for segregated ballast capacity according to [5].*

Figure 3 : Cargo tank boundary lines

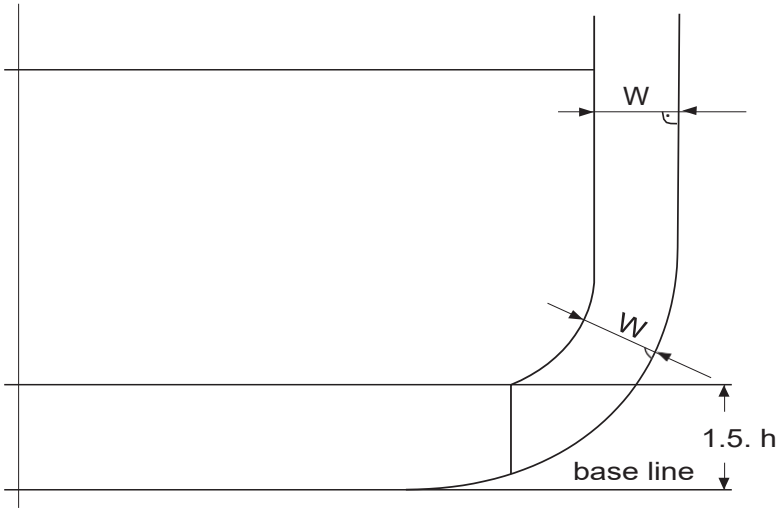
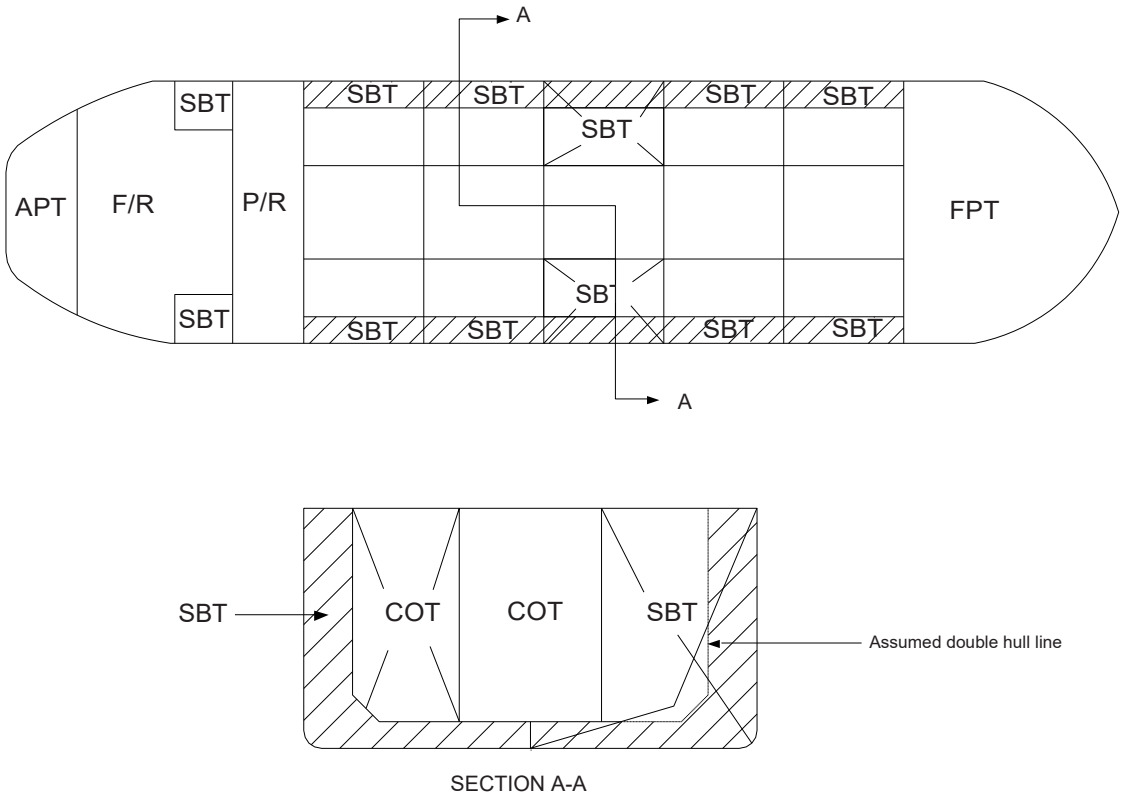


Figure 4 : Segregated ballast tanks located inboard of double hull



4.2.6 Alternative methods of design and construction *(1/7/2007)*

Other methods of design and construction of oil tankers may also be accepted as alternatives to the requirements prescribed in [4.2.2] to [4.2.5], provided that such methods ensure at least the same level of protection against oil pollution in the event of collision or stranding. Such methods are to be accepted by the Society.

Note 1: The Society considers the method described in IMO Resolution MEPC.110(49) as being acceptable.

4.2.7 Oil tankers of less than 5000 t deadweight

Oil tankers of less than 5000 t deadweight are to comply with [2.2.3] and [3.1.3].

5 Size and arrangement of segregated ballast tanks (SBT)

5.1 General

5.1.1 *Every crude oil tanker of 20000 t deadweight and above and every product carrier of 30000 t deadweight and above is to be provided with segregated ballast tanks and is to comply with [5.2] or [5.3], as appropriate.*

5.2 Capacity of SBT for oil tankers equal to or greater than 150 m in length

5.2.1 *The capacity of the segregated ballast tanks is to be so determined that the ship may operate safely on ballast voyages without recourse to the use of cargo tanks for water ballast. In all cases, however, the capacity of segregated ballast tanks is to be at least such that, in any ballast condition at any part of the voyage, including the conditions consisting of lightweight plus segregated ballast only, the ship's draughts and trim can meet each of the following requirements:*

- *the moulded draught amidships, d_m in metres (without taking into account any ship's deformation) is to be not less than 2,0 + 0,02 L*
- *the draughts at the forward and after perpendicular are to correspond to those determined by the draught amidships d_m as specified above, in association with the trim by the stern of not greater than 0,015L*
- *in any case the draught at the after perpendicular is to be not less than that which is necessary to obtain full immersion of the propeller(s)*
- *in no case is ballast water to be carried in cargo tanks, except:*
  - *on those rare voyages when weather conditions are so severe that, in the opinion of the Master, it is necessary to carry additional ballast water in cargo tanks for the safety of the ship*
  - *in exceptional cases where the particular character of the operation of an oil tanker renders it necessary to carry ballast water in excess of the quantity required to comply with the requirements above, provided that such operation of the oil tanker falls under the category of exceptional cases.*

5.3 Capacity of SBT for oil tankers less than 150 m in length

5.3.1 General

The capacity of the segregated ballast tanks is to be considered by the Society on a case-by-case basis. In general, the capacity of segregated ballast tanks is to be at least such that, in any ballast condition at any part of the voyage, including the conditions consisting of lightweight plus segregated ballast only, the ship's draught and trim satisfy the requirements on minimum and maximum values given, as guidance only, in [5.3.2], [5.3.3] and [5.3.4]. These values are the results of different formulations.

The formulations are based both on theoretical research and surveys of actual practice on tankers of differing configuration reflecting varying degrees of concern with propeller emergence, vibration, slamming, speed loss, rolling, docking and other matters. In addition, certain information concerning assumed sea conditions is included.

5.3.2 Formulation A

The following formulae were derived from a study of 26 tankers ranging in length from 50 to 150 m. The draughts were abstracted from ship's trim and stability books and represent departure ballast conditions. The ballast conditions represent sailing conditions in weather up to and including Beaufort 5.

The minimum mean draught, in m, and the maximum trim, in m, are obtained from the following formulae, respectively:

$d_m = 0,2 + 0,032\ L$

$t_m = (0,024 - 6,0.10^{-5}L)\ L$

5.3.3 Formulation B

The following formulae result from investigations based on theoretical research, and model and full scale tests. These formulae are based on a Sea 6 (International Sea Scale).

The minimum draughts, in m, at stern and at bow are obtained from the following formulae, respectively:

$d_{m,S} = 2,3 + 0,030\ L$

$d_{m,B} = 0,7 + 0,0170\ L$

or the minimum mean draught, in m, and the maximum trim, in m, are obtained from the following formulae, respectively:

$d_m = 1,55 + 0,023\ L$

$t_m = 1,6 + 0,013\ L$

5.3.4 Formulation C

The following formulae provide for certain increased draughts to aid in the prevention of propeller emergence and slamming in higher length ships.

The minimum draughts, in m, at stern and at bow are obtained from the following formulae, respectively:

$d_{m,S} = 2,0 + 0,0275\ L$

$d_{m,B} = 0,5 + 0,0225\ L$

6 Access arrangement

6.1 General

6.1.1 As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo tanks and ballast compartments.

6.1.2 Means of access to side and centre tanks may not be provided in the same transverse section.

6.2 Access to pipe tunnel and opening arrangement

6.2.1 Access to the pipe tunnel in the double bottom

The pipe tunnel in the double bottom is to comply with the following requirements:

- it may not communicate with the engine room
- provision is to be made for at least two exits to the open deck arranged at a maximum distance from each other. One of these exits fitted with a watertight closure may lead to the cargo pump room.

6.2.2 Doors between pipe tunnel and main pump room

This requirement also applies to ships with the service notation **FLStanker**.

Where there is a permanent access from a pipe tunnel to the main pump room, a watertight door is to be fitted complying with the requirements in Pt B, Ch 2, Sec 1, [6.2.1] for watertight doors open at sea and located below the freeboard deck. In addition the following is to be complied with:

- *in addition to bridge operation, the watertight door is to be capable of being manually closed from outside the main pump room entrance*
- *the watertight door is to be kept closed during normal operations of the ship except when access to the pipe tunnel is required.* A notice is to be affixed to the door to the effect that it may not be left open.

6.3 Access to compartments in the cargo area

6.3.1 General

Access to cofferdams, ballast tanks, cargo tanks and other compartments in the cargo area is to be direct from the open deck and such as to ensure their complete inspection. Access to double bottom compartments may be through a cargo pump room, pump room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

6.3.2 Access to the fore peak tank *(1/1/2026)*

The requirements for access to the fore peak tank in [7.2] and [7.3] apply.

6.3.3 Access through horizontal openings

For access through horizontal openings the dimensions are to be sufficient to allow a person wearing a self-contained, air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the compartment. The minimum clear opening is to be not less than 600 mm by 600 mm.

6.3.4 Access through vertical openings

For access through vertical openings the minimum clear opening is to be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

6.3.5 Oil tankers less than 5000 t deadweight

For oil tankers of less than 5000 t deadweight smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

6.4 Access to the bow

6.4.1 *(1/7/2008)*

This item [6.4] applies to ships subject to the International Load Line Convention 1966, as amended.

6.4.2 Oil tankers are to be provided either with a gangway between the superstructure or deckhouse aft and the forecastle, or with equivalent arrangements in accordance with the International Load Line Convention 1966, as amended.

6.4.3 *Oil tankers are to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means are to be accepted by the Society.*

Note 1: The Society considers means in compliance with the Guidelines adopted by the Maritime Safety Committee of IMO with Resolution MSC.62(67) on 5/12/1996 as being acceptable.

7 Fore peak ballast tanks and space arrangements

7.1 Definitions

7.1.1 *(1/1/2026)*

The following definitions apply in this Article:

- **Hazardous area**: means an area in which an explosive gas atmosphere is present, or may be expected to be present in quantities such as to require special precautions for the construction, installation and use of equipment.
- **Non-hazardous area**: means an area that is not a hazardous area.
- **Cargo area of tankers**: defined in regulation 3.6 of SOLAS Chapter II-2 for tankers to which regulation 1.6.1 of SOLAS Chapter II-2 as amended by IMO resolutions up to MSC.421(98) (hereinafter the same) applies, considering also the relevant interpretations in IACS UI SC211.

7.2 Fore peak ballast tanks and space arrangements

7.2.1 *(1/1/2026)*

The fore peak tank can be ballasted with the system serving other ballast tanks within the cargo area, provided:

a) The vent pipe openings are located on open deck at a distance from sources of ignition as required by IEC 60092-502:1999 Electrical installations in ships - Tankers - Special features; This requirement does not apply to sounding arrangements.

b) Access to the fore peak tank is direct from open deck. Alternatively, indirect access from the open deck to the forepeak tank may be from a pump-room, deep cofferdam, pipe tunnel, cargo hold, double hull space, bosun's store or similar compartment not intended for the carriage of oil or hazardous cargoes, conforming to the requirements of SOLAS II-1/3-6.3.1. Electrical equipment in such indirect access is to be of the certified safe type suitable for use in the hazardous area it opens into or is to be isolated before entry.

c) Continuous ventilation is maintained while accessing the forepeak tank.

d) The sounding arrangement to the fore peak tank is direct from open deck.

e) The forepeak tank is gas freed direct from open deck, or through a dedicated trunk to open deck. Before the manhole and the entrance of the dedicated trunk are opened, the trunk and the forepeak tank are to be confirmed as made gas free. Means are to be provided to free the space of gas without opening manholes or the entrance to a dedicated trunk. Manholes on the open deck and away from sources of ignition at the top of the dedicated trunk which are used to gas-free the space are allowed to be opened.

f) The fore peak ballast tank is considered as a hazardous zone 2 if segregated from cargo area with a cofferdam, or as a hazardous zone 1 if located adjacent to a cargo tank. For tankers where a bow thruster space is provided, the piping passing through the non-hazardous bow thruster room are to be fully welded and it is required to have the collision bulkhead valve located within the forepeak tank.

g) Means are to be provided on the open deck by a suitable portable instrument, to allow detection of toxic and flammable vapours within the FPT (based on the cargoes carried in current voyage, and since last de-ballasting of

FPT was carried out), in order to ensure the FPT is fully gas freed. In the case that sounding arrangements can be used as the means for the portable instrument additional means for the purpose is not required.

7.3 Additional requirements for forward spaces not being defined as a ballast tank

7.3.1 *(1/1/2026)*

Any spaces, voids and/or indirect accesses from the open deck or intermediate space being located adjacent to cargo tanks, and/or are defined as hazardous area zone 1 or 2, is to follow the same requirements to openings and access as reflected for fore peak ballast tanks in [7.2].

7.3.2 *(1/1/2026)*

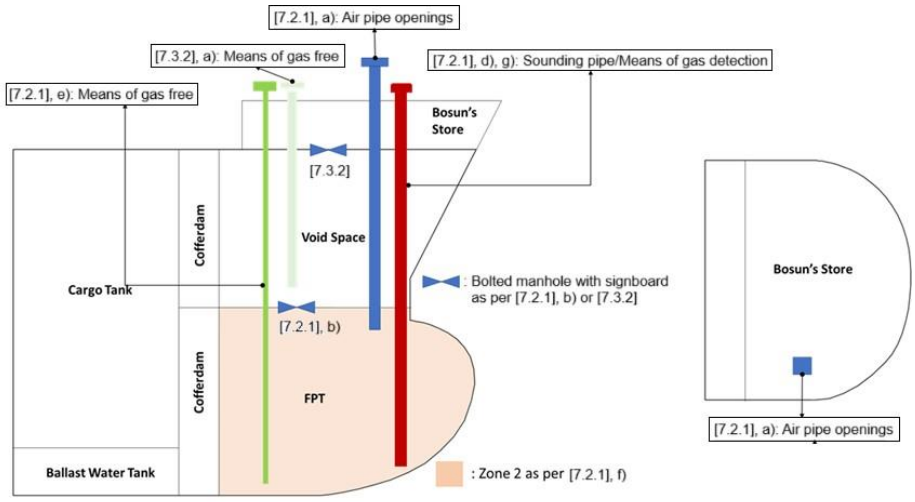
In case any spaces or voids are defined as non-hazardous spaces and have access to other non-hazardous spaces (such as bosun store), the following applies:

a) For any non-hazardous space with access to a hazardous space (example: fore peak ballast tank), the non-hazardous space is to have access directly to open deck and is to be gas freed directly from open deck, and not through the non-hazardous space (example: bosun store).

b) Access from bosun store to a non-hazardous space (example: void) having access to hazardous space (example: fore peak ballast tank) may be accepted through a gas tight bolted manhole, with signboard stating that the non-hazardous space cannot be entered until the space is confirmed gas free. Separation of such spaces are described in IEC 60092-502:1999 section 4.1.4 and 4.1.5 as applicable.

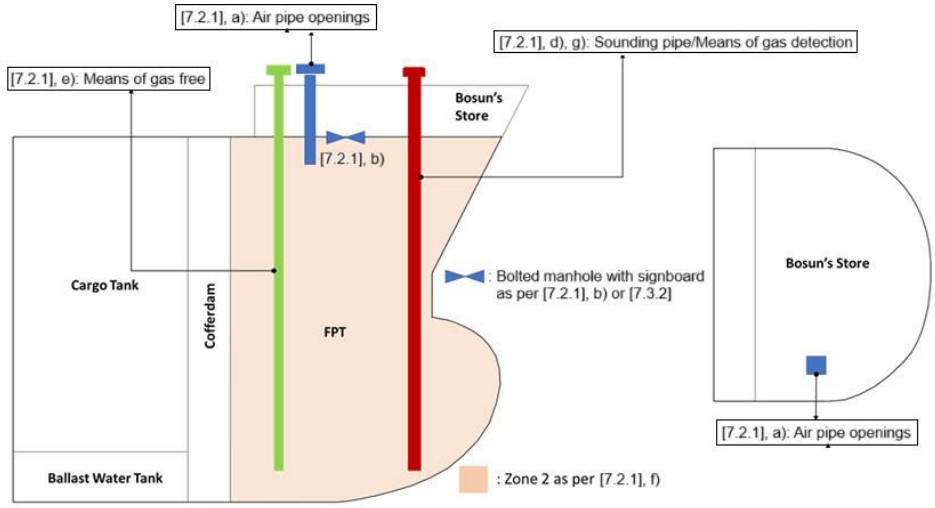
The following figures illustrate the above points:

Figure 5 : Sample 1 *(1/1/2026)*



<Operational requirements>
1. Continuous ventilation is maintained while accessing the FPT as per [7.2.1], c)
2. To detect toxic and flammable vapours within the FPT (based on the cargoes carried in current voyage, and since last de-ballasting of the FPT was carried out), in order to ensure the FPT is fully gas freed as per [7.2.1], g)
3. Where toxic-vapour-detection equipment is not available for some cargoes which require such detection, the FPT may be ventilated by dilution method at a minimum rate of 6 air changes/hr for a minimum of 24 hrs. Tank entry procedures to be done in accordance with IMO resolution A.1050(27) and IBC code 13.2.3.

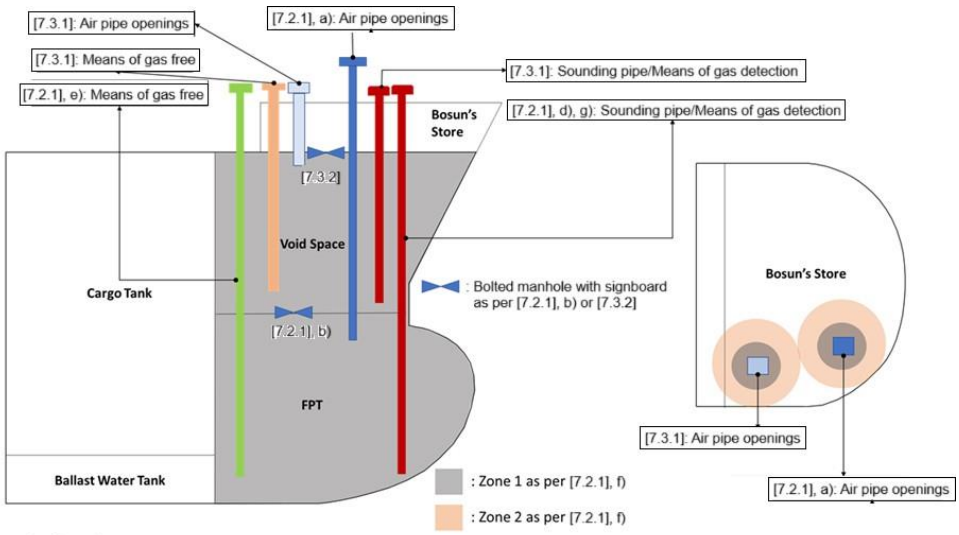
Figure 6 : Sample 2 *(1/1/2026)*



<Operational requirements>

1. Continuous ventilation is maintained while accessing the FPT as per [7.2.1], c)
2. To detect toxic and flammable vapours within the FPT (based on the cargoes carried in current voyage, and since last de-ballasting of the FPT was carried out), in order to ensure the FPT is fully gas freed as per [7.2.1], g)
3. Where toxic-vapour-detection equipment is not available for some cargoes which require such detection, the FPT may be ventilated by dilution method at a minimum rate of 6 air changes/hr for a minimum of 24 hrs. Tank entry procedures to be done in accordance with IMO resolution A.1050(27) and IBC code 13.2.3.

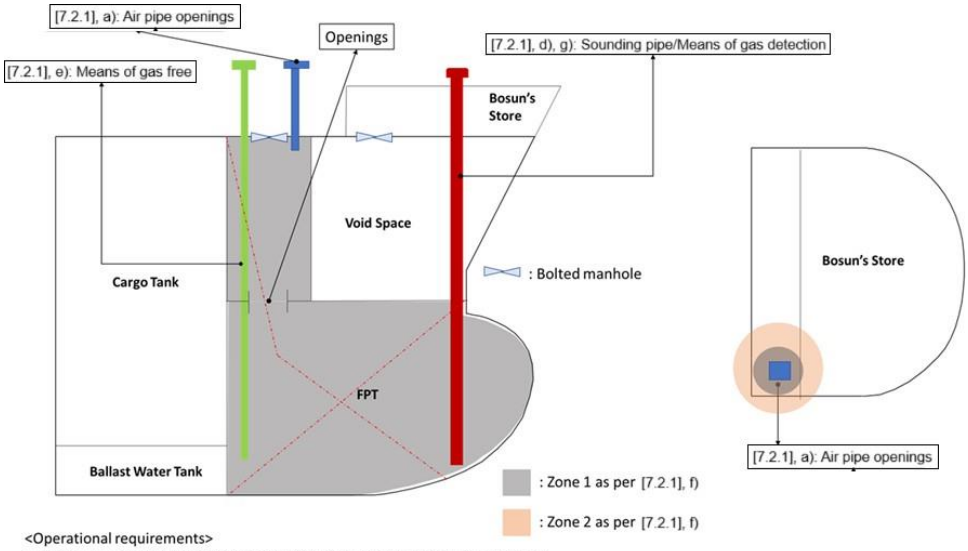
Figure 7 : Sample 3 *(1/1/2026)*



<Operational requirements>

1. Continuous ventilation is maintained while accessing the FPT as per [7.2.1], c)
2. To detect toxic and flammable vapours within the FPT (based on the cargoes carried in current voyage, and since last de-ballasting of the FPT was carried out), in order to ensure the FPT is fully gas freed as per [7.2.1], g)
3. Where toxic-vapour-detection equipment is not available for some cargoes which require such detection, the FPT may be ventilated by dilution method at a minimum rate of 6 air changes/hr for a minimum of 24 hrs. Tank entry procedures to be done in accordance with IMO resolution A.1050(27) and IBC code 13.2.3.

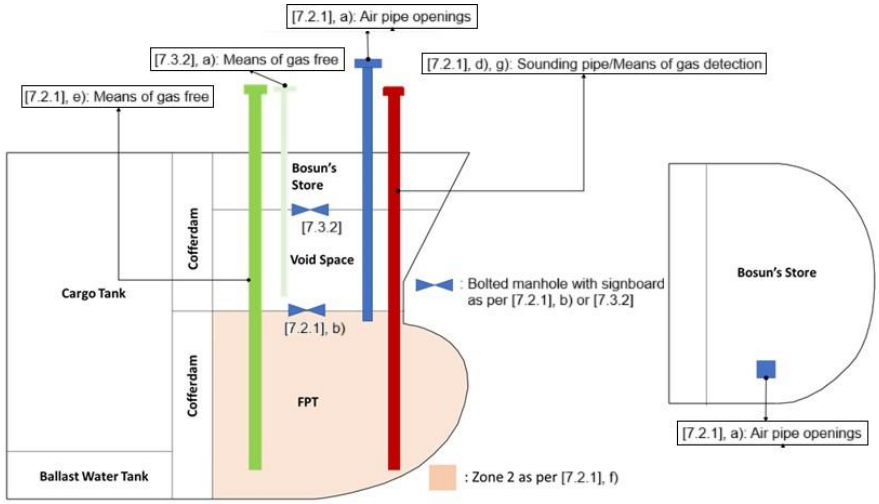
Figure 8 : Sample 4 *(1/1/2026)*



<Operational requirements>

1. Continuous ventilation is maintained while accessing the FPT as per [7.2.1], c)
2. To detect toxic and flammable vapours within the FPT (based on the cargoes carried in current voyage, and since last de-ballasting of the FPT was carried out), in order to ensure the FPT is fully gas freed as per [7.2.1], g)
3. Where toxic-vapour-detection equipment is not available for some cargoes which require such detection, the FPT may be ventilated by dilution method at a minimum rate of 6 air changes/hr for a minimum of 24 hrs. Tank entry procedures to be done in accordance with IMO resolution A.1050(27) and IBC code 13.2.3.

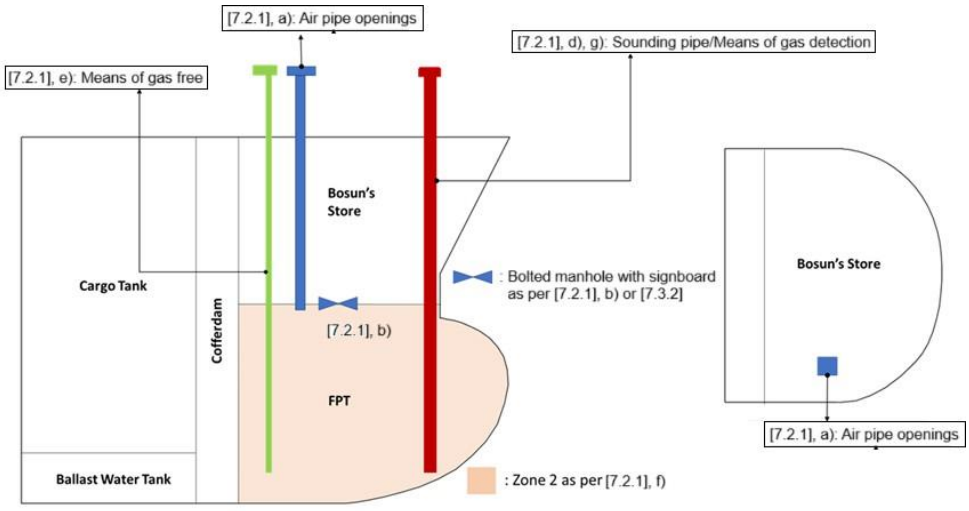
Figure 9 : Sample 5 *(1/1/2026)*



<Operational requirements>

1. Continuous ventilation is maintained while accessing the FPT as per [7.2.1], c)
2. To detect toxic and flammable vapours within the FPT (based on the cargoes carried in current voyage, and since last de-ballasting of the FPT was carried out), in order to ensure the FPT is fully gas freed as per [7.2.1], g)
3. Where toxic-vapour-detection equipment is not available for some cargoes which require such detection, the FPT may be ventilated by dilution method at a minimum rate of 6 air changes/hr for a minimum of 24 hrs. Tank entry procedures to be done in accordance with IMO resolution A.1050(27) and IBC code 13.2.3.

Figure 10 : Sample 6 *(1/1/2026)*



<Operational requirements>

1. Continuous ventilation is maintained while accessing the FPT as per [7.2.1], c)
2. To detect toxic and flammable vapours within the FPT (based on the cargoes carried in current voyage, and since last de-ballasting of the FPT was carried out), in order to ensure the FPT is fully gas freed as per [7.2.1], g)
3. Where toxic-vapour-detection equipment is not available for some cargoes which require such detection, the FPT may be ventilated by dilution method at a minimum rate of 6 air changes/hr for a minimum of 24 hrs. Tank entry procedures to be done in accordance with IMO resolution A.1050(27) and IBC code 13.2.3.

SECTION 3 HULL AND STABILITY

Symbols

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

E : Young's modulus, in N/mm^2, to be taken equal to:

- E = 2,06.10^5 N/mm^2 for steels in general
- E = 1,95.10^5 N/mm^2 for stainless steels.

1 Stability

1.1 Application

1.1.1 The requirements in [1.2.2] apply only to ships with the service notation **oil tanker ESP**.

1.2 Intact stability

1.2.1 General

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.6] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2. In addition, the requirements in [1.2.2] are to be complied with.

1.2.2 Liquid transfer operations

Ships with certain internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling, the design of oil tankers of 5000 t deadweight and above is to be such that the following criteria are complied with*:*

a) The intact stability criteria reported in b) is to be complied with for the worst possible condition of loading and ballasting as defined in c)*, consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.*

b) The initial metacentric height GMo, in m, corrected for free surface measured at 0° heel, is to be not less than 0,15. For the purpose of calculating GMo, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.

c) The vessel is to be loaded with:

- *all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank*
- *cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value*
- *full departure consumable*
- *1% of the total water ballast capacity.The maximum free surface moment is to be assumed in all ballast tanks.*

2 Structure design principles

2.1 Framing arrangement

2.1.1 In general, within the cargo tank region of ships of more than 90 m in length, the bottom, the inner bottom and the deck are to be longitudinally framed.

Different framing arrangements are to be considered by the Society on a case-by-case basis, provided that they are supported by direct calculations.

2.2 Bulkhead structural arrangement

2.2.1 General

Transverse bulkheads may be either plane or corrugated.

2.2.2 Corrugated bulkheads *(1/7/2002)*

For ships of less than 120 m in length, vertically corrugated transverse or longitudinal bulkheads may be connected to the double bottom and deck plating.

For ships equal to or greater than 120 m in length, a lower and an upper stool are generally to be fitted. Different arrangements may be considered by the Society on a case-by-case basis, provided that they are supported by direct calculations carried out according to Pt B, Ch 7, Sec 3. These calculations are to investigate, in particular, the zones of connection of the bulkhead with innert bottom and deck plating and are to be submitted to the Society for review.

3 Design loads

3.1 Hull girder loads

3.1.1 Still water loads

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1.2], still water loads are to be calculated for the following loading conditions, subdivided into departure and arrival conditions as appropriate:

- homogeneous loading conditions (excluding tanks intended exclusively for segregated ballast tanks) at maximum draft
- partial loading conditions
- any specified non-homogeneous loading condition
- light and heavy ballast conditions
- mid-voyage conditions relating to tank cleaning or other operations where, at the Society's discretion, these differ significantly from the ballast conditions.

3.2 Local loads

3.2.1 Bottom impact pressure

For oil tankers of 20000 t deadweight and above and product carriers of 30000 t deadweight and above, the draught T_F, to be considered in the calculation of the bottom impact pressure according to Pt B, Ch 9, Sec 1, [3.2], is that calculated by using the segregated ballast tanks only.

3.2.2 Cargo mass density

In the absence of more precise values, a cargo mass density of 0,9 t/m^3 is to be considered for calculating the internal pressures and forces in cargo tanks according to Pt B, Ch 5, Sec 6.

4 Hull scantlings

4.1 Plating

4.1.1 Minimum net thicknesses *(1/7/2002)*

The net thickness of the strength deck and bulkhead plating within or bounding the longitudinal extension of the cargo area is to be not less than the values given in Tab 1.

4.2 Ordinary stiffeners

4.2.1 Minimum net thicknesses

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

$t_{MIN} = 0,75\ L^{1/3}\ k^{1/6} + 4,5\ s$ for $L < 275$ m

$t_{MIN} = 1,5\ k^{1/2} + 7,0 + s$ for $L \geq 275$ m

where s is the spacing, in m, of ordinary stiffeners.

4.3 Primary supporting members

4.3.1 Minimum net thicknesses

The net thickness of plating which forms the webs of primary supporting members is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = 1,45\ L^{1/3}\ k^{1/6}$

4.3.2 Loading conditions for the analyses of primary supporting members

The still water and wave loads are to be calculated for the most severe loading conditions as given in the loading manual, with a view to maximising the stresses in the longitudinal structure and primary supporting members.

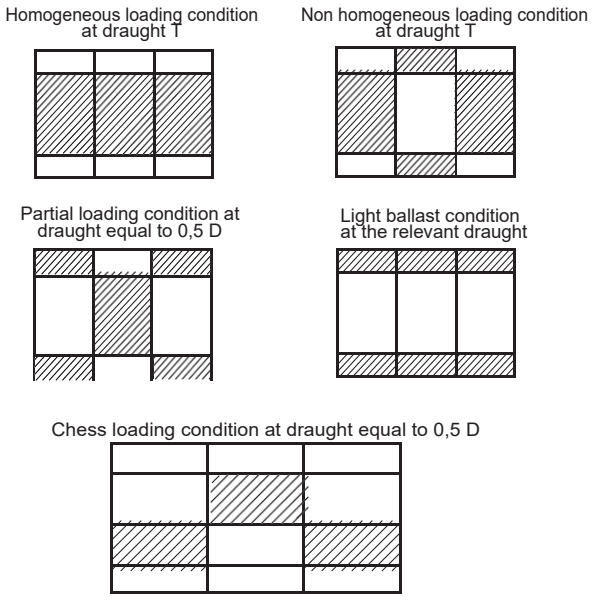
Where the loading manual is not available, the loading conditions to be considered in the analysis of primary supporting members in cargo and ballast tanks are those shown in:

- Fig 1 for ships less than 200 m in length
- Fig 2 and Fig 3 for ships equal to or greater than 200 m in length.

Table 1 : Minimum net thickness of the strength deck and bulkhead plating

Plating	Minimum net thickness, in mm	
Strength deck	$(5,5 + 0,02\ L)\ k^{1/2}$ $(8 + 0,0085\ L)\ k^{1/2}$	for $L < 200$ for $L \geq 200$
Tank bulkhead	$L^{1/3}\ k^{1/6} + 4,5\ s$ $1,5\ k^{1/2} + 8,2 + s$	for $L < 275$ for $L \geq 275$
Watertight bulkhead	$0,85\ L^{1/3}\ k^{1/6} + 4,5\ s$ $1,5\ k^{1/2} + 7,5 + s$	for $L < 275$ for $L \geq 275$
Wash bulkhead	$0,8 + 0,013\ L\ k^{1/2} + 4,5\ s$ $3,0\ k^{1/2} + 4,5 + s$	for $L < 275$ for $L \geq 275$
Note 1: s : Length, in m, of the shorter side of the plate panel.		

Figure 1 : Loading conditions for ships less than 200 m in length



4.3.3 Strength check of floors of cargo tank structure with hopper tank analysed through a three dimensional beam model

Where the cargo tank structure with hopper tank is analysed through a three dimensional beam model, to be carried out according to Pt B, Ch 7, App 1, the net shear sectional area of floors within 0,1 ℓ from the floor ends (see Fig 4 for the definition of ℓ) is to be not less than the value obtained, in cm^2, from the following formula:

$$A_{Sh} = 2\frac{Q}{\gamma_R \gamma_m y}$$

where:

Q : Shear force, in kN, in the floors at the ends of ℓ, obtained from the structural analysis

γ_R : Resistance partial safety factor:

$\gamma_R = 1,2$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

Figure 2 : Loading conditions for ships equal to or greater than 200 m in length *(1/7/2002)*

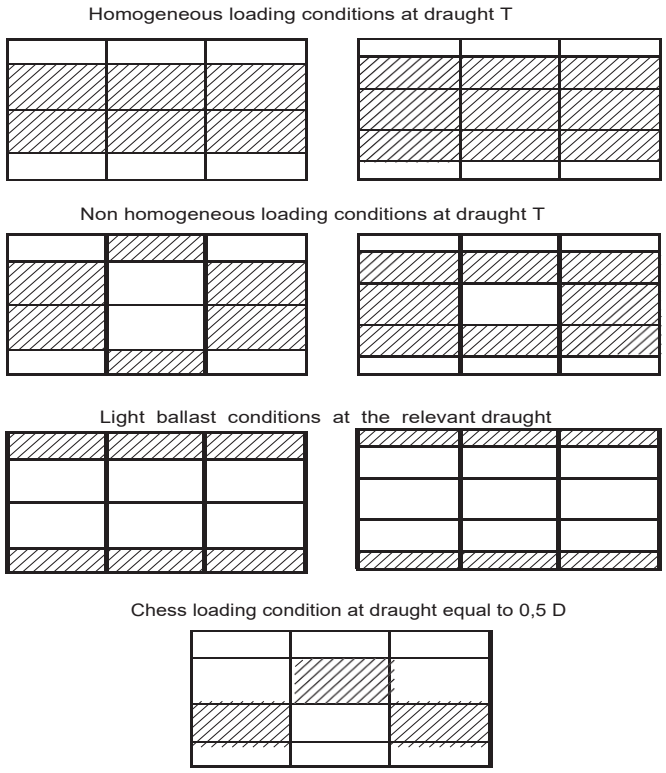
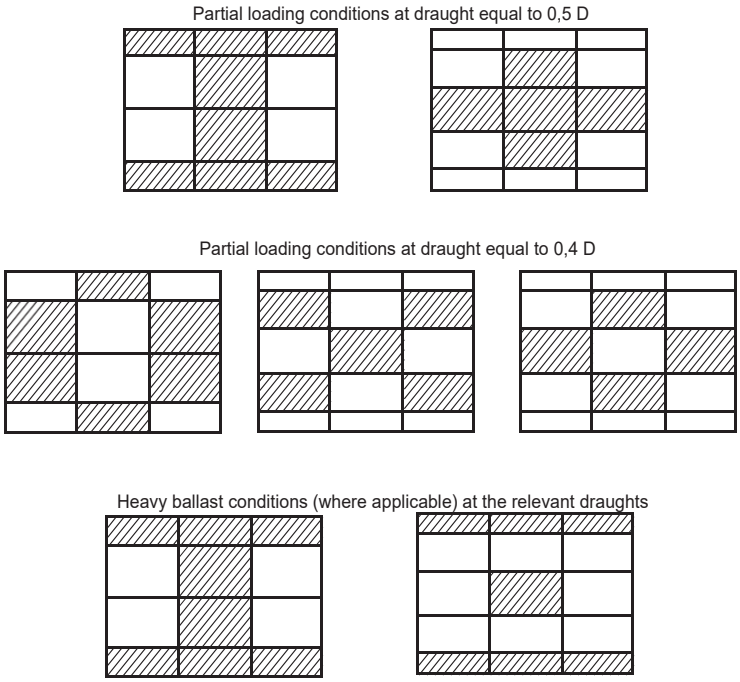


Figure 3 : Loading conditions for ships equal to or greater than 200 m in length



4.3.4 Strength checks of cross-ties analysed through a three dimensional beam model

a) Cross-ties analysed through three dimensional beam model analyses according to Pt B, Ch 7, Sec 3 are to be considered, in the most general case, as being subjected to axial forces and bending moments around the neutral axis perpendicular to the cross-tie web. This axis is identified as the y axis, while the x axis is that in the web plane (see Figures in Tab 2).

The axial force may be either tensile or compression. Depending on this, two types of checks are to be carried out, according to b) or c), respectively.

b) Strength check of cross-ties subjected to axial tensile forces and bending moments.

The net scantlings of cross-ties are to comply with the following formula:

$$10\frac{F_T}{A_{ct}} + 10^3\frac{M}{w_{yy}} \leq \frac{R_y}{\gamma_R\gamma_m}$$

where:

F_T : Axial tensile force, in kN, in the cross-ties, obtained from the structural analysis

A_{ct} : Net sectional area, in cm^2, of the cross-tie

M : Max ($|M_1|$, $|M_2|$)

M_1, M_2 : Algebraic bending moments, in kN.m, around the y axis at the ends of the cross-tie, obtained from the structural analysis

w_{yy} : Net section modulus, in cm^3, of the cross-tie about the y axis

γ_R : Resistance partial safety factor:

$\gamma_R = 1,02$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

c) Strength check of cross-ties subjected to axial compressive forces and bending moments.

The net scantlings of cross-ties are to comply with the following formulae:

$$10F_c\left(\frac{1}{A_{ct}} + \frac{\Phi e}{w_{xx}}\right) \leq \frac{R_y}{\gamma_R\gamma_m}$$

$$10\frac{F_c}{A_{ct}} + 10^3\frac{M_{max}}{w_{yy}} \leq \frac{R_y}{\gamma_R\gamma_m}$$

where:

F_C : Axial compressive force, in kN, in the cross-ties, obtained from the structural analysis

A_{ct} : Net cross-sectional area, in cm², of the cross-tie

$$\Phi = \frac{1}{1 - \frac{F_C}{F_{EX}}}$$

F_{EX} : Euler load, in kN, for buckling around the x axis:

$$F_{EX} = \frac{\pi^2 E I_{xx}}{10^5 \ell^2}$$

I_{xx} : Net moment of inertia, in cm⁴, of the cross-tie about the x axis

ℓ : Span, in m, of the cross-tie

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 2 for various types of profiles

w_{ww} : Net section modulus, in cm³, of the cross-tie about the x axis

M_{max} : Max ($|M_0|$, $|M_1|$, $|M_2|$)

$$M_0 = \frac{\sqrt{1 + t^2}(M_1 + M_2)}{2\cos(u)}$$

$$t = \frac{1}{\tan(u)}\left(\frac{M_2 - M_1}{M_2 + M_1}\right)$$

$$u = \frac{\pi}{2}\sqrt{\frac{F_C}{F_{EY}}}$$

F_{EY} : Euler load, in kN, for buckling around the y axis:

$$F_{EY} = \frac{\pi^2 E I_{yy}}{10^5 \ell^2}$$

I_{yy} : Net moment of inertia, in cm⁴, of the cross-tie about the y axis

M_1,M_2 : Algebraic bending moments, in kN.m, around the y axis at the ends of the cross-tie, obtained from the structural analysis

w_{yy} : Net section modulus, in cm³, of the cross-tie about the y axis

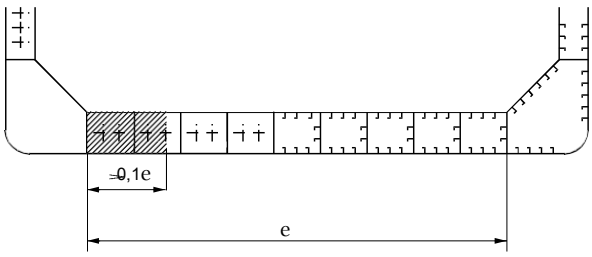
γ_R : Resistance partial safety factor:

γ_R = 1,02

γ_m : Material partial safety factor:

γ_m = 1,02

Figure 4 : End area of floors



4.3.5 Strength checks of cross-ties analysed through a three dimensional finite element model

a) In addition to the requirements in Pt B, Ch 7, Sec 3, [4] and Pt B, Ch 7, Sec 3, [6], the net scantlings of cross-ties subjected to compression axial stresses are to comply with the following formula:

$$|o| \leq \frac{\sigma_C}{\gamma_R \gamma_m}$$

where:

o : Compressive stress, in N/mm², obtained from a three dimensional finite element analysis, based on fine mesh modelling, according to Pt B, Ch 7, Sec 3 and Pt B, Ch 7, App 1

σ_c : Critical stress, in N/mm², defined in b)

γ_R : Resistance partial safety factor:

$\gamma_R = 1,02$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

b) The critical buckling stress of cross-ties is to be obtained, in N/mm^2, from the following formulae:

$$\sigma_c = \sigma_E \quad \text{for } \sigma_E \leq \frac{R_y}{2}$$

$$\sigma_c = R_y\left(1 - \frac{R_y}{4\sigma_E}\right) \quad \text{for } \sigma_E > \frac{R_y}{2}$$

where:

$\sigma_E = \min(\sigma_{E1}, \sigma_{E2})$,

σ_{E1} : Euler flexural buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E1} = \frac{\pi^2 E I}{10^4 A_{ct} \ell^2}$$

I : Min (I_{xx}, I_{yy})

I_{xx} : Net moment of inertia, in cm^4, of the cross-tie about the x axis defined in [4.3.4] a)

I_{yy} : Net moment of inertia, in cm^4, of the cross-tie about the y axis defined in [4.3.4] a)

A_{ct} : Net cross-sectional area, in cm^2, of the cross-tie

ℓ : Span, in m, of the cross-tie

σ_{E2} : Euler torsional buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E2} = \frac{\pi^2 E I_w}{10^4 I_o \ell^2} + 0,41E\frac{J}{I_o}$$

I_w : Net sectorial moment of inertia, in cm^4, of the cross-tie, specified in Tab 2 for various types of profiles

I_o : Net polar moment of inertia, in cm^4, of the cross-tie

$$I_o = I_{xx} + I_{yy} + A_{ct}(y_o + e)^2$$

y_o : Distance, in cm, from the centre of torsion to the web of the cross-tie, specified in Tab 2 for various types of profiles

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 2 for various types of profiles,

J : St. Venant's net moment of inertia, in cm^4, of the cross-tie, specified in Tab 2 for various types of profiles.

4.4 Strength check with respect to stresses due to the temperature gradient

4.4.1 *(1/7/2018)*

Direct calculations of stresses induced in the hull structures by the temperature gradient are to be performed for ships intended to carry cargoes at temperatures exceeding 90°C. In these calculations, the water temperature is to be assumed equal to 0°C.

The calculations are to be submitted to the Society for review.

4.4.2 The stresses induced in the hull structures by the temperature gradient are to comply with the checking criteria in Pt B, Ch 7, Sec 3, [4.3].

5 Other structures

5.1 Machinery space

5.1.1 Extension of the hull structures within the machinery space

Longitudinal bulkheads carried through cofferdams are to continue within the machinery space and are to be used preferably as longitudinal bulkheads for liquid cargo tanks. In any case, such extension is to be compatible with the shape of the structures of the double bottom, deck and platforms of the machinery space.

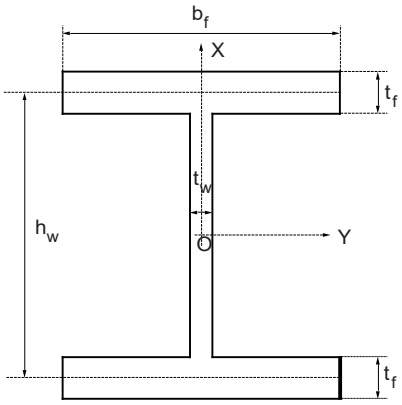
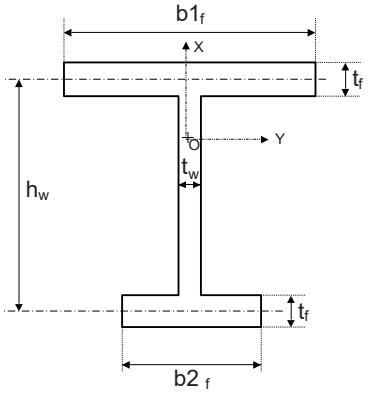
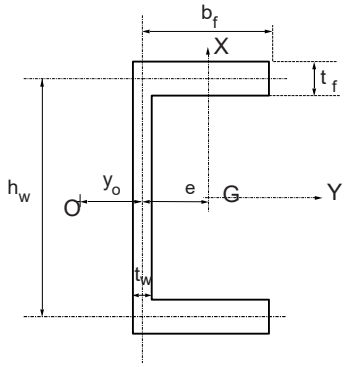
5.2 Opening arrangement

5.2.1 Tanks covers

Covers fitted on all cargo tank openings are to be of sturdy construction, and to ensure tightness for hydrocarbon and water.

Aluminium is not permitted for the construction of tank covers. The use of reinforced fibreglass covers is to be specially examined by the Society.

Table 2 : Calculation of cross-tie geometric properties

Cross-tie profile	e	y_0	J	I_W
T symmetrical 	0	0	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f h_w^2 b_f^3}{24}$
T non-symmetrical 	0	0	$\frac{1}{3}\lvert(b_{1f} + b_{2f})t_f^3 + h_w t_w^3\rvert$	$\frac{t_f h^2 b^3 b^3}{12(b^3_{1f} + b^3_{2f})}$
Non-symmetrical 	$\frac{b^2 t_f}{ht_w + 2bt_f}$	$\frac{3b^2 t}{6b_f t_f + h_w t_w}$	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f b^3 h^2 3b_f t_f + 2h_w t_w}{12 \quad 6b_f t_f + h_w t_w}$

6 Hull outfitting

6.1 Equipment

6.1.1 Emergency towing arrangements

The specific requirements in Pt B, Ch 10, Sec 4, [4] for ships with the service notation **oil tanker ESP** or **FLS tanker** and of 20000 t deadweight and above are to be complied with.

7 Protection of hull metallic structures

7.1 Protection of sea water ballast tanks

7.1.1 *All dedicated seawater ballast tanks are to have an efficient corrosion prevention system, such as hard protective coatings or equivalent.*

The coatings are preferably to be of a light colour, i.e. a colour easily distinguishable from rust which facilitates inspection.

Where appropriate, sacrificial anodes may also be used.

7.2 Protection by aluminium coatings

7.2.1 *(1/1/2014)*

The use of aluminium coatings containing more than 10% aluminium by weight in the dry film is prohibited in cargo tanks, the cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

8 Construction and testing

8.1 Welding and weld connections

8.1.1 The welding factors for some hull structural connections are specified in Tab 3. These welding factors are to be used, in lieu of the corresponding factors specified in Pt B, Ch 12, Sec 1, Tab 2, to calculate the throat thickness of fillet weld T connections according to Pt B, Ch 12, Sec 1, [2.3]. For the connections of Tab 3, continuous fillet welding is to be adopted.

8.2 Special structural details

8.2.1 The specific requirements in Pt B, Ch 12, Sec 2, [2.3] for ships with the service notation **oil tanker ESP** are to be complied with.

Table 3 : Welding factor w_F

Hull area	Connection		Welding factor w_F
	of	to	
Double bottom in way of cargo tanks	girders	bottom and inner bottom plating	0,35
		floors (interrupted girders)	0,35
	floors	bottom and inner bottom plating	0,35
		inner bottom in way of bulkheads or their lower stools	0,45
		girders (interrupted floors)	0,35
Bulkheads **(1)**	ordinary stiffeners	bulkhead plating	0,35
(1) Not required to be applied to ships with the additional service feature **flashpoint > 60°C**.			

SECTION 4 MACHINERY AND CARGO SYSTEMS FOR OIL TANKER ESP, OIL TANKER ESP CSR, FLS TANKER

1 General

1.1 Application

1.1.1 *(1/1/2012)*

The requirements of this Section apply to ships having the service notations:

- **oil tanker ESP**
- **oil tanker ESP CSR**
- **FLS tanker**

intended to carry products having any flashpoint.

The requirements in [2.1.3], [2.3.1], [2.3.5], [2.3.6], [2.3.7], [2.4.3], [3.4.6], [4.6.1] c) and d), [4.6.3] b), [4.6.4], [5] and [6.3.2], derived from MARPOL Annex I regulations, apply only to ships having the service notation **oil tanker ESP** or **oil tanker ESP CSR** (named oil tankers in this Section).

The requirements in [8.2] apply to ships having the service notation FLS tanker intended to carry substances of pollution category Z.

Some departures from these requirements may be accepted for ships of less than 500 gross tonnage as indicated in Tab 1.

1.2 Documents to be submitted

1.2.1 *(1/1/2012)*

The documents listed in Tab 2 are to be submitted for approval in four copies.

2 Piping systems other than cargo piping system

2.1 General

2.1.1 Materials *(1/1/2012)*

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

***2.1.2* Independence of piping systems** *(1/1/2012)*

a) Bilge, ballast and scupper systems serving spaces located within the cargo area:
   - are to be independent from any piping system serving spaces located outside the cargo area
   - are not to lead outside the cargo area.

b) Fuel oil systems are to:
   - be independent from the cargo piping system
   - have no connections with pipelines serving cargo or slop tanks.

***2.1.3* Passage through cargo tanks and slop tanks** *(1/1/2025)*

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted, ballast pipes passing through cargo tanks are to fulfil the following provisions:
   - they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
   - they are to be of extra-reinforced wall thickness as per Pt C, Ch 1, Sec 10, Tab5
   - they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

2.1.4 Pumps *(1/1/2012)*

One or more driven pumps are to be fitted, in a suitable space forward of cargo tanks, for bilge, ballast and, where relevant, fuel oil services.

Note 1: On ships of less than 500 gross tonnage, such pumps may be omitted provided that the above services are ensured by means of equivalent arrangements, subject to the approval of the Society.

Table 1 *(1/1/2012)*

Subject	Reference to this Section	Feature of the ship to which departures apply	Departures
Driven pumps for bilge, ballast, etc.	[2.1.4]	< 500 GRT	equivalent arrangements accepted
Drainage of pump rooms	[2.2.3]	< 500 GRT	hand pumps permitted
Drainage of cofferdams	[2.2.5]	< 500 GRT	hand pumps permitted

Table 2 : Documents to be submitted *(1/1/2012)*

No.	Description of the document **(1)**
1	General layout of cargo pump room with details of: • bulkhead penetrations • gas detection system • other alarms and safety arrangements
2	Diagram of cargo piping system
3	Diagram of the cargo tank venting system with: • indication of the outlet position • details of the pressure/vacuum valves and flame arrestors • details of the draining arrangements, if any
4	Diagram of the cargo tank level gauging system with overfill safety arrangements
5	Diagram of the cargo tank cleaning system
6	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
7	Diagram of the cargo heating systems
8	Diagram of inert gas system with details of the inert gas plant
9	Diagram of gas measurement system for double hull and double bottom spaces
(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.	

2.2 Bilge system

2.2.1 Bilge pumps *(1/1/2012)*

a) At least one bilge pump is to be provided for draining the spaces located within the cargo area. Cargo pumps or stripping pumps may be used for this purpose.

b) Bilge pumps serving spaces located within the cargo area are to be located in the cargo pump room or in another suitable space within the cargo area.

2.2.2 Draining of spaces located outside the cargo area *(1/1/2012)*

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 10, [6].

2.2.3 Draining of pump rooms *(1/1/2012)*

a) Arrangements are to be provided to drain the pump rooms by means of power pumps or bilge ejectors.

Note 1: On tankers of less than 500 gross tonnage, the pump rooms may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

b) Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:
   - a screw-down non-return valve is fitted on the bilge suctions, and
   - a remote control valve is fitted between the pump suction and the bilge distribution box.

c) Bilge pipe internal diameter is not to be less than 50 mm.

d) The bilge system of cargo pump rooms is to be capable of being controlled from outside.

e) High liquid level in the bilges is to activate an audible and visual alarm in the cargo control room and on the navigation bridge.

2.2.4 Draining of tunnels and pump rooms other than cargo pump rooms *(1/1/2012)*

Arrangements are to be provided to drain tunnels and pump rooms other than cargo pump rooms. Cargo pumps may be used for this service under the provisions of [2.2.3], item b).

2.2.5 Draining of cofferdams located at the fore and aft ends of the cargo spaces *(1/1/2012)*

a) When they are not intended to be filled with water ballast, cofferdams located at the fore and aft ends of the cargo spaces are to be fitted with drainage arrangements.

b) Aft cofferdams adjacent to the cargo pump room may be drained by a cargo pump in accordance with the provisions of [2.2.3], items b) and c), or by bilge ejectors.

c) Cofferdams located at the fore end of the cargo spaces may be drained by the bilge or ballast pumps required in [2.1.4], or by bilge ejectors.

d) Drainage of the after cofferdam from the engine room bilge system is not permitted.

Note 1: On tankers of less than 500 gross tonnage, cofferdams may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

2.2.6 Drainage of other cofferdams and void spaces located within the cargo area *(1/1/2012)*

Other cofferdams and void spaces located within the cargo area and not intended to be filled with water ballast are to be fitted with suitable means of drainage.

2.3 Ballast system

2.3.1 General *(1/1/2012)*

a) Every crude oil tanker of 20 000 tonnes deadweight and above and every product carrier of 30 000 tonnes deadweight and above is to be provided with segregated ballast tanks.

b) Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo oil and fuel oil systems.

c) In oil tankers of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

d) In:
   - crude oil tankers of 20 000 tonnes deadweight and above
   - product carriers of 30 000 tonnes deadweight and above,

   no ballast water is to be carried in cargo tanks, except in exceptional cases.

2.3.2 Ballast pumps *(1/1/2012)*

a) Ballast pumps are to be located in the cargo pump room, or a similar space within the cargo area not containing any source of ignition.

b) Where installed in the cargo pump room, ballast pumps are to comply with the applicable provisions of [3.2.3] and [3.2.4].

2.3.3 Pumping arrangements for ballast tanks within the cargo area *(1/1/2012)*

a) Ballast systems serving segregated ballast in the cargo area are to be entirely located within the cargo area and are not to be connected to other piping systems.

b) Segragated ballast tanks located within the cargo area are to be served by two different means. At least one of these means is to be a pump or an eductor used exclusively for dealing with ballast.

2.3.4 Pumping arrangement for cofferdams located at the fore and aft ends of the cargo spaces *(1/1/2012)*

Where they are intended to be filled with water ballast, the cofferdams located at the fore and aft ends of the cargo spaces may be emptied by a ballast pump located inside the machinery compartment or the forward space mentioned in [2.1.4], whichever is the case, provided that:

- the suction is directly connected to the pump and not to a piping system serving machinery spaces
- the delivery is directly connected to the ship side.

2.3.5 Emergency discharge of segregated ballast *(1/1/2012)*

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

2.3.6 Carriage of ballast water in cargo tanks *(1/1/2012)*

a) Provisions are to be made for filling cargo tanks with sea water, where permitted. Such ballast water is to be processed and discharged using the equipment referred to in [5].

b) The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

c) Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges. See also [5.3.4].

d) Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

2.3.7 Ballast pipes passing through tanks *(1/1/2025)*

a) In oil tankers of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

2.3.8 Fore peak ballast system on oil tankers *(1/1/2026)*

The fore peak tank can be ballasted with the system serving ballast tanks within the cargo area, provided the requirements in Sec 2, [7.2.1] are complied with.

2.3.9 Integrated cargo and ballast system *(1/1/2012)*

The requirements for integrated cargo and ballast systems are given in [3.5].

2.4 Air and sounding pipes of spaces other than cargo tanks

2.4.1 General *(1/1/2012)*

The air and sounding pipes fitted to the following spaces:

- cofferdams located at the fore and aft ends of the cargo spaces
- tanks and cofferdams located within the cargo area and not intended for cargo

are to be led to the open.

2.4.2 Air pipes *(1/1/2012)*

The air pipes referred to in [2.4.1] are to be arranged as per Pt C, Ch 1, Sec 10, [9] and are to be fitted with easily removable flame screens at their outlets.

2.4.3 Passage through cargo tanks *(1/1/2012)*

In oil tankers of 600 tonnes deadweight and above, the air and sounding pipes referred to in [2.4.1] are not to pass through cargo tanks except in the following cases:

- short lengths of piping serving ballast tanks
- lines serving double bottom tanks located within the cargo area, except in the case of oil tankers of 5000 tonnes deadweight and above

where the provisions of [2.1.3], item b) are complied with.

2.5 Scupper pipes

2.5.1 *(1/1/2012)*

Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt C, Ch 1, Sec 10, Tab 22, column 1.

2.6 Heating systems intended for cargo

2.6.1 General *(1/1/2012)*

a) Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 10.

b) The steam and heating media temperature within the cargo area is not to exceed 220° C.

c) Blind flanges or similar devices are to be provided on the heating circuits fitted to tanks carrying cargoes which are not to be heated.

d) Heating systems are to be so designed that the pressure maintained in the heating circuits is higher than that exerted by the cargo oil. This need not be applied to heating circuits which are not in service provided they are drained and blanked-off.

e) Isolating valves are to be provided at the inlet and outlet connections of the tank heating circuits. Arrangements are to be made to allow manual adjustement of the flow.

f) Heating pipes and coils inside tanks are to be built of a material suitable for the heated fluid. They are to have welded connections only.

2.6.2 Steam heating *(1/1/2012)*

To reduce the risk of liquid or gaseous cargo returns inside the engine or boiler rooms, steam heating systems of cargo tanks are to satisfy either of the following provisions:

- they are to be independent of other ship services, except cargo heating or cooling systems, and are not to enter machinery spaces, or
- they are to be provided with an observation tank on the water return system located within the cargo area. However, this tank may be placed inside the engine room in a well-ventilated position remote from boilers and other sources of ignition. Its air pipe is to be led to the open and fitted with a flame arrester.

2.6.3 Hot water heating *(1/1/2012)*

Hot water systems serving cargo tanks are to be independent of other systems. They are not to enter machinery spaces unless the expansion tank is fitted with:

- means for detection of flammable vapours
- a vent pipe led to the open and provided with a flame arrester.

2.6.4 Thermal oil heating

Thermal oil heating systems serving cargo tanks are to be arranged by means of a separate secondary system, located completely within the cargo area. However, a single circuit system may be accepted provided that:

- the system is so arranged as to ensure a positive pressure in the coil of at least 3 m water column above the static head of the cargo when the circulating pump is not in operation
- means are provided in the expansion tank for detection of flammable cargo vapours. Portable equipment may be accepted.
- valves for the individual heating coils are provided with a locking arrangement to ensure that the coils are under static pressure at all times.

3 Cargo pumping systems

3.1 General

3.1.1 *(1/1/2012)*

A complete system of pumps and piping is to be fitted for handling the cargo.

3.1.2 *(1/1/2012)*

Except where expressly permitted, and namely for the bow and stern cargo loading and unloading stations, this system is not to extend outside the cargo area and is to be independent of any other piping system on board.

3.2 Cargo pumping system

3.2.1 **Number and location of cargo pumps** *(1/1/2012)*

a) Each cargo tank is to be served by at least two separate fixed means of discharging and stripping. However, for tanks fitted with an individual submerged pump, the second means may be portable.

b) Cargo pumps are to be located:
- in a dedicated pump room, or
- on deck, or
- when designed for this purpose, within the cargo tanks.

3.2.2 **Use of cargo pumps** *(1/1/2012)*

a) Except where expressly permitted in [2.2] and [2.3], cargo pumps are to be used exclusively for handling the liquid cargo and are not to have any connections to compartments other than cargo tanks.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

3.2.3 **Cargo pumps drive** *(1/1/2012)*

a) Prime movers of cargo pumps are not to be located in the cargo area, except in the following cases:
- steam driven machine supplied with steam having a temperature not exceeding 220 °C
- hydraulic motors
- electric motors of certified type.

b) Pumps with a submerged electric motor are not permitted in cargo tanks.

c) Where cargo pumps are driven by a machine which is located outside the cargo pump room, the following arrangements are to be made:
1) drive shafts are to be fitted with flexible couplings or other means suitable to compensate for any misalignment
2) the shaft bulkhead or deck penetration is to be fitted with a gas-tight gland of a type approved by the Society. The gland is to be efficiently lubricated from outside the pump room and so designed as to prevent overheating. The seal parts of the gland are to be of material that cannot initiate sparks.
3) Temperature sensing devices are to be fitted for bulkhead shaft gland bearings; see [3.2.5].

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

3.2.4 **Design of cargo pumps** *(1/1/2012)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

c) Pump casings are to be fitted with temperature sensing devices; see [3.2.5].

3.2.5 **Monitoring of cargo pumps** *(1/1/2012)*

Cargo pumps are to be monitored as required in Tab 3.

3.2.6 **Control of cargo pumps** *(1/1/2012)*

Cargo pumps are to be capable of being stopped from:
- a position outside the pump room, and
- a position next to the pumps.

Table 3 : Monitoring of cargo pumps *(1/1/2012)*

Equipment, parameter	Alarm **(1)**	Indication **(2)**	Comments
pump, discharge pressure		L	• on the pump **(3)**, or • next to the unloading control station
pump casing, temperature	H		visual and audible, in cargo control room or pump control station
bulkhead shaft gland bearing, temperature	H		visual and audible, in cargo control room or pump control station

(1) H = high
(2) L = low
(3) and next to the driving machine if located in a separate compartment

3.3 Cargo piping design

3.3.1 General *(1/1/2012)*

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 10 applicable to piping systems of:
   - class III, in the case of ships having the service notation **oil tanker**
   - class II, in the case of ships having the service notation **FLS tanker**, with the exception of cargo pipes and accessories having an open end or situated inside cargo tanks, for which class III may be accepted.

b) For tests, refer to [6].

3.3.2 Materials *(1/1/2012)*

a) Cargo piping is, in general, to be made of steel or cast iron.

b) Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.

c) Spheroidal graphite cast iron may be used for cargo oil piping.

d) Grey cast iron may be accepted for cargo oil lines:
   - within cargo tanks, and
   - on the weather deck for pressure up to 1,6 Mpa.

   It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.

e) Plastic pipes may be used in the conditions specified in Pt C, Ch 1, App 3. Arrangements are to be made to avoid the generation of static electricity.

3.3.3 Connection of cargo pipe lengths *(1/1/2012)*

Cargo pipe lengths may be connected either by means of welded joints or, unless otherwise specified, by means of flange connections.

3.3.4 Expansion joints *(1/1/2012)*

a) Where necessary, cargo piping is to be fitted with expansion joints or bends.

b) Expansion joints including bellows are to be of a type approved by the Society.

c) Expansion joints made of non-metallic material may be accepted only inside tanks and provided they are:
   - of an approved type
   - designed to withstand the maximum internal and external pressure
   - electrically conductive.

d) In **oil tanker**, sliding type couplings are not to be used for expansion purposes where lines for cargo oil pass through tanks for segregated ballast.

e) In **FLS tanker**, slip joints are not to be used for cargo piping systems with the exception of pipe sections inside cargo tanks served by such sections.

3.3.5 Valves with remote control *(1/1/2012)*

a) Valves with remote control are to comply with Pt C, Ch 1, Sec 10, [2.7.3].

b) Submerged valves are to be remote controlled. In the case of a hydraulic remote control system, control boxes are to be provided outside the tank, in order to permit the emergency control of valves.

c) Valve actuators located inside cargo tanks are not to be operated by means of compressed air.

3.3.6 Cargo hoses *(1/1/2012)*

a) Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

b) Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 4 times the maximum pressure under cargo transfer conditions.

c) The ohmic electrical resistance of cargo hoses is not to exceed $10^6\,\Omega$.

3.4 Cargo piping arrangement and installation

3.4.1 Cargo pipes passing through tanks or compartments *(1/1/2012)*

a) Cargo piping is not to pass through tanks or compartments located outside the cargo area.

b) Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [2.1.3], item b).

c) Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [2.1.3], item b) are complied with.

d) Piping through cargo tanks, see also Ch 7, Sec 2, [3.1.4].

3.4.2 Cargo piping passing through bulkheads *(1/1/2012)*

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

3.4.3 Valves *(1/1/2012)*

a) Stop valves are to be provided to isolate each tank.

b) A stop valve is to be fitted at each end of the cargo manifold.

c) When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

d) Main cargo oil valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

3.4.4 Prevention of the generation of static electricity *(1/1/2014)*

To avoid the hazard of an incendive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the following requirements are to be complied with:

- the loading pipes are to be led as low as practicable in the tank
- the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than $10^6\,\Omega$.

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces

d) wafer-style valves with non-conductive (e.g. PTFE) gaskets or seals.

Where bonding straps are required, they are to be:

- clearly visible so that any shortcoming can be clearly detected
- designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint
- easy to install and replace.

3.4.5 Bow or stern cargo loading and unloading arrangements *(1/1/2012)*

Where the ship is arranged for loading and unloading outside the cargo area, the following provisions are to be complied with:

a) the piping outside the cargo area is to be fitted with a shut-off valve at its connection with the piping system within the cargo area and separating means such as blank flanges or removable spool pieces or equivalent (see Note 1) are to be provided when the piping outside the cargo area is not in use

Note 1: Those indicated in the IMO MSC/Circ. 474 are acceptable as equivalent

b) the shore connection is to be fitted with a shut-off valve and a blank flange

c) pipe connections outside the cargo area are to be of welded type only

d) arrangements are made to allow the piping outside the cargo area to be efficiently drained and purged.

3.4.6 Draining of cargo pumps and oil lines *(1/1/2012)*

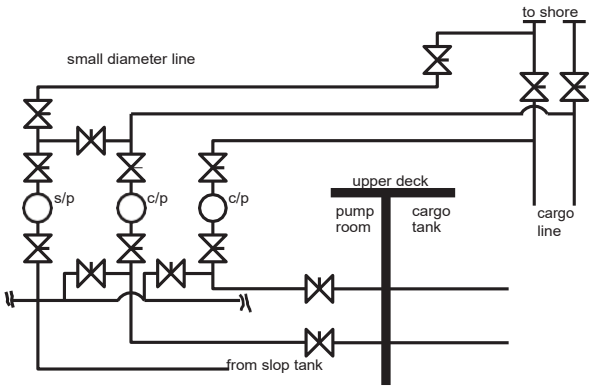
Every oil tanker required to be provided with segregated ballast tanks or fitted with a crude oil washing system is to comply with the following requirements:

a) it is to be equipped with oil piping so designed and installed that oil retention in the lines is minimised, and

b) means are to be provided to drain all cargo pumps and all oil lines at the completion of cargo discharge, where necessary by connection to a stripping device. The line and pump drainings are to be capable of being discharged both ashore and to a cargo tank or slop tank. For discharge ashore, a special small diameter line having a cross-sectional area not exceeding 10% of the main cargo discharge line is to be provided and is to be connected on the downstream side of the tanker's deck manifold valves, both port and starboard, when the cargo is being discharged; see Fig 1.

For oil tankers fitted with a crude oil washing system, refer also to App 2, [2.4.5].

Figure 1 : Connection of small diameter line to the manifold valve *(1/1/2012)*



3.4.7 Cleaning and gas-freeing *(1/1/2012)*

a) The cargo piping system is to be so designed and arranged as to permit its efficient cleaning and gas-freeing.

b) Requirements for inert gas systems are given in Part C, Chapter 4.

3.5 Integrated cargo and ballast systems design

3.5.1 Functional requirements *(1/1/2012)*

The operation of cargo and/or ballast systems may be necessary, under certain emergency circumstances or during the course of navigation, to enhance the safety of tankers.

As such, measures are to be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems. The same criteria apply to control systems of cargo and ballast valves.

3.5.2 Design features *(1/1/2012)*

The following design features are, inter alia, to be fitted:

a) the emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems. A single failure in the control system circuits or the emergency stop circuits is not to render the integrated cargo and ballast system inoperative;

b) manual emergency stops of the cargo pumps are to be arranged such that they do not cause the shutdown of the power pack making ballast pumps inoperable;

c) the control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

d) in the event of failure of the automatic or remote control systems, a secondary means of control is to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

4 Cargo tanks and fittings

4.1 Application

4.1.1 *(1/1/2012)*

The provisions of Article [4] apply to cargo tanks and slop tanks.

4.2 Cargo tank venting

4.2.1 Principle *(1/1/2012)*

Cargo tanks are to be provided with venting systems *entirely distinct from the air pipes of the other compartments of the ship. The arrangements and position of openings in the cargo tank deck from which emission of flammable vapours can occur are to be such as to minimise the possibility of flammable vapours being admitted to enclosed spaces containing a source of ignition, or collecting in the vicinity of deck machinery and equipment which may constitute an ignition hazard.*

4.2.2 Design of venting arrangements *(1/1/2026)*

The venting arrangements are to be so designed and operated as to ensure that neither pressure nor vacuum in cargo tanks exceeds design parameters and be such as to provide for:

a) the flow of the small volumes of vapour, air or inert gas mixtures caused by thermal variations in a cargo tank in all cases through pressure/vacuum valves, and

b) the passage of large volumes of vapour, air or inert gas mixtures during cargo loading and ballasting, or during discharging,

c) a secondary means of allowing full flow relief of vapour, air or inert gas mixtures to prevent overpressure or underpressure in the event of failure of the arrangements in b). In addition, for tankers constructed on or after 1 January 2017, the secondary means are to be capable of preventing over-pressure or under-pressure in the event of damage to, or inadvertent closing of, the means of isolation required in [4.2.3] b). Alternatively, pressure sensors may be fitted in each tank protected by the arrangement required in b), with a monitoring system in the ship's cargo control room or the position from which cargo operations are normally carried out. Such monitoring equipment is also to provide an alarm facility which is activated by detection of overpressure or under-pressure conditions within a tank.

For ships that apply pressure sensors in each tank as an alternative to having the secondary means of venting as per c), the setting of the overpressure alarm is to be above the pressure setting of the P/V-valve and the setting of the under-pressure alarm is to be below the vacuum setting of the P/V-valve. The alarm settings are to be within the design pressures of the cargo tanks. The settings are to be fixed and are not to be arranged for blocking or adjustment in operation. An exception is permitted for ships that carry different types of cargo and use P/V valves with different settings, one setting for each type of cargo. The settings may be adjusted to account for the different types of cargo.

4.2.3 Combination of venting arrangements *(1/1/2026)*

a) The venting arrangements in each cargo tank may be independent or, where the cargo is homogenous or, for multiple cargoes, where the vapours are compatible and do not require isolation, they may be combined with other cargo tanks or be incorporated into the inert gas piping.

b) Where the arrangements are combined with other cargo tanks, either stop valves or other acceptable means are to be provided to isolate each cargo tank. Where stop valves are fitted, they are to be provided with locking arrangements which are to be under the control of the responsible ship's officer. There is to be a clear visual indication of the operational status of the valves or other acceptable means. Where tanks have been isolated, it is to be ensured that relevant isolating valves are opened before cargo loading or ballasting or discharging of those tanks is commenced. Any isolation must continue to permit the flow caused by thermal variations in a cargo tank in accordance with [4.2.2] a). For tankers constructed on or after 1 January 2017, any isolation is also to continue to permit the passage of large volumes of vapour, air or inert gas mixtures during cargo loading and ballasting, or during discharging in accordance with [4.2.2] b).

c) If cargo loading and ballasting or discharging of a cargo tank or cargo tank group is intended, which is isolated from a common venting system, that cargo tank or cargo tank group is to be fitted with a means for overpressure or underpressure protection as required in [4.2.2] c).

4.2.4 **Arrangement of vent lines** *(1/1/2012)*

The venting arrangements are to be connected to the top of each cargo tank and are to be self-draining to the cargo tanks under all normal conditions of trim and list of the ship. Where it may not be possible to provide self-draining lines, permanent arrangements are to be provided to drain the vent lines to a cargo tank.

Plugs or equivalent means are to be provided on the lines after the safety relief valves.

4.2.5 **Openings for pressure release** *(1/1/2012)*

Openings for pressure release required by [4.2.2] a) are to:

a) have as great a height as is practicable above the cargo tank deck to obtain maximum dispersal of flammable vapours but in no case less than 2 m above the cargo tank deck,

b) be arranged at the furthest distance practicable but not less than 5 m from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery and equipment which may constitute an ignition hazard. Anchor windlass and chain locker openings constitute an ignition hazard.

4.2.6 **Pressure/vacuum valves** *(1/1/2012)*

a) One or more pressure/vacuum-breaking devices are to be provided to prevent the cargo tanks from being subject to:

1) a positive pressure, in excess of the test pressure of the cargo tank, if the cargo were to be loaded at the maximum rated capacity and all other outlets were left shut; and

2) a negative pressure in excess of 700 mm water gauge if cargo were to be discharged at the maximum rated capacity of the cargo pumps and the inert gas blowers were to fail.

Such devices are to be installed on the inert gas main unless they are installed in the venting system required by this item [4.2] or on individual cargo tanks.

b) Pressure/vacuum valves are to be set at a positive pressure not exceeding 0,021 MPa and at a negative pressure not exceeding 0,007 MPa. Higher setting values not exceeding 0,07 MPa may be accepted in positive pressure if the scantlings of the tanks are appropriate.

c) Pressure/vacuum valves required by item a) of [4.2.2] may be provided with a bypass when they are located in a vent main or masthead riser. Where such an arrangement is provided, there are to be suitable indicators to show whether the bypass is open or closed.

d) Pressure/vacuum valves are to be of a type approved by the Society in accordance with App 1.

e) Pressure/vacuum valves are to be readily accessible.

f) Pressure/vacuum valves are to be provided with a manual opening device so that valves can be locked on open position. Locking means on closed position are not permitted.

4.2.7 **Vent oulets** *(1/1/2012)*

Vent outlets for cargo loading, discharging and ballasting required by [4.2.2] b) are to:

a) permit:

- *the free flow of vapour mixtures, or*
- *the throttling of the discharge of the vapour mixtures to achieve a velocity of not less than 30 m/s,*

b) be so arranged that the vapour mixture is discharged vertically upwards,

c) where the method is by free flow of vapour mixtures, be such that the outlet is not less than 6 m above the cargo tank deck or fore and aft gangway if situated within 4 m of the gangway and located not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard,

d) where the method is by high velocity discharge, be located at a height not less than 2 m above the cargo tank deck and not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard. These outlets are to be provided with high velocity devices of a type approved by the Society,

e) be designed on the basis of the maximum designed loading rate multiplied by a factor of at least 1,25 to take account of gas evolution, in order to prevent the pressure in any cargo tank from exceeding the design pressure. The Master is to be provided with information regarding the maximum permissible loading rate for each cargo tank and in the case of combined venting systems, for each group of cargo tanks.

The arrangements for the venting of vapours displaced from the cargo tanks during loading and ballasting are to comply with this item [4.2] and are to consist of either one or more mast risers, or a number of high-velocity vents. The inert gas supply main may be used for such venting.

4.2.8 High velocity valves *(1/1/2012)*

a) High velocity valves are to be readily accessible.

b) High velocity valves not required to be fitted with flame arresters (see [4.2.9]) are not to be capable of being locked on open position.

4.2.9 Prevention of the passage of flame into the tanks *(1/1/2012)*

a) The venting system is to be provided with devices to prevent the passage of flame into the cargo tanks. The design, testing and locating of these devices are to comply with App 1.

Ullage openings are not to be used for pressure equalisation. They are to be provided with self-closing and tightly sealing covers. Flame arresters and screens are not permitted in these openings.

b) A flame arresting device integral to the venting system may be accepted.

c) Flame screens and flame arresters are to be designed for easy overhauling and cleaning.

4.2.10 Prevention of liquid rising in the venting system *(1/1/2012)*

a) Provisions are to be made to prevent liquid rising in the venting system; refer to [4.5].

b) Cargo tanks gas venting systems are not to be used for overflow purposes.

c) Spill valves are not considered equivalent to an overflow system.

4.3 Cargo tank purging and/or gas-freeing

4.3.1 General *(1/1/2012)*

a) Arrangements are to be made for purging and/or gas-freeing of cargo tanks. The arrangements *are to be such as to minimise the hazards due to the dispersal of flammable vapours in the atmosphere and to flammable mixtures in a cargo tank. Accordingly, the provisions of [4.3.2] and [4.3.3], as applicable, are to be complied with.*

b) In the case of fans installed in safe spaces, two non-return devices are to be fitted to avoid return of cargo vapours to safe spaces when the ventilation system is shut down. These non-return devices are to operate in all normal conditions of ship trim and list.

c) Discharge outlets are to be located at least 10 m measured horizontally from the nearest air intake and openings to enclosed spaces with a source of ignition and from deck machinery equipment which may constitute an ignition hazard.

4.3.2 Ships provided with an inert gas system *(1/1/2012)*

When the ship is provided with an inert gas system, the cargo tanks are first to be purged in accordance with the provisions of Part C, Chapter 4 until the concentration of hydrocarbon vapours in the cargo tanks has been reduced to less than 2% by volume. Thereafter, gas-freeing may take place at the cargo tank deck level.

4.3.3 Ships not provided with an inert gas system *(1/1/2012)*

When the ship is not provided with an inert gas system, the operation is to be such that the flammable vapour is discharged initially:

a) through the vent outlets as specified in [4.2.7], or

b) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 30 m/s maintained during the gas-freeing operation, or

c) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 20 m/s and which are protected by suitable devices to prevent the passage of flame.

The above outlets are to be located not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery, which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard.

When the flammable vapour concentration at the outlet has been reduced to 30% of the lower flammable limit, gas-freeing may thereafter be continued at cargo tank deck level.

4.4 Cargo tank level gauging systems

4.4.1 General *(1/1/2012)*

a) Each cargo or slop tank is to be fitted with a level gauging system indicating the liquid level along the entire height of the tank. Unless otherwise specified, the gauge may be portable or fixed with local reading.

b) Gauging devices and their remote reading systems are to be type approved.

c) Ullage openings and other gauging devices likely to release cargo vapour to the atmosphere are not to be arranged in enclosed spaces.

4.4.2 Definitions *(1/1/2012)*

a) A “restricted gauging device” means a device which penetrates the tank and which, when in use, permits a small quantity of vapour or liquid to be exposed to the atmosphere. When not in use, the device is completely closed. Examples are sounding pipes.

b) A “closed gauging device” means a device which is separated from the tank atmosphere and keeps tank contents from being released. It may:

- penetrate the tank, such as float-type systems, electric probe, magnetic probe or protected sight glass,
- not penetrate the tank, such as ultrasonic or radar devices.

c) An “indirect gauging device” means a device which determines the level of liquid, for instance by means of weighing or pipe flow meter.

4.4.3 Tankers fitted with an inert gas system *(1/1/2012)*

a) In tankers fitted with an inert gas system, the gauging devices are to be of the closed type.

b) Use of indirect gauging devices will be given special consideration.

4.4.4 Tankers not fitted with an inert gas system *(1/1/2012)*

a) In tankers not fitted with an inert gas system, the gauging devices are to be of the closed or restricted types. Ullage openings may be used only as a reserve sounding means and are to be fitted with a watertight closing appliance.

b) Where restricted gauging devices are used, provisions are to be made to:

- avoid dangerous escape of liquid or vapour under pressure when using the device
- relieve the pressure in the tank before the device is operated.

c) Where used, sounding pipes are to be fitted with a a self-closing blanking device.

4.5 Protection against tank overload

4.5.1 General *(1/1/2012)*

a) Provisions are to be made to guard against liquid rising in the venting system of cargo or slop tanks to a height which would exceed the design head of the tanks. This is to be accomplished by high level alarms or overflow control systems or other equivalent means, together with gauging devices and cargo tank filling procedures.

Note 1: For ships having the service notation **FLS tanker**, only high level alarms are permitted.

b) Sufficient ullage is to be left at the end of tank filling to permit free expansion of liquid during carriage.

c) High level alarms, overflow control systems and other means referred to in a) are to be independent of the gauging systems referred to in [4.4].

4.5.2 High level alarms *(1/1/2012)*

a) High level alarms are to be type approved.

b) High level alarms are to give an audible and visual signal at t he control station, where provided.

4.5.3 Other protection systems *(1/7/2021)*

Where the tank level gauging systems, cargo and ballast pump control systems and valve control systems are centralised in a single location, the provisions of [4.5.1] may be complied with by the fitting of a level gauge for the indication of the end of loading, in addition to that required for each tank under [4.4]. The readings of both gauges for each tank are to be as near as possible to each other and so arranged that any discrepancy between them can be easily detected.

4.6 Tank washing systems

4.6.1 General *(1/1/2012)*

a) Adequate means are to be provided for cleaning the cargo tanks.

b) For ships having the service notation FLS tanker carrying category Z substances, see [8].

c) Every crude oil tanker of 20 000 tonnes deadweight and above is to be fitted with a cargo tank cleaning system using crude oil washing and complying with App 2.

d) Crude oil washing systems fitted on oil tankers other than crude oil tankers of 20 000 tonnes deadweight or above are to comply with the provisions of App 2 related to safety.

4.6.2 Washing machines *(1/1/2012)*

a) Tank washing machines are to be of a type approved by the Society.

b) Washing machines are to be made of steel or other electricity conducting materials with a limited propensity to produce sparks on contact.

4.6.3 Washing pipes *(1/1/2012)*

a) Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 10, depending on the kind of washing fluid, water or crude oil.

b) Crude oil washing pipes are also to satisfy the requirements of Article [3.3].

4.6.4 Use of crude oil washing machines for water washing operations *(1/1/2012)*

Crude oil washing machines may be connected to water washing pipes, provided that isolating arrangements, such as a valve and a detachable pipe section, are fitted to isolate water pipes.

4.6.5 Installation of washing systems *(1/1/2012)*

a) Tank cleaning openings are not to be arranged in enclosed spaces.

b) The complete installation is to be permanently earthed to the hull.

5 Prevention of pollution by cargo oil

5.1 General

5.1.1 Application *(1/7/2015)*

Unless otherwise specified, the provisions of [5.2] apply only to oil tankers of 150 gross tonnage and above.

5.1.2 Provisions for oil tankers of less than 150 gross tonnage *(1/1/2012)*

The control of discharge for **oil tankers** of less than 150 gross tonnage is to be effected by the retention of oil on board with subsequent discharge of all contaminated washings to reception facilities unless adequate arrangements are made to ensure that the discharge of any effluent into the sea, where allowed, is effectively monitored to ensure that the total quantity of oil discharged into the sea does not exceed 1/30 000 of the total quantity of the particular cargo of which the residue formed a part.

5.1.3 Exemptions *(1/1/2012)*

a) The provisions of [5.2] may be waived in the following cases:

- oil tankers engaged exclusively on voyages within 50 miles from the nearest land and of 72 hours or less in duration and limited to trades between ports or terminals agreed by the Society, provided that oily mixtures are retained on board for subsequent discharge to reception facilities
- carrying products which through their physical properties inhibit effective product/water separation and monitoring, for which the control of discharge is to be effected by the retention of residues on board with discharge of all contaminated washings to reception facilities

b) Where, in the view of the Society, the equipment is not obtainable for the monitoring of discharge of oil refined products (white oils), compliance with such requirements may be waived provided that discharge is performed only in accordance with the applicable procedures.

5.2 Retention of oil on board

5.2.1 General *(1/1/2012)*

Adequate means are to be provided for transferring the dirty ballast residue and tank washings from the cargo tanks into a slop tank approved by the Society.

5.2.2 Capacity of slop tanks *(1/1/2012)*

The arrangement of the slop tank or combination of slop tanks is to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is not to be less than 3% of the oil carrying capacity of the ship, except that the Society may accept:

a) 2% for oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without the introduction of additional water into the system

b) 2% where segregated ballast tanks are provided in accordance with Sec 2, [5], or where a cargo tank cleaning system using crude oil washing is fitted in accordance with [4.6]. This capacity may be further reduced to 1,5% for oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without introduction of additional water into the system.

Oil tankers of 70 000 tonnes deadweight and above are to be fitted with at least two slop tanks.

5.2.3 Design of slop tanks *(1/1/2012)*

Slop tanks are to be so designed particularly in respect of the position of inlets, outlets, baffles or weirs where fitted, as to avoid excessive turbulence and entrainment of oil or emulsion with the water.

5.3 Pumping, piping and discharge arrangements

5.3.1 Discharge manifold *(1/1/2012)*

In every oil tanker, a discharge manifold for connection to reception facilities for the discharge of dirty ballast water or oil contaminated water is to be located on the open deck on both sides of the ship.

5.3.2 Discharge pipelines *(1/1/2012)*

In every oil tanker, pipelines for the discharge of ballast water or oil contaminated water from cargo tank areas to the sea, where permitted, are to be led to the open deck or to the ship side above the waterline in the deepest ballast condition, except that:

a) segregated ballast and clean ballast may be discharged below the waterline:
   - in ports or at offshore terminals, or
   - at sea by gravity,

   provided that the surface of the ballast water has been examined immediately before the discharge to ensure that no contamination with oil has taken place.

b) on every oil tanker at sea, dirty ballast water or oil contaminated water from tanks in the cargo area, other than slop tanks, may be discharged by gravity below the waterline, provided that sufficient time has elapsed in order to allow oil/water separation to have taken place and the water ballast has been examined immediately before the discharge with an oil/water interface detector, in order to ensure that the height of the interface is such that the discharge does not involve any increased risk of harm to the marine environment.

5.3.3 Discharge stopping *(1/1/2012)*

Means are to be provided for stopping the discharge into the sea of ballast water or oil contaminated water from cargo tank areas, other than those discharges below the waterline permitted under [5.3.2], from a position on the upper deck or above located so that the manifold in use referred to in [5.3.1] and the discharge to the sea from the pipelines referred to in [5.3.2] may be visually observed. Means for stopping the discharge need not be provided at the observation position if a positive communication system such as a telephone or radio system is provided between the observation position and the discharge control position.

5.3.4 Cargo piping connections to sea chests *(1/1/2012)*

On every oil tanker where a sea chest is permanently connected to the cargo pipeline system, it is to be equipped with both a sea chest valve and an inboard isolation valve. In addition to these valves, the sea chest is to be capable of isolation from the cargo piping system whilst the tanker is loading, transporting or discharging cargo by use of a positive means that is to the satisfaction of the Society. Such a positive means is a facility that is installed in the pipeline system

in order to prevent the section of pipeline between the sea chest valve and the inboard valve being filled with cargo under all circumstances.

Examples of positive means may take the form of blanks, spectacle blanks, pipeline blinds, evacuation or vacuum systems, or air or water pressure systems. In the event that evacuation or vacuum systems, or air or water pressure systems are used, then they are to be equipped with both a pressure gauge and alarm system to enable the continuous monitoring of the status of the pipeline section, and thereby the valve integrity, between the sea chest and inboard valves.

6 Certification, inspection and testing

6.1 Application

6.1.1 *(1/1/2012)*

The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt C, Ch 1, Sec 10, [21] for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials *(1/1/2012)*

Where required in Tab 4, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt C, Ch 1, Sec 10, [21.3.2].

6.2.2 Inspection of welded joints *(1/1/2012)*

Where required in Tab 4, welded joints are to be subjected to the examinations specified in Pt C, Ch 1, Sec 10, [3.6] for class II pipes.

6.2.3 Hydrostatic testing *(1/1/2012)*

a) Where required in Tab 4, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

c) Where fitted, bellow pieces of gas-tight penetration glands are to be pressure tested.

6.2.4 Tightness tests *(1/1/2012)*

Tightness of the following devices is to be checked:

- gas-tight penetration glands
- cargo tank P/V and high velocity valves.

Note 1: These tests may be carried out in the workshops or on board.

6.2.5 Check of the safety valves setting *(1/1/2012)*

The setting pressure of the pressure/vacuum valves is to be checked in particular with regard to [4.2.6].

6.2.6 Summary table *(1/1/2012)*

Inspections and tests required for cargo piping and other equipment fitted in the cargo area are summarised in Tab 4.

6.3 Shipboard tests

6.3.1 Pressure test *(1/1/2012)*

a) After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

b) The piping system used in crude oil washing systems is to be submitted to hydrostatic tests in accordance with, App 2, [3.2.1].

6.3.2 Survey of pollution prevention equipment *(1/1/2012)*

Every oil tanker of 150 gross tonnage and above is to be subjected to an initial survey before the ship is put in service, to ensure that the equipment, systems, fittings, arrangements and materials fully comply with the relevant provisions of [4.6] and [5].

Table 4 : Inspection and testing at works *(1/1/2012)*

No.	Item	Tests for materials		Inspections and tests for the products			References
		Y/N **(1)**	Type of material certificate **(2)**	during manu-facturing **(1)**	after completion **(1) (3)**	Type of product certificate **(2)**	
1	pipes, valves and fittings of class II (see [3.3.1])	Y	• C where ND>100 mm • W where ND≤100 mm	Y **(4)**	Y	C	[6.2.1] [6.2.1] [6.2.2] [6.2.3]
2	expansion joints and cargo hoses	Y **(5)**	W	N	Y	C	[6.2.1] [6.2.3]
3	cargo pumps	Y	W	Y **(6)**	Y	C	see note **(6)** [6.2.3]
4	gas-tight penetration glands	N		N	Y	C	[6.2.3], [6.2.4]
5	cargo tank P/V and high velocity valves	Y	C	Y	Y	C	[6.2.1] [6.2.2] **(4)** [6.2.3], [6.2.4] [6.2.5]
6	flame arresters	N		N	Y	C	see note **(3)**
7	Oil discharge monitoring and control system	N			Y **(7)**	C	see note **(3)**
8	Oil/water interface detector	N			Y **(7)**	C	see note **(3)**

(1) Y = required, N = not required.
(2) C = class certificate, W = works' certificate.
(3) includes the checking of the rule characteristics according to the approved drawings.
(4) only in the case of welded construction.
(5) if metallic.
(6) inspection during manufacturing is to be carried out according to a program approved by the Society.
(7) may also be carried out on board.

7 Steering gear

7.1 General

7.1.1 *(1/1/2012)*

In addition to the provisions of Pt C, Ch 1, Sec 11, the steering gear of **oil tankers** of 10000 gross tonnage and above is to comply with the requirements of [7].

The provision above also applies to **FLS tankers** of 10000 gross tonnage and above carrying flammable cargoes.

7.2 Design of the steering gear

7.2.1 *(1/1/2012)*

Every tanker of 10 000 gross tonnage and upwards is, subject to the provisions of [7.3], to comply with the following:

a) the main steering gear is to be so arranged that in the event of loss of steering capability due to a single failure in any part of one of the power actuating systems of the main steering gear, excluding the tiller, quadrant or components serving the same purpose, or seizure of the rudder actuators, steering capability is to be regained in not more than 45 s after the loss of one power actuating system;

b) the main steering gear is to comprise either:

1) two independent and separate power actuating systems, each capable of meeting the requirements of Pt C, Ch 1, Sec 11, [3.2.1]; or

2) at least two identical power actuating systems which, acting simultaneously in normal operation, are to be capable of meeting the requirements of Pt C, Ch 1, Sec 11, [3.2.1]. Where necessary to comply with this requirement, interconnection of hydraulic power actuating systems is to be provided. Loss of hydraulic fluid from one system is to be capable of being detected and the defective system automatically isolated so that the other actuating system or systems remain(s) fully operational;

c) steering gear other than that of the hydraulic type is to achieve equivalent standards.

7.3 Alternative design for ships of less than 100 000 tonnes deadweight

7.3.1 General *(1/1/2012)*

For tankers of 10 000 gross tonnage and upwards, but of less than 100 000 tonnes deadweight, solutions other than those set out in [7.2], which need not apply the single failure criterion to the rudder actuator or actuators, may be permitted provided that an equivalent safety standard is achieved and that:

a) following loss of steering capability due to a single failure of any part of the piping system or in one of the power units, steering capability is regained within 45 s; and

b) where the steering gear includes only a single rudder actuator, special consideration is given to stress analysis for the design including fatigue analysis and fracture mechanics analysis, as appropriate, to the material used, to the installation of sealing arrangements and to testing and inspection and to the provision of effective maintenance.

7.3.2 Materials *(1/1/2012)*

Parts subject to internal hydraulic pressure or transmitting mechanical forces to the rudder stock are to be made of duly tested ductile materials complying with recognised standards. Materials for pressure retaining components are to be in accordance with recognised pressure vessel standards. These materials are not to have an elongation of less than 12 per cent or a tensile strength in excess of 650 N/mm^2.

7.3.3 Design *(1/1/2012)*

a) Design pressure

The design pressure is assumed to be at least equal to the greater of the following:

1) 1,25 times the maximum working pressure to be expected under the operating conditions required in Pt C, Ch 1, Sec 11, [3.3.1],

2) the relief valve setting.

b) Analysis

1) The manufacturers of rudder actuators are to submit detailed calculations showing the suitability of the design for the intended service.

2) A detailed stress analysis of the pressure retaining parts of the actuator is to be carried out to determine the stress at the design pressure.

3) Where considered necessary because of the design complexity or manufacturing procedures, a fatigue analysis and fracture mechanics analysis may be required. In connection with the analyses, all foreseen dynamic loads are to be taken into account. Experimental stress analysis may be required in addition to, or in lieu of, theoretical calculations depending on the complexity of the design.

c) Allowable stresses

For the purpose of determining the general scantlings of parts of rudder actuators subject to internal hydraulic pressure, the allowable stresses are not to exceed:

- $\sigma_m \leq f$

- $\sigma_l \leq 1,5.f$
- $\sigma_b \leq 1,5.f$
- $\sigma_l + \sigma_b \leq 1,5.f$
- $\sigma_m + \sigma_b \leq 1,5.f$

where:

σ_m *: Equivalent primary general membrane stress*

σ_l *: Equivalent primary local membrane stress*

σ_b *: Equivalent primary bending stress*

f : the lesser of σ_B/A *or* σ_y/B

σ_B *: Specified minimum tensile strength of material at ambient temperature*

σ_y *: Specified minimum yield stress or 0,2 per cent proof stress of material at ambient temperature*

A : equal to:

- *4 for steel*
- *4,6 for cast steel*
- *5,8 for nodular cast iron*

B : equal to:

- *2 for steel*
- *2,3 for cast steel*
- *3,5 for nodular cast iron*

d) *Burst test*

1) *Pressure retaining parts not requiring fatigue analysis and fracture mechanics analysis may be accepted on the basis of a certified burst test at the discretion of the Society and the detailed stress analysis required by [7.3.3], item b), need not be provided.*

2) *The minimum bursting pressure is to be calculated as follows:*

$$P_b = P \cdot A \cdot \frac{\sigma_{Ba}}{\sigma_B}$$

where:

P_b *: Minimum bursting pressure*

P : Design pressure as defined in [7.3.3], item a)

A : as from [7.3.3], item c)

σ_{Ba} *: Actual tensile strength*

σ_B *: Tensile strength as defined in [7.3.3], item c).*

7.3.4 Construction details *(1/1/2012)*

a) *General*

The construction is to be such as to minimise the local concentration of stress.

b) *Welds*

1) *The welding details and welding procedures are to be approved.*

2) *All welded joints within the pressure boundary of a rudder actuator or connecting parts transmitting mechanical loads are to be full penetration type or of equivalent strength.*

c) *Oil seals*

1) *Oil seals between non-moving parts, forming part of the external pressure boundary, are to be of the metal upon metal type or of an equivalent type.*

2) *Oil seals between moving parts, forming part of the external pressure boundary, are to be duplicated, so that the failure of one seal does not render the actuator inoperative. Alternative arrangements providing equivalent protection against leakage may be accepted at the discretion of the Society.*

d) *Isolating valves*

Isolating valves are to be fitted at the connection of pipes to the actuator, and are to be directly mounted on the actuator.

e) *Relief valves*

Relief valves for protecting the rudder actuator against overpressure as required in Pt C, Ch 1, Sec 11, [2.2.5] are to comply with the following:

1) *the setting pressure is not to be less than 1,25 times the maximum working pressure expected under operating conditions required in Pt C, Ch 1, Sec 11, [3.3.1], item b),*
2) *the minimum discharge capacity of the relief valves is not to be less than the total capacity of all pumps which provide power for the actuator, increased by 10 per cent. Under such conditions, the rise in pressure is not to exceed 10 per cent of the setting pressure. In this regard, due consideration is to be given to extreme foreseen ambient conditions in respect of oil viscosity.*

7.3.5 Inspection and testing *(1/1/2012)*

a) Non-destructive testing

The rudder actuator is to be subjected to suitable and complete non-destructive testing to detect both surface flaws and volumetric flaws. The procedure and acceptance criteria for non-destructive testing is to be in accordance with requirements of recognised standards. If found necessary, fracture mechanics analysis may be used for determining maximum allowable flaw size.

b) Other testing

1) *Tests, including hydrostatic tests, of all pressure parts at 1,5 times the design pressure are to be carried out.*
2) *When installed on board the ship, the rudder actuator is to be subjected to a hydrostatic test and a running test.*

8 Specific requirements FLS tanker

8.1 Application

8.1.1 *(1/1/2012)*

The provisions of this Article, derived from Annex II of the MARPOL 73/78 Convention as amended, are related to the prevention of pollution by noxious liquid substances. They apply as follows:

a) Where the ship is granted only the service notation FLS tanker, these provisions replace those of [5] related to the prevention of pollution by cargo oil.

b) Where the ship is granted both service notations oil tanker-FLS tanker, these provisions are additional to those of [5].

8.2 Design requirements

8.2.1 General *(1/1/2012)*

The requirements of [8.2] apply to ships carrying category Z substances (see App 4, Tab 1).

8.2.2 Cargo piping and pumping system *(1/1/2012)*

The pumping and piping arrangement is to ensure that each tank does not retain a quantity of residue in excess of 75 litres in the tank and its associated piping. A performance test shall be carried out in accordance with Appendix 5 of Annex II of MARPOL 73/78 Convention as amended.

8.2.3 Underwater discharge *(1/1/2012)*

An underwater discharge outlet (or outlets) shall be fitted.

The underwater discharge outlet (or outlets) shall be located within the cargo area in the vicinity of the turn of the bilge and shall be so arranged as to avoid the re-intake of residue/water mixtures by the ship's seawater intakes.

The underwater discharge outlet arrangement is to be such that the residue/water mixture discharged into the sea will not pass through the ship's boundary layer. To this end, when the discharge is made normal to the ship's shell plating, the minimum diameter of the discharge outlet is governed by the following equation:

$$d = \frac{Q_d}{5L_d}$$

where:

d : Minimum diameter of the discharge outlet (m)

L_d : Distance from the forward perpendicular to the discharge outlet (m)

Q_d : The maximum rate selected at which the ship may discharge a residue/water mixture through the outlet (m^3/h).

When the discharge is directed at an angle to the ship's shell plating, the above relationship is to be modified by substituting for Q_d the component of Q_d which is normal to the ship's shell plating.

8.2.4 Ventilation equipment *(1/1/2012)*

a) If residues from cargo tanks are removed by means of ventilation, ventilation equipment meeting the following provisions is to be provided.

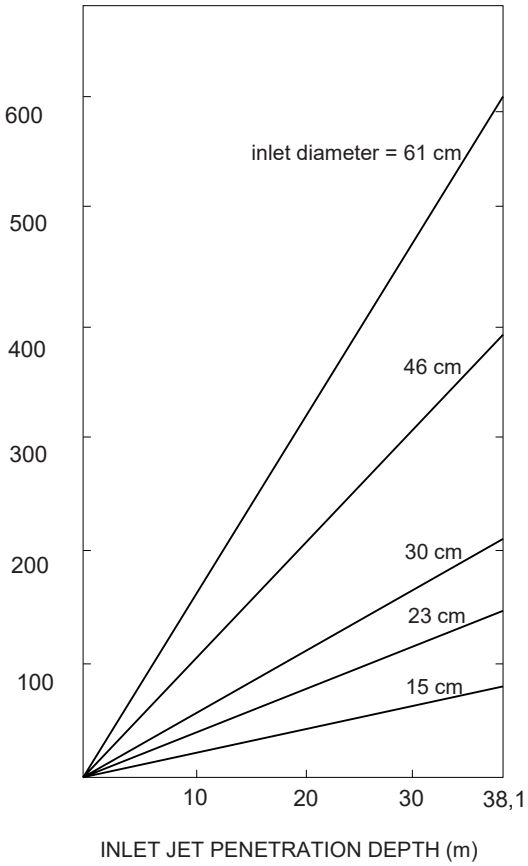
Note 1: Ventilation procedures may be applied only to those substances having a vapour pressure greater than 5 x 10^3 Pa at 20°C.

b) The ventilation equipment is to be capable of producing an air jet which can reach the tank bottom. Fig 2 may be used to evaluate the adequacy of ventilation equipment used for ventilating a tank of given depth.

c) The ventilation equipment is to be placed in the tank opening closest to the tank sump or suction point.

d) When practicable, the ventilation equipment is to be positioned so that the air jet is directed at the tank sump or suction point and impingement of the air jet on tank structural members is to be avoided as far as possible.

Figure 2 : Minimum flow rate as a function of jet penetration depth *(1/1/2012)*



Note: Jet penetration depth is to be compared against tank height.

SECTION 5 MACHINERY AND CARGO SYSTEMS FOR OIL TANKER ESP FLASHPOINT > 60°, OIL TANKER ESP CSR FLASHPOINT > 60°, ASPHALT TANKER, ASPHALT TANKER ESP, FLS TANKER FLASHPOINT >60°

1 General

1.1 Application

1.1.1 *(1/1/2012)*

The requirements of this Section apply to ships having the service notation:

- **oil tanker ESP, flashpoint > 60°C**
- **oil tanker ESP CSR, flashpoint > 60°C**
- **asphalt tanker**
- **asphalt tanker ESP**
- **FLS tanker, flashpoint > 60°C**

intended to carry products having flashpoint > 60°C.

The requirements in [2.1.3], [2.3.1], [2.3.3], [2.3.4], [2.3.5], [3.4.4], [5] and [6.3.2] derived from MARPOL Annex I regulations apply only to ships having the service notation **oil tanker ESP, flashpoint > 60°C** or **oil tanker ESP CSR, flashpoint > 60°C** (named oil tankers in this Section) or **asphalt tanker** or **asphalt tanker ESP** (named asphalt tanker in this Section).

The ships having the service notation **FLS tanker**, **flashpoint > 60°C** are named **FLS tankers** in this Section.

1.1.2 Additional requirements *(1/1/2012)*

Additional requirements are provided in:

- [8] for ships having the service notation **asphalt tanker** or **asphalt tanker ESP**
- [9] for ships intended to carry substances of pollution category Z.

1.2 Documents to be submitted

1.2.1 *(1/1/2012)*

The documents listed in Tab 1 are to be submitted for approval in four copies.

2 Piping systems other than cargo piping system

2.1 General

2.1.1 Materials *(1/1/2012)*

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

2.1.2 **Independence of piping systems** *(1/1/2012)*

a) Fuel oil systems are to:
   - be independent from the cargo piping system
   - have no connections with pipelines serving cargo or slop tanks.

2.1.3 **Passage through cargo tanks and slop tanks** *(1/1/2025)*

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted, ballast pipes passing through cargo tanks are to fulfil the following provisions:
- they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
- they are to be of extra-reinforced wall thickness as per Pt C, Ch 1, Sec 10, Tab5
- they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

2.2 Bilge system

2.2.1 Draining of spaces located outside the cargo area *(1/1/2012)*

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 10, [6].

Table 1 : Documents to be submitted *(1/1/2012)*

No.	Description of the document **(1)**
1	Diagram of cargo piping system
2	Diagram of the cargo tank venting system with indication of the outlet position
3	Diagram of the cargo tank level gauging system with overfill safety arrangements
4	Diagram of the cargo tank cleaning system
5	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
6	Diagram of the cargo heating systems
(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.	

2.2.2 Draining of pump rooms *(1/1/2012)*

a) Arrangements are to be provided to drain the pump rooms by means of power pumps or bilge ejectors.

Note 1: On tankers of less than 500 gross tonnage, the pump rooms may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

b) Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:
- a screw-down non-return valve is fitted on the bilge suctions.

c) Bilge pipe internal diameter is not to be less than 50 mm.

d) High liquid level in the bilges is to activate an audible and visual alarm in the cargo control room and on the navigation bridge.

2.2.3 Drainage of hold spaces, cofferdams and void spaces located within the cargo area *(1/1/2012)*

Hold spaces, cofferdams and void spaces located within the cargo area and not intended to be filled with water ballast are to be fitted with suitable means of drainage.

2.3 Ballast system

2.3.1 General *(1/1/2012)*

a) Every oil tanker certified as a product carrier of 30 000 tonnes deadweight and above is to be provided with segregated ballast tanks.

b) Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo oil and fuel oil systems.

c) In oil tankers of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

d) In oil tankers certified as product carriers of 30 000 tonnes deadweight and above, no ballast water is to be carried in cargo tanks, except in exceptional cases.

2.3.2 Pumping arrangements for ballast tanks within the cargo area *(1/1/2012)*

Segregated ballast tanks located within the cargo area are to be served by two different means. At least one of these means is to be a pump or an eductor used exclusively for dealing with ballast. The ballast system serving the spaces located outside the cargo area may be used for this purpose.

2.3.3 Emergency discharge of segregated ballast *(1/1/2012)*

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

2.3.4 Carriage of ballast water in cargo tanks *(1/1/2012)*

a) Provisions are to be made for filling cargo tanks with sea water, where permitted. Such ballast water is to be processed and discharged using the equipment referred to in [5].

b) The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

c) Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges. See also [5.4.4].

d) Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

2.3.5 Ballast pipes passing through tanks *(1/1/2025)*

a) In oil tankers and on asphalt tankers of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

2.3.6 Integrated cargo and ballast system *(1/1/2012)*

The requirements for integrated cargo and ballast systems are given in [3.5].

2.4 Scupper pipes

2.4.1 *(1/1/2012)*

Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt C, Ch 1, Sec 10, Tab 22, column 1.

2.5 Heating systems intended for cargo

2.5.1 General *(1/1/2012)*

Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 10.

3 Cargo pumping and piping systems

3.1 General

3.1.1 *(1/1/2012)*

A complete system of pumps and piping is to be fitted for handling the cargo.

3.2 Cargo pumping system

3.2.1 Number and location of cargo pumps *(1/1/2012)*

Each cargo tank is to be served by at least two separate fixed means of discharging and stripping. However, for tanks fitted with an individual submerged pump, the second means may be portable.

3.2.2 Use of cargo pumps *(1/1/2012)*

a) Except where expressly permitted in [2.2] and [2.3], cargo pumps are to be used exclusively for handling the liquid cargo and are not to have any connections to compartments other than cargo tanks.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

3.2.3 Cargo pump drive *(1/1/2012)*

Pumps with a submerged electric motor are not permitted in cargo tanks.

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

3.2.4 Design of cargo pumps *(1/1/2012)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

3.2.5 Monitoring of cargo pumps *(1/1/2012)*

Cargo pumps are to be monitored as required in Tab 2.

3.2.6 Control of cargo pumps *(1/1/2012)*

Cargo pumps are to be capable of being stopped from:

- a position outside the pump room, and
- a position next to the pumps.

3.3 Cargo piping design

3.3.1 General *(1/1/2012)*

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 10 applicable to piping systems of:
   - class III, in the case of oil tankers and asphalt tankers
   - class II, in the case of FLS tankers, with the exception of cargo pipes and accessories having an open end or situated inside cargo tanks, for which class III may be accepted.

b) For tests, refer to [6].

Table 2 : Monitoring of cargo pumps *(1/1/2012)*

Equipment, parameter	Alarm	Indication **(2)**	Comments
pump, discharge pressure		L	• on the pump **(3)**, or • next to the unloading control station
(1) L = low **(2)** and next to the driving machine if located in a separate compartment			

3.3.2 Materials *(1/1/2012)*

a) Cargo piping is, in general, to be made of steel or cast iron.

b) Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.

c) Spheroidal graphite cast iron may be used for cargo oil piping.

d) Grey cast iron may be accepted for cargo oil lines:
   - within cargo tanks, and
   - on the weather deck for pressure up to 1,6 MPa.

   It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.

e) Plastic pipes may be used in the conditions specified in Pt C, Ch 1, App 3. Arrangements are to be made to avoid the generation of static electricity.

3.3.3 Connection of cargo pipe lengths *(1/1/2012)*

Cargo pipe lengths may be connected either by means of welded joints or, unless otherwise specified, by means of flange connections.

3.3.4 Expansion joints *(1/1/2012)*

a) Where necessary, cargo piping is to be fitted with expansion joints or bends.

b) Expansion joints including bellows are to be of a type approved by the Society.

c) Expansion joints made of non-metallic material may be accepted only inside tanks and provided they are:
   - of an approved type
   - designed to withstand the maximum internal and external pressure
   - electrically conductive
   - in oil tankers and asphalt tankers, sliding type couplings are not to be used for expansion purposes where lines for cargo oil pass through tanks for segregated ballast.

d) In **FLS tanker**, slip joints are not to be used for cargo piping systems with the exception of pipe sections inside cargo tanks served by such sections.

3.3.5 Valves with remote control *(1/1/2012)*

a) Valves with remote control are to comply with Pt C, Ch 1, Sec 10, [2.7.3].

b) Submerged valves are to be remote controlled. In the case of a hydraulic remote control system, control boxes are to be provided outside the tank, in order to permit the emergency control of valves.

c) Valve actuators located inside cargo tanks are not to be operated by means of compressed air.

3.3.6 Cargo hoses *(1/1/2012)*

a) Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

b) Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 4 times the maximum pressure under cargo transfer conditions.

c) The ohmic electrical resistance of cargo hoses is not to exceed $10^6\,\Omega$.

3.4 Cargo piping arrangement and installation

3.4.1 Cargo pipes passing through tanks or compartments *(1/1/2012)*

a) Cargo piping is not to pass through tanks or compartments located outside the cargo area.

b) Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [2.1.3], item b).

c) Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [2.1.3], item b) are complied with.

d) Piping through cargo tanks, see also Ch 7, Sec 2, [3.1.4].

3.4.2 Cargo piping passing through bulkheads *(1/1/2012)*

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

3.4.3 Valves *(1/1/2012)*

a) Stop valves are to be provided to isolate each tank.

b) A stop valve is to be fitted at each end of the cargo manifold.

c) When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

d) Main cargo oil valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

3.4.4 Draining of cargo pumps and oil lines *(1/1/2012)*

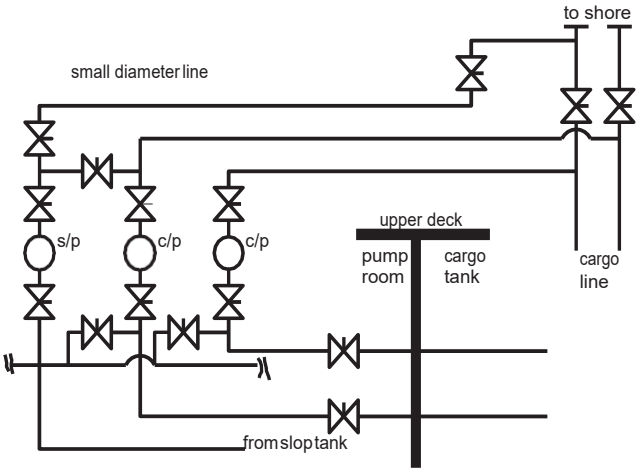
Every oil tanker and asphalt carrier required to be provided with segregated ballast tanks is to comply with the following requirements:

a) it is to be equipped with oil piping so designed and installed that oil retention in the lines is minimised, and

b) means are to be provided to drain all cargo pumps and all oil lines at the completion of cargo discharge, where necessary by connection to a stripping device. The line and pump drainings are to be capable of being discharged

both ashore and to a cargo tank or slop tank. For discharge ashore, a special small diameter line having a cross-sectional area not exceeding 10% of the main cargo discharge line is to be provided and is to be connected on the downstream side of the tanker's deck manifold valves, both port and starboard, when the cargo is being discharged; see Fig 1.

Figure 1 : Connection of small diameter line to the manifold valve *(1/1/2012)*



3.5 Integrated cargo and ballast systems design

3.5.1 Functional requirements *(1/1/2012)*

The operation of cargo and/or ballast systems may be necessary, under certain emergency circumstances or during the course of navigation, to enhance the safety of tankers.

As such, measures are to be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems. The same criteria apply to control systems of cargo and ballast valves.

3.5.2 Design features *(1/1/2012)*

The following design features are, inter alia, to be fitted:

a) the emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems. A single failure in the control system circuits or the emergency stop circuits is not to render the integrated cargo and ballast system inoperative;

b) manual emergency stops of the cargo pumps are to be arranged such that they do not cause the shutdown of the power pack making ballast pumps inoperable;

c) the control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

d) in the event of failure of the automatic or remote control systems, a secondary means of control is to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

4 Cargo tanks and fittings

4.1 Application

4.1.1 *(1/1/2012)*

The provisions of Article [4] apply to cargo tanks and slop tanks.

4.2 Cargo tank venting

4.2.1 *(1/1/2012)*

The relevant provisions of Pt C, Ch 1, Sec 10, [9] and Pt C, Ch 1, Sec 10, [11] are to be complied with.

Tank venting systems are to open to the atmosphere at a height of at least 760 mm above the weather deck. If the cargo is carried at a temperature exceeding the flashpoint by more than 15°C, this height is to be increased to 2,4 m.

Tanks may be fitted with venting systems of the open type provided with a flame screen. For ships carrying bulk cargoes with flashpoint > 100°C, the flame screen may be omitted.

4.3 Protection against tank overload

4.3.1 General *(1/1/2012)*

a) Provisions are to be made to guard against liquid rising in the venting system of cargo or slop tanks to a height which would exceed the design head of the tanks. This is to be accomplished by high level alarms or overflow control systems or other equivalent means, together with gauging devices and cargo tank filling procedures.

Note 1: For FLS tankers, only high level alarms are permitted.

b) Sufficient ullage is to be left at the end of tank filling to permit free expansion of liquid during carriage.

c) High level alarms, overflow control systems and other means referred to in a) are to be independent of the gauging systems referred to in [4.4].

4.3.2 High level alarms *(1/1/2012)*

a) High level alarms are to be type approved.

b) High level alarms are to give an audible and visual signal at t he control station, where provided.

4.3.3 Other protection systems *(1/1/2012)*

a) Where the tank level gauging systems, cargo and ballast pump control systems and valve control systems are centralised in a single location, the provisions of [4.4.1] may be complied with by the fitting of a level gauge for the indication of the end of loading, in addition to that required for each tank under [4.4]. The readings of both gauges for each tank are to be as near as possible to each other and so arranged that any discrepancy between them can be easily detected.

b) Where a tank can be filled only from other tanks, the provisions of [4.4.1] are considered as complied with.

4.4 Tank washing systems

4.4.1 General *(1/1/2012)*

a) Adequate means are to be provided for cleaning the cargo tanks.

b) For FLS tankers carrying category Z substances, the provisions of [9.2.2] are to be applied.

4.4.2 Washing machines *(1/1/2012)*

a) Tank washing machines are to be of a type approved by the Society.

b) Washing machines are to be made of steel or other electricity conducting materials with a limited propensity to produce sparks on contact.

4.4.3 Washing pipes *(1/1/2012)*

Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 10, depending on the kind of washing fluid or water.

4.4.4 Installation of washing systems *(1/1/2012)*

Tank cleaning openings are not to be arranged in enclosed spaces.

5 Prevention of pollution by cargo oil

5.1 General

5.1.1 Application *(1/1/2012)*

Unless otherwise specified, the provisions of [5.2] and [5.3] apply only to oil tankers of 150 gross tonnage and above.

5.1.2 Provisions for oil tankers of less than 150 gross tonnage *(1/1/2012)*

The control of discharge for **oil tankers** of less than 150 gross tonnage is to be effected by the retention of oil on board with subsequent discharge of all contaminated washings to reception facilities unless adequate arrangements are made to ensure that the discharge of any effluent into the sea, where allowed, is effectively monitored to ensure that the total quantity of oil discharged into the sea does not exceed 1/30 000 of the total quantity of the particular cargo of which the residue formed a part.

5.1.3 Exemptions *(1/1/2012)*

a) The provisions of [5.2] and [5.3] may be waived in the following cases:
   - oil tankers engaged exclusively on voyages within 50 miles from the nearest land and of 72 hours or less in duration and limited to trades between ports or terminals agreed by the Society, provided that oily mixtures are retained on board for subsequent discharge to reception facilities
   - oil tankers carrying products which through their physical properties inhibit effective product/water separation and monitoring, for which the control of discharge is to be effected by the retention of residues on board with discharge of all contaminated washings to reception facilities
   - asphalt tankers.

b) Where, in the view of the Society, the equipment referred to in [5.3.1] and [5.3.2] is not obtainable for the monitoring of discharge of oil refined products (white oils), compliance with such requirements may be waived provided that discharge is performed only in accordance with the applicable procedures.

5.2 Retention of oil on board

5.2.1 General *(1/1/2012)*

Adequate means are to be provided for transferring the dirty ballast residue and tank washings from the cargo tanks into a slop tank approved by the Society.

5.2.2 Capacity of slop tanks *(1/1/2012)*

The arrangement of the slop tank or combination of slop tanks is to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is not to be less than 3% of the oil carrying capacity of the ship, except that the Society may accept:

a) 2% for oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without the introduction of additional water into the system

b) 2% where segregated ballast tanks are provided in accordance with Sec 2, [5], or where a cargo tank cleaning system using crude oil washing is fitted in accordance with [4.4]. This capacity may be further reduced to 1,5% for oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without introduction of additional water into the system.

Oil tankers of 70 000 tonnes deadweight and above are to be fitted with at least two slop tanks.

5.2.3 Design of slop tanks *(1/1/2012)*

Slop tanks are to be so designed particularly in respect of the position of inlets, outlets, baffles or weirs where fitted, as to avoid excessive turbulence and entrainment of oil or emulsion with the water.

5.3 Oil discharge monitoring and control system

5.3.1 General *(1/1/2012)*

a) An oil discharge monitoring and control system is to be fitted.

b) A manually operated alternative method is to be provided.

5.3.2 Design of the discharge monitoring and control system *(1/1/2012)*

a) The discharge monitoring and control system is to be of a type approved in compliance with the provisions of IMO Resolution A.586(14).

b) The discharge monitoring and control system is to be fitted with a recording device to provide a continuous record of the discharge in litres per nautical mile and total quantity discharged, or the oil content and rate of discharge. This record is to be identifiable as regards time and date.

c) The oil discharge monitoring and control system is to come into operation when there is any discharge of effluent into the sea and is to be such as will ensure that any discharge of oily mixture is automatically stopped when the instantaneous rate of discharge of oil content exceeds 30 litres per nautical mile.

d) Any failure of the monitoring and control system is to stop the discharge.

5.3.3 Oil/water interface detectors *(1/1/2012)*

Effective oil/water interface detectors approved by the Society are to be provided for a rapid and accurate determination of the oil/water interface in slop tanks and are to be available for use in other tanks where the separation of oil and water is effected and from which it is intended to discharge effluent directly to the sea.

5.4 Pumping, piping and discharge arrangements

5.4.1 Discharge manifold *(1/1/2012)*

In every oil tanker and asphalt tanker, a discharge manifold for connection to reception facilities for the discharge of dirty ballast water or oil contaminated water is to be located on the open deck on both sides of the ship.

5.4.2 Discharge pipelines *(1/1/2012)*

In every oil tanker and asphalt tanker , pipelines for the discharge of ballast water or oil contaminated water from cargo tank areas to the sea, where permitted, are to be led to the open deck or to the ship side above the waterline in the deepest ballast condition, except that:

a) segregated ballast and clean ballast may be discharged below the waterline:
   - in ports or at offshore terminals, or
   - at sea by gravity,

   provided that the surface of the ballast water has been examined immediately before the discharge to ensure that no contamination with oil has taken place.

b) on every oil tanker and asphalt tanker at sea, dirty ballast water or oil contaminated water from tanks in the cargo area, other than slop tanks, may be discharged by gravity below the waterline, provided that sufficient time has elapsed in order to allow oil/water separation to have taken place and the water ballast has been examined immediately before the discharge with an oil/water interface detector referred to in [5.3.3], in order to ensure that the height of the interface is such that the discharge does not involve any increased risk of harm to the marine environment.

5.4.3 Discharge stopping *(1/1/2012)*

On every oil tanker and asphalt tanker means are to be provided for stopping the discharge into the sea of ballast water or oil contaminated water from cargo tank areas, other than those discharges below the waterline permitted under [5.4.2], from a position on the upper deck or above located so that the manifold in use referred to in [5.4.1] and the discharge to the sea from the pipelines referred to in [5.4.2] may be visually observed. Means for stopping the discharge need not be provided at the observation position if a positive communication system such as a telephone or radio system is provided between the observation position and the discharge control position.

5.4.4 Cargo piping connections to sea chests *(1/1/2012)*

On every oil tanker and asphalt tanker where a sea chest is permanently connected to the cargo pipeline system, it is to be equipped with both a sea chest valve and an inboard isolation valve. In addition to these valves, the sea chest is to be capable of isolation from the cargo piping system whilst the tanker is loading, transporting or discharging cargo by use of a positive means that is to the satisfaction of the Society. Such a positive means is a facility that is installed in the pipeline system in order to prevent the section of pipeline between the sea chest valve and the inboard valve being filled with cargo under all circumstances.

Examples of positive means may take the form of blanks, spectacle blanks, pipeline blinds, evacuation or vacuum systems, or air or water pressure systems. In the event that evacuation or vacuum systems, or air or water pressure systems are used, then they are to be equipped with both a pressure gauge and alarm system to enable the continuous monitoring of the status of the pipeline section, and thereby the valve integrity, between the sea chest and inboard valves.

6 Certification, inspection and testing

6.1 Application

6.1.1 *(1/1/2012)*

The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt C, Ch 1, Sec 10, [21] for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials *(1/1/2012)*

Where required in Tab 3, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt C, Ch 1, Sec 10, [21.3.2].

6.2.2 Inspection of welded joints *(1/1/2012)*

Where required in Tab 3, welded joints are to be subjected to the examinations specified in Pt C, Ch 1, Sec 10, [3.6] for class II pipes.

6.2.3 Hydrostatic testing *(1/1/2012)*

a) Where required in Tab 3, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

c) Where fitted, bellow pieces of gas-tight penetration glands are to be pressure tested.

6.2.4 Tightness tests *(1/1/2012)*

Tightness of the following devices is to be checked:

- gas-tight penetration glands
- cargo tank P/V and high velocity valves.

Note 1: These tests may be carried out in the workshops or on board.

6.2.5 Check of the safety valves setting *(1/1/2012)*

The setting pressure of the pressure/vacuum valves is to be checked in particular with regard to Sec 4, [4.2.6].

6.2.6 Summary table *(1/1/2012)*

Inspections and tests required for cargo piping and other equipment fitted in the cargo area are summarised in Tab 3.

6.3 Shipboard tests

6.3.1 Pressure test *(1/1/2012)*

a) After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

b) The piping system used in crude oil washing systems is to be submitted to hydrostatic tests in accordance with, App 2, [3.2.1].

6.3.2 Survey of pollution prevention equipment *(1/1/2012)*

Every oil tanker of 150 gross tonnage and above is to be subjected to an initial survey before the ship is put in service, to ensure that the equipment, systems, fittings, arrangements and materials fully comply with the relevant provisions of [4.4] and [5].

7 Steering gear

7.1 General

7.1.1 *(1/1/2012)*

In addition to the provisions of Pt C, Ch 1, Sec 11, the steering gear on oil tankers and asphalt tankers of 10000 gross tonnage and above is to comply with the requirements of [7].

The provision above also applies to ships having the service notation FLS tanker of 10000 gross tonnage and above carrying flammable cargoes.

7.2 Design of the steering gear

7.2.1 *(1/1/2012)*

Every tanker of 10 000 gross tonnage and upwards is, subject to the provisions of [7.3], to comply with the following:

a) the main steering gear is to be so arranged that in the event of loss of steering capability due to a single failure in any part of one of the power actuating systems of the main steering gear, excluding the tiller, quadrant or components serving the same purpose, or seizure of the rudder actuators, steering capability is to be regained in not more than 45 s after the loss of one power actuating system;

b) the main steering gear is to comprise either:

1) two independent and separate power actuating systems, each capable of meeting the requirements of Pt C, Ch 1, Sec 11, [3.2.1]; or

2) at least two identical power actuating systems which, acting simultaneously in normal operation, are to be capable of meeting the requirements of Pt C, Ch 1, Sec 11, [3.2.1]. Where necessary to comply with this

requirement, interconnection of hydraulic power actuating systems is to be provided. Loss of hydraulic fluid from one system is to be capable of being detected and the defective system automatically isolated so that the other actuating system or systems remain(s) fully operational;

c) steering gear other than that of the hydraulic type is to achieve equivalent standards.

7.3 Alternative design for ships of less than 100 000 tonnes deadweight

7.3.1 General *(1/1/2012)*

For tankers of 10 000 gross tonnage and upwards, but of less than 100 000 tonnes deadweight, solutions other than those set out in [7.2], which need not apply the single failure criterion to the rudder actuator or actuators, may be permitted provided that an equivalent safety standard is achieved and that:

a) following loss of steering capability due to a single failure of any part of the piping system or in one of the power units, steering capability is regained within 45 s; and

b) where the steering gear includes only a single rudder actuator, special consideration is given to stress analysis for the design including fatigue analysis and fracture mechanics analysis, as appropriate, to the material used, to the installation of sealing arrangements and to testing and inspection and to the provision of effective maintenance.

7.3.2 Materials *(1/1/2012)*

Parts subject to internal hydraulic pressure or transmitting mechanical forces to the rudder stock are to be made of duly tested ductile materials complying with recognised standards. Materials for pressure retaining components are to be in accordance with recognised pressure vessel standards. These materials are not to have an elongation of less than 12 per cent or a tensile strength in excess of 650 N/mm^2.

Table 3 : Inspection and testing at works *(1/1/2012)*

No.	Item	Tests for materials		Inspections and tests for the products			References
		Y/N **(1)**	Type of material certificate **(2)**	during manu-facturing **(1)**	after completion **(1) (3)**	Type of product certificate **(2)**	
1	pipes, valves and fittings of class II (see [3.3.1])	Y	• C where ND>100 mm • W where ND≤100 mm	Y **(4)**	Y	C	[6.2.1] [6.2.1] [6.2.2] [6.2.3]
2	expansion joints and cargo hoses	Y **(5)**	W	N	Y	C	[6.2.1] [6.2.3]
3	cargo pumps	Y	W	Y **(6)**	Y	C	see note **(6)** [6.2.3]
4	gas-tight penetration glands	N		N	Y	C	[6.2.3] [6.2.4]
5	cargo tank P/V and high velocity valves	Y	C	Y	Y	C	[6.2.1] [6.2.2] **(4)** [6.2.3] [6.2.4] [6.2.5]

(1) Y = required, N = not required.
(2) C = class certificate, W = works' certificate.
(3) includes the checking of the rule characteristics according to the approved drawings.
(4) only in the case of welded construction.
(5) if metallic.
(6) inspection during manufacturing is to be carried out according to a program approved by the Society.
(7) may also be carried out on board.

No.	Item	Tests for materials		Inspections and tests for the products			References
		Y/N **(1)**	Type of material certificate **(2)**	during manu-facturing **(1)**	after completion **(1) (3)**	Type of product certificate **(2)**	
6	flame arresters	N		N	Y	C	see note **(3)**
7	Oil discharge monitoring and control system	N			Y **(7)**	C	see note **(3)**
8	Oil/water interface detector	N			Y **(7)**	C	see note **(3)**

(1) Y = required, N = not required.
(2) C = class certificate, W = works' certificate.
(3) includes the checking of the rule characteristics according to the approved drawings.
(4) only in the case of welded construction.
(5) if metallic.
(6) inspection during manufacturing is to be carried out according to a program approved by the Society.
(7) may also be carried out on board.

7.3.3 Design *(1/1/2012)*

a) Design pressure

The design pressure is assumed to be at least equal to the greater of the following:

1) 1,25 times the maximum working pressure to be expected under the operating conditions required in Pt C, Ch 1, Sec 11, [3.3.1],

2) the relief valve setting.

b) Analysis

1) The manufacturers of rudder actuators are to submit detailed calculations showing the suitability of the design for the intended service.

2) A detailed stress analysis of the pressure retaining parts of the actuator is to be carried out to determine the stress at the design pressure.

3) Where considered necessary because of the design complexity or manufacturing procedures, a fatigue analysis and fracture mechanics analysis may be required. In connection with the analyses, all foreseen dynamic loads are to be taken into account. Experimental stress analysis may be required in addition to, or in lieu of, theoretical calculations depending on the complexity of the design.

c) Allowable stresses

For the purpose of determining the general scantlings of parts of rudder actuators subject to internal hydraulic pressure, the allowable stresses are not to exceed:

- $\sigma_m \leq f$
- $\sigma_l \leq 1,5.f$
- $\sigma_b \leq 1,5.f$
- $\sigma_l + \sigma_b \leq 1,5.f$
- $\sigma_m + \sigma_b \leq 1,5.f$

where:

σ_m : *Equivalent primary general membrane stress*

σ_l : *Equivalent primary local membrane stress*

σ_b : *Equivalent primary bending stress*

f : *the lesser of* σ_B/A *or* σ_y/B

σ_B : *Specified minimum tensile strength of material at ambient temperature*

σ_y : *Specified minimum yield stress or 0,2 per cent proof stress of material at ambient temperature*

A : equal to:

- *4 for steel*
- *4,6 for cast steel*
- *5,8 for nodular cast iron*

B : equal to:

- *2 for steel*
- *2,3 for cast steel*
- *3,5 for nodular cast iron*

d) Burst test

1) Pressure retaining parts not requiring fatigue analysis and fracture mechanics analysis may be accepted on the basis of a certified burst test at the discretion of the Society and the detailed stress analysis required by [7.3.3], item b), need not be provided.

2) The minimum bursting pressure is to be calculated as follows:

$$P_b = P \cdot A \cdot \frac{\sigma_{Ba}}{\sigma_B}$$

where:

P_b *: Minimum bursting pressure*

P *: Design pressure as defined in [7.3.3], item a)*

A *: as from [7.3.3], item c)*

σ_{Ba} *: Actual tensile strength*

σ_B *: Tensile strength as defined in [7.3.3], item c).*

7.3.4 Construction details *(1/1/2012)*

a) General

The construction is to be such as to minimise the local concentration of stress.

b) Welds

1) The welding details and welding procedures are to be approved.

2) All welded joints within the pressure boundary of a rudder actuator or connecting parts transmitting mechanical loads are to be full penetration type or of equivalent strength.

c) Oil seals

1) Oil seals between non-moving parts, forming part of the external pressure boundary, are to be of the metal upon metal type or of an equivalent type.

2) Oil seals between moving parts, forming part of the external pressure boundary, are to be duplicated, so that the failure of one seal does not render the actuator inoperative. Alternative arrangements providing equivalent protection against leakage may be accepted at the discretion of the Society.

d) Isolating valves

Isolating valves are to be fitted at the connection of pipes to the actuator, and are to be directly mounted on the actuator.

e) Relief valves

Relief valves for protecting the rudder actuator against overpressure as required in Pt C, Ch 1, Sec 11, [2.2.5] are to comply with the following:

1) the setting pressure is not to be less than 1,25 times the maximum working pressure expected under operating conditions required in Pt C, Ch 1, Sec 11, [3.3.1], item b),

2) the minimum discharge capacity of the relief valves is not to be less than the total capacity of all pumps which provide power for the actuator, increased by 10 per cent. Under such conditions, the rise in pressure is not to exceed 10 per cent of the setting pressure. In this regard, due consideration is to be given to extreme foreseen ambient conditions in respect of oil viscosity.

7.3.5 Inspection and testing *(1/1/2012)*

a) Non-destructive testing

The rudder actuator is to be subjected to suitable and complete non-destructive testing to detect both surface flaws and volumetric flaws. The procedure and acceptance criteria for non-destructive testing is to be in accordance with

requirements of recognised standards. If found necessary, fracture mechanics analysis may be used for determining maximum allowable flaw size.

b) Other testing

1) Tests, including hydrostatic tests, of all pressure parts at 1,5 times the design pressure are to be carried out.

2) When installed on board the ship, the rudder actuator is to be subjected to a hydrostatic test and a running test.

8 Additional requirements for asphalt tankers

8.1 Application

8.1.1 *(1/1/2012)*

The provisions of this Article apply, in addition to those contained in Articles [1] to [7] above, to oil tankers having the additional service notation **asphalt carrier**.

8.2 Additional requirements

8.2.1 Heating systems *(1/1/2026)*

a) Cargo tanks intended for the carriage of asphalt solutions are to be equipped with a heating system capable of preserving the asphalt solutions in their liquid state. Valves are to be fitted on the heating system inlet and outlet.

b) Cargo piping and associated fittings outside tanks are to be provided with suitable heating devices. For heating of piping and fittings, refer to Sec 4, [2.6].

c) Steam heating systems of cargo tanks are to be fitted with more than one boiler, so that the steam supply to the cargo heating system can be maintained in case of failure of any single boiler.

8.2.2 Thermometers *(1/1/2012)*

Each tank is to be equipped with at least two thermometers in order to ascertain the temperature of the asphalt solution.

8.2.3 Insulation *(1/1/2012)*

Cargo piping and associated fittings outside tanks are to be suitably insulated, where necessary.

9 Specific requirements for FLS tanker

9.1 Application

9.1.1 *(1/1/2012)*

The provisions of this Article, derived from Annex II of the MARPOL 73/78 Convention, are related to the prevention of pollution by noxious liquid substances. They apply as follows:

a) Where the ship is granted only the service notation **FLS tanker**, these provisions replace those of [5] related to the prevention of pollution by cargo oil.

b) Where the ship is granted both service notations **oil tanker, flashpoint > 60°C** and **FLS tanker, flashpoint > 60°C**, these provisions are additional to those of [5].

9.2 Design requirements

9.2.1 General *(1/1/2012)*

The requirements of [9.2] apply to ships carrying category Z substances (see App 4, Tab 1).

9.2.2 Cargo piping and pumping system *(1/1/2012)*

The pumping and piping arrangement is to ensure that each tank does not retain a quantity of residue in excess of 75 litres in the tank and its associated piping. A performance test shall be carried out in accordance with Appendix 5 of Annex II of MARPOL 73/78 Convention as amended

9.2.3 Underwater discharge *(1/1/2012)*

An underwater discharge outlet (or outlets) shall be fitted.

The underwater discharge outlet (or outlets) shall be located within the cargo area in the vicinity of the turn of the bilge and shall be so arranged as to avoid the re-intake of residue/water mixtures by the ship's seawater intakes.

The underwater discharge outlet arrangement is to be such that the residue/water mixture discharged into the sea will not pass through the ship's boundary layer. To this end, when the discharge is made normal to the ship's shell plating, the minimum diameter of the discharge outlet is governed by the following equation:

$$d = \frac{Q_d}{5L_d}$$

where:

d : Minimum diameter of the discharge outlet (m)

L_d : Distance from the forward perpendicular to the discharge outlet (m)

Q_d : The maximum rate selected at which the ship may discharge a residue/water mixture through the outlet (m^3/h).

When the discharge is directed at an angle to the ship's shell plating, the above relationship is to be modified by substituting for Q_d the component of Q_d which is normal to the ship's shell plating.

9.2.4 Ventilation equipment *(1/1/2012)*

a) If residues from cargo tanks are removed by means of ventilation, ventilation equipment meeting the following provisions is to be provided.

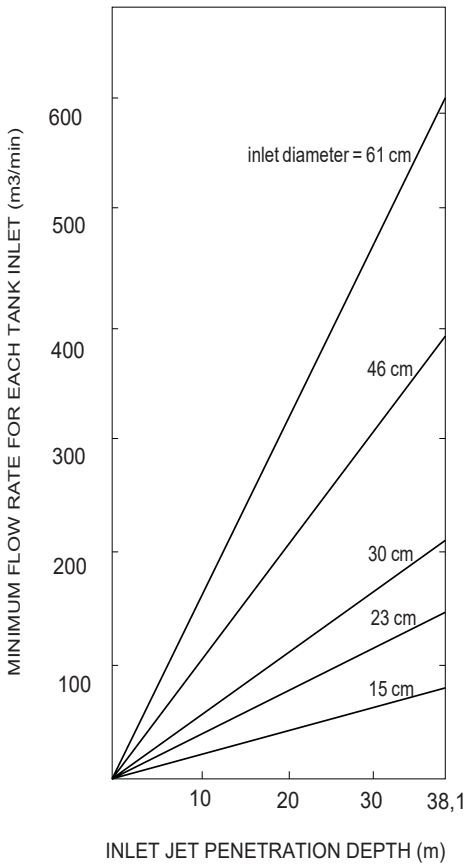
Note 1: Ventilation procedures may be applied only to those substances having a vapour pressure greater than 5.10^3 Pa at 20°C.

b) The ventilation equipment is to be capable of producing an air jet which can reach the tank bottom. Fig 2 may be used to evaluate the adequacy of ventilation equipment used for ventilating a tank of given depth.

c) The ventilation equipment is to be placed in the tank opening closest to the tank sump or suction point.

d) When practicable, the ventilation equipment is to be positioned so that the air jet is directed at the tank sump or suction point and impingement of the air jet on tank structural members is to be avoided as far as possible.

Figure 2 : Minimum flow rate as a function of jet penetration depth *(1/1/2012)*



Note: Jet penetration depth is to be compared against tank height.

SECTION 6 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/4/2006)*
The requirements in this Section apply, in addition to those contained in Part C, Chapter 2, to ships with the service notations **oil tanker ESP** or **oil tanker ESP CSR** or **FLS tanker**.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 *(1/1/2007)*
Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

1.3.2 In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.3 *(1/7/2009)*
The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

1.4 Electrical equipment

1.4.1 *(1/1/2007)*
Electrical equipment, cables and wiring are not to be installed in hazardous locations unless they conform with standards not inferior to those given in IEC 60092-502 Standard.

However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Society, to ensure that an equivalent level of safety is assured.

1.5 Earth detection

1.5.1 *(1/1/2007)*
For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [1.3.1].

1.6 Precautions against inlet of gases or vapours

1.6.1 Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

1.7 Electrical equipment permitted in hazardous areas

1.7.1 *(1/1/2007)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5], and Pt C, Ch 2, Sec 3, [10.1.6].

1.7.2 *(1/1/2007)*

In addition to the requirements of [1.7.1], in Zone 1 and Zone 2 the installation of the following is permitted:

hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of animpressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

1.7.3 The explosion group and temperature class of electrical equipment of a certified safe type are to be at least IIA and T3 in the case of ships arranged for the carriage of crude oil or other petroleum products.

Other characteristics may be required for dangerous products other than those above.

1.7.4 Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

2 Special requirements for oil tankers carrying flammable liquids having a flash point not exceeding 60°C

2.1 Hazardous area classification

2.1.1 *(1/1/2007)*

For hazardous area classification see Tab 1.

3 Special requirements for oil tankers carrying flammable liquids having a flash point exceeding 60°C

3.1 Hazardous area classification

3.1.1 *(1/1/2007)*

For hazardous area classification see Tab 2.

3.2 Cargoes heated to a temperature above their flash point and cargoes heated to a temperature within 15°C of their flash point

3.2.1 *(1/1/2007)*

The requirements under [2] apply.

4 Special requirements for FLS tankers

4.1 General, hazardous locations and types of equipment

4.1.1 The requirements under Ch 8, Sec 10 apply.

Table 1 : Classification of hazardous areas for oil tankers carrying flammable liquids having a flash point not exceeding 60°C *(1/7/2012)*

Spaces		Hazardous area
N.	Description	
1	Interior of cargo tanks, slop tanks, any pipework of pressure relief or other venting systems for cargo and slop tanks, pipes and equipment containing cargo or developing flammable gases or vapours.	Zone 0
2	Void spaces adjacent to, above or below integral cargo tanks.	Zone 1
3	Hold spaces containing independent cargo tanks.	Zone 1
4	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks.	Zone 1
5	Cargo pump rooms.	Zone 1
6	Enclosed or semi-enclosed spaces immediately above cargo tanks (e.g. 'tweendecks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the Society.	Zone 1
7	Spaces other than cofferdams, adjacent to and below the top of a cargo tank (e.g. trunks, passageways and holds) as well as double bottoms and pipe tunnels below cargo tanks.	Zone 1
8	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump room ventilation outlets and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation.	Zone 1
9	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6m radius centred upon the centre of the outlet, and within a hemisphere of 6m radius below the outlet.	Zone 1
10	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5m of cargo pump room entrances, cargo pump room ventilation inlets, openings into cofferdams or other Zone 1 spaces.	Zone 1
11	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck.	Zone 1
12	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where structures are restricting the natural ventilation and to the full breadth of the ship plus 3m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4m above the deck.	Zone 1
13	Compartments for cargo hoses.	Zone 1
14	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located.	Zone 1
15	Areas 2m beyond the area defined in item 8.	Zone 2
16	Areas of 1,5 m surrounding open or semi-enclosed spaces of Zone 1.	Zone 2
17	Areas 4m beyond the cylinder and 4m beyond the sphere defined in item 9.	Zone 2
18	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service areas and 3m beyond these up to a height of 2,4m above the deck.	Zone 2
19	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4m above the deck surrounding open or semi-enclosed spaces of Zone 1.	Zone 2
20	Spaces forward of the open deck areas to which reference is made in item 12 and item 18, below the level of the main deck, and having an opening on the main deck or at a level less than 0,5m above the main deck, unless: a) the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilation system inlets and exhausts, are situated at least 5m from the foremost cargo tank and at least 10m measured horizontally from any cargo tank outlet or gas or vapour outlet; and b) the spaces are mechanically ventilated.	Zone 2

Table 2 : Hazardous areas classification for oil tankers carrying flammable liquids having a flash point exceeding 60°C unheated or heated to a temperature below and not within 15°C of their flash point

Spaces		Hazardous area
No.	Description	
1	Interior of cargo tanks, slop tanks, any pipework of pressure relief or other venting systems for cargo and slop tanks, pipes and equipment containing cargo.	Zone 2

APPENDIX 1 DEVICES TO PREVENT THE PASSAGE OF FLAME INTO THE CARGO TANKS

1 General

1.1 Application

1.1.1 *(1/4/2006)*

This Appendix is intended to cover the design, testing, location and maintenance of "devices to prevent the passage of flame into cargo tanks" (hereafter called "devices") of ships having the service notations **oil tanker ESP, oil tanker ESP CSR** or **combination carrier** carrying crude oil, petroleum products having a flashpoint of 60°C (closed cup test) or less and a Reid vapour pressure below atmospheric pressure, and other liquids with similar fire hazard. It also applies to ships having the service notation **FLS tanker** carrying flammable products having such a flashpoint.

1.1.2 *(1/4/2006)*

Ships having the service notations **oil tanker ESP**, **oil tanker ESP CSR**, **combination carrier** or **FLS tanker** and fitted with an inert gas system in accordance with Pt C, Ch 4, Sec 1, [9] are to be fitted with devices which comply with this Appendix, except that the tests specified in [4.2.3] and [4.3.3] are not required. Such devices are only to be fitted at openings unless they are tested in accordance with [4.4].

1.1.3 This Appendix is intended for devices protecting cargo tanks containing crude oil, petroleum products and flammable chemicals. In the case of the carriage of chemicals, the test media referred to in [4] can be used. However, devices for chemical tankers dedicated to the carriage of products with MESG less than 0,9 mm are to be tested with appropriate media.

Note 1: For MESG (Maximum Experimental Safe Gap) reference should be made to IEC - publication 79-1.

1.1.4 Devices are to be tested and located in accordance with this Appendix.

1.1.5 Devices are installed to protect:

a) openings designed to relieve pressure or vacuum caused by thermal variations (see Sec 4, [4.2.2], item a));

b) openings designed to relieve pressure or vacuum during cargo loading, ballasting or discharging (see Sec 4, [4.2.2], item b));

c) outlets designed for gas-freeing (see Sec 4, [4.3.3]).

1.1.6 Devices are not to be capable of being bypassed or blocked open unless they are tested in the bypassed or blocked open position in accordance with [4].

1.1.7 This Appendix does not include consideration of sources of ignition such as lightning discharges, since insufficient information is available to formulate equipment recommendations. All cargo handling, tank cleaning and ballasting operations are to be suspended on the approach of an electrical storm.

1.1.8 This Appendix is not intended to deal with the possibility of the passage of flame from one cargo tank to another on tankers with common venting systems.

1.1.9 When outlet openings of gas-freeing systems on tankers not fitted with inert gas systems are required to be protected with devices, they are to comply with this Appendix except that the tests specified in [4.2.3] and [4.3.3] are not required.

1.1.10 Certain of the tests prescribed in [4] of this Appendix are potentially hazardous, but no attempt is made in this Appendix to specify safety requirements for these tests.

1.2 Definitions

1.2.1 Premise

For the purpose of this Appendix, the definitions given in the following paragraphs are applicable.

1.2.2 Flame arrester

A flame arrester is a device to prevent the passage of flame in accordance with a specified performance standard. Its flame arresting element is based on the principle of quenching.

1.2.3 Flame screen

A flame screen is a device utilising wire mesh to prevent the passage of unconfined flames in accordance with a specified performance standard.

1.2.4 Flame speed

The flame speed is the speed at which a flame propagates along a pipe or other system.

1.2.5 Flashback

Flashback is the transmission of a flame through a device.

1.2.6 High velocity vent

A high velocity vent is a device to prevent the passage of flame consisting of a mechanical valve which adjusts the opening available for flow in accordance with the pressure at the inlet of the valve in such a way that the efflux velocity cannot be less than 30 m/s.

1.2.7 Pressure/vacuum valve

A pressure/vacuum valve is a device designed to maintain pressure and vacuum in a closed container within preset limits.

Note 1: Pressure/vacuum valves are devices to prevent the passage of flame when designed and tested in accordance with this Appendix.

1.3 Instruction manual

1.3.1 The manufacturer is to supply a copy of the instruction manual, which is to be kept on board the tanker and which is to include:

a) installation instructions

b) operating instructions

c) maintenance requirements, including cleaning (see [2.3.3])

d) a copy of the laboratory report referred to in [4.6]

e) flow test data, including flow rates under both positive and negative pressures, operating sensitivity, flow resistance and velocity.

2 Design of the devices

2.1 Principles

2.1.1 Depending on their service and location, devices are required to protect against the propagation of:

a) moving flames, and/or

b) stationary flames from pre-mixed gases after ignition of gases resulting from any cause.

2.1.2 When flammable gases from outlets ignite, the following four situations may occur:

a) at low gas velocities the flame may:

   1) flashback, or

   2) stabilise itself as if the outlet were a burner.

b) at high gas velocities, the flame may:

   1) burn at a distance above the outlet, or

   2) be blown out.

2.1.3 In order to prevent the passage of flame into a cargo tank, devices are to be capable of performing one or more of the following functions:

a) permitting the gas to pass through passages without flashback and without ignition of the gases on the protected side when the device is subjected to heating for a specified period;

b) maintaining an efflux velocity in excess of the flame speed for the gas irrespective of the geometric configuration of the device and without the ignition of gases on the protected side, when the device is subjected to heating for a specified period; and

c) preventing an influx of flame when conditions of vacuum occur within the cargo tanks.

2.2 Mechanical design

2.2.1 The casing or housing of devices is to meet similar standards of strength, heat resistance and corrosion resistance as the pipe to which it is attached.

2.2.2 The design of devices is to allow for ease of inspection and removal of internal elements for replacement, cleaning or repair.

2.2.3 All flat joints of the housing are to be machined true and are to provide an adequate metal-to-metal contact.

2.2.4 Flame arrester elements are to fit in the housing in such a way that flame cannot pass between the element and the housing.

2.2.5 Resilient seals may be installed only if their design is such that if the seals are partially or completely damaged or burned, the device is still capable of effectively preventing the passage of flame.

2.2.6 Devices are to allow for efficient drainage of moisture without impairing their efficiency to prevent the passage of flame.

2.2.7 The casing, flame arrester element and gasket materials are to be capable of withstanding the highest pressure and temperature to which the device may be exposed under both normal and specified fire test conditions.

2.2.8 End-of-line devices are to be so constructed as to direct the efflux vertically upwards.

2.2.9 Fastenings essential to the operation of the device, i.e. screws, etc., are to be protected against loosening.

2.2.10 Means are to be provided to check that any valve lifts easily without remaining in the open position.

2.2.11 Devices in which the flame arresting effect is achieved by the valve function and which are not equipped with flame arrester elements (e.g. high velocity valves) are to have a width of the contact area of the valve seat of at least 5 mm.

2.2.12 Devices are to be resistant to corrosion in accordance with [4.5.1].

2.2.13 Elements, gaskets and seals are to be of material resistant to both seawater and the cargoes carried.

2.2.14 The casing of the housing is to be capable of passing a hydrostatic pressure test, as required in [4.5.2].

2.2.15 In-line devices are to be able to withstand without damage or permanent deformation the internal pressure resulting from detonation when tested in accordance with [4.4].

2.2.16 A flame arrester element is to be designed to ensure quality control of manufacture to meet the characteristics of the prototype tested, in accordance with this Appendix.

2.3 Performance

2.3.1 Devices are to be tested in accordance with [4.5] and thereafter shown to meet the test requirements of [4.2] to [4.4], as appropriate.

Note 1: End-of-line devices which are intended for exclusive use at openings of inerted cargo tanks need not be tested against endurance burning as specified in [4.2.3].

Note 2: Where end-of-line devices are fitted with cowls, weather hoods and deflectors, etc., these attachments are to be fitted for the tests described in [4.2].

Note 3: When venting to atmosphere is not performed through an end-of-line device according to Note 2, or a detonation flame arrester according to [3.2.2], the in-line device is to be specifically tested with the inclusion of all pipes, tees, bends, cowls, weather hoods, etc., which may be fitted between the device and atmosphere. The testing is to consist of the flashback test in [4.2.2] and, if for the given installation it is possible for a stationary flame to rest on the device, the testing is also to include the endurance burning test in [4.2.3].

2.3.2 Performance characteristics such as the flow rates under both positive and negative pressure, operating sensitivity, flow resistance and velocity are to be demonstrated by appropriate tests.

2.3.3 Devices are to be designed and constructed to minimise the effect of fouling under normal operating conditions. Instructions on how to determine when cleaning is required and the method of cleaning are to be provided for each device in the manufacturer's instruction manual.

2.3.4 Devices are to be capable of operating in freezing conditions and if any device is provided with heating arrangements so that its surface temperature exceeds 85°C, then it is to be tested at the highest operating temperature.

2.3.5 Devices based upon maintaining a minimum velocity are to be capable of opening in such a way that a velocity of 30 m/s is immediately initiated, maintaining an efflux velocity of at least 30 m/s at all flow rates and, when the gas flow is interrupted, closing in such a way that this minimum velocity is maintained until the valve is fully closed.

2.3.6 In the case of high velocity vents, the possibility of inadvertent detrimental hammering leading to damage and/or failure is to be considered, with a view to eliminating it.

Note 1: Hammering is intended to mean a rapid full stroke opening/closing, not foreseen by the manufacturer during normal operations.

2.4 Flame screens

2.4.1 Flame screens are to be:

a) designed in such a manner that they cannot be inserted improperly in the opening

b) securely fitted in openings so that flames cannot circumvent the screen

c) able to meet the requirements of this Appendix. For flame screens fitted at vacuum inlets through which vapours cannot be vented, the test specified in [4.2.3] need not be complied with.

d) protected against mechanical damage.

2.5 Marking of devices

2.5.1 Each device is to be permanently marked, or have a permanently fixed tag made of stainless steel or other corrosion-resistant material, to indicate:

a) the manufacturer's name or trade mark

b) the style, type, model or other manufacturer's designation for the device

c) the size of the outlet for which the device is approved

d) the approved location for installation, including maximum or minimum length of pipe, if any, between the device and the atmosphere

e) the direction of flow through the device

f) the test laboratory and report number, and

g) compliance with the requirements of this Appendix.

3 Sizing, location and installation of devices

3.1 Sizing of devices

3.1.1 To determine the size of devices to avoid inadmissible pressure or vacuum in cargo tanks during loading or discharging, calculations of pressure losses are to be carried out.

The following parameters are to be taken into account:

a) loading/discharge rates

b) gas evolution

c) pressure loss through devices, taking into account the resistance coefficient

d) pressure loss in the vent piping system

e) pressure at which the vent opens if a high velocity valve is used

f) density of the saturated vapour/air mixture

g) possible fouling of a flame arrester; 70% of its rated performance is to be used in the pressure drop calculation of the installation.

3.2 Location and installation of devices

3.2.1 General

a) Devices are to be located at the vent outlets to atmosphere unless tested and approved for in-line installation.

b) Devices for in-line installation may not be fitted at the outlets to atmosphere unless they have also been tested and approved for that position.

3.2.2 Detonation flame arresters

Where detonation flame arresters are installed as in-line devices venting to atmosphere, they are be located at a sufficient distance from the open end of the pipeline so as to preclude the possibility of a stationary flame resting on the arrester.

3.2.3 Access to the devices

Means are to be provided to enable personnel to reach devices situated more than 2 m above deck to facilitate maintenance, repair and inspection.

4 Type test procedures

4.1 Principles

4.1.1 Tests are to be conducted by a laboratory acceptable to the Society.

4.1.2 Each size of each model is to be submitted for type testing. However, for flame arresters, testing may be limited to the smallest and the largest sizes and one additional size in between to be chosen by the Society. Devices are to have the same dimensions and most unfavourable clearances expected in the production model. If a test device is modified during the test program, the testing is to be restarted.

4.1.3 Tests described in this Article using gasoline vapours (a non-leaded petroleum distillate consisting essentially of aliphatic hydrocarbon compounds with a boiling range approximating 65°C - 75°C), technical hexane vapours or technical propane, as appropriate, are suitable for all devices protecting tanks containing a flammable atmosphere of the cargoes referred to in Sec 1, [1.1.1]. This does not preclude the use of gasoline vapours or technical hexane vapours for all tests referred to in this Article.

4.1.4 After the relevant tests, the device is not to show mechanical damage that affects its original performance.

4.1.5 Before the tests the following equipment, as appropriate, is to be properly calibrated:

a) gas concentration meters

b) thermometers

c) flow meters

d) pressure meters, and

e) time recording devices.

4.1.6 The following characteristics are to be recorded, as appropriate, throughout the tests:

a) concentration of fuel in the gas mixture

b) temperature of the test gas mixture at inflow of the device, and

c) flow rates of the test gas mixtures when applicable.

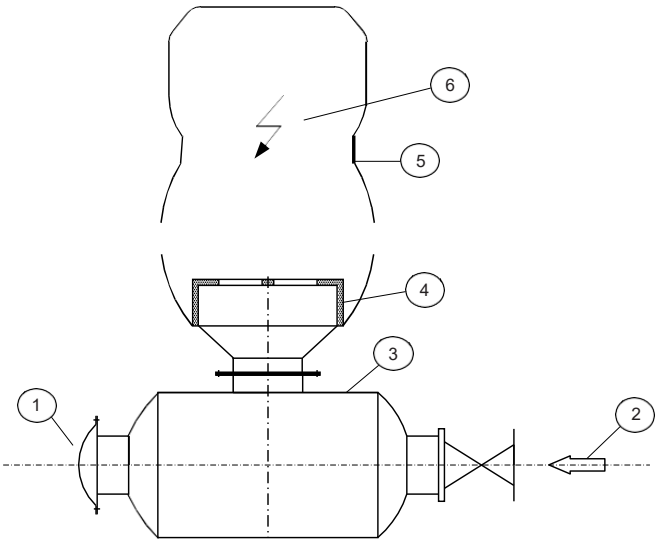
4.1.7 Flame passage is to be observed by recording, e.g. temperature, pressure, or light emission, by suitable sensors on the protected side of the device; alternatively, flame passage may be recorded on video tape.

4.2 Test procedure for flame arresters located at openings to the atmosphere

4.2.1 Test rig

The test rig is to consist of an apparatus producing an explosive mixture, a small tank with a diaphragm, a flanged prototype of the flame arrester, a plastic bag and a firing source in three positions (see Fig 1). Other test rigs may be used, provided the tests referred to in this Article are carried out to the satisfaction of the Society.

Figure 1 : Test rig for flashback test



(1): Plastic bursting diaphragm

(2): Explosive mixture inlet

(3) : Tank

(4) : Flame arresting device

(5): Plastic bag

(6): Ignition source

Note 1: The dimensions of the plastic bag are dependent on those of the flame arrester, but for flame arresters normally used on tankers the plastic bag may have a circumference of 2 m, a length of 2,5 m and a wall thickness of 0,05 mm.

Note 2: In order to avoid remnants of the plastic bag from falling back on to the device being tested after ignition of the fuel/air mixture, it may be useful to mount a coarse wire frame across the device within the plastic bag. The frame is to be so constructed as not to interfere with the test result.

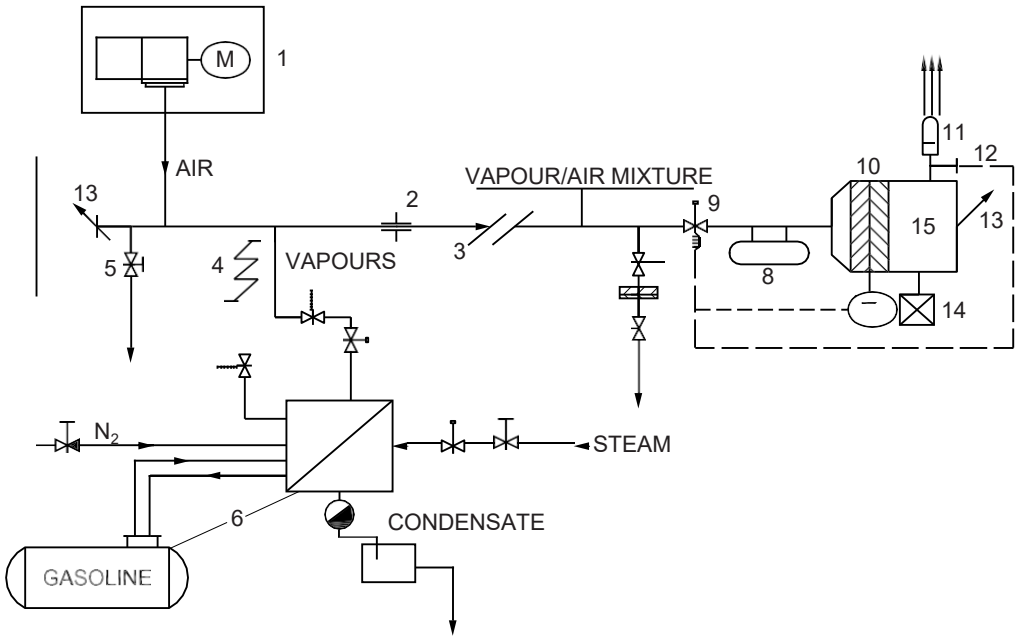
4.2.2 Flashback test

A flashback test is to be carried out as follows:

a) The tank, flame arrester assembly and the plastic bag (see [4.2.1]) enveloping the prototype flame arrester are to be filled so that this volume contains the most easily ignitable propane/air mixture (see IEC Publication 79/1). The concentration of the mixture is to be verified by appropriate testing of the gas composition in the plastic bag. Where devices referred to in [2.3.1], Note 3 are tested, the plastic bag is to be fitted at the outlet to atmosphere. Three ignition sources are to be installed along the axis of the bag, one close to the flame arrester, another as far away as possible therefrom, and the third at the mid-point between these two. These three sources are to be fired in succession, twice in each of the three positions. The temperature of the test gas is to be within the range of 15°C to 40°C.

b) If a flashback occurs, the tank diaphragm will burst and this will be audible and visible to the operator by the emission of a flame. Flame, heat and pressure sensors may be used as an alternative to a bursting diaphragm.

Figure 2 : Schematic Plan of the Test Plant for High Velocity Valves (endurance burning test only)



(1): Fan with variable speed

(2): Volume rate indicator

(3): Pipe (diameter=500 mm, length=30 m)

(4): Heated vapour pipe

(5) : Air bypass

(6) : Evaporator and gasoline storage tank

(7): Vapour/air mixture bypass

(8) : Extinguishing agents

(9) : Automatic control and quick action stop valve

(10) : Explosion arresting crimped ribbon with temperature sensors for the safety of the test rig

(11): High velocity valve to be tested

(12) : Flame detector

(13) : Bursting diaphragm

(14) : Concentration indicator

(15) : Tank

4.2.3 Endurance burning test

An endurance burning test is to be carried out, in addition to the flashback test, for flame arresters at outlets where flows of explosive vapour are foreseeable:

a) The test rig as referred to in [4.2.1] may be used, without the plastic bag. The flame arrester is to be so installed that the mixture emission is vertical. In this position the mixture is to be ignited. Where devices referred to in [2.3.1] Note 3, are tested, the flame arrester is to be so installed as to reflect its final orientation.

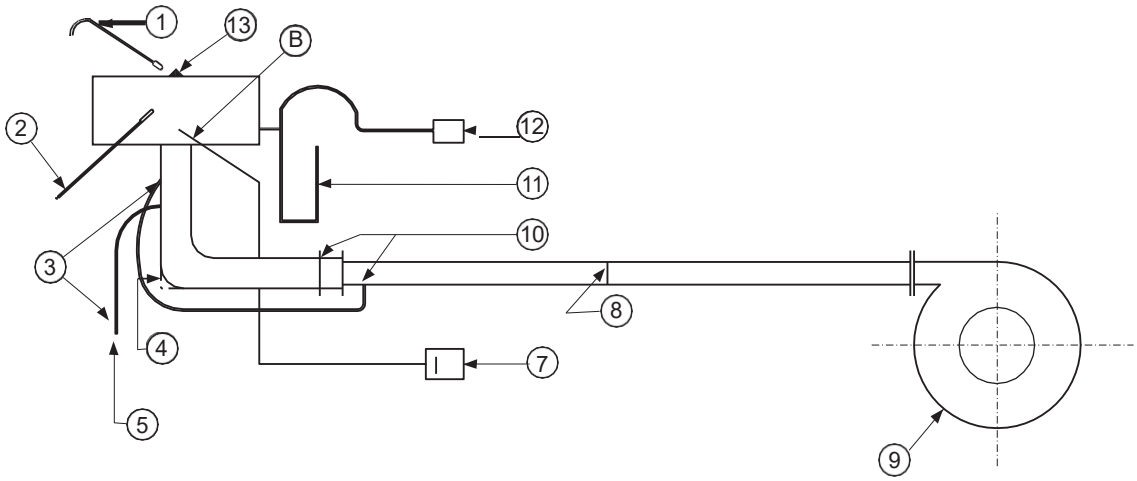
b) Endurance burning is to be achieved by using the most easily ignitable gasoline vapour/air mixture or the most easily ignitable technical hexane vapour/air mixture with the aid of a continuously operated pilot flame or a continuously operated spark igniter at the outlet. The test gas is be introduced upstream of the tank shown in Fig 1. Maintaining the concentration of the mixture as specified above, by varying the flow rate, the flame arrester is to be heated until the highest obtainable temperature on the cargo tank side of the arrester is reached. Temperatures are to be measured, for example, at the protected side of the flame quenching matrix of the arrester (or at the seat of the valve in the case of testing high velocity vents according to [4.3]). The highest obtainable temperature may be considered to have been reached when the rate of rise of temperature does not exceed 0,5°C per minute over a ten-minute period. This temperature is to be maintained for a period of ten minutes, after which the flow is to be stopped and the conditions observed. The temperature of the test gas is to be within the range of 15°C to 40°C.

   If no temperature rise occurs at all, the arrester is to be inspected for a more adequate position of the temperature sensor, taking account of the visually registered position of the stabilised flame during the first test sequence. Positions which require the drilling of small holes into fixed parts of the arrester are to be taken into account. If all

this is not successful, the temperature sensor is to be affixed at the unprotected side of the arrester in a position near to the stabilised flame.

If difficulties arise in establishing stationary temperature conditions (at elevated temperatures), the following criterion is to apply: using the flow rate which produced the maximum temperature during the foregoing test sequence, endurance burning is to be continued for a period of two hours from the time the above-mentioned flow rate has been established. After that period the flow is to be stopped and the conditions observed. Flashback is not to occur during this test.

Figure 3 : Test Rig for High Velocity Vents



(1) : Primary igniter
(2) : Secondary igniter
(3) : Cocks
(4) : Explosion door
(5) : Gas supply
(6) : Flashback detector
(7) : Chart recorder
(8) : Flow meter
(9) : Fan
(10) : Spade blank and bypass line for low rates
(11): Pressure gauge
(12) : Gas analyser
(13) : High velocity vent to be tested

4.2.4 Pressure/vacuum valve integrated to a flame arresting device

When a pressure/vacuum valve is integrated to a flame arresting device, the flashback test is to be performed with the pressure/ vacuum valve blocked open. If there are no additional flame quenching elements integrated in a pressure valve, this valve is to be considered and tested as a high velocity vent valve according to [4.3].

4.3 Test procedures for high velocity vents

4.3.1 Test rig

The test rig is to be capable of producing the required volume flow rate. In Fig 2 and Fig 3 drawings of suitable test rigs are shown. Other test rigs may be used provided the tests are performed to the satisfaction of the Society.

4.3.2 Flow condition test

A flow condition test is to be carried out with high velocity vents using compressed air or gas at agreed flow rates. The following are to be recorded:

a) the flow rate; where air or a gas other than vapours of cargoes with which the vent is to be used is employed in the test, the flow rates achieved are to be corrected to reflect the vapour density of such cargoes

b) the pressure before the vent opens; the pressure in the test tank on which the device is located is not to rise at a rate greater than 0,01 MPa/min

c) the pressure at which the vent opens

d) the pressure at which the vent closes

e) the efflux velocity at the outlet which is not to be less than 30 m/s at any time when the valve is open.

4.3.3 Fire safety tests

The following fire safety tests are to be conducted while adhering to [2.3.6] using a mixture of gasoline vapour and air or technical hexane vapour and air, which produces the most easily ignitable mixture at the point of ignition. This mixture is to be ignited with the aid of a permanent pilot flame or a spark igniter at the outlet.

a) Flashback tests in which propane may be used instead of gasoline or hexane are to be carried out with the vent in the upright position and then inclined at 10° from the vertical. For some vent designs further tests with the vent inclined in more than one direction may be necessary. In each of these tests the flow is to be reduced until the vent closes and the flame is extinguished, and each is to be carried out at least 50 times. The vacuum side of combined valves is to be tested in accordance with [4.2.2] with the vacuum valve maintained in the open position for the duration of this test, in order to verify the efficiency of the device which is to be fitted.

b) An endurance burning test, as described in [4.2.3], is to be carried out. Following this test, the main flame is to be extinguished and then, with the pilot flame burning or the spark igniter discharging, small quantities of the most easily ignitable mixture are to be allowed to escape for a period of ten minutes maintaining a pressure below the valve of 90% of the valve opening setting, during which time flashback is not to occur. For the purpose of this test the soft seals or seats are to be removed.

4.4 Test rig and test procedures for detonation flame arresters located in-line

4.4.1 A flame arrester is to be installed at one end of a pipe of suitable length and of the same diameter as the flange of the flame arrester. On the opposed flange a pipe of a length corresponding to 10 pipe diameters is to be affixed and closed by a plastic bag or diaphragm. The pipe is to be filled with the most easily ignitable mixture of propane and air, which is then to be ignited. The velocity of the flame near the flame arrester is to be measured and is to have the same value as that for stable detonations.

Note 1: The dimensions of the plastic bag are to be at least 4 m circumference, 4 m length and a material wall thickness of 0,05 mm.

4.4.2 Three detonation tests are to be conducted, no flashback is to occur through the device and no part of the flame arrester is to be damaged or show permanent deformation.

4.4.3 Other test rigs may be used provided the tests are carried out to the satisfaction of the Society. A drawing of the test rig is shown in Fig 4.

4.5 Operational test procedure

4.5.1 Corrosion test

A corrosion test is to be carried out. In this test a complete device, including a section of the pipe to which it is fitted, is to be exposed to a 5% sodium chloride solution spray at a temperature of 25°C for a period of 240 hours, and allowed to dry for 48 hours. An equivalent test may be conducted to the satisfaction of the Society. Following this test, all movable parts are to operate properly and there are to be no corrosion deposits which cannot be washed off.

4.5.2 Hydraulic pressure test

A hydraulic pressure test is to be carried out in the casing or housing of a sample device, in accordance with [2.2.15].

4.6 Laboratory report

4.6.1 The laboratory report is to include:

a) detailed drawings of the device

b) types of tests conducted; where in-line devices are tested, this information is to include the maximum pressures and velocities observed in the test

c) specific advice on approved attachments

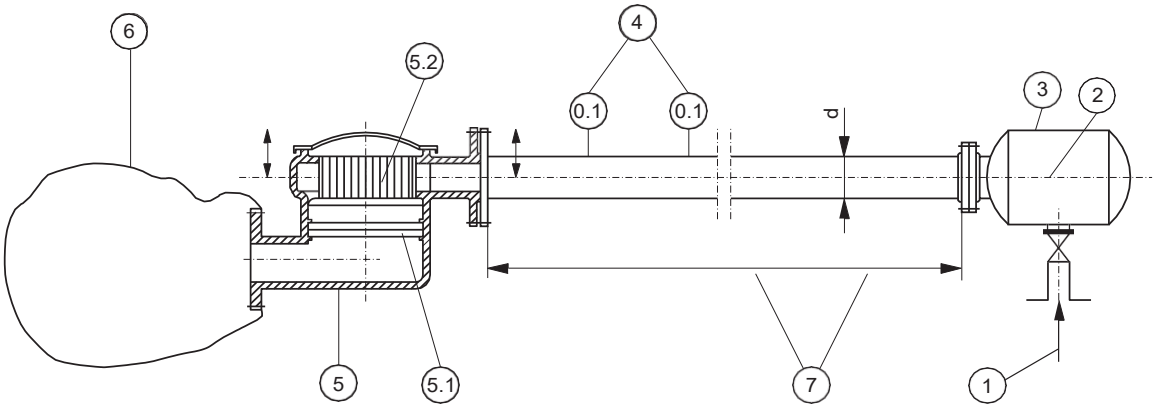
d) types of cargo for which the device is approved

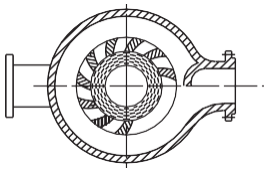
e) drawings of the test rig

f) in the case of high velocity vents, the pressures at which the device opens and closes and the efflux velocity, and

g) all the information marked on the device in [2.5].

Figure 4 : Test Rig for Arresters Located In-Line





SECTION A-A

(1) : Explosive mixture inlet
(2) : Ignition source; ignition within non-streaming mixture
(3): Tank
(4) : Measuring system for flame speed of a stable detonation
(5) : Flame arrester located in-line; (5.1): Flame arrester element; (5.2): Shock wave absorber
(6): Plastic bag
(7): l/d = 100

APPENDIX 2 DESIGN OF CRUDE OIL WASHING SYSTEMS

1 General

1.1 Application

1.1.1 *(1/4/2006)*
This Appendix applies to ships having the notation **oil tanker ESP** or **oil tanker ESP CSR** in the conditions stated in Sec 4, [4.6.1].

1.2 Definitions

1.2.1 Arrival ballast
For the purpose of this Appendix, “arrival ballast” means clean ballast as defined in Sec 1, [1.3.5].

1.2.2 Departure ballast
For the purpose of this Appendix, “departure ballast” means ballast other than arrival ballast.

1.3 Operations and Equipment Manual

1.3.1 The Operations and Equipment Manual of the crude oil washing system is to be submitted to the Society for information. It is to contain at least the following information:

a) line drawing of the crude oil washing system showing the respective position of pumps, lines and washing machines which relate to the crude oil washing system

b) a description of the system and a listing of procedures for checking that equipment is working properly during crude oil washing operations. This is to include a listing of the system and equipment parameters to be monitored, such as line pressure, oxygen level, machine revolutions, duration of cycles, etc. The established values for these parameters are to be included. The results of the tests carried out in accordance with [3.3] and the values of all parameters monitored during such tests are also to be included.

c) other information referred to in [2.1.8], [2.2.2], [2.3.2], [2.3.5], [2.4.3] and [3.3.1].

2 Design and installation

2.1 Piping

2.1.1 The crude oil washing pipes and all valves incorporated in the supply piping system are to be of steel or other equivalent material, of adequate strength having regard to the pressure to which they may be subjected, and properly jointed and supported.

Note 1: Grey cast iron may be permitted in the supply system for crude oil washing systems when complying with nationally approved standards.

2.1.2 The crude oil washing system is to consist of permanent pipework and is to be independent of the fire mains and of any system other than for tank washing except that sections of the ship’s cargo system may be incorporated into the crude oil washing system provided that they meet the requirements applicable to crude oil pipework. Notwithstanding the above requirements, in combination carriers the following arrangements may be allowed:

a) the removal of the equipment, if necessary, when carrying cargoes other than crude oil, provided that, when reinstated, the system is as originally fitted and tested for oil-tightness

b) the use of flexible hose pipes to connect the crude oil washing system to tank washing machines if it is necessary to locate these machines in a cargo tank hatch cover. Such flexible hose pipes are to be provided with flanged connections, manufactured and tested in accordance with standards acceptable to the Society, and consistent with the duties the hoses are required to perform. The length of these hoses is not to be greater than necessary to connect the tank washing machines to an adjacent point just outside the hatch coaming. The hoses are to be removed to a suitably prepared and protected stowage location when not in use.

2.1.3 Provisions are to be made to prevent overpressure in the tank washing supply piping. Any relief device fitted to prevent overpressure is to discharge into the suction side of the supply pump. Alternative methods to the satisfaction of the Society may be accepted provided an equivalent degree of safety and environmental protection is provided.

Note 1: Where the system is served only by centrifugal pumps so designed that the pressure derived cannot exceed that for which the piping is designed, a temperature sensing device located in the pump casing is required to stop the pump in the case of overheating.

2.1.4 Where hydrant valves are fitted for water washing purposes on tank washing lines, all such valves are to be of adequate strength and provisions are to be made for such connections to be blanked off by blank flanges when washing lines may contain crude oil. Alternatively, hydrant valves are to be isolated from the crude oil washing system by spade blanks.

2.1.5 All connections for pressure gauges or other instrumentation are to be provided with isolating valves adjacent to the lines unless the fitting is of the sealed type.

2.1.6 No part of the crude oil washing system is to enter machinery spaces. Where the tank washing system is fitted with a steam heater for use when water washing, the heater is to be located outside machinery spaces and effectively isolated during crude oil washing by double shut-off valves or by clearly identifiable blanks.

2.1.7 Where combined crude oil-water washing supply piping is provided, the piping is to be so designed that it can be drained so far as practicable of crude oil, before water washing is commenced, into designated spaces. These spaces may be the slop tank or other cargo spaces.

2.1.8 The piping system is to be of such diameter that the greatest number of tank cleaning machines required, as specified in the Operations and Equipment Manual, can be operated simultaneously at the designed pressure and throughput. The arrangement of the piping is to be such that the required number of tank cleaning machines for each cargo compartment as specified in the Operations and Equipment Manual can be operated simultaneously.

2.1.9 The crude oil washing supply piping is to be anchored (firmly attached) to the ship's structure at appropriate locations, and means are to be provided to permit freedom of movement elsewhere to accommodate thermal expansion and flexing of the ship. The anchoring is to be such that any hydraulic shock can be absorbed without undue movement of the supply piping. The anchors are normally to be situated at the ends furthest from the entry of the crude oil supply to the supply piping. If tank washing machines are used to anchor the ends of branch pipes then special arrangements are necessary to anchor these sections when the machines are removed for any reason.

2.2 Tank washing machines

2.2.1 Tank washing machines for crude oil washing are to be permanently mounted and of a design acceptable to the Society.

2.2.2 The performance characteristic of a tank washing machine is governed by nozzle diameter, working pressure and the movement pattern and timing. Each tank cleaning machine fitted is to have a characteristic such that the sections of the cargo tank covered by that machine will be effectively cleaned within the time specified in the Operations and Equipment Manual.

2.2.3 Tank washing machines are to be mounted in each cargo tank and the method of support is to be to the satisfaction of the Society. Where a machine is positioned well below the deck level to cater for protuberances in the tank, consideration may need to be given to additional support for the machine and its supply piping.

2.2.4 Each machine is to be capable of being isolated by means of stop valves in the supply line. If a deck mounted tank washing machine is removed for any reason, provision is to be made to blank off the oil supply line to the machine for the period the machine is removed. Similarly, provision is to be made to close the tank opening with a plate or equivalent means.

Note 1: Where more than one submerged machine is connected to the same supply line, a single isolating stop valve in the supply line may be acceptable provided the rotation of the submerged machine can be verified in accordance with [2.2.10]

2.2.5 The number and location of tank washing machines are to be to the satisfaction of the Society.

2.2.6 The location of the machines is dependent upon the characteristics detailed in [2.2.2] and upon the configuration of the internal structure of the tank.

2.2.7 The number and location of the machines in each cargo tank are to be such that all horizontal and vertical areas are washed by direct impingement or effectively by deflection or splashing of the impinging jet. In assessing an

acceptable degree of jet deflection and splashing, particular attention is to be paid to the washing of upward facing horizontal areas and the following parameters are to be used:

a) For horizontal areas of a tank bottom and the upper surfaces of a tank's stringers and other large primary structural members, the total area shielded from direct impingement by deck or bottom transverses, main girders, stringers or similar large primary structural members is not to exceed 10 per cent of the horizontal area of the tank bottom, the upper surface of stringers, and other large primary structural members.

b) For vertical areas of the sides of a tank, the total area of the tank's sides shielded from direct impingement by deck or bottom transverses, main girders, stringers or similar large primary structural members is not to exceed 15 per cent of the total area of the tank's sides.

In some installations, it may be necessary to consider the fitting of more than one type of tank washing machine in order to effect adequate coverage.

Note 1: With regard to the application of this requirement, a slop tank is considered as a cargo tank.

2.2.8 At the design stage the following minimum procedures are to be used to determine the area of the tank surface covered by direct impingement:

a) Using suitable structural plans, lines are set out from the tips of each machine to those parts of the tank within the range of the jets.

b) Where the configuration of the tanks is considered by the Society to be complicated, a pinpoint of light simulating the tip of the tank washing machine in a scale model of the tank is to be used.

2.2.9 The design of the deck mounted tank washing machines is to be such that means are provided external to cargo tanks which, when crude oil washing is in progress, would indicate the rotation and arc of the movement of the machine. Where the deck mounted machine is of the non-programmable, dual nozzle type, alternative methods to the satisfaction of the Society may be accepted provided an equivalent degree of verification is attained.

2.2.10 Where submerged machines are required, they are to be non-programmable and, in order to comply with the requirements of [2.2.7], it is to be possible to verify their rotation by one of the following methods:

a) by indicators external to the tanks

b) by checking the characteristic sound pattern of the machine, in which case the operation of the machine is to be verified towards the end of each wash cycle. Where two or more submerged machines are installed on the same supply line, valves are to be provided and arranged so that the operation of each machine can be verified independently of other machines on the same supply line.

c) by gas freeing the tank and checking the operation of the machine with water during ballast voyages.

2.3 Pumps

2.3.1 Pumps supplying crude oil to tank cleaning machines are to be either the cargo pumps or pumps specifically provided for the purpose.

2.3.2 The capacity of the pumps is to be sufficient to provide the necessary throughput at the required pressure for the maximum number of tank cleaning machines required to be operated simultaneously as specified in the Operations and Equipment Manual. In addition to the above requirement, if an eductor system is fitted for tank stripping, the pumps are to be capable of supplying the eductor driving fluid to meet the provisions of [2.4.2].

2.3.3 The capacity of the pumps is to be such that the requirements of [2.3.2] can be met with any one pump inoperative. The pumping and piping arrangements are to be such that the crude oil washing system can be effectively operated with any one pump out of use.

2.3.4 The carriage of more than one grade of cargo is not to prevent crude oil washing of tanks.

2.3.5 To permit crude oil washing to be effectively carried out where the back pressure presented by the shore terminal is below the pressure required for crude oil washing, provision is to be made such that an adequate pressure to the washing machines can be maintained in accordance with [2.3.2]. This requirement is to be met with any one cargo pump out of action. The minimum supply pressure required for crude oil washing is to be specified in the Operations and Equipment Manual. Should this minimum supply pressure not be obtainable, crude oil washing operations are not to be carried out.

2.4 Stripping system

2.4.1 The design of the system for stripping crude oil from the bottom of every cargo tank is to be to the satisfaction of the Society.

2.4.2 The design and capacity of the tank stripping system are to be such that the bottom of the tank being cleaned is kept free of accumulations of oil and sediment towards completion of the tank washing process.

2.4.3 The stripping system is to be at least 1,25 times the total throughput of all the tank cleaning machines to be operated simultaneously when washing the bottom of the cargo tanks as described in the ship's Operations and Equipment Manual.

2.4.4 Means such as level gauges, hand dipping and stripping system performance gauges as referred to in [2.4.8] are to be provided for checking that the bottom of every cargo tank is dry after crude oil washing. Suitable arrangements for hand dipping are to be provided at the aftermost portion of a cargo tank and in three other suitable locations unless other approved means are fitted for efficiently ascertaining that the bottom of every cargo tank is dry. For the purpose of this paragraph, the cargo tank bottom is to be considered "dry" if there is no more than a small quantity of oil near the stripping suction with no accumulation of oil elsewhere in the tank.

2.4.5 Means are to be provided to drain all cargo pumps and lines at the completion of cargo discharge, where necessary, by connection to a stripping device. The line and pump draining is to be capable of being discharged both to a cargo tank and ashore. For discharge ashore, a special small diameter line is to be provided for this purpose and connected outboard of the ship's manifold valve. The cross-sectional area of this line is not to exceed 10 per cent of that of a main cargo discharge line.

Note 1: In crude oil tankers having individual cargo pumps in each tank, each pump having an individual piping system, dispensation from the required special small diameter line may be granted in cases where the combined amount of oil left in the tank after stripping and the volume of oil in the piping system from the manifold to the tank is less than 0,00085 times the volume of the cargo tank. The above consideration is also to apply if a deepwell cargo pump system is provided with an evacuating system for retained oil.

2.4.6 The means for stripping oil from cargo tanks are to be a positive displacement pump, self-priming centrifugal pump or eductor or other methods to the satisfaction of the Society. Where a stripping line is connected to a number of tanks, means are to be provided for isolating each tank not being stripped at that particular time.

2.4.7 The carriage of more than one grade of cargo is not to prevent crude oil washing of tanks.

2.4.8 Equipment is to be provided for monitoring the efficiency of the stripping system. All such equipment is to have remote read out facilities in the cargo control room or in some other safe and convenient place easily accessible to the officer in charge of cargo and crude oil washing operations. Where a stripping pump is provided, the monitoring equipment is to include either a flow indicator, or a stroke counter or revolution counter as appropriate, and pressure gauges at the inlet and discharge connections of the pump or equivalent. Where eductors are provided, the monitoring equipment is to include pressure gauges at the driving fluid intake and at the discharge and a pressure/vacuum gauge at the suction intake.

2.4.9 The internal structure of the tank is to be such that drainage of oil to the tank suctions of the stripping system is adequate to meet the requirements of [2.4.2] and [2.4.4].

2.5 Ballast lines

2.5.1 Where a separate ballast water system for ballasting cargo tanks is not provided, the arrangement is to be such that the cargo pump, manifolds and pipes used for ballasting can be safely and effectively drained of oil before ballasting.

3 Inspection and testing

3.1 Initial survey

3.1.1 The initial survey required in Sec 4, [6.3.2] is to include a complete inspection of the crude oil washing equipment and arrangements and, except for the cases specified in [3.3.3], an examination of the tanks after they have been crude oil washed and the additional checks specified in [3.3.1] and [3.3.2] to ensure that the washing system efficiency is in accordance with this Appendix.

3.2 Piping

3.2.1 The piping system is to be tested to one and a half times the working pressure after it has been installed on the ship.

3.3 Tank washing machines

3.3.1 To confirm the cleanliness of the tank and to verify the design in respect of the number and location of the tank washing machines, a visual inspection is to be made by entry to the tanks after a crude oil wash but prior to any water rinse which may be specified in the Operations and Equipment Manual. The bottom of the tank to be inspected may, however, be flushed with water and stripped in order to remove any wedge of liquid crude oil remaining on the tank bottom before gas freeing for entry. This inspection is to ensure that the tank is essentially free of oil clingage and deposits. If the flushing procedure is adopted, a similar but unflushed tank is to be used for the test specified in [3.3.2] below.

3.3.2 To verify the effectiveness of the stripping and drainage arrangements, a measurement is to be made of the amount of oil floating on top of the departure ballast. The ratio of the volume of oil on top of the departure ballast water to the volume of tanks that contain this water is not to exceed 0,00085. This test is to be carried out after crude oil washing and stripping in a tank similar in all relevant respects to the tank examined in accordance with [3.3.1] above, which has not been subjected to a water rinse or to the intervening water flushing permissible in [3.3.1] above.

3.3.3 When the Society is satisfied that ships are similar in all relevant respects, the provisions of [3.3.1] and [3.3.2] need only be applied to one such ship. Furthermore, where a ship has a series of tanks that are similar in all relevant respects then, for that series of tanks, the requirements of [3.3.1] need only be applied to one tank of that series.

3.4 Stripping system

3.4.1 Care is to be taken that both longitudinal and transverse drainage are satisfactory. Drainage is to be verified during the inspection required by [3.3].

APPENDIX 3 LIST OF OILS

1 Application

1.1 List of oils

1.1.1 *(1/7/2011)*
The list of oils given in Appendix 1 of Annex I of the MARPOL 73/78 Convention, except that naphtha solvent is, in the opinion of the Society, to be considered as a chemical to which Chapter 8 applies, includes the oils the carriage in bulk of which is covered by the service notations:

- **oil tanker**
- **oil tanker ESP**
- **oil tanker ESP, flash point >60°C**
- **oil tanker ESP CSR**
- **oil tanker ESP CSR, flash point >60°C**
- **asphalt tanker**
- **asphalt tanker ESP**.

under the provisions of Sec 1, [1.1.1].

APPENDIX 4 LIST OF "EASY CHEMICALS"

1 Application

1.1 Scope of the list of easy chemicals

1.1.1 The list set out in this Appendix includes all chemical products to which the IBC Code does not apply. Such products, referred to as "easy chemicals", are allowed to be carried by ships having the service notation **FLS tanker** or, where their flashpoint is above 60 °C, also by ships having the service notation **FLS tanker flash point > 60 °C**.

Where indicated in the list, some products are also allowed to be carried by ships having the service notation **tanker**.

1.2 Safety and pollution hazards

1.2.1 *(1/1/2009)*

a) The following are products, which have been reviewed for their safety and pollution hazards and determined not to present hazards to such an extent as to warrant application of the IBC *Code.*

b) Although the products listed in this chapter fall outside the scope of the IBC *Code, the attention is drawn to the fact that some safety precautions may be needed for their safe transportation. Accordingly, shall prescribe appropriate safety requirements.*

c) Some liquid substances are identified as falling into Pollution Category Z and, therefore, subject to certain requirements of Annex II of MARPOL 73/78.

d) Liquid mixtures which are assessed or provisionally assessed under regulation 6.3 of MARPOL Annex II as falling into Pollution Category Z or OS, and which do not present safety hazards, may be carried under the appropriate entry in this Appendix for Noxious or Non-Noxious Liquid Substances, not otherwise specified (n.o.s.).

e) The substances identified as falling into pollution category III are not subject to any requirements of Annex II of MARPOL 73/78 in particular in respect of:

- the discharge of bilge or ballast water or other residues or mixtures containing only such substances
- the discharge into the sea of clean ballast or segregated ballast.

2 List of "easy chemicals"

2.1 List, symbols and notations

2.1.1 The list of "easy chemicals" is given in Tab 1. The relevant symbols and notations used in Tab 1 are given in Tab 2.

Table 1 : List of easy chemicals *(1/1/2007)*

Product name	UN number	Pollution category	Tank vents	Elec. eqpt temp. class	Elec. eqpt apparatus group	Flash point (°C)	Gauging	Vapour detection	Fire protection	High level alarm	Chem. family	Density (t/m^3)	Melting point (°C)	Service notation
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
Acetone	1090	Z	Cont	T1	IIA	-18	R	F	A	Y	18	0,79	-	FLS
Alcoholic beverages, not otherwise specified.	3065	Z	Cont	-	-	20 to 60 **(1)**	R	F	A	Y	-	1,00	-	FLS
Apple juice	-	OS	Open	-	-	NF	O	-	-	N	-	1,00	-	T
n-Butyl alcohol	1120	Z	Cont	T2	IIA	29	R	F	A	Y	20	0,81	-	FLS
sec-Butyl alcohol	1120	Z	Cont	T2	IIA	24	R	F	A	Y	20	0,81	-	FLS
Clay slurry	-	OS	Open	-	-	NF	O	-	-	N	-	1,50	-	T
Coal slurry	-	OS	Open	-	-	NF	O	-	A, B	N	-	1,50	-	T
Diethylene glycol	-	Z	Open	T3	IIB	>60	O	-	A	N	40	1,12	-	FLS>60
Ethyl alcohol	1170	Z	Cont	T2	IIA	13	R	F	A	Y	20	0,79	-	FLS
Ethylene carbonate	-	Z	Open	T2	-	>60	O	-	A	N	-	1,32	36	FLS>60
Glucose solution	-	OS	Open	-	-	NF	O	-	-	N	-	1,50	-	T
Glycerine	-	Z	Open	T2	IIA	>60	O	-	A	N	20	1,26	18	FLS>60
Glycerol monooleate	-	Z	-	-	-	-	-	-	-	-	-	-	-	-
Hexamethylenetetramine solutions	-	Z	Open	-	-	NF	O	-	-	N	7	1,50	-	T
Hexylene glycol	-	Z	Open	T2	IIA	>60	O	-	B, C	N	20	0,92	-	FLS>60
Isopropyl alcohol	1219	Z	Cont			22	R	F	A	Y	20	0,78	-	FLS
Kaolin slurry	-	OS	Open			NF	O	-	-	N	43	1,50	-	T
Magnesium hydroxide slurry	-	Z	Open	-	-	NF	O	-	-	N	-	1,23	-	T
Methyl propyl ketone	-	Z	Cont	-	-	<60	R	F	A	Y	18	0,82	-	FLS
N-Methylglucamine solution (70% or less)	-	Z	-	-	-	-	-	-	-	-	-	-	-	-
Molasses	-	OS	Open	-	-	>60	O	-	A	N	20	1,45	-	FLS>60
Noxious liquid (11), not otherwise specified, Cat. Z	-	Z	Cont	-	-	<60	R	F	A	Y	-	1,00	-	FLS
Non-noxious liquid (12), not otherwise specified, Cat. OS	-	OS	Cont	-	-	<60	R	F	A	Y	-	1,00	-	FLS
Polyaluminium chloride solution	-	Z	Open	-	-	NF	O	-	-	N	-	1,25	-	T

Product name	UN number	Pollution category	Tank vents	Elec. eqpt temp. class	Elec. eqpt apparatus group	Flash point (°C)	Gauging	Vapour detection	Fire protection	High level alarm	Chem. family	Density (t/m^3)	Melting point (°C)	Service notation
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
Potassium formate solutions	-	Z	-	-	-	-	-	-	-	-	-	-	-	-
Propylene carbonate	-	Z	-	-	-	-	-	-	-	-	-	-	-	-
Propylene glycol	-	Z	Open	T2	IIA	>60	O	-	A	N	20	1,03	-	FLS>60
Sodium acetate solutions	-	Z	Open	-	-	NF	O	-	-	N	-	1,45	-	T
Sodium sulphate solutions	-	Z	Open	-	-	NF	O	-	-	N	-	1,45	-	T
Tetraethylene glycol	-	Z	Open	-	-	>60	O	-	A	N	40	1,50	-	FLS>60
Tetraethyl silicate monomer/oligomer (20% in ethanol)	-	Z	-	-	-	-	-	-	-	-	-	-	-	-
Water	-	OS	Open	-	-	NF	O	-	-	N	-	1,00	-	T

(1) Composition dependent.
(2) Isomer dependent.
(3) Flashpoint not determined by a closed-cup method.
(4) Depends on acetate content.

Table 2 : Symbols and notations used in the list of easy chemicals

Items	Col.	Comments
Product name	(a)	Gives the alphabetical name of the products.
UN number	(b)	The number relating to each product shown in the recommendations proposed by the United Nations Committee of Experts on the Transport of Dangerous Goods. UN numbers, where available, are given for information only.
Pollution category	(c)	The letter Z refers to the pollution category Z as defined in Annex II of MARPOL 73/78. The symbol OS means that the product was evaluated and found to fall outside the pollution categories X, Y and Z defined in Annex II of MARPOL 73/78.
Tank vents	(d)	
Electrical equipment temperature class	(e)	The symbols T1 to T6 refer to the electrical equipment temperature classes defined in IEC Publication 79-0.
Electrical equipment apparatus group	(f)	The symbols IIA and IIB refer to the electrical equipment apparatus groups defined in IEC Publication 79-0.
Flashpoint	(g)	
Gauging	(h)	
Vapour detection	(i)	
Fire protection	(j)	The letters A, B, C and D refer to the following fire-extinguishing media determined to be effective for certain products: A : alcohol-resistant foam (or multi-purpose foam) B : regular foam, encompasses all foams that are not of an alcohol-resistant type, including fluoro-protein and aqueous-film-forming foam (AFFF) C : water spray D : dry chemical (powder).
High level alarm	(k)	
Chemical family	(l)	
Density	(m)	
Melting point	(n)	
Service notation	(o)	The symbols FLS, FLS>60 and T are defined as follows: FLS : means that the product is allowed to be carried by a ship having the service notation **FLS tanker** FLS>60: means that the product is allowed to be carried by a ship having the service notation **FLS tanker**, **flash point > 60°C**, T : means that the product is allowed to be carried by a ship having the service notation **tanker**.

Chapter 8
CHEMICAL TANKERS

SECTION 1 GENERAL

1 Scope

1.1 Application

1.1.1 Chemical tankers *(1/4/2025)*

The **chemical tanker** service notation, in accordance with Pt A, Ch 1, Sec 2, [4.5.4], may be granted to ships which are intended for the carriage of products listed in the table in Chapter 17 of the IBC Code. These ships are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), as amended. In these Rules reference to this Code and its amendments is made by the wording “IBC Code”.

The **chemical tanker** service notation may be completed by the additional feature **IMO 1**, **IMO 2** or **IMO 3** when the ship complies with the requirements for the assignment of type 1, type 2 or type 3, respectively, according to Chapter 2 of the IBC Code.

Ships assigned with the service notation **chemical tanker** and the additional service feature **IMO 2** or **IMO 3** may be completed by the additional service feature **IMO 1 (tank name)**, when the ship complies with the requirements for the assignment of type 1, according to Chapter 2 paragraphs 2.5, 2.7, 2.8 and 2.9 of the IBC Code, and the location of the named tank complies with the requirements for a type 1 ship in paragraph 2.6 of the IBC Code.

Ships assigned with the service notation **chemical tanker** and the additional service feature **IMO 3** may be completed by the additional service feature **IMO 2 (tank name)**, when the ship complies with the requirements for the assignment of type 2, according to Chapter 2 paragraphs 2.5, 2.7, 2.8 and 2.9 of the IBC Code, and the location of the named tank complies with the requirements for a type 2 ship in paragraph 2.6 of the IBC Code.

The **chemical tanker** service notation may be completed by the additional service feature **methanol bunker** when the ship is in compliance with the requirements in App 1.

1.1.2 IBC Code requirements and the Society’s rules

a) For ships with the service notation **chemical tanker**, the IBC Code requirements are to be considered as rule requirements, with the exception indicated in [1.1.3].

b) The requirements of this Chapter supplement those of the IBC Code. These requirements include additional mandatory class requirements, as well as the Society’s interpretations of the IBC Code, which are also to be considered mandatory for class.

c) In general, this Chapter applies to cargo containment and handling systems and to the interfaces between these systems and the other parts of the ship, which are to comply with the applicable Sections of the hull and machinery Rules.

1.1.3 IBC Code requirements not within the scope of classification *(1/1/2007)*

The following requirements of the IBC Code are not within the scope of classification:

- Chapter 1, Section1.4 - Equivalents
- Chapter 1, Section 1.5 - Surveys and certification
- Chapter 2, Section 2.4 - Condition of loading
- Chapter 2, Section 2.5 - Damage assumption
- Chapter 2, Section 2.7 - Flooding assumption
- Chapter 2, Section 2.8 - Standard of damage
- Chapter 2, Section 2.9 - Survival requirements
- Chapter 11 - Fire protection and fire extinction
- Chapter 14 - Personnel protection
- Chapter 16 - Operating requirements
- Chapter 16A - Additional measures for the protection of the marine environment.

These requirements are applied by the Society when acting on behalf of the flag Administration, within the scope of delegation (see [1.1.8]).

1.1.4 Carriage of products not listed in the Code

The requirements of the IBC Code and the additional requirements of this Chapter are also applicable to new products, which may be considered to come within the scope of these Rules, but are not at present listed in either of the tables in Chapter 17 or Chapter 18 of the IBC Code.

1.1.5 Particularly hazardous products

For the carriage in bulk of products which are not listed in either of the tables in Chapter 17 or Chapter 18 of the IBC Code, presenting more severe hazards than those covered by the IBC Code, the Society reserves the right to establish requirements and/or conditions additional to those contained in these Rules.

1.1.6 Correspondence of the IBC Code with Part E Chapter 8 of the Rules

All the requirements of this Chapter are cross referenced to the applicable Chapters, Sections or paragraphs of the IBC Code, as appropriate.

1.1.7 Equivalence

As far as the requirements for class are concerned, the following wording in the IBC Code is to be given the meanings indicated in Tab 1.

Table 1

IBC Code wording	Meaning for Classification only
Administration	Society
IGC Code or Gas Code	Chapter 9
Recognised Standard	Rules
should be	is to be or are to be (as appropriate)

1.1.8 Certificate of Fitness

a) The responsibility for interpretation of the IBC Code requirements for the purpose of issuing an International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk lies with the Administration of the state whose flag the ship is entitled to fly.

b) Whenever the Society is authorised by an Administration to issue on its behalf the "Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk", or where the Society is authorised to carry out investigations and surveys on behalf of an Administration on the basis of which the "Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk" will be issued by the Administration, or where the Society is requested to certify compliance with the IBC Code, the full compliance with the requirements of the IBC Code, including the operative requirements mentioned in [1.1.3], is to be granted by the Society.

2 Additional requirements

2.1 Emergency towing arrangement

2.1.1 Emergency towing arrangements are to be fitted on chemical tankers of 20.000 d_{wt} and above in accordance with Pt B, Ch 10, Sec 4, [4].

2.2 Steering gear

2.2.1 Additional requirements for steering gear of chemical tankers of 10000 d_{wt} and above are given in Ch 7, Sec 4, [7].

3 Documentation to be submitted

3.1 Standard list of documents

3.1.1 Tab 2 lists the plans, information, analysis, etc. which are to be submitted in addition to the information required in the other Parts of the Rules for the parts of the ship not affected by the cargo, as applicable.

Table 2 : Documents to be submitted

No.	A/I	Document
1	I	List of products to be carried, including maximum vapour pressure, maximum liquid cargo temperature and other important design conditions
2	I	General arrangement plan, showing location of cargo tanks and fuel oil, ballast and other tanks
3	A	Gas-dangerous zones plan
4	A	Location of void spaces and accesses to dangerous zones
5	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
6	A	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.
7	A	Hull stress analysis
8	A	Hull ship-motion analysis, where a direct analysis is preferred to the methods indicated in Section 4
9	A	Intact and damage stability calculations
10	A	Scantlings, material and arrangement of the cargo containment system
11	A	Details of steel cladding or lining
12	A	Plans and calculations of safety relief valves
13	A	Details of cargo handling, including arrangements and details of piping and fittings
14	A	Details of cargo pumps
15	A	Details of process pressure vessels and relative valving arrangement
16	A	Bilge and ballast system in cargo area
17	A	Gas freeing system in cargo tanks including inert gas system
18	A	Ventilation system in cargo area
19	A	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
20	A	Schematic electrical wiring diagram
21	A	Gas detection system
22	A	Cargo tank instrumentation
23	A	Details of fire-extinguishing appliances and systems in cargo area
24	I	Loading and unloading operation description, including cargo tank filling limits, where applicable

Note 1: A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

SECTION 2 SHIP SURVIVAL CAPABILITY AND LOCATION OF CARGO TANKS

1 Freeboard and intact stability

1.1 Intact stability

1.1.1 General

IBC CODE REFERENCE : Ch 2, 2.2

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.7] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

1.1.2 Information to be supplied

IBC CODE REFERENCE : Ch 2, 2.5

The Master of the ship is to be supplied with a Loading Manual as specified in Pt B, Ch 11, Sec 2, [3] and a Trim and Stability booklet as specified in Pt B, Ch 3, App 2.

2 Location of cargo tanks

2.1 Minimum distance of cargo tanks from shell

2.1.1 Exceptions

IBC CODE REFERENCE : Ch 2, 2.6.1

Any cargo tank, irrespective of its location, may be used for collecting contaminated cargo pump room bilge water or tank washings, as an exception to the requirements in IBC Code 2.6.1.1.

2.2 Suction wells

2.2.1

IBC CODE REFERENCE : Ch 2, 2.6.2

In general, the area of suction wells is not to be greater than that required to accommodate cargo pumps, suction pipes, valves, heating coils etc., and to ensure efficient flow and the necessary access for cleaning and maintenance.

3 Flooding assumptions

3.1 Tunnels, ducts and pipes in the damaged zone

3.1.1 Strength of internal structures

Tunnels, ducts, pipes, doors, bulkheads and decks which might form watertight boundaries of intact spaces in the case of assumed conventional damage are to have minimum strength adequate to withstand the pressure height corresponding to the deepest equilibrium waterline in damaged conditions.

SECTION 3 SHIP ARRANGEMENT

1 Cargo segregation

1.1 Segregation of cargoes mutually reacting

1.1.1 Common edges

IBC CODE REFERENCE : Ch 3, 3.1.2

The common edge in a cruciform joint, either vertically or horizontally, may be considered a “double barrier” for the purpose of segregation:

- between mutually reactive products (see Fig 1)
- between water reactive products and water (see Fig 1).

1.1.2 Chain lockers

IBC CODE REFERENCE : Ch 3, 3.1.2

The chain locker is to be arranged outside the cargo area.

1.2 Cargo piping arrangement

1.2.1 Bow or stern loading arrangement

IBC CODE REFERENCE : Ch 3, 3.1.3

The requirement in IBC Code 3.1.3 is considered to be satified if the requirements in IBC Code 3.7, relevant to bow or stern loading and unloading arrangements, are complied with.

2 Accommodation, service and machinery spaces and control stations

2.1 Air intakes and other openings to accommodation spaces

2.1.1

IBC CODE REFERENCE : Ch 3, 3.2.2

The requirements relevant to air intakes in IBC Code 3.2.2 are also intended to be applicable to air outlets. This interpretation also applies to the requirements in IBC Code 3.2.3, 3.7.4, 8.3, 15.12.1.3 and 19.3.8.

2.2 Windows, sidescuttles and doors

2.2.1 General requirements

IBC CODE REFERENCE : Ch 3, 3.2.3

a) Access facing the cargo area or other prohibited zones is to be restricted to stores for cargo-related and safety equipment, cargo control stations and emergency shower spaces.

b) Entrances and openings to service spaces located forward of the cargo area may not face such area. However, for small ships alternative arrangements may be specially considered by the Society.

c) The bolt spacing for bolted plates mentioned in the paragraph in the reference is to be such as to guarantee a suitable gas-tightness.

2.2.2 Ships fitted with deckhouses originating from main deck

IBC CODE REFERENCE : Ch 3, 3.2.3

On all chemical tankers, regardless of the type of products to be carried, where a deckhouse is substituted for a superstructure and liquid products could flow along the sides of the house, the house front is to be continued to the sides of the ship in the form of a sill, or a permanent spillage barrier is to be arranged as described in Regulation II-2/56.6 of SOLAS 74(83).

3 Cargo pump rooms

3.1 General requirement

3.1.1 Means of escape

IBC CODE REFERENCE : Ch 3, 3.3.1

In general, a cargo pump room is to be provided with one set of access/escape ladders. Where it is envisaged that personnel are normally employed in a pump room or the pump room is unusually large, an additional means of escape may be required.

3.1.2 Segregation

IBC CODE REFERENCE : Ch 3, 3.3.1

Cargo pump rooms and pump rooms may not give direct access to other ship spaces and are to be separated from adjacent spaces by means of gas-tight bulkheads and/or decks.

3.2 Machinery driven by shafting passing through pump room bulkheads

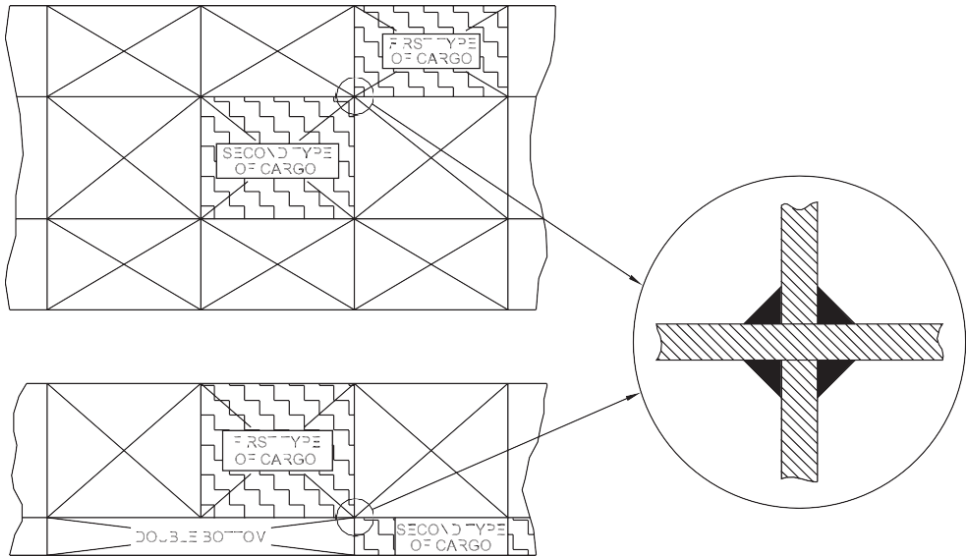
3.2.1

IBC CODE REFERENCE : Ch 3, 3.3.7

a) Bulkhead or deck penetrations of cargo pump rooms, or of pump rooms intended for runs of shafts driving pumps and/or fans, are to be provided with gas-tight sealing devices to the satisfaction of the Society.

b) Lubrication or other means of ensuring permanence of gas-tightness of the above-mentioned sealing devices is to be arranged in such a way that it can be checked from outside the cargo pump room.

Figure 1 : Segregation of mutually hazardously reactive cargoes



4 Fuel tanks in cargo area

4.1 Definition

4.1.1 *(1/7/2017)*

Cargo tank block is the part of the ship as indicated in Fig 2 extending from the aft bulkhead of the aftmost cargo or slop tank to the forward bulkhead of the forward most cargo or slop tank, extending to the full depth and beam of the ship, but not including the area above the deck of the cargo or slop tank.

4.2 Location of fuel tanks in cargo area

4.2.1 *(1/7/2019)*

a) These requirements apply to chemical tankers carrying toxic (see Note 1) liquid cargoes.

b) Fuel tanks located with a common boundary to cargo or slop tanks shall not be situated within nor extend partly into the cargo tank block. Such tanks may, however, be situated aft and/or forward of the cargo tank block.

c) They may be accepted when located as independent tanks on open deck in the cargo area subject to spill and fire safety considerations.

d) The arrangement of independent fuel tanks and associated fuel piping systems, including the pumps, can be as for fuel tanks and associated fuel piping systems located in the machinery spaces. For electrical equipment, requirements to hazardous area classification must however be met.

Note 1: toxic liquid cargoes include those for which toxic vapour detection is specified in column "k" of the table of chapter 17 of the IBC Code.

5 Access arrangement

5.1 Access to compartments in the cargo area

5.1.1 Access to fuel oil tanks

IBC CODE REFERENCE : Ch 3, 3.4.1

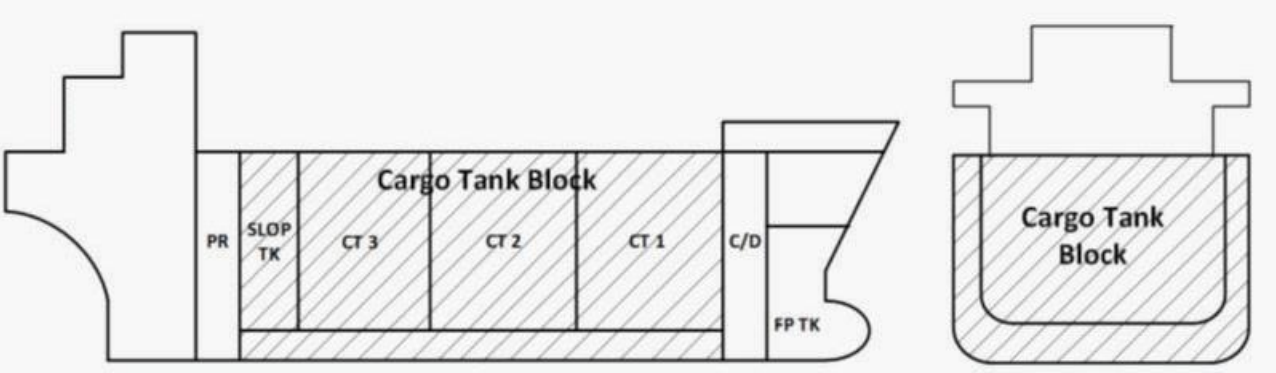
The requirements in IBC Code 3.4.1 apply to fuel oil tanks adjacent to cargo tanks even if such fuel oil tanks are not included in the “cargo area” as defined in IBC Code 1.3.5.

5.1.2 Accesses and escapes from double bottom tanks and similar spaces

IBC CODE REFERENCE : Ch 3, 3.4.1

To cater for restrictions in the movement of personnel and to limit the time needed for a possible emergency escape, two separate means of access are generally to be fitted in double bottom tanks and similar spaces where obstructions impede movement. The two accesses are to be as widely separated as practicable. Only one access may be approved in special circumstances if, it being understood that the escapes have the required dimensions, the ability to readily traverse the space and to remove an injured person can be proved to the satisfaction of the Society.

Figure 2 *(1/7/2017)*

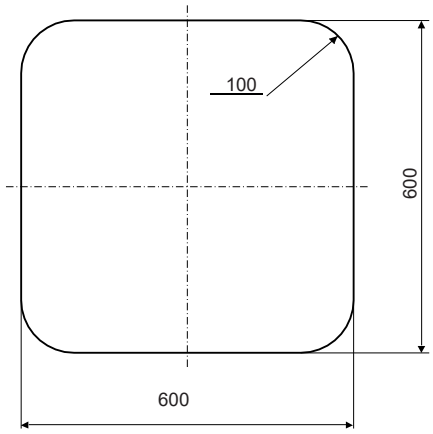


5.1.3 Access through horizontal openings

IBC CODE REFERENCE : Ch 3, 3.4.2

The shape of the minimum acceptable clear opening of 600 mm by 600 mm is indicated in Fig 3.

Figure 3 : Shape of minimum acceptable clear opening of 600 mm by 600 mm



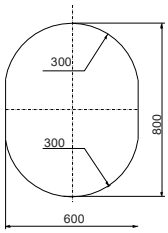
5.1.4 Access through vertical openings

IBC CODE REFERENCE : Ch 3, 3.4.3

For pressure cargo tanks only, access openings may be circular openings having a diameter not less than 600 mm.

The minimum size of vertical oval openings is defined in Fig 4.

Figure 4 : Minimum size of vertical oval openings



5.2 Access to the bow

5.2.1 *(1/7/2008)*

This item [5.2] applies to ships subject to the International Load Line Convention 1966, as amended.

5.2.2 *(1/7/2006)*

Chemical tankers are to be provided either with a gangway between the superstructure or deckhouse aft and the forecastle, or with equivalent arrangements in accordance with the International Load Line Convention 1966, as amended.

5.2.3 *(1/7/2006)*

Chemical tankers are to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means are to be accepted by the Society.

Note 1: The Society considers means in compliance with the Guidelines adopted by the Maritime Safety Committee of IMO with Resolution MSC.62(67) on 5/12/1996 as being acceptable.

6 Bilge and ballast arrangements

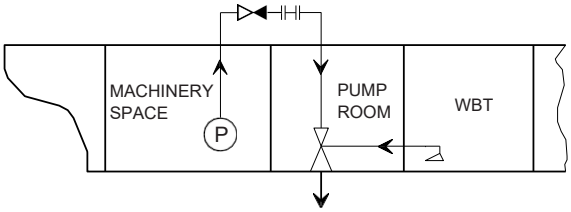
6.1 Ballast segregation

6.1.1 Eductors

IBC CODE REFERENCE : Ch 3, 3.5.1

An eductor situated in the cargo area using water power from pumps in the machinery spaces may be accepted as a means to discharge permanent ballast from tanks and/or double bottoms adjacent to cargo tanks, provided the supply line is above deck level and a non-return valve and removable spool piece are fitted in the supply line outside the machinery space (see Fig 5).

Figure 5 : Discharge arrangement



6.2 Ballast filling arrangement

6.2.1 Clarification

IBC CODE REFERENCE : Ch 3, 3.5.2

The filling of cargo tanks with ballast may be performed at deck level by means of pumps serving permanent ballast tanks, as specified in IBC Code 3.5.2, provided that a removable spool piece or flexible hose plus a shut-off valve are fitted on the inlet to the cargo tank. The shut-off valve is in addition to the required non-return valve. Consideration is to be given to the arrangement of the in-tank piping and the possible creation of static electricity (see Fig 5).

6.3 Bilge

6.3.1 Arrangement

IBC CODE REFERENCE : Ch 3, 3.5.3

The relaxation relevant to the bilge system for spaces which are separated from cargo tanks by a double bulkhead is to be understood as limited to spaces not enclosing piping which may contain cargo.

6.3.2 Use of cargo pumps as bilge pumps

IBC CODE REFERENCE : Ch 3, 3.5.3

a) Cargo pumps may also be used as bilge pumps provided they are connected to the bilge piping through a shut-off valve and a non-return valve arranged in series.

b) In the case of carriage of corrosive liquids, one of the cargo pumps, as specified in IBC Code 3.5.3, may be used for bilge service provided it is connected to the bilge piping through two shut-off valves plus a non-return valve arranged in series.

c) In cargo pump rooms of ships carrying toxic or corrosive products, suitable means for conveying spills from cargo pumps and valves to collecting trays are to be fitted. Trays may also consist of part of the pump room bottom, suitably bounded and protected against the corrosive action of products. Spills may be disposed of by means of suitable pumps or eductors. In the case of carriage of mutually incompatible products, the above-mentioned means for collecting and disposing of spills are to be different and separated from each other.

6.4 Fore peak ballast tanks and space arrangements

6.4.1 *(1/1/2026)*

The requirements in Ch 7, Sec 2, [7] apply, with the following deviations:

a) The definition of “Cargo area of tankers” in Ch 7, Sec 2, [7.1.1] is to be changed into:

Cargo area of tankers: defined in paragraph 1.3.6 of the IBC Code as amended by IMO resolutions up to MSC.460(101), considering also the relevant interpretations in IACS UI SC211.

b) the arrangements shown in Ch 7, Sec 2, Fig 7 and Fig 8 are not applicable as they apply to oil tankers only.

7 Bow or stern loading and unloading arrangements

7.1 Coamings

7.1.1

IBC CODE REFERENCE : Ch 3, 3.7.7

In general, the height of the coaming is to be not less than 150 mm. In any case, it is to be not less than 50 mm above the upper edge of the sheerstrake.

8 Hull outfitting

8.1 Equipment

8.1.1 Emergency towing arrangements

The specific requirements in Pt B, Ch 10, Sec 4, [4] for ships with the service notation **chemical tanker** and not less than 20000 t deadweight are to be complied with.

SECTION 4 CARGO CONTAINMENT

Symbols

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

1 Structure design principles

1.1 Materials

1.1.1 Steels for hull structure

IBC CODE REFERENCE: Ch 4

In addition to the requirements of Pt B, Ch 4, Sec 1, [2], materials of cargo tanks are to be considered by the Society on a case-by-case basis for all the products intended to be carried.

1.1.2 Rolled plates

IBC CODE REFERENCE: Ch 4

Rolled plates of non-alloyed steel or stainless steel may be used for the construction of tanks. Mechanical characteristics, approval procedure and testing of these plates are to comply with the applicable requirements in Part D.

1.1.3 Young's modulus for stainless steels

IBC CODE REFERENCE: Ch 4

For stainless steels, Young's modulus is to be taken equal to 193000 N/mm^2.

1.1.4 Rubber and synthetic material liner

IBC CODE REFERENCE: Ch 4

The suitability of rubber or synthetic material lining is to be considered by the Society on a case-by-case basis.

1.2 Hull structure

1.2.1 Framing arrangement

IBC CODE REFERENCE: Ch 4

In general, within the cargo tank region of chemical tankers of more than 90 m in length, the bottom, the inner bottom and the deck are to be longitudinally framed.

Different framing arrangements are considered by the Society on a case-by-case basis, provided that they are supported by direct calculations.

1.3 Bulkhead structure

1.3.1 Corrugated bulkhead connections

IBC CODE REFERENCE: Ch 4

For ships with L < 120 m, vertically corrugated transverse or longitudinal bulkheads may be connected to the double bottom and deck plating (see Fig 1).

For ships with L ≥ 120 m, a lower and an upper stool are generally to be fitted (see Fig 2). Different arrangements may be considered by the Society on a case-by-case basis, provided that they are supported by direct calculations carried out according to Pt B, Ch 7, Sec 3. These calculations are to investigate, in particular, the zones of connection of the bulkhead with bottom and deck plating and are to be submitted to the Society for review.

Figure 1 : Corrugated bulkhead connections without stool

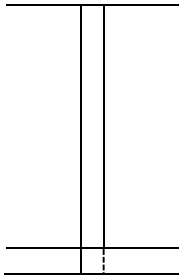
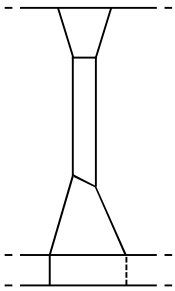


Figure 2 : Corrugated bulkhead connections with lower and upper stools



2 Hull girder loads

2.1 Still water loads

2.1.1 Loading conditions

IBC CODE REFERENCE: Ch 4

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1], still water loads are to be calculated for the following loading conditions:

- homogeneous loading conditions (excluding tanks intended exclusively for segregated ballast tanks) at maximum draught
- partial loading conditions
- high density cargo, heated cargo and segregated cargo loading conditions
- any specified non-homogeneous loading condition
- light and heavy ballast conditions
- mid-voyage conditions related to tank cleaning or other operations where these differ significantly from the ballast conditions.

3 Scantlings of integral tanks

3.1 Plating

3.1.1 Minimum net thicknesses *(1/7/2002)*

IBC CODE REFERENCE: Ch 4

The net thickness of the strength deck and bulkhead plating within or bounding the longitudinal extension of the cargo area is to be not less than the values given in Tab 1.

Table 1 : Minimum net thickness of the strength deck and bulkhead plating

Plating	Minimum net thickness, in mm
Strength deck	$(5,5 + 0,02\ L)\ k^{1/2}$ for $L < 200$ $(8 + 0,0085\ L)\ k^{1/2}$ for $L \geq 200$
Tank bulkhead	$L^{1/3}\ k^{1/6} + 4,5\ s$
Watertight bulkhead	$0,85\ L^{1/3}\ k^{1/6} + 4,5\ s$
Wash bulkhead	$0,8 + 0,013\ L\ k^{1/2} + 4,5\ s$
Note 1: s : Length, in m, of the shorter side of the plate panel.	

3.1.2 Calculation of equivalent thickness for clad plates made of non-alloyed steel - stainless steel

IBC CODE REFERENCE: Ch 4

The clad plate thickness is to be not less than that obtained from the following formula:

$$t_P = t + t_S\left(1 - \frac{E_I}{206000}\right)$$

where:

t : Thickness, in mm, of the clad plate, to be obtained from the applicable formulae in Pt B, Ch 7, Sec 1, as if it were made of homogeneous material with the following properties:

- elastic modulus, in N/mm^2, to be taken equal to:

  $E = 206000$

- material factor, to be obtained from the following formula:

  $$k_0 = k\frac{E_I}{206000}$$

k : Material factor of the rolled stainless steel plate, defined in Pt B, Ch 4, Sec 1, [2.3]

E_I : Elastic modulus, in N/mm^2, of the rolled stainless steel plate

t_S : Thickness, in mm, of the stainless steel cladding, to be taken not less than 2,0 mm.

Stainless steel cladding thicknesses other than those above are to be considered by the Society on a case-by-case basis.

3.2 Ordinary stiffeners

3.2.1 Minimum net thicknesses

IBC CODE REFERENCE: Ch 4

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = 0,75\ L^{1/3}\ k^{1/6} + 4,5\ s$

where s is the spacing, in m, of ordinary stiffeners.

3.3 Primary supporting members

3.3.1 Minimum net thicknesses

IBC CODE REFERENCE: Ch 4

The net thickness of plating which forms the webs of primary supporting members is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = 1,45\ L^{1/3}\ k^{1/6}$

3.3.2 Loading conditions

IBC CODE REFERENCE: Ch 4

The still water and wave loads are to be calculated for the most severe of the loading conditions specified in [2.1.1], with a view to maximising the stresses in the longitudinal structure and primary supporting members.

3.3.3 Cargo tank structure with hopper tank analysed through a three dimensional beam model

IBC CODE REFERENCE: Ch 4

Where the cargo tank structure with hopper tank is analysed through a three dimensional beam model, to be carried out in accordance with the requirements in Pt B, Ch 7, App 1, the net shear sectional area of floors within 0,1 ℓ from the floor ends (see Fig 3 for the definition of ℓ) is to be not less than the value obtained, in cm^2, from the following formula:

$$A_{Sh} = 2\frac{Q}{\gamma_R \gamma_m R_y}$$

where:

Q : Maximum shear force, in kN, obtained from the direct calculations

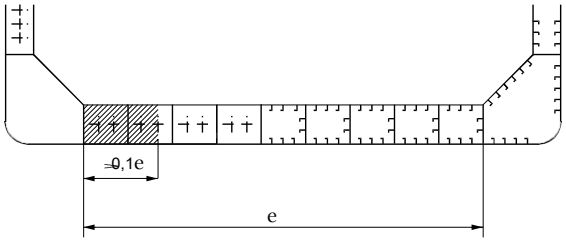
γ_R : Resistance partial safety factor:

$\gamma_R = 1,2$

γ_m : Material partial safety factor:

$\gamma_m = 1,02$

Figure 3 : End area of floors



4 Scantlings of independent tank structures

4.1 Plating

4.1.1 Strength checks

IBC CODE REFERENCE: Ch 4

In general, the net thickness of plating of independent tanks is to be not less than those obtained from the applicable formulae in Pt B, Ch 7, Sec 1, where the lateral pressures are to be calculated according to Part B, Chapter 5 and the hull girder stresses may be taken equal to zero.

Where, due to the tank arrangement, the above approximation is deemed unacceptable by the Society, the stresses in the tank due to the hull girder loads are to be taken into account. These stresses are, in general, to be calculated by means of direct calculations based on a finite element model of the hull and the tank with its supporting and keying system.

4.1.2 Calculation of equivalent thickness of clad plates made of non-alloyed steel - stainless steel

IBC CODE REFERENCE: Ch 4

The requirements in [3.1.2] apply.

4.2 Ordinary stiffeners

4.2.1 Strength check

IBC CODE REFERENCE: Ch 4

In general, the net scantlings of ordinary stiffeners of independent tanks are to be not less than those obtained from the applicable formulae in Pt B, Ch 7, Sec 2, where the lateral pressures are to be calculated according to Part B, Chapter 5 and the hull girder stresses may be taken equal to zero.

Where, due to the tank arrangement, the above approximation is deemed unacceptable by the Society, the stresses in the tank due to the hull girder loads are to be taken into account. These stresses are generally to be calculated as specified in [4.1.1].

4.3 Primary supporting members

4.3.1 Loading conditions

IBC CODE REFERENCE: Ch 4

The still water and wave loads are to be calculated for the most severe of the loading conditions specified in [2.1.1], with a view to maximising the stresses in the longitudinal structure and primary supporting members.

4.3.2 Strength checks

IBC CODE REFERENCE: Ch 4

The net scantlings of primary supporting members of both the hull and independent tanks are to be obtained by means of direct calculations based on criteria to be agreed by the Society on a case-by-case basis.

5 Supports of independent tanks

5.1 Structural arrangement

5.1.1 General

IBC CODE REFERENCE: Ch 4

The reaction forces in way of tank supports are to be transmitted as directly as possible to the hull primary supporting members, minimising stress concentrations.

Where the reaction forces are not in the plane of primary members, web plates and brackets are to be provided in order to transmit these loads by means of shear stresses.

5.1.2 Openings

IBC CODE REFERENCE: Ch 4

In tank supports and hull structures in way, openings are to be reduced as much as possible and local strengthening may be necessary.

5.2 Calculation of reaction forces in way of tank supports

5.2.1

IBC CODE REFERENCE: Ch 4

The reaction forces in way of tank supports are to be obtained from the structural analysis of the tank, considering the loads specified in Part B, Chapter 5.

If the tank supports are not able to react in tension, the final distribution of the reaction forces at the supports may not show any tensile forces.

5.3 Scantlings of independent tank supports and hull structures in way

5.3.1 Scantlings

IBC CODE REFERENCE: Ch 4

The net scantlings of plating, ordinary stiffeners and primary supporting members of tank supports and hull structures in way are to be not less than those obtained by applying the criteria in Part B, Chapter 7, where the hull girder loads and the lateral pressure are to be calculated according to Part B, Chapter 5.

The values of reaction forces in way of tank supports to be considered for the scantlings of these structural elements are defined in [5.2].

6 Other structures

6.1 Machinery space

6.1.1 Extension of the hull structures within the machinery space

IBC CODE REFERENCE: Ch 4

Longitudinal bulkheads carried through cofferdams are to continue within the machinery space and be used preferably as longitudinal bulkheads for liquid cargo tanks. This extension is to be compatible with the shape of the structures of the double bottom, of the deck and of platforms in the machinery space.

7 Protection of hull metallic structures

7.1 Aluminium coatings

7.1.1 *(1/1/2014)*

IBC CODE REFERENCE: Ch 4

The use of aluminium coatings containing more than 10% aluminium by weight in the dry film is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

7.2 Passivation treatment

7.2.1

IBC CODE REFERENCE: Ch 4

For a stainless steel structure, a passivation treatment is to be made carefully on the whole area of the tanks for a new ship, and on the whole repaired area in the case of repairs. This applies in particular to the passivation treatment of the welds.

8 Construction and testing

8.1 Welding and weld connections

8.1.1 Welding of bulkheads of cargo tanks of type 1 chemical carriers

IBC CODE REFERENCE: Ch 4

The boundaries of bulkheads of cargo tanks of type 1 chemical carriers are to be connected, for their whole length, to the hull structures by means of full penetration welding, as defined in the “Guide for welding”.

8.1.2 Welding of bulkheads of cargo tanks of type 2 chemical carriers *(1/7/2003)*

IBC CODE REFERENCE: Ch 4

The lower part of the boundaries of bulkheads of cargo tanks, i.e. the connection with the bottom (or double bottom, if any) and the connection with the lower part of the sloping plates, of type 2 chemical carriers are to be connected, for their whole length, to the hull structures by means of full penetration welding, as defined in Pt B, Ch 12, Sec 1, [2.4.1].

The other part of the tank boundaries may be connected by means of fillet welding, as defined in Pt B, Ch 12, Sec 1, [2.4.1]. In addition, partial penetration welding, as defined in Pt B, Ch 12, Sec 1, [2.4.1], may be considered on the basis of the results of strength analyses.

However, any more stringent requirement defined for specific connection types in Pt B, Ch 12, Sec 1 and Pt B, Ch 12, Sec 2, as the case may be, is to be complied with.

8.1.3 Welding of stiffeners made of non-alloyed steel to stainless steel plates

IBC CODE REFERENCE: Ch 4

In general, stiffeners made of non-alloyed steel may not be directly welded to thin stainless steel plates.

However, where the welding of stiffeners and hull components made of normal strength steel to stainless steel plates is deemed acceptable by the Society, such welding is to be performed using austenitic-ferritic electrodes with high-grade nickel and chromium, such as the electrode type with 24% Cr, 14% Ni and 3% Mo.

8.1.4 Welding on clad plates

IBC CODE REFERENCE: Ch 4

Welds carried out on clad plates are to be considered by the Society on a case-by-case basis.

In particular, when fillet welding is carried out directly on the rolled plate, the ultrasonic inspection of the plating bond is to be performed on a strip bond 100 mm wide, centred on the plate perpendicular to the plating. This ultrasonic inspection is to be carried out in accordance with Pt D, Ch 2, Sec 1, [8.9].

8.2 Special structural details

8.2.1

IBC CODE REFERENCE: Ch 4

The specific requirements in Pt B, Ch 12, Sec 2, [2.3] for ships with the service notation **chemical tanker** are to be complied with.

8.3 Testing

8.3.1 Tank testing

IBC CODE REFERENCE: Ch 4

In addition to the requirements in Pt B, Ch 12, Sec 3, [2.2], the tank testing is to comply with Tab 2.

Table 2 : Additional requirements for chemical carrier tank testing

Structure to be tested	Testing requirements	Structural test pressure
Integral or independent tanks.	Structural testing of cargo tank boundaries from at least one side, as defined in Pt B, Ch 12, Sec 3, [2.2].	The greater of the following: • 2,4 m head of water above the highest point of the tank, • setting pressure of the safety relief valves, where relevant.

SECTION 5 CARGO TRANSFER

1 Piping scantlings

1.1 Pipe wall thickness calculation

1.1.1 Piping subjected to green seas

IBC CODE REFERENCE : Ch 5, 5.1.1

For piping subjected to green seas, the design pressure P, in bar, in the formula in paragraph 5.1.1 of the IBC Code is to be replaced by an equivalent pressure P' given by the following formula:

$$P' = \frac{1}{2}\left(P + \sqrt{P^2 + 0{,}006R'K\frac{D_C}{D}}\right)$$

where:

D_C : External diameter of the pipe taking into account the insulation (in mm), whose thickness is to be taken at least equal to:

40 mm if $D \leq 50$ mm

80 mm if $D \geq 150$ mm

Intermediate values are to be determined by interpolation.

R' : Drag corresponding to the effect of green seas, in da N/m^2, such as given in Tab 1 as a function of the location of the pipes and of their height H (in m) above the deepest loadline; intermediate values are to be determined by interpolation.

K : permissible stress, in N/mm^2

1.1.2 Corrosion allowance

IBC CODE REFERENCE : Ch 5, 5.1.1

The coefficient c (added corrosion thickness) for the formula in paragraph 5.1.1 of the IBC Code is normally to be equal to at least 3 mm. The Society may accept a lesser value for pipes made of austenitic or austenitic-ferritic stainless steel, pipes with internal lining or, if applicable, pipes with acceptable external protective lining or painting.

2 Piping fabrication and joining details

2.1 Pipes not required to be joined by welding

2.1.1

IBC CODE REFERENCE : Ch 5, 5.2.2

Cargo piping is to be welded except for necessary flanged connections to valves, expansion joints (as permitted in paragraph 5.2.2.1 of the IBC Code), spool pieces and similar fittings or where required for coating, lining, fabrication, inspection or maintenance.

2.1.2 Flanged connections *(1/7/2011)*

IBC CODE REFERENCE: Ch 5, 5.3.1

Flange types A and B in Pt C, Ch 1, Sec 10, Fig 1 are acceptable in piping systems with design pressure p > 1,6 MPa.

Flange types A, B, C1, C2 and C3 are acceptable in piping systems with design pressure $p \leq 1{,}6$ MPa.

The type of flanges on open-ended cargo piping or cargo piping placed inside cargo tanks may be considered by the Society on a case-by-case basis.

2.2 Expansion joints

2.2.1

IBC CODE REFERENCE : Ch 5, 5.2.4

The use of bellows is not permitted for corrosive and polymerising products, except if provision is made to prevent stagnation of liquids.

Table 1

External diameter of pipe **(1)**	Aft of the quarter of the ship's length			Forward of the quarter of the ship's length		
	H≤8	H=13	H≥18	H≤8	H=13	H≥18
≤25	1500	250	150	2200	350	150
50	1400	250	150	2000	350	150
75	1100	250	150	1600	350	150
100	700	250	150	700	350	150
≥150	500	250	150	700	350	150
(1) D_C if the pipe is insulated, D otherwise.						

2.3 Non-destructive testing of welding

2.3.1

IBC CODE REFERENCE : Ch 5, 5.2.5

a) Butt welded pipes and accessories are to be radiographic at random and entirely checked by means of a dye-penetrant test or an equivalent method.

b) radiographic examinations are to cover at least 10% of the connections and may be extended, at the request of the Surveyor depending on the results of the inspection.

c) Relaxation of the above requirements may be considered by the Society on a case-by-case basis for pipes welded at workshops. However, this only applies to ships exclusively intended to carry cargoes with minor fire risk.

2.4 Certification, inspection and testing of piping system

2.4.1 *(1/7/2011)*

Pipes, valves, fittings and other components are to be tested according to Tab 2.

3 Piping arrangements

3.1 Arrangement of cargo piping

3.1.1 Arrangement of cargo piping under deck

IBC CODE REFERENCE : Ch 5, 5.5.2

The intent of the provisions in paragraph 5.5.2 of the IBC Code is to preclude the hazard of cargo leaking past a shut-off valve gland into the space where the valve is located.

3.1.2 Arrangement of cargo piping on deck

IBC CODE REFERENCE : Ch 5, 5.5.2

Cargo piping on cargo tanks is to be extended down to the bottom of each tank.

3.1.3 Aluminised pipes

IBC CODE REFERENCE : Ch 5, 5.5

Aluminised pipes may be permitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

3.2 Removable piping systems

3.2.1

IBC CODE REFERENCE : Ch 5, 5.5

Pumps, piping and associated fittings are to constitute a permanently fitted system; in general, removable parts are not allowed, except for specific cases for which it can be proved, to the satisfaction of the Society, that no effective alternative solutions are available. In such circumstances, the safety measures deemed necessary will be considered by the Society on a case-by-case basis.

4 Cargo transfer control systems

4.1 General

4.1.1

IBC CODE REFERENCE : Ch 5, 5.6.1

a) One blank flange is to be provided in addition to the stop valve required in paragraph 5.6.1.2 of the IBC Code at each cargo hose connection.

b) The requirements of paragraph 5.6.1 of the IBC Code are not intended to be additional to those for piping below deck in 5.5.2 and 5.5.3 of the IBC Code.

Table 2 *(1/7/2011)*

No.	Item	Tests for materials **(1)**		Inspections and tests for the products **(1)**		
		Tests required	Type of material certificate **(2) (3)**	During manu-facturing (NDT)	After completion	Type of product certificate **(2)**
1	pipes, flanges and fittings	X	C **(4)**		X	C
2	valves	X	C **(4)**	X **(5)**	X	C
3	pumps	X	W		X	C
4	cargo tank P/V and high velocity valves	X	C	X	X	C

(1) X = test required.
(2) C = class certificate, W = works' certificate.
(3) W is requested for pipes of open-ended piping and piping within cargo tanks.
(4) W is accepted for d < 100 mm
(5) if of welded construction

4.2 Control, monitoring and alarm devices and cargo control room

4.2.1

IBC CODE REFERENCE : Ch 5, 5.6

a) The cargo pump control is to be fitted in a position which is readily accessible, even in the event that the cargo piping or hoses break. This position is to be clearly indicated.

b) Where a cargo control room is fitted, the following controls, monitoring and alarms are to be connected to this room:
- cargo pump control
- control of loading/unloading valves
- level gauges
- temperature indicators
- high level alarms
- very high level alarms
- high/low temperature alarms
- high/low pressure alarms
- fixed gas detecting system alarms.

c) In general, high/low temperature alarms are also to be transduced to the navigating bridge.

d) The cargo control room is to be located above the weather deck and may be considered as a dangerous space or a safe space, depending on its location and on the possible presence of a product or of its vapours. If it is considered a dangerous space, it is to be provided with a ventilation system capable of supplying at least 20 air changes per hour, it is not to be located in the accommodation area and only safe type electrical equipment is allowed.

e) A cargo control room without cargo pump and valve control is defined as a "cargo control station".

5 Ship’s cargo hoses

5.1 Compatibility

5.1.1

IBC CODE REFERENCE : Ch 5, 5.7.1

The requirement of paragraph 5.7.1 of the IBC Code applies to cargo hoses carried on board the vessel and "compatibility with the cargo" means that:

a) the cargo hose does not lose its mechanical strength or deteriorate unduly when in contact with the cargo, and

b) the cargo hose material does not affect the cargo in a hazardous way.

Consideration is to be given to internal and external surfaces with respect to the above where hoses may be used as an integral part of, or connected to, emergency cargo pumps and submerged in the cargo tank.

6 Bonding

6.1 Static electricity

6.1.1 Acceptable resistance

IBC CODE REFERENCE : Ch 10, 10.3

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than $10^6\ \Omega$.

6.1.2 Bonding straps *(1/1/2014)*

IBC CODE REFERENCE : Ch 10, 10.3

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

d) wafer-style valves with non-conductive (e.g. PTFE) gaskets or seals.

Where bonding straps are required, they are to be:

- clearly visible so that any shortcoming can be clearly detected
- designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint
- easy to install and replace.

7 Integrated cargo and ballast system

7.1 General

7.1.1 *(1/1/2004)*

The requirements for integrated cargo and ballast systems are given in Ch 7, Sec 4, [3.5].

SECTION 6 MATERIALS FOR CONSTRUCTION

1 General

1.1 Material and coating characteristics

1.1.1 *(1/1/2007)*

IBC CODE REFERENCE : Ch 6, 6.1

a) As a general requirement, the provisions under Part D of the Rules apply. Materials for tanks are, in any case, to have properties which are not lower than those of hull steels used according to Part D of the Rules; if of quality other than required, their use will be considered by the Society on a case-by-case basis.

b) In the construction of cargo tanks intended to carry cargo and sea water ballast alternately, the utmost care is to be given to the selection of structural material (in general austenitic stainless steel) with particular attention to its resistance to different types of isolated corrosion:

- pitting
- stress corrosion
- interstice corrosion.

In addition, these structures are to be constructed with the same type of material to avoid galvanic corrosion, which would arise if dissimilar materials were present. In addition to the structures, the above is also intended to apply to the materials of systems, devices and apparatuses fitted in the tanks.

c) Sea water ballast tank structures may be partly of stainless steel and partly of hull steel, provided suitable measures are taken against hull steel corrosion. The use of appropriate protective coatings is subject to the positive outcome of the previous checks and tests, to the satisfaction of the Society, which may also require surveys to be performed at shorter intervals than for normal surveys. In estimating the suitability of the protective system, the Society may also require that the cathodic area is drastically reduced (for example, by also suitably protecting stainless steel structures) for the purpose of avoiding extremely isolated corrosion in hull steel structures which could possibly turn out, for various reasons, not to be protected by coating.

d) The use of aluminium coatings is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo gas may accumulate.

SECTION 7 CARGO TEMPERATURE CONTROL

1 General

1.1 Cargo heating and cooling systems

1.1.1 Cargo temperature control systems

IBC CODE REFERENCE : Ch 7, 7.1.1

Wherever a particular temperature (higher or lower than the ambient temperature) is required to be maintained for the preservation of the cargo, one of the following systems is to be adopted:

a) thermally insulated tanks capable of maintaining the temperature of the cargo within acceptable limits for the time of the voyage.

b) a heating or cooling plant or refrigerating plant.

c) a combination of a) and b) above.

1.1.2 Additional requirements for heating and cooling plants *(1/7/2007)*

IBC CODE REFERENCE : Ch 7, 7.1.1

a) Manifolds for the delivery and backflow of heating media are to be fitted on the weather deck; connections to cargo tanks for inlet and outlet are to be in way of the cargo tank top.

b) Where the heat exchanger room is located in the accommodation area and considered as gas-safe, it is to be treated as a machinery space (not a category A machinery space) and provided with independent mechanical extraction ventilation as well as with scuppers discharging directly into the machinery space.

c) The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

1.1.3 Reference temperature

IBC CODE REFERENCE : Ch 7, 7.1.1

Wherever the cargo temperature is maintained by a heating or refrigerating plant, unless otherwise indicated in the contract specification, the system is to be designed taking into account the reference temperatures indicated in Tab 1.

Table 1

Reference temperature (°C)		
	Heating system	Cooling system
Sea	0	32
Air	5	45

1.1.4 Redundancy *(1/7/2002)*

IBC CODE REFERENCE : Ch 7, 7.1.1

Wherever the heating or cooling system is essential for the preservation of the cargo, the following components are to be duplicated:

a) heating or cooling sources; in cargo heating systems, the Society may permit only one fired boiler capable of supplying the requested heating capacity to be installed, provided that sufficient spares for the burner and relevant auxiliaries are carried on board to enable any failure of the burner to be rectified by the ship's crew

b) circulating pumps for cargo and heating or cooling media; if suitable for the use, cargo pumps may be employed for the circulation of the heating or cooling media

c) refrigeration plant.

1.2 Valves and other fittings

1.2.1 Means for purging

IBC CODE REFERENCE : Ch 7, 7.1.3

Cargo heating or cooling systems are to be fitted with the necessary connections to purge, by inert gas or compressed air, the heating or cooling circuit of each cargo tank and to perform the pressure testing of the system.

1.3 Cargo temperature measuring system

1.3.1 Alarm

IBC CODE REFERENCE : Ch 7, 7.1.5

a) An alarm system is required for those products which are carried in a heated condition (see paragraph 15.13.6 of the IBC Code) and for which, in column "o" of the tables in Chapter 17 of the IBC Code, reference is made to the requirements of paragraph 15.13 of the IBC Code.

b) An alarm system is required for those products for which a carrying temperature not greater than certain limits is required by Chapter 15 of the IBC Code, such as elementary phosphorus and molten sulphur.

c) An alarm connection to the navigating bridge and to the cargo control station, if fitted, is to be provided.

1.4 Requirements for special products

1.4.1 Products which may damage the cargo heating or cooling system

IBC CODE REFERENCE : Ch 7, 7.1.6

a) The provisions of paragraph 7.1.6 of the IBC Code also apply to products which may damage the cargo heating or cooling system.

b) If the sampling equipment mentioned in paragraph 7.1.6.3 of the IBC Code consists of an observation tank for drains, this tank is generally to comply with the following requirements:

- it is to be located in the cargo area and provided with an air pipe with the end fitted with a flame screen, as per the Rules, and arranged at not less than 3 m from openings of accommodation spaces and from sources of ignition
- it is to be fitted with a connection for discharge into the slop tanks with associated shut-off valves and sight glass and equipped with a sampling cock for backflowing medium analysis.

SECTION 8 CARGO TANK VENTING AND GAS-FREEING ARRANGEMENTS

1 Cargo tank venting

1.1 Venting system drainage

1.1.1 Large amounts of drainage

IBC CODE REFERENCE: Ch 8, 8.2.2

When large amounts of drainage from vent lines of the cargo tanks are envisaged, a hose connection to the drain line of the slop tank is to be provided.

2 Types of tank venting system

2.1 Position of vent outlets

2.1.1 Outlets from tanks intended for flammable and toxic products

IBC CODE REFERENCE: Ch 8, 8.3.3

Vent outlets of cargo tanks intended for the carriage of flammable or toxic products are to be arranged at a distance of not less than 3 m from exhaust ducts and as far as possible from inlet ducts to pump rooms and cargo pump rooms.

3 Cargo tank gas-freeing

3.1 Fans

3.1.1

IBC CODE REFERENCE : Ch 8, 8.5

a) The impellers and housing of either fixed or portable fans fitted in dangerous spaces are to be of non-sparking materials according to paragraph 12.1.8 of the IBC Code.

b) In the case of fans installed in safe spaces, two non-return devices are to be fitted to avoid return of flammable and/or toxic cargo vapours to safe spaces when the ventilation system is shut down. These non-return devices are to operate in all normal conditions of ship trim and list.

SECTION 9 ENVIRONMENTAL CONTROL

1 General

1.1 Control by inerting or padding

1.1.1 Padding medium

IBC CODE REFERENCE : Ch 9, 9.1.3

The padding medium is to be compatible from the point of view of safety with the products to be carried, it is not to react with them and with air and it is to have chemical and physical properties deemed suitable by the Society. The system is to comply with the requirements for inert gas systems, as applicable.

1.2 Control by drying

1.2.1 Simultaneous carriage of incompatible products

IBC CODE REFERENCE : Ch 9, 9.1.4

In the case of simultaneous carriage of mutually incompatible products, dry gas supply piping systems to each cargo space are to be separate from each other.

1.3 Special requirements for inert gas systems on chemical carriers

1.3.1 Applicability *(1/1/2007)*

IBC CODE REFERENCE : Ch 9, 9.1

See Pt C, Ch 4, Sec 1, [8.2].

1.3.2 Simultaneous carriage of incompatible products

IBC CODE REFERENCE : Ch 9, 9.1

The inert gas system is to comply with the requirements of paragraph 9.1.5.1 of the IBC Code, adapted, to the satisfaction of the Society, to the individual characteristics of the products to be carried. In the case of simultaneous carriage of mutually incompatible products, inert gas supply piping systems to each cargo space are to be separate from each other.

1.3.3 Ships with no fixed inert gas system

IBC CODE REFERENCE : Ch 9, 9.1

Where no fixed installation for inert gas and/or dry gas production is provided for on board, the minimum quantity to be kept on board is established by the Master, based on the duration of the voyage, the anticipated daily temperature variations, gas leakage through cargo tank seals and experience of previous similar cases.

1.3.4 Additional requirements

IBC CODE REFERENCE : Ch 9, 9.1

a) These requirements apply where an inert gas system based on oil fired inert gas generators is fitted on board chemical tankers. Any proposal to use other sources of inert gas will be specially considered.

b) In addition to the provisions in paragraph 9.1.5.1 of the IBC Code, the inert gas system is to comply with the requirements of IMO Resolution A 567(14). Any use of the word "Administration" in the Resolution is to be considered as meaning the Society.

c) As an alternative to the water seal in the inert gas line on deck, an arrangement consisting of two shut-off valves in series with a venting valve in between may be accepted. The following conditions apply:

- The operation of the valve is to be automatically executed. Signals for opening/closing are to be taken from the process directly, e.g. inert gas flow or differential pressure.
- An alarm for faulty operation of the valves is to be provided, e.g. the operation status of "blower stop" and "supply valve(s) open" is an alarm condition.

d) In addition to the requirements detailed in Resolution A567(14), the followings are to be complied with:

1) Plans in diagrammatic form are to be submitted for appraisal and are to include the following:
   - details and arrangement of inert gas generating plant including all control monitoring devices
   - arrangement of piping system for distribution of the inert gas.
2) In all cases, automatic combustion control, capable of producing suitable inert gas under all service conditions, is to be fitted.
3) When two blowers are provided, the total required capacity of the inert gas system is preferably to be divided equally between the two and in no case is one blower to have a capacity less than 1/3 of the total required.
4) Materials used in inert gas systems are to be suitable for their intended purpose in accordance with the Rules. In particular those parts of scrubbers, blowers, non-return devices, scrubber effluent and other drain pipes which may be subjected to corrosive action of the gases and/or liquids are to be either constructed of corrosion-resistant material or lined with rubber, glass fibre, epoxy resin or other equivalent coating material.
5) A compartment in which any oil fired inert gas generator is situated is to be treated as a machinery space of category A in respect of fire protection.
6) All of the equipment is to be installed on board and tried under working conditions to the satisfaction of the Surveyor.

1.4 Ventilation

1.4.1

IBC CODE REFERENCE : Ch 9, 9.1

When a cargo space ventilation system other than the venting system mentioned under paragraph 8.2 of the IBC Code is required by these provisions, such system is to comply with the requirements established by the Society in each case.

SECTION 10 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 The requirements in this Section apply, in addition to those contained in Part C, Chapter 2, to chemical tankers.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 *(1/1/2007)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

1.3.2 *(1/1/2007)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.3 *(1/7/2009)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

1.4 Electrical equipment

1.4.1 *(1/1/2007)*

Electrical equipment, cables and wiring are not to be installed in hazardous locations unless they conforms with standards not inferior to those given in IEC 60092-502 Standard.

1.5 Earth detection

1.5.1 *(1/1/2007)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [1.3.1].

1.6 Precautions against inlet of gases or vapours

1.6.1 *(1/1/2007)*

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

1.7 Electrical equipment permitted in hazardous areas

1.7.1 *(1/1/2007)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5] and Pt C, Ch 2, Sec 3, [10.1.6].

1.7.2 *(1/1/2007)*

In addition to the requirements of [1.7.1], in Zone 1 and Zone 2 the installation of the following is permitted: hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of an impressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

1.7.3 *(1/1/2007)*

Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

2 Special requirements for chemical tankers carrying flammable liquids having a flashpoint not exceeding 60°C

2.1 Hazardous area classification

2.1.1 *(1/1/2007)*

For hazardous area classification see Ch 7, Sec 6, Tab 1.

3 Special requirements for chemical tankers carrying flammable liquids having a flashpoint exceeding 60°C

3.1 Hazardous area classification

3.1.1 *(1/1/2007)*

For hazardous area classification see Ch 7, Sec 5, Tab 2.

3.2 Cargoes heated to a temperature above their flashpoint and cargoes heated to a temperature within 15°C of their flashpoint

3.2.1 *(1/1/2007)*

The requirements under [2] apply.

SECTION 11 FIRE PROTECTION AND FIRE EXTINCTION

1 General

1.1

1.1.1 *(1/1/2007)*
This Section is void, as the provisions of Chapter 11 of the IBC Code are not mandatory for the class.

SECTION 12 MECHANICAL VENTILATION IN THE CARGO AREA

1 Spaces normally entered during cargo handling operations

1.1 Miscellaneous requirements

1.1.1 Ventilation system stopping

IBC CODE REFERENCE : Ch 12, 12.1

All required ventilation systems are to be capable of being stopped from a position located outside the served spaces and above the weather deck.

1.1.2 Warning notices

IBC CODE REFERENCE : Ch 12, 12.1

In the proximity of entrances to all spaces served by the required mechanical ventilation systems, a clearly visible warning is to be posted requiring such spaces to be adequately ventilated prior to entering and relevant ventilation systems to be kept in operation all the time persons are present in the spaces themselves.

1.1.3 Prevention of dangerous operation of electric motors

IBC CODE REFERENCE : Ch 12, 12.1

A suitable automatic device is to be fitted to prevent operation of electric motors driving cargo pumps and operation of other electrical equipment not of a certified safe type prior to ventilating the spaces where such motors or equipment are located, in order to render them gas-safe (to this end it is pointed out that IEC provisions require at least 10 changes of air based on the volume of the served space).

1.1.4 Prevention of dangerous operation of cargo pumps

IBC CODE REFERENCE : Ch 12, 12.1

An automatic device is to be fitted capable of stopping motors driving cargo pumps and de-energising any other electrical equipment not of a certified safe type in the case of stoppage of ventilation in spaces where such motors and equipment are fitted. This provisions does not apply to motors and other electrical equipment fitted in the engine room.

1.1.5 Alternative to extraction type ventilation systems

IBC CODE REFERENCE : Ch 12, 12.1

As an alternative to ventilation systems of the extraction type, required in [1.1.4], a ventilation system of the positive pressure type may be accepted:

- in the case of cargo pump rooms adjacent to cargo tanks or to other gas-dangerous spaces, or
- where, in adjacent gas-safe spaces, inclusive of spaces containing motors of cargo pumps, an adequate overpressure is kept in relation to the cargo pump rooms themselves.

1.1.6 Location of upper end of inlet ducts

IBC CODE REFERENCE : Ch 12, 12.1

With reference to the requirements of [1.1.5], the upper ends of inlet ducts are generally to be located at a distance not less than 3 m from ventilation ducts and air intakes serving the safe spaces mentioned therein.

1.1.7 Minimum distance between inlet and extraction ducts

IBC CODE REFERENCE : Ch 12, 12.1

With reference to 12.1.6 of IBC Code, the upper ends of (inlet and extraction) ventilation ducts serving the same space are to be located at a distance from each other, measured horizontally, of not less than 3 m and, in general, at an adequate height above the weather deck, but in any case not less than 2,4 m. Greater heights are required in paragraph 15.17 of the IBC Code.

1.1.8 Upper ends of ventilation ducts in ships carrying materials producing flammable vapours

IBC CODE REFERENCE : Ch 12, 12.1

For flammable products, or for products which may react with the ship's materials producing flammable vapours (such as strong acids), the upper ends of ventilation ducts are to be located at a distance of not less than 3 m from any source of ignition, as per the provisions of Sec 8, [2.1].

1.1.9 Dampers

IBC CODE REFERENCE : Ch 12, 12.1

Ventilation ducts are to be provided with metallic dampers, fitted with the indication "open" and "closed". The dampers are to be located above the weather deck, in a readily accessible position.

1.1.10 Location of electric motors of fans

IBC CODE REFERENCE : Ch 12,12.1

Electric motors driving fans are to be placed outside the served spaces and outside the ventilation ducts, in a suitable position with respect to the presence of flammable vapours.

1.1.11 Penetration of motor shafts through bulkheads

IBC CODE REFERENCE : Ch 12, 12.1

Runs of shafts of electric motors driving fans through bulkheads or decks of gas-dangerous spaces or through ventilation ducts are to be provided with gas-tight seals, with oil glands or equivalent means, deemed suitable by the Society.

1.2 Additional requirements for non-sparking fans

1.2.1 Non-sparking fans

IBC CODE REFERENCE : Ch 12, 12.1

a) A fan is considered as non-sparking if in both normal and abnormal conditions it is unlikely to produce sparks.

b) The air gap between the impeller and the casing is to be not less than 0,1 of the shaft diameter in way of the impeller bearing and not less than 2 mm. It need not be more than 13 mm.

1.2.2 Materials for non-sparking fans

IBC CODE REFERENCE : Ch 12, 12.1

a) The impeller and the housing in way of the impeller are to be made of alloys which are recognised as being spark proof by appropriate tests.

b) Electrostatic charges in both the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation on board of the ventilation units is to be such as to ensure their safe bonding to the hull.

c) Tests may not be required for fans having the following combinations:

- impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity
- impellers and housings of non-ferrous materials
- impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous materials is fitted in way of the impeller
- any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm design tip clearance.

d) The following impellers and housings are considered as sparking and are not permitted:

- impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance
- housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
- any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

1.2.3 Type test for non-sparking fans

IBC CODE REFERENCE : Ch 12, 12.1

Type tests on the finished product are to be carried out in accordance with the requirements of the Society or an equivalent national or international standard.

2 Pump rooms and other enclosed spaces normally entered

2.1 Clarification of general requirement

2.1.1 *(1/1/2001)*

IBC CODE REFERENCE : Ch 12, 12.2

a) The arrangements for the ventilation system of spaces to which paragraph 12.2 of the IBC Code applies are to comply, in general, with the provisions set out in the previous item 1, as applicable.

b) The provisions of paragraph 12.2 of the IBC Code apply to all pump rooms, whether or not the control for pumps and valves which are installed in such rooms is fitted externally.

c) The distance of the upper ends of extraction and inlet ducts from air intakes and other openings of spaces mentioned in paragraph 12.1.5 of the IBC Code is not to be less than 3 m measured horizontally. These systems are to be capable of being controlled from outside the spaces they serve and, in the proximity of the entrances to such spaces, the warning notice mentioned in [1.1.2] is to be posted.

3 Spaces not normally entered

3.1 Portable fans

3.1.1 *(1/1/2001)*

IBC CODE REFERENCE : Ch 12, 12.3

a) The type of portable fans and their connections to spaces to be ventilated are to be deemed suitable by the Society. Portable fans driven by electric or internal combustion motors are not acceptable.

b) The arrangements for the ventilation of these spaces are to comply, in general, with the provisions set out in the previous item 1, as applicable.

SECTION 13 INSTRUMENTATION

1 Gauging

1.1 Types of gauging devices

1.1.1 Arrangement

IBC CODE REFERENCE : Ch 13, 13.1.1

a) In almost all cases a cargo code which requires a high level alarm and overflow control also requires a closed gauging device. A cargo tank containing such a product therefore requires three sensors:
   1) one level gauging
   2) one high level alarm
   3) one overflow control

b) The sensing elements for 1), 2) and 3) are to be separated, although sensors for 2) and 3) (reed switches, float chambers, electronic devices, etc.) may be contained in the same tube.

c) Electronic, pneumatic and hydraulic circuits required for sensors 1), 2) and 3) are to be independent of each other such that a fault on any one will not render either of the others inoperative.

d) Where processing units are used to give digital or visual indication, such as in a bridge space, the independence of circuitry is to be maintained at least beyond this point.

e) The power is to be supplied from distribution boards.

f) Where a control room or a bridge space containing a modular unit is envisaged, separate level indication and visual alarms are to be provided for each of the functions 1), 2) and 3). An audible alarm is also to be provided but since this is not directional it need not be separate.

g) An audible alarm is also to be arranged in the cargo area.

h) Where there is no control room, an audible and visual alarm is to be arranged at the cargo control station.

i) Testing of sensors is to be arranged from outside the tanks, although entry into product clean tanks is not precluded.

j) Simulation testing of electronic circuits or circuits which are self-monitored is acceptable.

1.1.2 Example of restricted gauging device

IBC CODE REFERENCE : Ch 13, 13.1.1

A restricted gauging device may consist of a sounding pipe with an inside diameter not greater than 200 mm, fitted with a gas-tight plug. The pipe is to have holes in order to make its internal pressure equal to that of the tank. Therefore the holes are to be located inside the cargo tank in the proximity of the top.

2 Vapour detection

2.1 Vapour detection instruments

2.1.1 Spaces to be monitored

IBC CODE REFERENCE : Ch 13, 13.2.1

Vapour detection instruments, either fixed or portable, are to be of a type recognised suitable by the Society for the products to be carried. The spaces to be monitored are:

- cargo pump rooms
- spaces containing motors driving cargo pumps, except for the machinery space
- enclosed spaces containing cargo piping, equipment connected with cargo handling, cofferdams, enclosed spaces and double bottoms adjacent to cargo tanks
- pipe tunnels
- other spaces, in the opinion of the Society, depending on the ship type.

Where a fixed system is installed, it is to serve the spaces among those listed above which are normally entered by the crew.

2.2 Gas Measurements

2.2.1 *(1/1/2007)*

The fitting of gas measuring equipment is subject to the provisions of Pt C, Ch 4, Sec 1, [5.2.4] b)1).

SECTION 14 PROTECTION OF PERSONNEL

1 General

1.1

1.1.1 *(1/7/2012)*
This Section is void, as the provisions of Chapter 14 of the IBC Code are not mandatory for the class.

SECTION 15 SPECIAL REQUIREMENTS

1 Ammonium nitrate solution (93% or less)

1.1 Ammonia injection

1.1.1 Injection procedure

IBC CODE REFERENCE: Ch 15, 15.2.6

Gaseous ammonia may be injected into the cargo while the latter is circulated by the cargo pump.

1.2 Cargo pumps

1.2.1 Seal

IBC CODE REFERENCE: Ch 15, 15.2.7

The seal for the centrifugal pump is to be a stuffing box provided with a lantern ring. Fresh water under pressure is to be injected into the stuffing box at the location of the lantern ring (see Fig 1).

2 Hydrogen peroxide solutions

2.1 Hydrogen peroxide solutions over 60% but not over 70%

2.1.1 Water spray system

IBC CODE REFERENCE: Ch 15, 15.5.10

It is specified that, for the purpose of evaluating the estimated size of the cargo spill in the case of failure, cargo piping/hose failure is to be assumed to be total.

3 Propylene oxide and mixtures of ethylene oxide/propylene oxide with an ethylene oxide content of not more than 30% by mass

3.1 Tank cleaning

3.1.1

IBC CODE REFERENCE: Ch 15, 15.8.3

Until an amendment in this respect is prepared at IMO, it is specified that the initial wording of the text of paragraph 15.8.3 of the IBC Code "Before loading, ..." is to be intended as follows: "Before initial loading of these products and before each loading of these products subsequent to loading of other products....."

3.2 Joints in cargo lines

3.2.1

IBC CODE REFERENCE: Ch 15, 15.8.12

Screwed connections are only allowed for accessory and instrumental lines with an external diameter of 25 mm or less.

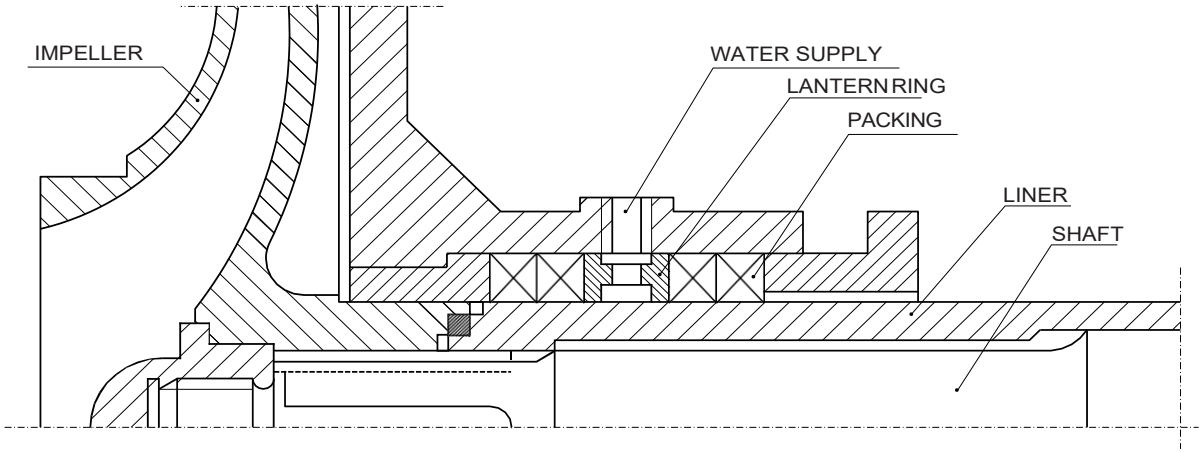
3.3 Oxygen content in tank vapour spaces

3.3.1 Analysing equipment

IBC CODE REFERENCE: Ch 15, 15.8.28

Analysing equipment to determine oxygen and propylene oxide contents is to be of a type recognised as suitable by the Society. When portable analysers are used, there are to be at least two. When a fixed system is installed, a portable analyser is also to be provided.

Figure 1 : Seal



3.4 Valves at cargo hose connections

3.4.1 Shut-off valve closing time

IBC CODE REFERENCE: Ch 15, 15.8.30

The closing time of shut-off valves provided at each cargo hose connection is to take account of the loading/unloading rate and is to be such as to avoid dangerous overpressure in cargo piping and hoses.

4 Sulphur (molten)

4.1 Fire-fighting system

4.1.1 Cargo tank protection

IBC CODE REFERENCE: Ch 15, 15.10

Cargo tanks are to be protected by a fixed CO_2 extinguishing system in accordance with Part C, Chapter 4, or a steam extinguishing system. In the latter case, tank drying arrangements are to be provided to prevent corrosion after use of steam.

4.1.2 CO_2 nozzles

IBC CODE REFERENCE: Ch 15, 15.10

Under normal service conditions, CO_2 tank feed nozzles are to be blanked off by means of a breaking disk to prevent pipes from being chocked by sulphur. Nozzles are to be located at the upper part of the tank, above liquid level.

5 Acids

5.1 Lining

5.1.1 *(1/7/2011)*

IBC CODE REFERENCE: Ch 15, 15.11.2

"Lining" is an acid-resistant material that is applied to the tank or piping system in a solid state with a defined elasticity property.

5.2 Electrical arrangements

5.2.1

IBC CODE REFERENCE: Ch 15, 15.11.15

In enclosed spaces adjacent to cargo tanks, electrical materials and equipment complying with the provisions of paragraph 10.1.2 of the IBC Code are allowed.

5.3 Leak detection system

5.3.1 Leak detectors

IBC CODE REFERENCE: Ch 15, 15.11.7

There are to be at least two leak detection apparatuses designed and calibrated to detect leakage of cargo into spaces adjacent to cargo tanks. The apparatuses may consist of a pH-meter, a gas detector suitable for the detection of hydrogen/air mixtures, of a type deemed suitable by the Society, or of other suitable systems. These apparatuses may be fixed or portable; if a fixed system is installed, a portable apparatus is also to be provided.

6 Toxic products

6.1 Return line to shore installation

6.1.1 Valving on connection to shore installation

IBC CODE REFERENCE: Ch 15, 15.12.2

The above-mentioned systems are to be fitted with a shut-off valve and a blank flange in way of the vapour return line to the shore installation.

7 Cargoes protected by additives

7.1 Prevention of blockage by polymerisation

7.1.1 Arrangements

IBC CODE REFERENCE: Ch 15, 15.13.6

In addition to being designed so as to avoid internal obstructions due to polymer formation, the above-mentioned systems are to be fitted with pressure/vacuum valves and devices to prevent the passage of flame which are accessible for inspection and maintenance.

8 Cargoes with a vapour pressure greater than 0,1013 MPa (1,013 bar) absolute at 37,8°C

8.1 General

8.1.1 System for maintaining cargo temperature below boiling point *(1/7/2021)*

IBC CODE REFERENCE: Ch 15, 15.14.1

Any system installed for the purpose of keeping the cargo temperature below its boiling point is to be constructed to the satisfaction of the Society.

8.2 Return of expelled gases

8.2.1 Valving of shore connection

IBC CODE REFERENCE: Ch 15, 15.14.4

The above-mentioned systems are to be fitted with a shut-off valve and a blank flange in way of the vapour return line to the shore installation.

9 Special cargo pump room requirements

9.1 Clarification

9.1.1

IBC CODE REFERENCE: Ch 15, 15.18

As far as concerns the possibility of allowing the arrangement of cargo pump rooms below deck in specific cases, it is specified that, in practice, no circumstance can be foreseen where such an arrangement may be permitted.

10 Overflow control

10.1 Independence of systems

10.1.1 Gauging devices

IBC CODE REFERENCE: Ch 15, 15.19

In almost all cases where, for the carriage of a product, a cargo high level alarm or cargo overflow control is required, a closed gauging device is also required.

10.1.2 Separation of device sensing elements

IBC CODE REFERENCE: Ch 15, 15.19

A cargo tank intended to carry such a product therefore requires:

a) level gauging

b) high level alarm

c) overflow control.

The sensing elements for the devices under a), b) and c) are to be separated, although sensors for b) and c) (micro-switches, float chambers, electronic devices, etc.) may be contained in the same metal tube sections.

10.1.3 Electronic and hydraulic circuits for sensors

IBC CODE REFERENCE: Ch 15, 15.19

Electronic, pneumatic and hydraulic circuits required for sensors for a), b) and c) are to be independent of each other such that a fault on any one of them will not render either of the others inoperative. Where processing units are used to give digital or visual indication such as in a bridge space, the independence of circuitry is to be maintained at least up to such units. The power is to be supplied from distribution boards.

10.1.4 Alarms in cargo control room

IBC CODE REFERENCE: Ch 15, 15.19

Where a cargo control room or a bridge space containing a modular unit is envisaged, separate level indications and visual alarms are to be provided for each of the functions a), b) and c). An audible alarm is also to be provided; there need not be a separate alarm for each function since separate alarms could not be distinguished. An audible alarm is also to be arranged in the cargo area.

10.1.5 Alarms where cargo control room is not provided

IBC CODE REFERENCE: Ch 15, 15.19

a) Where no cargo control room is provided, an audible and visual alarm is to be arranged at the cargo control station, which generally coincides with the navigating bridge.

b) The audible and visual high level and cargo overflow alarms are to be located so as to be easily heard and noticed by the personnel in charge of loading/unloading operations. Attention is drawn to the fact that such alarms are generally grouped together into two independent signals; therefore it is not possible to single out directly the cargo tank from which the alarm signal is coming. In such cases, the Master is to arrange for a person to be present at the cargo control station, in order to be able to warn the personnel in charge of loading operations on deck.

10.1.6 Testing of sensors

IBC CODE REFERENCE: Ch 15, 15.19

Testing of sensors is to be arranged from outside the tanks, although entry into product clean tanks is not prohibited. Simulation testing of electronic circuits or circuits which are self-monitoring is acceptable.

SECTION 16 OPERATIONAL REQUIREMENTS AND ADDITIONAL MEASURES FOR THE PROTECTION OF THE MARINE ENVIRONMENT

1 General

1.1 Applicability

1.1.1 This Section is void, as the provisions of Chapter 16 and 16A of the IBC Code are operating requirements which are not mandatory for the class.

SECTION 17 SUMMARY OF MINIMUM REQUIREMENTS

1 General

1.1 Applicability

1.1.1 *(1/1/2007)*
This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 17 of the IBC Code.

SECTION 18 LIST OF CHEMICALS TO WHICH THIS CHAPTER DOES NOT APPLY

1 General

1.1 Applicability

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 18 of the IBC Code.

SECTION 19 INDEX OF PRODUCTS CARRIED IN BULK

1 General

1.1 Applicability

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 19 of the IBC Code.

SECTION 20 TRANSPORT OF LIQUID CHEMICAL WASTES

1 General

1.1 Applicability

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 20 of the IBC Code.

SECTION 21 CRITERIA FOR ASSIGNING CARRIAGE REQUIREMENTS FOR PRODUCTS SUBJECT TO THE IBC CODE

1 General

1.1 Applicability

1.1.1 *(1/1/2007)*

This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 21 of the IBC Code.

APPENDIX 1 METHANOL BUNKER SHIPS

1 General

1.1 Application

1.1.1 *(1/4/2025)*

The requirements of this Appendix apply to Chemical Tankers complying with Chapter 8, and intended to load methanol from land based or offshore terminals, chemical tankers or trucks and transfer the methanol to methanol fueled ships.

Ships complying with the requirements of this Appendix will be granted the additional service feature **methanol bunker** which may be complemented by one or more of the following:

- **IG-Bunker** (Inert Gas Bunker) where the methanol bunker ship is designed to also supply inert gas, to ensure gas freeing and aeration, to a methanol fueled ship.
- **BT** (Bunker Trust) where the methanol bunker ship is designed with arrangement for the verification of the methanol quality and quantity delivered to the receiving ship.
- **VCS-Bunker** (Vapour Control System Bunker) where the methanol bunker ship is designed with systems for control of vapour emission from cargo tanks from receiving ship during bunkering.

1.1.2 *(1/4/2025)*

The requirements of this Appendix supplement those in Chapter 8.

In general, this Appendix does not address cargo containment and handling systems and the interfaces between these systems and the other parts of the ship, which are to comply with the applicable Sections of the Rules.

1.2 Scope

1.2.1 *(1/4/2025)*

This Appendix addresses:

- the design and installation of the piping system of the methanol bunker ship intended to transfer methanol from land based or offshore terminals, chemical tanker or trucks and to transfer methanol to the methanol fueled ship and the vapour transfer system to/from these units.
- the safety arrangements.

1.2.2 *(1/4/2025)*

Ships intended to load, carry and transfer ethanol or similar alcohol-based fuels will be considered on a case-by-case basis, and the Society reserves the right to establish additional requirements.

2 Definitions

2.1 Bunker Emergency Shut-down system (ESD)

2.1.1 *(1/4/2025)*

A bunker ESD is a system that safely and effectively stops the transfer of methanol (and vapour as applicable) between the receiving ship and the bunker ship in the event of an emergency during the bunkering operation, and puts the system in a safe condition.

2.2 Bunkering connections

2.2.1 *(1/4/2025)*

Bunkering connections correspond to the end of the fixed piping of the methanol bunker ship (i.e. manifold for a system with flexible hose and before the swivel for a system with transfer arm).

2.3 Custody Transfer Metering system

2.3.1 *(1/4/2025)*

Custody Transfer Metering system in fluid measurement is a measuring point (location) where the fluid is being measured for sale from one party to another.

2.4 Emergency Release Coupling (ERC) or Breakaway Coupling (BRC)

2.4.1 *(1/4/2025)*

A breakaway coupling or Emergency Release Coupling (ERC) is a coupling located in the methanol transfer system (at one end of the transfer system, either the receiving ship end or the methanol bunker ship end, or in the middle of the transfer system), which separates at a predetermined section when required, each separated section containing a self-closing shut-off valve, which seals automatically.

An emergency release coupling can be activated:

- by external forces applied to the predetermined section exceeding a predetermined value, and/or
- by manual, remote or automatic control, in case of emergency.

2.5 ESD link system or Ship-ship link (SSL)

2.5.1 *(1/4/2025)*

ESD link system or Ship-ship or ship-shore link (SSL) is a communication system to transmit ESD signals and other signals between two different ESD systems (ship to shore/ship or vice versa) via compatible system technologies such as pneumatic, electric, fiber-optic or radio transmission.

2.5.2 ESD Bunkering Concept *(1/4/2025)*

ESD bunkering concept is a document describing the safety philosophy of the methanol bunkering arrangement and procedure. It describes how risks associated with this type of fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures. The results of the risk analysis (see [4.1]) shall be reflected in the safety concept.

2.6 Methanol bunkering station

2.6.1 *(1/4/2025)*

Methanol bunkering station means the following equipment and the area where they are fitted:

- bunkering connections for hoses and piping used for liquid and vapour return lines
- isolating valves and emergency shut-down valves
- drip trays, draining arrangement and other arrangements such as water curtain intended for the protection of the ship structure from cold leakages
- gas detection system through thermal camera or gas detectors for enclosed space
- bunkering system ESD indication
- inerting and purging system connections
- pressure relieving system for the bunkering manifold.

2.7 Methanol transfer system

2.7.1 *(1/4/2025)*

A methanol transfer system is a system used to connect the methanol bunker ship and the receiving ship in order to transfer methanol or both methanol and its vapours.

The methanol transfer system includes:

- loading arms and transfer hoses, as applicable
- manifold including valves and instrumentation
- QCDC
- Breakaway Coupling (BRC) or Emergency Release Coupling (ERC)
- isolation flanges.

2.8 Measuring Instruments Directive (MID)

2.8.1 *(1/4/2025)*

The Measuring Instruments Directive (MID) for Custody Transfer metering for liquids, is the European Directive that sets down the essential requirements for a wide range of measuring instruments. It provides options for the manufacturer as to how the requirements are met and which organizations to apply to for conformity assessment.

2.9 OIML R117-1

2.9.1 *(1/4/2025)*

OIML R117-1 is a recommendation issued by the ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE (OIML). The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States. R117-1 addresses the Dynamic measuring systems for liquids other than water.

2.10 Pendant

2.10.1 *(1/4/2025)*

Pendant for ESD system is a portable device provided by one ship to another ship or shore terminal or provided by the shore to the ship for the manual tripping of its ESD system by the other party in the absence of a compatible ship-ship link (SSL).

2.11 Quick Connect and Disconnect Coupling (QCDC)

2.11.1 *(1/4/2025)*

A QCDC is a manual or powered mechanical device used to connect the methanol transfer system to the receiving ship manifold. The coupling consists of a Nozzle (male) and a receptacle (female). The nozzle allows quick connection and disconnection of the fuel supply hose to the receptacle, mounted on the methanol manifold.

2.12 Safety zone

2.12.1 *(1/4/2025)*

The safety zone is a zone around the methanol bunker ship, the bunkering station of the receiving ship and the methanol transfer system, where the only activities to be performed are the bunkering operations and related activities and where safety measures are taken to cope with a possible spill of methanol.

2.13 Transfer arm

2.13.1 *(1/4/2025)*

Transfer arm refers to any system allowing supporting transfer hoses or rigid pipes during bunkering operations.

3 Document to be submitted

3.1 General

3.1.1 *(1/4/2025)*

The drawings and related information to be submitted are listed in Tab 1.

3.1.2 *(1/4/2025)*

The operating manuals and procedures to be submitted are listed in Tab 2.

Table 1 : Documents to be submitted *(1/4/2025)*

No	A/I	Documents
1	A	Arrangement of the ship showing the location of the bunkering station and bunkering control station
2	I	Risk assessment report including operational constraints for the bunkering operation such as minimum visibility, day/night, maximum wind and wave, weather condition.
3	I	List of all bunkering equipment with their technical specification (including hoses)
4	A	Details of methanol transfer system and vapor return line system (including their capacity)
5	A	Details of Purging and Inerting system supplying inert gas to the bunker station and bunkering equipment (including their capacity)
6	I	Details of Custody Transfer Metering system with relevant certificates (if BT feature is applicable)
7	A	ESD Bunkering Concept including cause and effect matrix
8	A	Block diagram of Control, Monitoring and Safety System
9	A	ESD link system (SSL) description and list of communication devices used for the bunkering operation with their specification
10	A	Drip trays coamings and holding tank arrangement for the collection of methanol spills
11	I	Instrumentation list and relevant Safety certificates for electrical equipment located in hazardous areas and concerning the bunkering, where applicable
12	A	Drawings of transfer arm
13	I	Fender and mooring arrangement for bunkering operation with mooring analysis
14	A	Bunkering station manifold specification and drawings, with strength calculation including values of maximum allowable working pressure and allowable loads at manifold flange
15	A	Access and walkway arrangement to bunkering station
Note 1: A = to be submitted for approval I = to be submitted for information		

Table 2 : Operating manuals and procedures to be submitted *(1/4/2025)*

No	A/I	Documents
1	I	Operational manual including bunkering procedure (with details of maximum allowable bunkering flow and maximum allowable working pressure), all information required in MSC.1/Circ.1621 para. 17.4
2	I	Bunkering Safety Checklist according to MSC.1/Circ.1621 para. 17.4.3
3	I	Safety Zones Layout for the bunkering operation
4	I	Maintenance and storage instruction manual for the bunkering equipment
Note 1: A = to be submitted for approval I = to be submitted for information		

4 General design requirements

4.1 Risk Assessment

4.1.1 Methanol transfer system *(1/4/2025)*

A risk assessment shall be conducted according to MSC.1/Circ.1621 paragraphs. 4.2, 5.10.2, 8.3.1.1 and 13.5 as far as applicable.

The goal of the risk assessment is to identify all safety, environmental and asset hazards associated to the methanol transfer system during bunkering operation and their possible mitigation where required. The risk analysis can be of qualitative or semi-quantitative type and shall be based on international recognized standards and TASNEEF Guide for Risk Analysis.

4.1.2 *(1/4/2025)*

The risk assessment is to be performed using the most appropriate techniques such HAZID (Hazards Identification), FMEA (Failure Mode and Effect Analysis) or HAZOP (Hazard and Operability study) as far as applicable and at least the following items shall be assessed:

- bunkering station including manifold arrangement and drip tray or coaming
- ESD Bunkering System
- Bunkering Equipment
- ESD Link system (SSL)
- Voice communication System between methanol bunker ship and receiving ship
- Monitoring, Control and Safety System of bunkering operation
- Fender and mooring arrangement

taking into account the following operations:

- arrival, approach and mooring of methanol bunker ship close to the receiving ship
- connection and testing of methanol transfer system including ESD link system (SSL) and bunker ESD system
- methanol bunkering procedure (including hose handling, hose connection, methanol supply)
- methanol bunkering in parallel with other activities (SIMOPs)
- disconnection of the methanol bunker hose in normal and emergency condition (including draining, purging and inerting).

4.1.3 *(1/4/2025)*

The SIMOPs shall be defined with reference to international recognized standards or guidelines such as CWA 17540 “Ships and marine technology - Specification for bunkering of methanol fuelled vessels” and other activities identified by the risk assessment experts considering the expected port operations of the receiving ship.

4.1.4 *(1/4/2025)*

The risk assessment study is to include a vapor/liquid methanol release and toxicity analysis (e.g. gas dis-persion analysis) and is to define safety zones taking into account the concentration limits relevant to fire, explosion and toxic exposure.

4.2 Hazardous area

4.2.1 General *(1/4/2025)*

In general, safety and security zones are to comply with IACS Rec. 142, Section 2 and they are to be addressed during the risk assessment for the methanol bunkering operation taking into account the toxicity of methanol.

4.2.2 *(1/4/2025)*

In addition to the hazardous areas in accordance with Ch 7, Sec 6, Tab 1, the following Zone 1 are to be included:

- methanol bunkering station and 3 m beyond these, up to a height of 2,4 m above the deck
- areas on the open deck within spillage coamings surrounding methanol bunkering connections and manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck
- when applicable, transfer arm operating area extended by 3 m on either direction.

4.3 Materials

4.3.1 *(1/4/2025)*

Materials used in methanol transfer systems, piping system for methanol and other systems or components in contact with methanol or gas are to be in accordance with IBC Code, Chapter 6 considering the corrosion hazard of methanol.

4.4 Arrangement of bunkering system

4.4.1 **Methanol bunkering station** *(1/4/2025)*

The methanol bunkering station is to be located on open deck so that sufficient natural ventilation is provided. Closed or semi-enclosed bunkering stations will be subject to special consideration and are subject to risk assessment as specified in [4.1]. Access to closed or semi-enclosed bunkering station from other non-hazardous closed or semi-enclosed space shall be granted via airlock.

The methanol bunkering station when not located in the cargo area shall be separated from accommodation and control stations through gas tight divisions and the layout is subject to risk assessment.

Methanol bunkering station may be accepted at the ship bow and stern provided that the relevant requirements of IBC Code Para 3.7 are complied with.

The maximum allowable loads are to be indicated on a warning plate fitted on the manifold or nearby.

The manifold shall be arranged at least with the following instruments and fittings:

- pressure gauge
- pressure transmitter
- temperature gauge
- temperature transmitter
- sampling point for flammable vapor detection
- safety relief valve fitted in between the presentation flange and ESD bunkering valve.

4.4.2 Drip trays and coamings *(1/4/2025)*

Arrangements should be made for safe management of the maximum amount of methanol spills and leakages according to the risk assessment as required in [4.1]. Coamings and/or drip trays are to be provided below the bunkering connections together with a means of safely collecting and storing spills. This could be a drain to a dedicated holding tank equipped with a level indicator and alarm. Where coamings or drip trays are subject to rainwater, provision should be made to drain rainwater overboard.

4.4.3 Bunkering control station *(1/4/2025)*

Control of the bunkering operation should be possible from a bunkering control station. The bunkering control station may be within the cargo control room. At this location, overfilling alarm and automatic and manual shutdown are to be indicated.

Unobstructed direct or camera view of the methanol bunkering station is to be available from the bunkering control station.

A methanol system schematic/piping and instrumentation diagram (P&ID) shall be reproduced and permanently mounted in the bunkering control station.

4.4.4 Methanol Transfer Systems *(1/4/2025)*

The manifold for transfer of methanol fuel shall be fitted with manually operated stop valve and a remotely/automatically operated valve (ESD valve) fitted in series.

The methanol transfer system is to include at least an emergency release coupling (ERC or BRC) and an insulation flange. A Quick Connect Disconnect Coupling (QCDC) may be installed together with above mentioned components.

The ERC or BRC is to be fitted on the receiving ship side, but may be accepted also fitted on methanol transfer system side provided that the relevant scenario is considered during the risk analysis required in [4.1].

The hoses are to be adequately supported and protected to prevent potential damage or sparks in the event of activation of the ERC or BRC.

The manifolds are to be capable to withstand the allowable loads as defined in an international recognized standard or guideline such as SGMF TGN-06-04 "Technical Guidance Manifold" or equivalent.

The bunkering transfer rate is to be capable of being controlled to match with the capabilities and requirements of the receiving ship.

The maximum methanol transfer rate is to be declared and justified, taking into consideration:

- the maximum flow permitted by the ERC or BRC
- the maximum flow permitted by the hose
- the maximum flow permitted by the QCDC
- the maximum allowable working pressure of the receiving ship bunkering station.

The design of the transfer system is to be such that the lines can be drained and purged by nitrogen after a normal or emergency disconnection.

4.4.5 Methanol Bunkering ESD system *(1/4/2025)*

A bunkering ESD system is to be installed in addition to the ESD required by IBC Code, if a separate transfer system is provided.

All electrical components of the ESD systems are to be of suitable safe type taking into account the hazard categorization of the area where they are located.

4.4.6 Vapour return handling *(1/4/2025)*

If the methanol bunker ship is requested to be capable of handling all or part of the vapours from the receiving ship generated during the methanol bunkering operation, its vapour handling capacity is to be indicated and justified.

4.4.7 Lighting *(1/4/2025)*

Lighting shall illuminate the bunker station area, and if installed in a hazardous area are to be compliant with applicable hazardous area equipment requirements. Lighting shall adequately illuminate the bunkering operation work area as follows:

- methanol bunker hose(s)
- connection and couplings on both receiving ship and bunkering ship
- ESD system call points
- communication systems
- fire-fighting equipment
- passage ways / gangways intended to be used by the personnel in charge of the bunkering operation
- vent mast(s).

4.5 Mooring and fendering

4.5.1 *(1/4/2025)*

Steel to steel contact between methanol bunker ship and receiving ship e.g. via mooring lines, ladders, gangways, chains for fender support etc. shall be avoided through the use of insulation. Bunker hoses/pipes shall be supported and isolated to prevent electrical contact with the receiving ship.

4.5.2 *(1/4/2025)*

The rubber fenders used for keeping the distance between the methanol bunkering ship and receiving ship shall be built according to an international recognized standard such as ISO 17357-2 or equivalent. The dimensions and arrangement of fenders shall be verified during risk assessment as required in [4.1] taking into consideration the interferences of the hazardous areas of both ships and the minimum bend radius of the bunkering hose.

5 Hoses and pumps

5.1 Hose design requirements

5.1.1 General *(1/4/2025)*

The hoses used for bunkering are to comply with the requirements in IBC Code para. 5.7.

For bunkering hoses the following characteristics are to be defined by the designer and submitted to the Society:

- Minimum/Maximum Allowable Working Temperature
- Maximum Allowable Working Pressure
- Minimum Bend Radius
- Maximum Allowable Crush Load
- Maximum Allowable Axial Load.

5.1.2 Hose maximum working pressure and strength *(1/4/2025)*

The maximum working pressure specified by manufacturer is not to be less than 1 MPa in accordance with IBC Code para. 5.7.3.

The strength of the hoses is to be compatible with the maximum release forces of the ERC or BRC.

5.1.3 Materials *(1/4/2025)*

All materials of hose assembly are to be suitable for marine environment, compatible with each other, with methanol liquids and vapours and with the inerting media.

5.1.4 End connection and coupling *(1/4/2025)*

The end fittings are to be made of corrosion resistant material and in accordance with international recognized standards.

5.2 Type approval, testing and certification of methanol bunkering hoses

5.2.1 *(1/4/2025)*

Bunkering hoses are to be type approved by the Society.

Flexible hoses intended for the handling of methanol are to be in compliance with design and testing requirements standards EN1474-2, or EN21012 or equivalent standards and IBC Code para. 5.7.

5.2.2 *(1/4/2025)*

All hoses are to be individually certified by the Society at satisfactory outcome of testing according to [5.3], carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

5.3 Testing of Hoses at workshop

5.3.1 **Pressure test** *(1/4/2025)*

Each hose assembly is to be subjected to a hydraulic pressure test at ambient temperature to a pressure not less than 1,5 times the maximum operating (nominal) pressure, to demonstrate that the hose assembly is capable of withstanding pressure without leaking.

5.3.2 **Non destructive testing of welding** *(1/4/2025)*

Welds of the hose assembly are to be subjected to non destructive testing (NDT) according to international recognized standards.

5.4 Hoses documentation

5.4.1 *(1/4/2025)*

A hose technical file containing the following information is to be kept on board:

- hose identification number
- type approval certificate issued by Society
- product test certificate issued by Society
- overall weight of the hose and end fittings assembly
- date of entry into service
- inspection intervals and lifetime
- instructions for the handling, storage and installation of hose.

5.5 Marking of products

5.5.1 *(1/4/2025)*

Each hose is to be permanently marked according to a recognized international standard or the following information:

- Manufacturer's name or logo
- hose designation and size
- Maximum Allowable Working Pressure
- maximum and minimum allowable working temperature
- date of manufacture
- marking from Society.

5.6 Transfer pumps

5.6.1 *(1/4/2025)*

The transfer pumps if different from cargo pumps shall comply with requirements specified in Sec 5, [2.4].

All pumps are to be pressure tested in the presence of the Surveyor.

6 Quick Connect Disconnect Coupler (QCDC)

6.1 Type approval, testing and certification of QCDC

6.1.1 *(1/4/2025)*

QCDC are to be type approved by the Society.

6.1.2 *(1/4/2025)*

All QCDC are to be individually certified by the Society at satisfactory outcome of testing according to [6.3] carried out by the manufacturer in the presence of the Surveyor, unless an alternative certification scheme is agreed with the Society.

6.2 Type testing

6.2.1 *(1/4/2025)*

The QCDC is to be subjected to a type test to confirm the release performance according to an international recognized standard such as ISO 21593, ISO 16904 or equivalent.

6.3 Workshop testing

6.3.1 **Pressure test** *(1/4/2025)*

The QCDC is to be subjected to a hydrostatic pressure test, at ambient temperature, to a pressure not less than 1,5 times the Maximum Allowable Working Pressure to demonstrate that the QCDC is capable of withstanding pressure without leakage.

7 Emergency Release Coupling (ERC) and Breakaway Coupling (BRC)

7.1 Type approval, testing and certification of QCDC

7.1.1 General *(1/4/2025)*

Transfer arms and hoses shall be fitted with an Emergency Release Coupling (ERC) or Breakaway Coupling (BRC) designed to minimize the release of methanol on emergency disconnection. The emergency release coupling is to be designed as breakaway coupling i.e. with automatic disconnection in case the design loads are exceeded. The design load of the ERC or BRC are not to be greater that the manifold allowable loads as defined in [4.4.4].

Additionally the emergency release coupling may be designed with manual or remote and automatic activation by the ESD bunkering system.

7.1.2 *(1/4/2025)*

Each separate section is to contain a self-closing shut-off valve, which seals automatically on disconnection.

7.1.3 *(1/4/2025)*

All electrical components of the emergency release coupling are to be certified of a suitable safe type.

When applicable, the availability of power to the ERC is to be monitored and arranged so that bunkering operation is automatically stopped in case of loss of power supply to the ERC.

7.1.4 *(1/4/2025)*

The bunkering line is to be designed and arranged to withstand the surge pressure that may result from the activation of the ERC.

7.2 Type approval, testing and certification of ERC

7.2.1 *(1/4/2025)*

ERC are to be type approved by the Society.

7.2.2 *(1/4/2025)*

All ERCs are to be individually certified by the Society at satisfactory outcome of testing according to [7.4] carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

7.3 Type testing

7.3.1 *(1/4/2025)*

The ERC and BRC are to be subjected to a type test according to an international recognized standard such as ISO 18683 or equivalent to confirm the values of axial and shear forces at which it automatically separates. Additionally the tightness of the self-closing shut-off valves after separation is to be tested.

7.3.2 *(1/4/2025)*

When applicable, the ERC and BRC are to be subjected to a type test to confirm the release in case of remote or automatic activation.

7.4 Workshop testing

7.4.1 **Pressure test** *(1/4/2025)*

The ERC and BRC are to be subjected to a hydrostatic pressure test, at ambient temperature, to a pressure not less than 1,5 times the Maximum operating (nominal) pressure, to demonstrate that the ERC and BRC are capable of withstanding pressure without leaking.

8 Electrical insulation flanges

8.1 General

8.1.1 *(1/4/2025)*

Each insulation flange is to be subjected to a test of electrical resistance in air and the resistance is to be of at least 1000 Ω but less than 1 MΩ.

8.1.2 *(1/4/2025)*

The resistance of each insulation flange is to be measured after installation in the complete methanol transfer system and the resistance is to be not less than 1000 Ω.

9 Hose Supports and transfer arms

9.1 General

9.1.1 *(1/4/2025)*

Arrangements are to be made so that the hoses can be suitably supported in such a way that the minimum allowable bending radius is complied with.

9.1.2 *(1/4/2025)*

Arrangements such as cranes or winches are to be available for the handling of hoses whose size or weight does not allow a safe manual handling.

9.1.3 *(1/4/2025)*

Non electrical equipment located in hazardous area and belonging to items such as cranes, winches, etc. is to be suitable for explosive atmosphere according to international recognized standard (e.g. ISO 80079-36 or equivalent).

9.1.4 *(1/4/2025)*

Electrical equipment located in hazardous area is to comply with IBC Code para 10.

9.2 Transfer arms

9.2.1 *(1/4/2025)*

Transfer arms are to be approved by the Society.

9.2.2 *(1/4/2025)*

Transfer arms are to be designed and constructed in accordance with a recognized national or international standards acceptable to the Society as EN1474-1.

9.2.3 *(1/4/2025)*

The maximum allowable operating amplitude and forces acting on the loading arm during the bunkering operations are to be defined and compatible with the hoses and ERC. The exceeding of loading arm envelope is to activate two stages alarms in bunker control station and on the navigation bridge.

The initiation of the first stage is to activate a visual and audible alarm.

The initiation of the second stage is to activate the ESD and ERC system.

9.2.4 *(1/4/2025)*
All loading arms are to be individually certified by the Society at satisfactory outcome of tests, as required for lifting appliances and operational tests, or per recognized international standards, carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

9.2.5 *(1/4/2025)*
The operational test per [9.2.4] is to give evidence of compliance with the design criteria per [9.2.3].

10 Inert Gas System

10.1 Installation and inerting capacity

10.1.1 *(1/4/2025)*
An inert gas system is to be fitted on board, to enable purging and inerting of the bunkering lines; the system is to be in compliance with IBC Code para. 8.5.

10.1.2 *(1/4/2025)*
The inerting capacity is to be designed according the bunkering operations and when based on inert gas storage on board, the capacity is not to be less than 5 times the volume of the hose and pipes to be purged.

11 Vapour detection

11.1 Vapour detection in enclosed spaces

11.1.1 *(1/4/2025)*
Permanently installed vapour detectors are to be fitted in all hazardous areas including bunkering station if of enclosed or semi-enclosed type, methanol process room and other enclosed spaces containing methanol piping or other equipment not equipped with double walled piping.

11.1.2 *(1/4/2025)*
The number of detectors in each space is to be considered taking into account the size, layout and ventilation of the space. At least two independent detectors are required in each hazardous area.

11.1.3 *(1/4/2025)*
The detection equipment is to be located where vapour may accumulate and in the ventilation outlets. Gas/vapour dispersion analysis or a physical smoke test is to be used to find the best arrangement.

11.1.4 *(1/4/2025)*
An audible and visual alarm is to be activated before the vapour concentration reaches 20% of the lower explosive limit (LEL).

11.1.5 *(1/4/2025)*
Audible and visual alarms from the vapour detection equipment are to be located on the bridge and in the bunkering control station.

11.2 Vapour detection in open spaces

11.2.1 *(1/4/2025)*
The installation of vapour detectors camera is to be evaluated on the basis of the risk assessment as defined in [4.1], for open spaces classed as hazardous areas (e.g. bunkering station, hose handling areas).

12 Control and safety systems

12.1 General

12.1.1 *(1/4/2025)*
Appropriate segregation shall be maintained between control, monitoring/alarm and safety functions to limit the effects of single failures during bunkering.

Failure of one part of the integrated system shall not affect the functionality of other parts, except for those functions directly dependent on the defective part.

Being the bunkering control system combined with the cargo control system all relevant requirements specified in the IBC Code para. 5.6 are to be complied with.

12.2 Emergency Shut-down Systems (ESD)

12.2.1 *(1/4/2025)*

An ESD system is to be fitted to safely and effectively stop the transfer of methanol (and vapour as applicable) between the receiving ship and the bunkering ship in the event of an emergency during the bunkering operation.

The ESD safety system is to be designed so as to limit the consequence of failures. It is to be constructed on the fail-to safety principle.

The ESD system is to be of the self-check type; as a rule, failure within the ESD including the outside connection, is to activate an alarm.

The control systems involved in the ESD, which is a linked system to allow both parties (on board receiving ship and the methanol bunkering ship) to shut down the transfer in an emergency situation, is to be capable of being activated automatically or manually.

The ESD system normally includes two stages:

- ESD-stage 1, a stage in which the methanol transfer process is shut down in a controlled manner
- ESD-stage 2, a stage in which decoupling of the transfer system between the methanol bunker ship and receiving ship is activated.

The ESD-1 and ESD-2 logic shall be verified and agreed among stakeholders during the risk assessment as required in [4.1] also considering applicable international recognized standard or guidelines (e.g. SIGTTO Recommendations for Emergency Shutdown and Related Safety Systems).

Where provided, override command of ESD system has to be clearly indicated in the Bunkering control station.

The ESD-1 and ESD-2 trips are to trigger visual and audible alarms in the navigation bridge, engine control room, cargo and bunkering control room and manifold area.

12.2.2 *(1/4/2025)*

An ESD link system (SSL ship/shore link or ship/ship link) is to be fitted. The SSL may be various type (e.g.: electric, fibre-optic, radio transmission, pneumatic). The SSL is to have an adequate reliability and redundancy level according to a recognized international standard or guideline (e.g.: SIGTTO Recommendations for Emergency Shutdown and Related Safety Systems).

12.2.3 *(1/4/2025)*

At least one local manual activation position for the ESD system is to be fitted in a place that has a clear view of the manifold area (the 'clear view' may be provided via CCTV) but is at a safe distance from the manifold.

12.2.4 *(1/4/2025)*

Any activation of the ESD systems is to be implemented simultaneously on both methanol bunker vessel and receiving ship.

12.2.5 *(1/4/2025)*

At least one local manual activation position for the ESD system is to be made available for the methanol fueled ship being bunkered, this may be in the form of an ESD System pendant with sufficient length of cable.

12.2.6 *(1/4/2025)*

The bunkering lines are to be designed and arranged to withstand the surge pressure that may result from the activation of the emergency release coupling and quick closing of ESD valves. If not demonstrated to be required at a higher value due to pressure surge considerations, a default time of 5 seconds from the trigger of the alarm to full closure of the ESD valves is to be arranged.

The timing sequence is to ensure that the involved pumps and vapour compressors (if any) are given a stop command not later than the closing command to the manifold valve.

12.2.7 *(1/4/2025)*

The components of the ESD system located in hazardous and safety zones are to be of a suitable safe type.

12.2.8 *(1/4/2025)*

All electrical components of the emergency release coupling actuator and of the ESD systems that are provided by the methanol bunkering ship are to be approved and certified by the Society.

12.3 Alarms and safety actions

12.3.1 *(1/4/2025)*

The alarms and safety function/actions required for the transfer system are given in Tab 3 and they are additional to those required in the MSC.1/Circ.1621 Table 15.1. The extent of alarms and safety functions may be reconsidered on the basis of outcome from risk assessment.

The receiving ship is expected to be capable of transmitting at least an ESD signal via an hardwired system.

Table 3 : Alarms and safety actions required for the transfer system *(1/4/2025)*

Parameters	Alarm	Activation of the Bunker ESD systems (ESD-1)	Automatic activation of the emergency release coupling (ESD-2) **(1)**
Fire Detection in way of tank domes or manifold area for receiving ship and methanol bunker ship **(1)**	X	X	
Shutdown signal from shore or receiving ship	X	X	
Loss of ESD linked system **(1)**	X	X	
Loss of power supply to methanol bunkering control system	X	X	
ESD logic failure	X	X	
Low Pressure in cargo valve remote control system	X		
Low Low Pressure in cargo valve remote control system	X	X	
Stop of the ventilation of enclosed or semi-enclosed bunkering station	X	X	
Loss of actuating power to the common loading arm maneuvering system or to the ERC of individual loading arms	X	X	
High level in surge drum (where provided)	X		
High High level in surge drum (where provided)	X	X	
Low pressure in the supply cargo tank	X		
Low Low pressure in the supply cargo tank	X	X	
Sudden pressure drop at the transfer pump discharge	X	X	
High level in the methanol storage tank of receiving ship **(1)**	X		
High High level in the methanol storage tank of receiving ship **(1)**	X	X	
High pressure in the methanol storage tank of receiving ship **(1)**	X		
High High pressure in the methanol storage tank of receiving ship **(1)**	X	X	
High pressure in the manifold vapor return system	X		
High high pressure in the manifold vapor return system (if any)	X	X	
High pressure in the manifold of liquid supply system	X		
High High pressure in the manifold of liquid supply system	X	X	
Methanol leakage/spill in the manifold drip tray/coamings	X	X	
Vapour detection in bunkering station of receiv-ing ship **(1)**	X	X	
Vapour detection in bunkering station of bunkering ship	X	X	
(1) when the receiving ship is equipped with an SSL compatible with the methanol bunkering ship SSL			

Parameters	Alarm	Activation of the Bunker ESD systems (ESD-1)	Automatic activation of the emergency release coupling (ESD-2) **(1)**
Excessive movement of ship from berth/ship	X	X	X
Disconnection of the ERC	X	X	
(1) when the receiving ship is equipped with an SSL compatible with the methanol bunkering ship SSL			

12.4 Communication systems

12.4.1 *(1/4/2025)*
A two-way voice communication system is to be provided between the methanol bunkering ship and the receiving ship.

12.4.2 *(1/4/2025)*
The components of the communication system located in hazardous and safety zones are to be of a suitable safe type.

13 Testing of the methanol transfer system at workshop

13.1 Pressure test

13.1.1 *(1/4/2025)*
All piping and pressure vessels of the methanol transfer system are to be subjected to a hydraulic pressure test in the presence of a Society Surveyor, at ambient temperature, to a pressure not less than 1,5 times the nominal pressure, to demonstrate the capability to withstand pressure without leaking.

13.2 Inspection of welds

13.2.1 *(1/12/2020)*
When applicable, the welds of the methanol transfer system are to be subjected to a non-destructive testing and all butt welds are to be subjected to a 100% radiographic or ultrasonic examination.

14 Testing and trials of the methanol transfer system at yard

14.1 Onboard tests and trials

14.1.1 *(1/4/2025)*
After assembly on board, the following tests and trials are to be carried out in the presence of a Surveyor.

14.2 Piping leak test

14.2.1 *(1/4/2025)*
A leak test, using air or water or other suitable medium, of the completely assembled and equipped methanol transfer and vapour return systems, in steps of 10-20% up to 90% of the operational pressure of the methanol system is to be carried out in the presence of a Society Surveyor.

14.3 Inerting

14.3.1 *(1/4/2025)*
Inerting of the total methanol system following the approved inerting procedure is to be carried out in the presence of a Society Surveyor.

15 Implementation survey

15.1 Survey at the first methanol bunkering

15.1.1 *(1/4/2025)*
Upon issuance of the additional service feature **methanol bunker**, a dedicated survey is to be carried out on occasion of the first methanol bunkering to be carried out according to the approved methanol bunkering procedure.

15.1.2 *(1/4/2025)*

During the survey the following is to be carried out:

a) examination of transfer piping systems including supporting arrangements.

b) verification of satisfactory operation of:

- control and monitoring systems
- connections systems (QCDC)
- ESD system
- piping purging and inerting systems.

16 Additional features

16.1 IG-Bunker (Inert Gas Bunker)

16.1.1 General *(1/4/2025)*

The additional feature **IG-Bunker** (Inert Gas Bunker) is assigned to methanol bunker ship designed to also supply inert gas to a methanol fueled ship to ensure inerting of the receiving ship systems, and complying with the following requirements.

16.1.2 **Inert Gas system** *(1/4/2025)*

The inert gas system is to comply with Pt C, Ch 4, Sec 1, [9].

16.1.3 **Piping system** *(1/4/2025)*

The lines used for the inert gas are to be separate from the methanol liquid and vapour lines used for normal operation.

16.1.4 **Document to be submitted** *(1/4/2025)*

The following documents are to be submitted to the Society for approval in addition to the information required in [3]:

- diagram of the Inert gas system
- procedure for supplying inert gas to the receiving ship.

16.2 BT (Bunker Trust)

16.2.1 General *(1/4/2025)*

The additional feature **BT** (Bunker Trust) is assigned to methanol bunker ship designed with arrangement for the verification of the methanol quality and quantity delivered to the receiving ship according to international recognized standard (e.g. ISO 6583) or equivalent or according to a methanol fuel specification agreed among the stakeholders.

16.2.2 **Documents to be submitted** *(1/4/2025)*

The following documents are to be submitted to the Society for approval in addition to the information required in [3]:

- diagram of the methanol sampling arrangement
- technical specification of methanol analyzer
- Methanol Sampling procedure
- evidence of approval of the measuring system according to MID or OIML R117-1.

16.2.3 **Sampling System** *(1/4/2025)*

The ship has to be fitted with a sampling system in accordance with international recognized standard (e.g. IMPCA Methanol Sampling Methods - Procedures for Methanol Cargo Handling on Shore and Ship) or equivalent. Other type of system or piping arrangement are subject to special consideration and they are evaluated case by case.

The sampling procedure shall be included in the risk assessment as required in [4.1.2].

The methanol analyzer is to be type approved.

16.2.4 **Custody Transfer Measuring System** *(1/4/2025)*

A Custody Transfer Measuring System is to be installed on the methanol bunker ship.

A recognized thirty party should approve the design and instruments against MID or OIML R117-1; evidence of this is required to be supplied to the Society.

16.3 VCS-Bunker (Vapour Control System Bunker)

16.3.1 General *(1/4/2025)*

The additional feature **VCS-Bunker** (Vapour Control System Bunker) is assigned to methanol bunker ship in compliance with Pt F, Ch 13, Sec 7 for the assignment of notation **VCS-TRANSFER**.

16.3.2 Vapour return handling *(1/4/2025)*

The methanol bunker ship is to be capable of handling all or part of the vapours from receiving ship generated during the methanol bunkering operation, in addition to its own Boil-Off Gas (BOG), without release to the atmosphere. The vapour handling capacity of the methanol bunker ship is to be indicated and justified.

Different ways to dispose of the vapours may be considered, such as:

- re-liquefaction
- utilization by the gas consuming equipment of the methanol bunkering ship (e.g. gas or dual-fuel engines or boilers)
- gas combustion unit.

A combination of these means is possible and other solutions may be accepted if they are duly justified to the Society.

Chapter 9
LIQUEFIED GAS CARRIER

SECTION 1 GENERAL

1 Scope

1.1 Applicability

1.1.1 IGC Code requirements and the Society's Rules *(1/10/2025)*

a) Ships which are intended for the carriage of liquefied gases are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, as amended. In these Rules reference to this Code and its amendments is made by the wording "IGC Code".

Accordingly, for ships for which the service notation **liquefied gas carrier**, in accordance with Pt A, Ch 1, Sec 2, [4.5.5], is requested, the IGC Code requirements are to be considered as rule requirements, with the exception indicated in [1.1.2].

When the additional service feature **LNG bunker** or **ammonia bunker** is requested, the ship is to be in compliance with the requirements in App 1.

When the additional service feature **REGASIFICATION SYSTEM** is requested, the ship is to be fitted with a regasification system in compliance with the requirements in App 2.

b) The requirements of this Chapter supplement those of the IGC Code, as amended. These requirements include additional mandatory class requirements, as well as the Society's interpretations of the IGC Code, which are also to be considered mandatory for class.

c) This Chapter and the IGC Code refer to ships carrying those products which are listed in the table in Chapter 19 of the IGC Code and in Section 19 of this Chapter.

d) This Chapter and the IGC Code include requirements for the carriage of cargo in containment systems incorporating integral, membrane or independent tank types as detailed in Chapter 4 of the IGC Code and in Sec 4.

e) In general, this Chapter applies to cargo containment and handling systems and to the interfaces between these systems and the remainder of the ship, which is to comply with the applicable Sections of the hull and machinery Rules.

1.1.2 IGC Code requirements not within the scope of classification *(1/1/2021)*

The following requirements of the IGC Code are not within the scope of classification:

- Chapter 1, Section 1.3 - Equivalents
- Chapter 1, Section 1.4 - Surveys and certification
- Chapter 2, Section 2.2.8 - Conditions of loading
- Chapter 2, Section 2.3 - Damage assumptions
- Chapter 2, Section 2.5 - Flood assumptions
- Chapter 2, Section 2.6 - Standard of damage
- Chapter 2, Section 2.7 - Survival requirements
- Chapter 11 - Fire protection and extinction
- Chapter 14 - Personnel protection
- Chapter 18 - Operating requirements (apart for few exceptions stated in Sec 18).

These requirements are applied by the Society when acting on behalf of the flag Administration, within the scope of delegation (see [1.1.7]).

1.1.3 Carriage of products not listed in the Code

The requirements of the IGC Code and the additional requirements of this Chapter are also applicable to new products, which may be considered to come within the scope of these rules, but are not at present listed in the table in Chapter 19 of the IGC Code.

1.1.4 Particularly hazardous products

For the carriage in bulk of products which are not listed in the table in Chapter 19 of the IGC Code, presenting more severe hazards than those covered by the IGC Code, the Society reserves the right to establish requirements and/or conditions additional to those contained in these rules.

1.1.5 Correspondence of the IGC Code with Part E Chapter 9 of the Rules

All the requirements of this Chapter are cross referenced to the applicable Chapters, Sections or paragraphs of the IGC Code, as appropriate.

1.1.6 Equivalencies

As far as the requirements for class are concerned, the following wording in the IGC Code is to be given the meanings indicated in Tab 1.

Table 1

IGC Code word	Meaning for Classification only
Administration	Society
IBC Code or Chemical Code	Part E Chapter 8 of the Rules
Recognised Standard	Rules
should be	is to be or are to be (as applicable)

1.1.7 Certificate of fitness

a) The responsibility for interpretation of the IGC Code requirements for the purpose of issuing an International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk lies with the Administration of the state whose flag the ship is entitled to fly.

b) Whenever the Society is authorised by an Administration to issue on its behalf the "Certificate of Fitness for the Carriage of Liquefied Gases in Bulk", or where the Society is authorised to carry out investigations and surveys on behalf of an Administration on the basis of which the "Certificate of Fitness for the Carriage of Liquefied Gases in Bulk" will be issued by the Administration, or where the Society is requested to certify compliance with the IGC Code, the full compliance with the requirements of the IGC Code, including the operative requirements mentioned in [1.1.2], is to be granted by the Society.

2 Additional requirements

2.1 Emergency towing arrangement

2.1.1 Emergency towing arrangements are to be fitted on liquefied gas tankers of 20.000 dwt and above in accordance with Pt B, Ch 10, Sec 4, [4].

2.2 Steering gear

2.2.1 Additional requirements for steering gear of liquefied gas carriers of 10.000 dwt and above are given in Ch 7, Sec 4, [7].

3 Documentation to be submitted

3.1 Standard list of documents

3.1.1 Tab 2 lists the plans, information, analysis, etc. which are to be submitted in addition to the information required in the other Parts of the Rules for the parts of the ship not affected by the cargo, as applicable.

4 Cargo equipment trials

4.1 Scope

4.1.1 Trials in working conditions

All the equipment to which this Chapter is applicable is to be tested in actual working conditions.

4.1.2 Trials to be carried out when the ship is loaded

Those trials which may only be carried out when the ship is loaded are to be held at the first loading of the ship.

4.2 Extent of the tests

4.2.1 Cargo equipment testing procedure

The cargo equipment testing procedure is to be submitted to the Society for review.

4.2.2 Ships with mechanical refrigeration units

Ships fitted with a mechanical refrigeration unit are to be subjected to an initial testing procedure in order to check the suitability of the plant in respect of the applicable requirements. The recording of the data of the reliquefaction system, such as working duration and ambient conditions, may be carried out during the first loaded voyage.

4.2.3 Use of cargo as fuel

The arrangements for using cargo as fuel are to be subjected to a special testing procedure.

Table 2 : Documents to be submitted *(1/7/2020)*

No	A/I	Documents
1	I	List of products to be carried, including maximum vapour pressure, maximum liquid temperature and other important design conditions
2	I	General arrangement plan, showing location of cargo tanks and fuel oil, ballast and other tanks
3	I	P&A manual, when applicable
4	A	Gas-dangerous zones plan
5	A	Location of void spaces and accesses to dangerous zones
6	A	Air locks between safe and dangerous zones
7	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
8	A	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.
9	A	Calculation of the hull temperature in all the design cargo conditions
10	A	Distribution of quality and steel grades in relation to the contemplated actual temperature obtained by the calculation in item 9
11	A	Hull stress analysis
12	A	Hull ship motion analysis, where a direct analysis is preferred to the methods indicated in Sec 4
13	A	Intact and damage stability calculations
14	A	Scantlings, material and arrangement of the cargo containment system, including the secondary barrier, if any.
15	A	Stress analysis of the cargo tanks, including fatigue analysis and crack propagation analysis for type “B” tanks. This analysis may be integrated with that indicated in item 11
16	I	Calculation of the thermal insulation suitability, including boil-off rate and refrigeration plant capability, if any, cooling down and temperature gradients during loading and unloading operations
17	A	Details of insulation
18	A	Details of ladders, fittings and towers in tanks and relative stress analysis, if any
19	A	Details of tank domes and deck sealings
20	A	Plans, arrangement and calculations of safety relief valves
21	A	Details of cargo handling and vapour system, including arrangements and details of piping and fitting
22	A	Details of cargo pumps and cargo compressors
23	A	Details of process pressure vessels and relative valving arrangement
24	A	Piping stress analysis when T<-110°C
Note 1: A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

No	A/I	Documents
25	A	Control cargo tank pressure philosophy (description)
26	A	Cargo operating manual
27	A	Bilge and ballast system in cargo area
28	A	Gas freeing system in cargo tanks including inert gas system
29	A	Interbarrier space drainage, inerting and pressurisation systems
30	A	Ventilation system in cargo area
31	A	Hull structure heating system, if any
32	A	Refrigeration and reliquefaction plant system diagram, if any
33	A	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
34	A	Schematic electrical wiring diagram in cargo area
35	A	Gas detection system
36	A	Cargo tank instrumentation, including cargo and hull temperature monitoring system
37	A	Emergency shutdown system
38	A	Jettison system, if any
39	A	Details of fire-extinguishing appliances and systems in cargo area
40	A	Loading and unloading operation description, including cargo tank filling limits
41	A	Cargo tank testing and inspection procedures
42		For machinery using gas as fuel
	I	a) General arrangement plan of the machinery plant
	I	b) Description of the entire plant
	A	c) Gas piping plans for the machinery plant
	A	d) Complete list of the safety, gas detection and warning equipment
	A	e) Drawings of the boilers
	I	f) Detailed drawings of the gas inlet and fuel inlet equipment
	I	g) Gas characteristics
	A	h) General arrangement plan of the gas treatment plant, including gas compressors, prime movers and gas preheaters
	A	i) Drawings of the gas storage tanks
	A	j) Drawings of the gas compressors and preheaters
Note 1: A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

5 Construction and testing

5.1 Equipment to be witnessed

5.1.1 *(1/1/2021)*

In case any of the following equipment is fitted:

a) regasification, reliquefaction and inert gas production system,

b) equipment for use of gas as fuel for boilers and internal combustion engines

is also to be tested to the satisfaction of the Surveyor.

SECTION 2 SHIP SURVIVAL CAPABILITIES AND LOCATION OF CARGO TANKS

1 Freeboard and intact stability

1.1 Intact stability

1.1.1 General

IGC CODE REFERENCE : Ch 2, 2.2.2

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.8] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

1.1.2 Free surface effect of liquids

IGC CODE REFERENCE : Ch 2, 2.2.3

The free surface effect is to be calculated in accordance with Pt B, Ch 3, Sec 2, [4].

1.1.3 Information to be supplied

IGC CODE REFERENCE : Ch 2, 2.2.5

The Master of the ship is to be supplied with a Loading Manual as specified in Pt B, Ch 11, Sec 2, [3] and a Trim and Stability booklet as specified in Pt B, Ch 3, App 2.

SECTION 3 SHIP ARRANGEMENT

1 Segregation of the cargo area

1.1 Segregation of hold spaces

1.1.1 Bow thruster location

IGC CODE REFERENCE : Ch 3, 3.1.1

Bow thrusters are allowed to be fitted forward of the hold spaces.

2 Accommodation, service and machinery spaces and control stations

2.1 General

2.1.1 Precautions against hazardous vapours

IGC CODE REFERENCE : Ch 3, 3.2.2

Compliance with the relevant requirements of the IGC Code, in particular with 3.2.4, 3.8, 8.2.10 and 12.1.6, as applicable, also ensures compliance with the requirements in IGC Code 3.2.2, relevant to precautions against hazardous vapours.

2.1.2 Air outlets

IGC CODE REFERENCE : Ch 3, 3.2.4

The requirements in IGC Code 3.2.4, relevant to air intakes, are also intended to be applicable to air outlets. This interpretation also applies to the requirements in IGC Code 3.8.4

2.1.3 Doors facing cargo area

IGC CODE REFERENCE : Ch 3, 3.2.4

Doors facing the cargo area or located in prohibited zones in the sides are to be restricted to stores for cargo-related and safety equipment, cargo control stations as well as decontamination showers and eye wash.

Where such doors are permitted, the space may not give access to other spaces covered in IGC Code 3.2.4 and the common boundaries with these spaces are to be insulated with A60 class bulkheads.

2.1.4 Exemptions, ventilation openings and type of closures

IGC CODE REFERENCE : Ch 3, 3.2.6

The requirement for fitting air intakes and openings with closing devices operable from inside the space in ships intended to carry toxic products is to apply to spaces which are used for the ship’s radio and main navigating equipment, cabins, mess rooms, toilets, hospitals, galleys, etc., but does not apply to spaces not normally manned such as engine room casings, steering gear compartments.

The closing devices are to give a reasonable degree of gas-tightness. Ordinary steel fire-flaps without gaskets/seals are normally not considered satisfactory.

2.1.5 Openings for removal of machinery

IGC CODE REFERENCE : Ch 3, 3.2.6

Bolted plates of A60 class for removal of machinery may be accepted on bulkheads facing cargo areas, provided signboards are fitted to warn that these plates may only be opened when the ship is in gas-free condition.

3 Cargo pump rooms and cargo compressor rooms

3.1 Location of cargo pump rooms and cargo compressor rooms

3.1.1 Electrical equipment in cargo pump rooms and cargo compressor rooms

IGC CODE REFERENCE : Ch 3, 3.3

Cargo pump rooms and/or cargo compressor rooms of ships carrying flammable gases may not contain electrical equipment, except as provided for in Chapter 10 of the IGC Code, or other ignition sources such as internal combustion engines or steam engines with operating temperature which could cause ignition or explosion of mixtures of such gases, if any, with air.

4 Access arrangement

4.1 Access to compartments in the cargo area

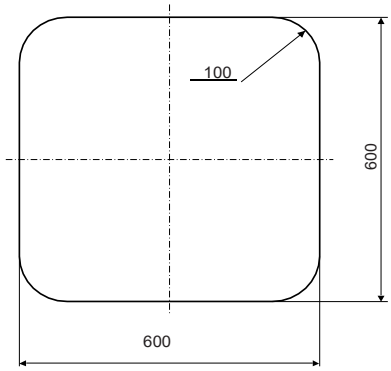
4.1.1 Passage through hatches and manholes *(1/1/2020)*

IGC CODE REFERENCE : Ch 3, 3.5

For the purpose of the requirements in IGC Code 3.5.3, the following applies:

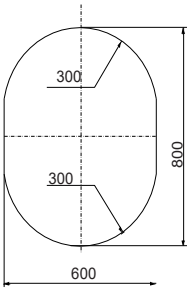
a) The term “minimum clear opening of not less than 600 x 600 mm” means that such openings may have corner radii up to a maximum of 100 mm (see Fig 1).

Figure 1 : Minimum horizontal hatch size



b) The term “minimum clear opening of not less than 600 x 800 mm” also includes an opening of the size specified in Fig 2:

Figure 2 : Minimum size of manholes



4.1.2 Cofferdams

IGC CODE REFERENCE : Ch 3, 3.5

Where fitted, cofferdams are to have sufficient size for easy access to all their parts. The width of the cofferdams may not be less than 600 mm.

4.1.3 Pipe tunnels

IGC CODE REFERENCE : Ch 3, 3.5

Pipe tunnels are to have enough space to permit inspection of pipes. The pipes in pipe tunnels are to be installed as high as possible from the ship’s bottom.

4.1.4 Access to pipe tunnels

IGC CODE REFERENCE : Ch 3, 3.5

Access to pipe tunnels through manholes in the engine space is not permitted.

4.2 Access to the bow

4.2.1 *(1/7/2008)*

This item [4.2] applies to ships subject to the International Load Line Convention 1966, as amended.

4.2.2 *(1/7/2006)*

Liquefied gas carriers are to be provided either with a gangway between the superstructure or deckhouse aft and the forecastle, or with equivalent arrangements in accordance with the International Load Line Convention 1966, as amended.

4.2.3 *(1/7/2006)*

Liquefied gas carriers are to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means are to be accepted by the Society.

Note 1: The Society considers means in compliance with the Guidelines adopted by the Maritime Safety Committee of IMO with Resolution MSC.62(67) on 5/12/1996 as being acceptable.

5 Air-locks

5.1 Arrangement

5.1.1

IGC CODE REFERENCE : Ch 3, 3.6.1

Air-locks are to be such as to provide easy passage and are to cover a deck area of not less than 1,5 m^2. Air-locks are to be kept unobstructed and may not be employed for other uses, such as storage.

5.2 Alarm

5.2.1 Alarm signalling lamp

IGC CODE REFERENCE : Ch 3, 3.6.3

The alarm systems are to be of the intrinsically safe type. However, signalling lamps may be of a safe type authorised for the dangerous spaces in which they are installed.

5.3 Electrical equipment

5.3.1 Acceptable alternatives to differential pressure

IGC CODE REFERENCE : Ch 3, 3.6.4

The following means are considered acceptable alternatives to differential pressure sensing devices in spaces having a ventilation rate not less than 30 air changes per hour:

- monitoring of current or power in the electrical supply to the ventilation motors; or
- air flow sensors in the ventilation ducts.

In spaces where the ventilation rate is less than 30 air changes per hour and where one of the above alternatives is fitted, in addition to the alarms required in IGC Code 3.6.3, arrangements are to be made to de-energise electrical equipment which is not of the certified safe type if more than one air-lock door is moved from the closed position.

5.3.2 Compressors for boil-off system

IGC CODE REFERENCE : Ch 3, 3.6.4

Lack of overpressure or air flow is not to imply the stopping of motors driving compressors used for the boil-off system mentioned in IGC Code 16; therefore, such engines are to be of the certified safe type and the relevant control appliance is to be fitted in a non-gas-dangerous space.

The requirement above is not applicable if, during manoeuvring and operations in port, only fuel oil is used or when the automatic transfer from gas to fuel oil, as per IGC Code 16.5.4, operates also when such electric motors are stopped without causing the shut-off of the boiler.

5.4 Ventilation

5.4.1 Air changes

IGC CODE REFERENCE : Ch 3, 3.6.5

The spaces protected by air-locks are to be ventilated for the time necessary to give at least 10 air changes prior to energising the non-safe type electrical installations.

6 Bilge, ballast and fuel oil arrangements

6.1 Drainage arrangement

6.1.1 Drainage of dry spaces in the cargo area

IGC CODE REFERENCE : Ch 3, 3.7

Dry spaces within the cargo area are to be fitted with a bilge or drain arrangement not connected to the machinery space.

Spaces not accessible at all times are to be fitted with sounding arrangements.

Spaces without a permanent ventilation system are to be fitted with a pressure/vacuum relief system or with air pipes.

6.2 Additional requirements relative to the bilge system

6.2.1 Operation of the bilge system in cargo and interbarrier spaces

IGC CODE REFERENCE : Ch 3, 3.7

Bilge arrangements for holds containing cargo tanks and for interbarrier spaces are to be operable from the weather deck.

6.2.2 Means for leakage detection

IGC CODE REFERENCE : Ch 3, 3.7

With reference to the means to ascertain leakages in holds and/or in interbarrier spaces, the following requirements apply:

- the above-mentioned means is to be suitable to ascertain the presence of water:
  - in holds containing type C independent tanks
  - in holds and interbarrier spaces outside the secondary barrier
- the above-mentioned means is to be suitable to ascertain the presence of liquid cargo in the spaces adjacent to cargo tanks which are not type C independent tanks.

  Where the aforesaid spaces may be affected by water leakages from the adjacent ship structures, the means is also to be suitable to ascertain the presence of water.

  Where the above-mentioned means is constituted by electrical level switches, the relevant circuits are to be of the intrinsically safe type and signals are to be transduced to the wheelhouse and to the cargo control station, if fitted.

7 Bow or stern loading and unloading arrangements

7.1 Locations of stopping devices for cargo pumps and compressors

7.1.1

IGC CODE REFERENCE : Ch 3, 3.8.7

Devices to stop cargo pumps and cargo compressors and to close cargo valves are to be fitted in a position from which it is possible to keep under control the loading/unloading manifolds.

8 Hull outfitting

8.1 Equipment

8.1.1 Emergency towing arrangements

The specific requirements in Pt B, Ch 10, Sec 4, [4] for ships with the service notation **liquefied gas carrier** and not less than 20000 t deadweight are to be complied with.

SECTION 4 CARGO CONTAINMENT

Symbols

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

1 Definitions

1.1 Design pressure in harbour conditions

1.1.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.13.2.3

Where the vapour pressure in harbour conditions is greater than p_0, defined in IGC 4.1.2, this value is to be specified in the operating instructions for the ship's Master.

1.2 Design temperature

1.2.1 **Use of cargo heater to raise the cargo temperature** *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.1.3

Where a cargo heater, intended to raise the cargo temperature to a value permissible for cargo tanks, is envisaged, the following requirements are to be complied with:

- the piping and valves involved are to be suitable for the design loading temperature
- a thermometer is to be fitted at the heater outlet. It is to be set at the design temperature of the tanks and, when activated, it is to give a visual and audible alarm. This alarm is to be installed in the cargo control station or, when such a station is not foreseen, in the wheelhouse.
- The following note is to be written on the Certificate of Fitness: "The minimum permissible temperature in the cargo preheater is °C".

2 Design loads

2.1 Internal pressure for integral tanks, membrane tanks and type A independent tanks

2.1.1 General

The inertial internal liquid pressure is to be calculated according to Part B, Chapter 5.

2.2 Internal pressure for type B and C independent tanks

2.2.1 General *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4 13.2 and 4.28

The inertial internal liquid pressure is to be calculated considering the ship in the following mutually exclusive conditions:

Figure 1 : Dimensionless acceleration in upright ship condition

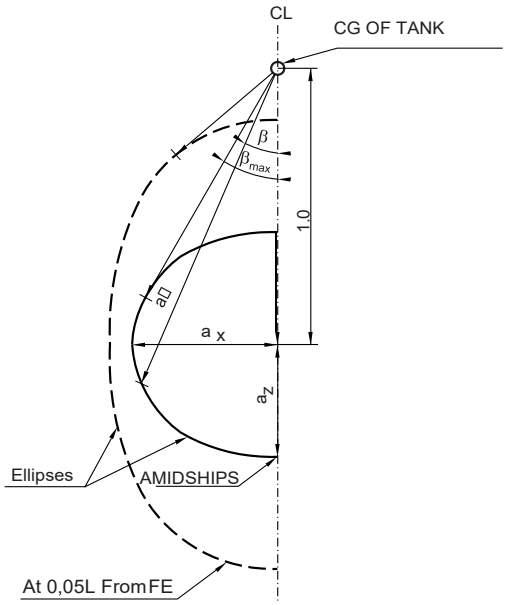


Figure 2 : Dimensionless acceleration in inclined ship condition

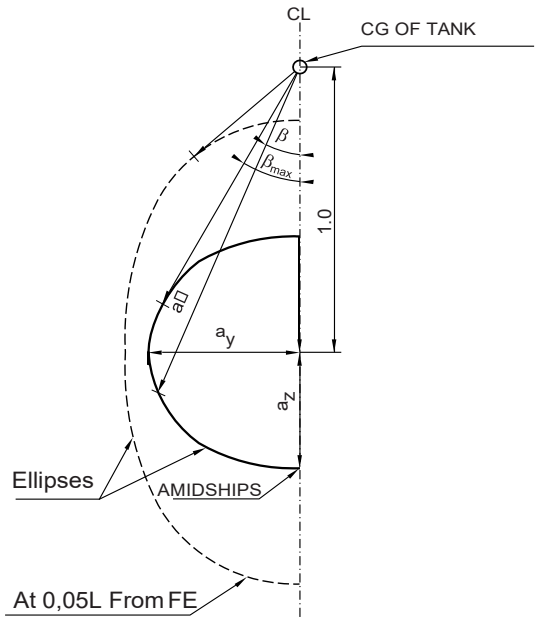
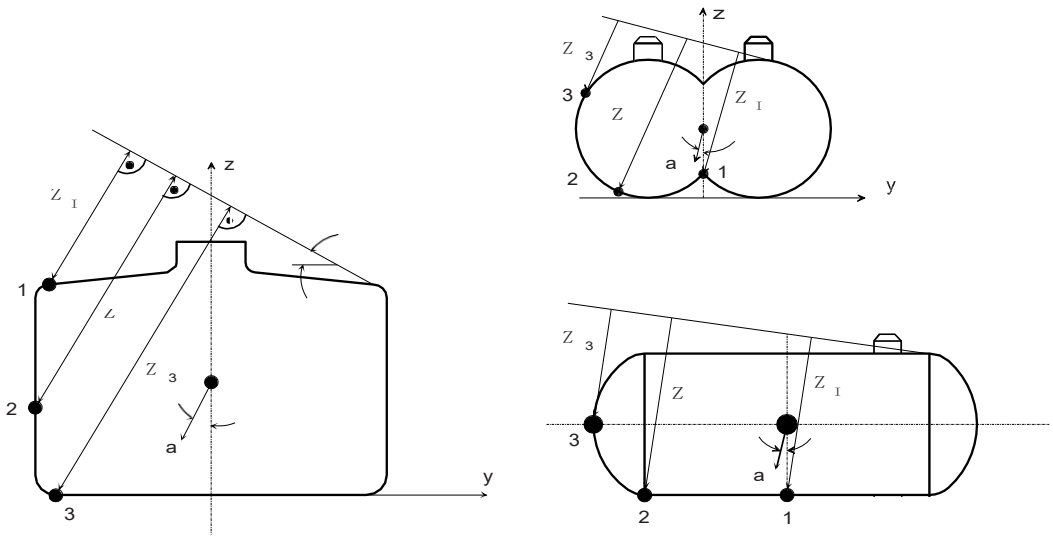


Figure 3 : Determination of liquid height Z_β for pressure points 1, 2 and 3



- upright ship conditions (see [2.2.2])
- inclined ship conditions (see [2.2.3]).

2.2.2 Accelerations in upright ship conditions *(1/1/2020)*

In these conditions, the ship encounters waves which produce ship motions in the X-Z plane, i.e. surge, heave and pitch.

The dimensionless acceleration a_β is to be obtained, for an arbitrary direction β, in accordance with Fig 1, in which the wave transverse and vertical accelerations a_X and a_Z, respectively, are calculated from the formula in IGC Code 4.28.2.

2.2.3 Accelerations in inclined ship conditions *(1/1/2020)*

In these conditions, the ship encounters waves which produce ship motions in the X-Y and Y-Z planes, i.e. sway, heave, roll and yaw.

The dimensionless acceleration a_β is to be obtained, for an arbitrary direction β, in accordance with Fig 2, in which the wave longitudinal and vertical accelerations a_Y and a_Z, respectively, are calculated from the formula in IGC Code 4.28.2.

2.2.4 Liquid heights and pressure *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.28.1.2

The liquid heights Z_β are to be calculated in accordance with Fig 3 at each calculation point of the tank.

At each calculation point, the maximum internal pressure $(P_{gd})_{max}$ is to be obtained for the β direction which gives the maximum value of P_{gd}, according to IGC Code 4.28.1.2 (see Fig 4).

2.2.5 Cargo mass density *(1/1/2020)*

Where the maximum mass density of the liquid carried is not given, the following values, in t/m^3, are to be considered:

- ρ_L = 0,50 t/m^3 for methane
- ρ_L = 0,58 t/m^3 for propane
- ρ_L = 0,60 t/m^3 for butane
- ρ_L = 0,70 t/m^3 for ammonia (anhydrous).

3 Hull scantlings

3.1 Plating

3.1.1 Minimum net thicknesses *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.24, 4.25 and 4.26

The net thickness of the weather strength deck, trunk deck, tank bulkhead and watertight bulkhead plating within or bounding the longitudinal extension of the cargo area is to be not less than the values given in Tab 1.

3.2 Ordinary stiffeners

3.2.1 Minimum net thicknesses

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

$t_{MIN} = 0,8 + 0,013\ L\ k^{1/2} + 4,5\ s$ for $L < 220$ m

$t_{MIN} = 3\ k^{1/2} + 4,5 + s$ for $L \geq 220$ m

where s is the spacing, in m, of ordinary stiffeners.

Figure 4 : Determination of internal pressure for pressure points 1, 2 and 3

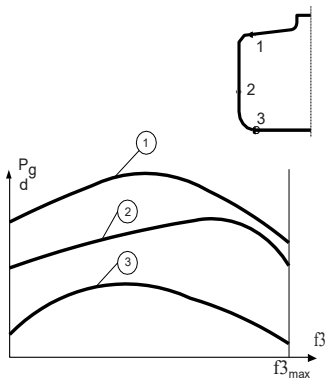


Table 1 : Minimum net thickness of the weather strength deck, trunk deck, tank bulkhead and watertight bulkhead plating

Plating	Minimum net thickness, in mm	
Weather strength deck and trunk deck at midship	Longitudinal framing	$1,6 + 0,032\ L\ k^{1/2} + 4,5\ s$ for $L < 220$ $6\ k^{1/2} + 5,7 + s$ for $L \geq 220$
	Transverse framing	$1,6 + 0,04\ L\ k^{1/2} + 4,5\ s$ for $L < 220$ $6\ k^{1/2} + 7,5 + s$ for $L \geq 220$
Weather strength deck and trunk deck at ends and between hatchways	$2,1 + 0,013\ L\ k^{1/2} + 4,5\ s$	
Tank bulkhead	$1,7 + 0,013\ L\ k^{1/2} + 4,5\ s$	
Watertight bulkhead	$1,3 + 0,013\ L\ k^{1/2} + 4,5\ s$	
Note 1: s : Length, in m, of the shorter side of the plate panel.		

3.3 Primary supporting members

3.3.1 Minimum net thicknesses

The net thickness of plating which forms the webs of primary supporting members is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = 4,1 + 0,015\ L\ k^{1/2}$

4 Structural analysis of integral tanks

4.1 Scantlings

4.1.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.25.2

The net scantlings of plating, ordinary stiffeners and primary supporting members of integral tanks are to be not less than those obtained from Part B, Chapter 7, where the hull girder loads and the internal pressure are to be calculated according to Part B, Chapter 5.

5 Structural analysis of membrane tanks

5.1 General

5.1.1 Specific allowable hull girder stresses and/or deflections, indicated by the Designer, are to be taken into account for the determination of the scantlings.

5.2 Scantlings

5.2.1 *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.24

The net scantlings of plating, ordinary stiffeners and primary supporting members of membrane tanks are to be not less than those obtained from Part B, Chapter 7, where the hull girder loads and the internal pressure are to be calculated according to Part B, Chapter 5.

6 Structural analysis of type A independent tanks

6.1 Scantlings

6.1.1 *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.21

The net scantlings of plating, ordinary stiffeners and primary supporting members of type A independent tanks are to be not less than those obtained from Part B, Chapter 7, where the hull girder loads and the internal pressure are to be calculated according to Part B, Chapter 5.

When calculating the internal pressure, the presence of the dome may be disregarded.

7 Structural analysis of type B independent tanks

7.1 Plating and ordinary stiffeners

7.1.1 Strength check of plating and ordinary stiffeners subject to lateral pressure *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.22

The net scantlings of plating and ordinary stiffeners of type B independent tanks are to be not less than those obtained from the applicable formulae in Part B, Chapter 7, where the internal pressure is to be calculated according to [2.2].

7.1.2 Buckling check *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.22.3.2

The scantlings of plating and ordinary stiffeners of type B independent tanks are to be not less than those obtained from the applicable formulae in Part B, Chapter 7.

7.2 Primary supporting members

7.2.1 Analysis criteria *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.22

The analysis of the primary supporting members of the tank subjected to lateral pressure based on a three dimensional model is to be carried out according to the following requirements:

- the structural modelling is to comply with the requirements from Pt B, Ch 7, App 1, [1] to Pt B, Ch 7,App 1, [3]
- the stress calculation is to comply with the requirements in Pt B, Ch 7, App 1, [5]
- the model extension is to comply with [7.2.2]
- the wave hull girder loads and the wave pressures to be applied on the model are to comply with [7.2.3]
- the inertial loads to be applied on the model are to comply with [7.2.4].

7.2.2 Model extension

The longitudinal extension of the structural model is to comply with Pt B, Ch 7, App 1, [3.2]. In any case, the structural model is to include the hull and the tank with its supporting and keying system.

7.2.3 Wave hull girder loads and wave pressures *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.22

Wave hull girder loads and wave pressures are to be obtained from a complete analysis of the ship motion and accelerations in irregular waves, to be submitted to the Society for approval, unless these data are available from similar ships.

These loads are to be obtained as the most probable the ship may experience during its operating life, for a probability level of 10^{-8}.

7.2.4 Inertial loads *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

The inertial loads are to be obtained from the formulae in IGC 4.13.2.

7.2.5 Yielding check of primary supporting members of type B independent tanks primarily constructed of bodies of revolution *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

The equivalent stresses of primary supporting members are to comply with the following formula:

$\sigma_E \leq \sigma_{ALL}$

where:

σ_E : Equivalent stress, in N/mm^2, to be obtained from the formula in IGC 4.18.1.4 for each of the following stress categories, defined in IGC 4.28.3:

- primary general membrane stress
- primary local membrane stress
- primary bending stress
- secondary stress

σ_{ALL} : allowable stress, defined in IGC 4.22.3.1.1 for each of the stress categories above.

7.2.6 Yielding check of primary supporting members of type B independent tanks primarily constructed of plane surfaces *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

The equivalent stresses of primary supporting members are to comply with the following formula:

$\sigma_E \leq \sigma_{ALL}$

where:

σ_E : Equivalent stress, in N/mm^2, to be obtained from the formulae in Pt B, Ch 7, App 1, [5.1], as a result of direct calculations to be carried out in accordance with [7.2.1]

σ_{ALL} : Allowable stress, in N/mm^2, to be obtained from Tab 2.

Table 2 : Allowable stress for primary supporting members primarily constructed of plane surfaces

Material	Allowable stress, in N/mm^2
C-Mn steel and Ni-steels	The lesser of: •0,75 R_{eH} •0,5 R_m
Austenitic steels	The lesser of: •0,80 R_{eH} •0,4 R_m
Aluminium alloy	The lesser of: •0,75 R_{eH} •0,35 R_m
Note 1: R_{eH} : Minimum yield stress, in N/mm^2, of the material, as defined in Pt B, Ch 4, Sec 1, [2.1] R_m : Ultimate minimum tensile strength, in N/mm^2, of the material, as defined in Pt B, Ch 4, Sec 1, [2.1].	

7.2.7 Buckling check of local buckling of plate panels of primary supporting members *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

A local buckling check is to be carried out according to Pt B, Ch 7, Sec 1, [5] for plate panels which constitute primary supporting members.

In performing this check, the stresses in the plate panels are to be obtained from direct calculations to be carried out in accordance with [7.2.1].

7.3 Fatigue analysis

7.3.1 General *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.18.2 and 4.22.4

The fatigue analysis is to be performed for areas where high wave induced stresses or large stress concentrations are expected, for welded joints and parent material. Such areas are to be defined by the Designer and agreed by the Society on a case-by-case basis.

7.3.2 Material properties *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.18.2

The material properties affecting fatigue of the items checked are to be documented. Where this documentation is not available, the Society may request to obtain these properties from experiments performed in accordance with recognised standards.

7.3.3 Wave loads *(1/1/2020)*

In upright ship and in inclined ship conditions the wave loads to be considered for the fatigue analysis of the tank include:

- maximum and minimum wave hull girder loads and wave pressures, to be obtained from a complete analysis of the ship motion and accelerations in irregular waves, to be submitted to the Society for approval, unless these data are available from similar ships. These loads are to be obtained as the most probable the ship may experience during its operating life, for a probability level of 10^{-8}.
- Maximum and minimum inertial pressures, to be obtained from the formulae in IGC Code 4.28.1.2 as a function of the arbitrary direction β.

7.3.4 Simplified stress distribution for fatigue analysis *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.18.2.5

The simplified long-term distribution of wave loads indicated in IGC Code 4.18.2.5 may be represented by means of 8 stress ranges, each characterised by an alternating stress $\pm\sigma_i$ and a number of cycles n_i (see Fig 5). The corresponding values of σ_i and n_i are to be obtained from the following formulae:

$$\sigma_i = \sigma_0 \left(1{,}0625 - \frac{i}{8}\right)$$

$$n_i = 0{,}9 \cdot 10^{\,i}$$

where:

σ_i : Stress (i = 1, 2,..., 8), in N/mm^2 (see Fig 5)

σ_0 : Most probable maximum stress over the life of the ship, in N/mm^2, for a probability level of 10^{-8}

n_i : Number of cycles for each stress σ_i considered (i = 1, 2,..., 8).

7.3.5 Conventional cumulative damage *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.18.2.2

For each structural detail for which the fatigue analysis is to be carried out, the conventional cumulative damage is to be calculated according to the following procedure:

- the long-term value of hot spot stress range $\Delta\sigma_{S,0}$ is to be obtained from the following formula:

  $$\Delta\sigma_{S,0} = |\sigma_{S,MAX} - \sigma_{S,MIN}|$$

  where:

  $\sigma_{S,MAX}$, $\sigma_{S,MIN}$: Maximum and minimum hot spot stress to be obtained from a structural analysis carried out in accordance with Pt B, Ch 7, App 1, where the wave loads are those defined in [7.3.3]
- the long-term value of the notch stress range $\Delta\sigma_{N,0}$ is obtained from the formulae in Pt B, Ch 7, Sec 4, [3.3] as a function of the hot spot stress range $\Delta\sigma_{S,0}$
- the long-term distribution of notch stress ranges $\Delta\sigma_{N,I}$ is to be calculated. Each stress range $\Delta\sigma_{N,I}$ of the distribution, corresponding to n_i stress cycles, is obtained from the formulae in [7.3.4], where σ_0 is taken equal to $\Delta\sigma_{N,0}$.
- For each notch stress range $\Delta\sigma_{N,I}$, the number of stress cycles N_I which cause the fatigue failure is to be obtained by means of S-N curves corresponding to the as-rolled condition (see Fig 6). The criteria adopted for obtaining the S-N

curves are to be documented. Where this documentation is not available, the Society may require the curves to be obtained from experiments performed in accordance with recognised standards.

- The conventional cumulative damage for the i notch stress ranges $\Delta\sigma_{N,I}$ is to be obtained from the formula in IGC Code 4.18.2.2.

Figure 5 : Simplified stress distribution for fatigue analysis

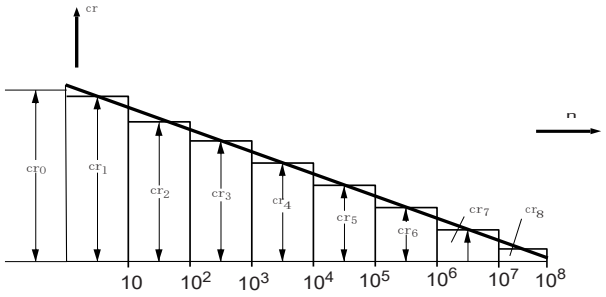
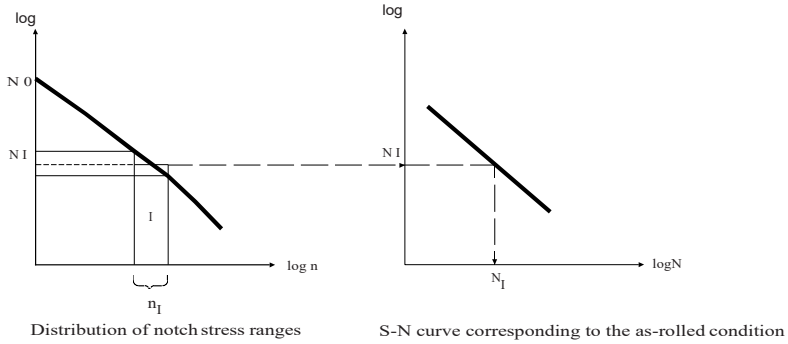


Figure 6 : Fatigue check based on conventional cumulative damage method



7.3.6 Check criteria

The conventional cumulative damage, to be calculated according to [7.3.5], is to be not greater than C_W, defined in IGC 4.4.5.6.

7.4 Crack propagation analysis

7.4.1 General *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

The crack propagation analysis is to be carried out for highly stressed areas. The latter are to be defined by the Designer and agreed by the Society on a case-by-case basis. Propagation rates in the parent material, weld metal and heat-affected zone are to be considered.

The following checks are to be carried out:

- crack propagation from an initial defect, in order to check that the defect will not grow and cause a brittle fracture before the defect is detected; this check is to be carried out according to [7.4.4]
- crack propagation from an initial through thickness defect, in order to check that the defect, resulting in a leakage, will not grow and cause a brittle fracture less than 15 days after its detection; this check is to be carried out according to [7.4.5].

7.4.2 Material properties *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

The material fracture mechanical properties used for the crack propagation analysis, i.e. the properties relating the crack propagation rate to the stress intensity range at the crack tip, are to be documented for the various thicknesses of parent material and weld metal alike. Where this documentation is not available, the Society may request to obtain these properties from experiments performed in accordance with recognised standards.

7.4.3 Simplified stress distribution for crack propagation analysis *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.18.2.6.3

The simplified wave load distribution indicated in IGC Code 4.18.2.6.3 may be represented over a period of 15 days by means of 5 stress ranges, each characterised by an alternating stress $\pm\sigma_i$ and number of cycles, n_i (see Fig 7). The corresponding values of σ_i and n_i are to be obtained from the following formulae:

$$\sigma_i = \sigma_0 \left(1,1 - \frac{i}{5,3}\right)$$

$$n_i = 0,913 \cdot 10^i$$

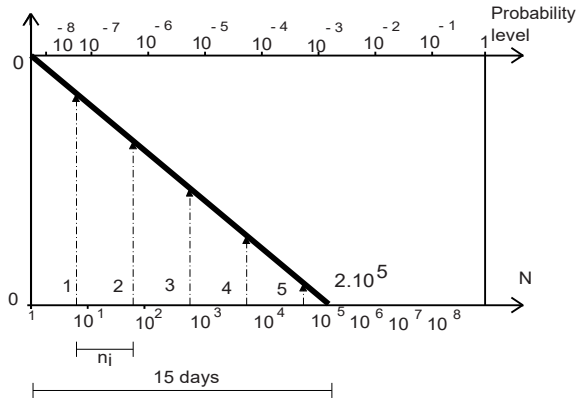
where:

σ_i : Stress (i = 1,06; 2,12; 3,18; 4,24; 5,30), in N/mm^2, (see Fig 7)

σ_0 : Defined in [7.3.4]

n_i : Number of cycles for each stress σ_i considered (i = 1,06; 2,12; 3,18; 4,24; 5,30).

Figure 7 : Simplified stress distribution for crack propagation analysis



7.4.4 Crack propagation analysis from an initial defect *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

It is to be checked that an initial crack will not grow, under wave loading based on the stress distribution in [7.3.4], beyond the allowable crack size.

The initial size and shape of the crack is to be considered by the Society on a case-by-case basis, taking into account the structural detail and the inspection method.

The allowable crack size is to be considered by the Society on a case-by-case basis; in any event, it is to be taken less than that which may lead to a loss of effectiveness of the structural element considered.

7.4.5 Crack propagation analysis from an initial through thickness defect *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

It is to be checked that an initial through thickness crack will not grow, under dynamic loading based on the stress distribution in [7.4.3], beyond the allowable crack size.

The initial size of the through thickness crack is to be taken not less than that through which the minimum flow size that can be detected by the monitoring system (e.g. gas detectors) may pass.

The allowable crack size is to be considered by the Society on a case-by-case basis; in any event, it is to be taken far less than the critical crack length, defined in [7.4.6].

7.4.6 Critical crack length *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.22

The critical crack length is the crack length from which a brittle fracture may initiate and it is to be considered by the Society on a case-by-case basis. In any event, it is to be evaluated for the most probable maximum stress experienced by the structural element in the ship life, which is equal to the stress in the considered detail obtained from the structural analysis to be performed in accordance with [7.2.1].

8 Structural analysis of type C independent tanks

8.1 Stiffening rings in way of tank supports

8.1.1 Structural model *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.23

The stiffening rings in way of supports of horizontal cylindrical tanks are to be modelled as circumferential beams constituted by web, flange, doubler plate, if any, and plating attached to the stiffening rings.

8.1.2 Width of attached plating *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.23

On each side of the web, the width of the attached plating to be considered for the yielding and buckling checks of the stiffening rings, as in [8.1.5] and [8.1.6], respectively, is to be obtained, in mm, from the following formulae:

- $b = 0{,}78\sqrt{rt}$ for cylindrical shell,
- $b = 20\ t_b$ for longitudinal bulkheads (in the case of lobe tanks)

where:

r : Mean radius, in mm, of the cylindrical shell

t : Shell thickness, in mm

t_b : Bulkhead thickness, in mm.

A doubler plate, if any, may be considered as belonging to the attached plating.

8.1.3 Boundary conditions *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.23

The boundary conditions of the stiffening ring are to be modelled as follows:

- circumferential forces applied on each side of the ring, whose resultant is equal to the shear force in the tank and calculated through the bi-dimensional shear flow theory
- reaction forces in way of tank supports, to be obtained according to [9.2].

8.1.4 Lateral pressure *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.23

The lateral pressure to be considered for the check of the stiffenung rings is to be obtained from [2.2].

8.1.5 Yielding check *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.23

The equivalent stress in stiffening rings in way of supports is to comply with the following formula:

$$\sigma_E \leq \sigma_{ALL}$$

where:

σ_E : Equivalent stress in stiffening rings calculated for the load cases defined in IGC 4.13.9 and IGC 4.14.1, in N/mm^2, and to be obtained from the following formula:

$$\sigma_E = \sqrt{(\sigma_N + \sigma_B) + 3\tau^2}$$

σ_N : Normal stress, in N/mm^2, in the circumferential direction of the stiffening ring

σ_B : Bending stress, in N/mm^2, in the circumferential direction of the stiffening ring

τ : Shear stress, in N/mm^2, in the stiffening ring

σ_{ALL} : Allowable stress, in N/mm^2, to be taken equal to the lesser of the following values:

- $0{,}57\ R_m$
- $0{,}85\ R_{eH}$

R_m : Defined in Pt B, Ch 4, Sec 1, [2.1]

R_{eH} : Defined in Pt B, Ch 4, Sec 1, [2.1].

8.1.6 Buckling check *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.23

The buckling strength of the stiffening rings is to be checked in compliance with the applicable formulae in Pt B, Ch 7, Sec 2.

9 Supports

9.1 Structural arrangement

9.1.1 General *(1/1/2020)*

REFERENCE IGC CODE : Ch 4, 4.8

The reaction forces in way of tank supports are to be transmitted as directly as possible to the hull primary supporting members, minimising stress concentrations.

Where the reaction forces are not in the plane of primary members, web plates and brackets are to be provided in order to transmit these loads by means of shear stresses.

9.1.2 Structure continuity

Special attention is to be paid to continuity of structure between circular tank supports and the primary supporting members of the ship.

9.1.3 Openings *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.8

In primary supporting members of tank supports and hull structures in way of tank supports which constitute hull supports, openings are to be avoided and local strengthening may be necessary.

9.1.4 Antiflotation arrangements *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.8.2

Adequate clearance between the tanks and the hull structures is to be provided in all operating conditions.

9.2 Calculation of reaction forces in way of tank supports

9.2.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.8

The reaction forces in way of tank supports are to be obtained from the structural analysis of the tank or stiffening rings in way of tank supports, considering the loads specified in:

- [6], for the structural analysis of type A independent tanks
- [7], for the structural analysis of type B independent tanks
- [8], for the structural analysis of type C independent tanks.

The final distribution of the reaction forces at the supports is not to show any tensile forces.

9.3 Keys

9.3.1 General

Fillings lower than 90% are generally not admitted for tanks having no upper rolling keys.

The structure of the tank and of the ship is to be reinforced in way of the keys so as to support the reactions and the corresponding moments.

9.3.2 Rolling keys

Rolling keys are to be checked under transverse and vertical accelerations, defined in Pt B, Ch 5, Sec 3, [3.4.1] for the inclined ship conditions, and applied on the maximum weight of the full tank.

It is to be checked that the combined stress in rolling keys is in compliance with the following formula:

$\sigma_{ALL} > \sigma_C$

where:

σ_{ALL} : Allowable stress, N/mm^2, to be taken equal to the minimum of 0,75 R_{eH} and 0,5 R_m

R_{eH} : Yield stress, in N/mm^2, of the steel used, at 20°C

R_m : Minimum ultimate tensile strength, in N/mm^2, at 20°C.

9.3.3 Pitching keys

Pitching keys are to be checked under longitudinal accelerations, to be taken not less than 0,3, and vertical accelerations, defined in Pt B, Ch 5, Sec 3, [3.4.1] for the upright conditions, and applied on the maximum weight of the full tank.

It is to be checked that the combined stress in pitching keys is in compliance with the following formula:

$\sigma_{ALL} > \sigma_C$

where:

σ_{ALL} : Allowable stress, N/mm^2, defined in [9.3.2].

9.4 Scantlings of type C independent tank supports and hull structures in way

9.4.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.8

The net scantlings of plating, ordinary stiffeners and primary supporting members of tank supports and hull structures in way are to be not less than those obtained by applying the criteria in Part B, Chapter 7.

The hull girder loads and the lateral pressure to be considered in the formulae above are to be obtained from the formulae in Part B, Chapter 5.

The values of reaction forces in way of tank supports to be considered for the scantlings of these structural elements are to be obtained from a structural analysis of the tank (see [9.2]) in which the ship accelerations defined in [2.2] are multiplied by 0,625.

10 Secondary barrier

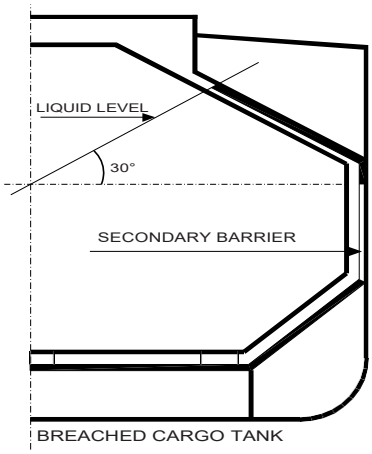
10.1 Secondary barrier extent

10.1.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.6

The extent of the secondary barrier is to be not less than that necessary to protect the hull structures assuming that the cargo tank is breached at a static angle of heel of 30°, with an equalisation of the liquid cargo in the tank (see Fig 8).

Figure 8 : Secondary barrier extension



10.1.2 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.6.2.4 and 4.7.7

For containment systems with glued secondary barriers:

- At the time of construction, a tightness test should be carried out in accordance with approved system designers' procedures and acceptance criteria before and after initial cool down. Low differential pressures tests are not considered an acceptable test.
- If the designer's threshold values are exceeded, an investigation is to be carried out and additional testing such as thermographic or acoustic emissions testing should be carried out.
- The values recorded should be used as reference for future assessment of secondary barrier tightness.

For containment systems with welded metallic secondary barriers, a tightness test after initial cool down is not required.

11 Insulation

11.1 Heating of structures

11.1.1 Segregation of heating plant *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.19.1.6

Where a hull heating system complying with IGC 4.19.1.6 is installed, this system is to be contained solely within the cargo area or the drain returns from the hull heating coils in the wing tanks, cofferdams and double bottom are to be led to a degassing tank. The degassing tank is to be located in the cargo area and the vent outlets are to be located in a safe position and fitted with a flame screen.

11.1.2 Temperature of steam and heating media within the cargo area *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.19.1.6

The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

12 Materials

12.1 Insulation material characteristics

12.1.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.19.3.1 and 4.19.3.4

The materials for insulation are to be approved by the Society.

The approval of bonding materials, sealing materials, lining constituting a vapour barrier or mechanical protection is to be considered by the Society on a case-by-case basis. In any event, these materials are to be chemically compatible with the insulation material.

12.1.2 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.19.3.1 and 4.19.3.4

Before applying the insulation, the surfaces of the tank structures or of the hull are to be carefully cleaned.

12.1.3 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.19.3.1 and 4.19.3.4

Where applicable, the insulation system is to be suitable to be visually examined at least on one side.

12.1.4 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.19.3.1 and 4.19.3.4

When the insulation is sprayed or foamed, the minimum steel temperature at the time of application is to be not less than the temperature given in the specification of the insulation.

13 Construction and testing

13.1 Weld joint design

13.1.1 *(1/1/2020)*

IGC CODE REFERENCE: Ch 4, 4.20.1.1

For tee welds in type A or type B independent tanks, the wording "for dome-to-shell connections only" is to be interpreted to mean as follows:

- Welded corners (i.e. corners made of weld metal) shall not be used in the main tank shell construction, i.e. corners between shell side (sloped plane surfaces parallel to hopper or top side inclusive if any) and bottom or top of the tank, and between tank end transverse bulkheads and bottom, top or shell sides (sloped plane surfaces inclusive if any) of the tank. Instead, tank corners which are constructed using bent plating aligned with the tank surfaces and connected with in-plane welds are to be used.
- Tee welds can be accepted for other localized constructions of the shell such as suction well, sump, dome, etc. where tee welds of full penetration type shall also be used.

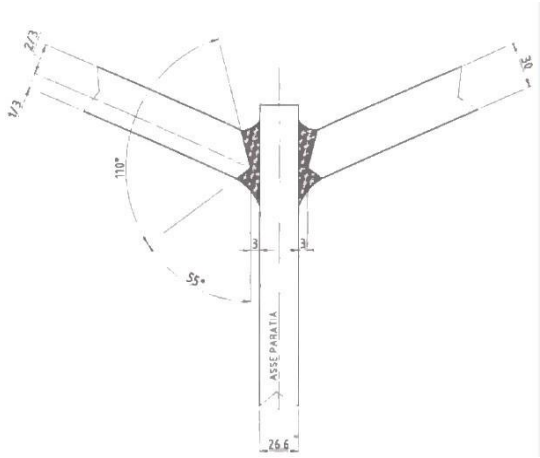
13.1.2 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.20.1.2

For welds of type C independent bi-lobe tank with centerline bulkhead, the wording "Other edge preparations" is to be interpreted to mean as follows:

Cruciform full penetration welded joints in a bi-lobe tank with centreline bulkhead can be accepted for the tank structure construction at tank centreline welds with beve preparation subject to the approval of the Administration or recognised organization acting on its behalf, based on the results of the tests carried out at the approval of the welding procedure. (See below example)

Figure 9 : *(1/1/2020)*



13.2 Integral tank testing

13.2.1 *(1/1/2020)*

IGC CODE REFERENCE: Ch 4, 4.25.5

The testing of integral tanks is to comply with the requirements in Pt B, Ch 12, Sec 3.

13.3 Membrane and semi-membrane tanks testing

13.3.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.24.9.1

The testing of membrane and semi-membrane tanks is to comply with the requirements in Pt B, Ch 12, Sec 3.

13.4 Independent tank testing

13.4.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.21.5, 4.22.6, 4.23.6

The conditions in which testing is performed are to simulate as far as possible the actual loading on the tank and its supports.

13.4.2 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.21.5, 4.22.6, 4.23.6

When testing takes place after installation of the cargo tank, provision is to be made prior to the launching of the ship in order to avoid excessive stresses in the ship structures.

13.5 Final tests

13.5.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.20.3

The tests on the completed system are to be performed in the presence of a Surveyor and are to demonstrate that the cargo containment arrangements are capable of being inerted, cooled, loaded and unloaded in a satisfactory way and that all the safety devices operate correctly.

13.5.2 *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.20.3

Tests are to be performed at the minimum service temperature or at a temperature very close to it.

13.5.3 *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.20.3

The reliquefaction and inert gas production systems, if any, and the installation, if any, for use of gas as fuel for boilers and internal combustion engines are also to be tested to the satisfaction of the Surveyor.

13.5.4 *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.20.3

All operating data and temperatures read during the first voyage of the loaded ship are to be sent to the Society.

13.5.5 *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.20.3

All data and temperatures read during subsequent voyages are to be kept at the disposal of the Society for a suitable period of time.

14 Structural details

14.1 Special structural details

14.1.1 The specific requirements in Pt B, Ch 12, Sec 2, [2.4] for ships with the service notation **liquefied gas carrier** are to be complied with.

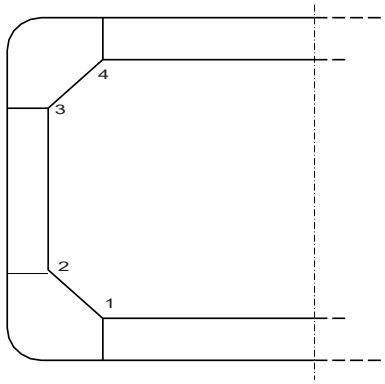
14.2 Connections of the inner hull plating with intermediate plating

14.2.1 *(1/1/2020)*
IGC CODE REFERENCE : Ch 4, 4.20

The connections of the inner hull plating with intermediate plating are to be made according to:

- sheets 4.5 to 4.7 in Pt B, Ch 12, App 1 for position 1 in Fig 10
- sheets 6.8 and 6.9 in Pt B, Ch 12, App 1 for position 2 in Fig 10
- for positions 3 and 4 in Fig 10 in a similar way to positions 1 and 2.

Figure 10 : Positions of connections



14.2.2 Where there is no prolonging bracket in way of knuckle joints in positions 1 and/or 2, the connection of transverse webs to the inner hull and longitudinal girder plating is to be made with partial penetration welds over a length not less than 400 mm.

14.3 Connections of inner bottom with transverse cofferdam bulkheads

14.3.1 General

In addition to sheet 3.5 in Pt B, Ch 12, App 1, the requirements in [14.3.2] to [14.3.4] apply.

14.3.2 Floors *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.20

The thickness and material properties of the supporting floors are to be at least equal to those of the cofferdam bulkhead plating.

14.3.3 Vertical webs within cofferdam bulkhead *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.20

Vertical webs fitted within the cofferdam bulkhead are to be aligned with the double bottom girders.

14.3.4 Manholes

IGC CODE REFERENCE : Ch 4, 4.20

Manholes in double bottom floors aligned with the cofferdam bulkhead plating are to be located as low as practicable and at mid-distance between two adjacent longitudinal girders.

14.4 Cut-outs and connections

14.4.1 Cut-outs *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.20

Cut-outs for the passage of inner hull and cofferdam bulkhead ordinary stiffeners through the vertical webs are to be closed by collar plates welded to the inner hull plating.

14.4.2 Connection of the cargo containment system to the hull structure *(1/1/2020)*

IGC CODE REFERENCE : Ch 4, 4.20

Where deemed necessary, adequate reinforcements are to be fitted in the double hull and transverse cofferdams at connection of the cargo containment system to the hull structure. Details of the connection are to be submitted to the Society for approval.

SECTION 5 PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR AND PRESSURE PIPING SYSTEMS

1 General

1.1 Process pressure vessels

1.1.1

IGC CODE REFERENCE : Ch 5, 5.1.2

Process pressure vessels handling cargo are to be considered at least as class 2 pressure vessels, in accordance with Pt C, Ch 1, Sec 3, [1.4.1].

1.1.2 Temperature of steam and heating media within the cargo area *(1/7/2007)*

IGC CODE REFERENCE : Ch 5, 5.1

The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

2 Cargo and process piping

2.1 General

2.1.1 *(1/1/2023)*

Cargo pipes, including single wall pipes and inner pipes of double wall arrangements, belong to Class I piping systems, as defined in Pt C, Ch 1, Sec 10, [1.5].

Outer pipes of double wall cargo piping arrangements belong to Class II piping systems, as defined in Pt C, Ch 1, Sec 10, [1.5].

***2.1.2* Provisions for protection of piping against thermal stress** *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.7.1, 5.11.6.4

Expansion joints are to be protected from extensions and compressions greater than the limits fixed for them and the connected piping is to be suitably supported and anchored. Bellow expansion joints are to be protected from mechanical damage.

The design and installation of expansion bellows is to be in accordance with recognized standards acceptable to the Society.

***2.1.3* Segregation of high temperature piping** *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.7.2

High temperature pipes are to be thermally isolated from the adjacent structures. In particular, the temperature of pipelines is not to exceed 220 °C in gas-dangerous zones.

***2.1.4* Pressure relief valve setting** *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.5.6 and 5.5.7

Pressure relief valves are to be set to discharge at a pressure not greater than the design pressure such that the overpressure during discharge does not exceed 110% of the design pressure.

***2.1.5* Protection against leakage** *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.2

Where the piping system is intended for liquids having a boiling point lower than - 30 °C, permanent means to avoid possibility of contact between leaks and hull structures are to be provided in all those locations where leakage might be expected, such as shore connections, pump seals, flanges subject to frequent dismantling, etc.

***2.1.6* Means for detecting the presence of liquid cargo** *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.2

The means to detect the presence of liquid cargo may be constituted by electrical level switches whose circuit is intrinsically safe. The alarm signals given by the level switches are to be transmitted to the wheelhouse and to the cargo control station, if provided.

2.1.7 Connections of relief valve discharges to cargo tanks *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.2

The connections, if any, to the cargo tanks of relief valve discharges fitted on the liquid phase cargo piping are not to be fitted with shut-off valves, but are to be provided with non-return valves in the proximity of the tanks.

2.1.8 Centrifugal pumps *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.2

Overpressure relief valves on cargo pumps may be omitted in the case of centrifugal pumps having a maximum delivery head, the delivery valve being completely closed, not greater than that permitted for the piping.

2.2 Scantlings based on internal pressure

2.2.1 Piping scantlings *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.2.2, 5.11.2.4 and 5.11.4

Piping systems are to be designed in accordance with recognized standards acceptable to the Society.

The minimum thickness is to be in accordance with recognized standards acceptable to the Society.

2.2.2 Piping subject to green seas *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.2.2

In particular for piping subject to green seas, the design pressure P, in bar, in the formula in 5.11.2.2 of the IGC CODE is to be replaced by an equivalent pressure P' given by the following formula:

$$P' = \frac{1}{2}\left(P + \sqrt{P^2 + 0{,}006R'K\frac{D_C}{D}}\right)$$

where:

D_C : External diameter of the pipe taking into account the insulation (in mm), whose thickness is to be taken at least equal to:

40 mm if $D \leq 50$ mm

80 mm if $D \geq 150$ mm

Intermediate values are to be determined by interpolation.

R' : Drag corresponding to the effect of green seas, in da N/m², such as given in Tab 1 as a function of the location of the pipes and of their height H (in m) above the deepest loadline; intermediate values are to be determined by interpolation.

K : permissible stress, in N/mm²

Table 1

External diameter of pipe **(1)**	Aft of the quarter of the ship's length			Forward of the quarter of the ship's length		
	H ≤ 8	H = 13	H ≥ 18	H ≤ 8	H = 13	H ≥18
≤ 25	1500	250	150	2200	350	150
50	1400	250	150	2000	350	150
75	1100	250	150	1600	350	150
100	700	250	150	700	350	150
≥150	500	250	150	700	350	150

(1) D_C if the pipe is insulated, D otherwise.

2.3 Design pressure

2.3.1 Design pressure definition *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.4.1

For each piping section, the maximum pressure value among those applicable in paragraph 5.11.2.2 of the IGC Code is to be considered.

Higher or lower values of the saturated and superheated vapour pressure at 45°C may be used if agreed upon by the Society.

2.4 Permissible stress

2.4.1 Flanges, valves and fittings *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.6.1, 5.11.6.2

For flanges not complying with a standard, the dimensions and type of gaskets are to be to the satisfaction of the Society.

Flanges are to be selected as to type, made and tested in accordance with the Pt C, Ch 1, Sec 10.

2.5 Stress analysis

2.5.1 Calculations in accordance with recognised standards *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

When such an analysis is required, it is to be carried out in accordance with the requirements listed below. Subject to this condition, calculations in accordance with recognised standards are admitted by the Society.

2.5.2 Calculation cases *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The calculations are to be made for every possible case of operation, but only those leading to the most unfavourable results are required to be submitted.

2.5.3 Loads to be taken for calculation *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The calculations are to be carried out taking into account the following loads:

a) piping not subject to green seas:
   - pressure
   - weight of the piping with insulation and internal medium
   - contraction

b) piping subject to green seas that is liable to be in operation at sea and in port:
   - pressure
   - weight of the piping with insulation and internal medium
   - green seas
   - contraction
   - ship motion accelerations

c) piping subject to green seas that is in operation only in port; the more severe of the following two combinations of loads:
   - pressure
   - weight of the piping with insulation and internal medium
   - contraction

   and
   - weight of the piping
   - green seas
   - expansion, assuming that the thermal stresses are fully relaxed.

2.5.4 Green sea directions *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

When green seas are considered, their effects are to be studied, unless otherwise justified, in the following three directions:

- axis of the ship
- vertical
- horizontal, perpendicular to the axis of the ship. The load on the pipes is the load R' defined in [2.2.2].

2.5.5 Stress intensity *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The stress intensity is to be determined as specified in the formulae in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures:

a) for primary stresses resulting from:
   - pressure
   - weight
   - green seas

b) for primary stresses and secondary stresses resulting from contraction.

2.5.6 Stress intensity limits *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

a) For the first case, the stress intensity is to be limited to the lower of:
   $0,8\ R_e$ and $0,4\ R_m$

b) For the second case, the stress intensity is to be limited to the lower of:
   $1,6\ R_e$ and $0,8\ R_m$.

2.5.7 Piping with expansion devices *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

For piping fitted with expansion devices, their characteristics are to be submitted to the Society. Where these characteristics are such that the forces and moments at the ends of the devices are negligible for the contraction they must absorb, the calculation of the loads due to contraction in the corresponding piping is not required. It is, however, to be checked that the stress intensity corresponding to the primary stresses does not exceed the limits given in [2.5.6].

2.5.8 Flexibility coefficient *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The flexibility coefficient of elbows is to be determined from the formulae given in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures.

2.5.9 Local stresses *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.11.5

Particular attention is to be paid to the calculation of local stresses in the assemblies subjected to axial forces and bending moments. The Society reserves the right to request additional justifications or local strengthening where considered necessary.

2.6 Materials

2.6.1 *(1/1/2023)*

IGC CODE REFERENCE : Ch 5, 5.12

Aluminised pipes may be fitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

For an outer pipe or duct equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour, the effects of both pressure and possible low temperature in the event of a high pressure line failure shall be taking into account.

Tests for materials are required for all cargo pipes belonging to Class I irrespective of their diameter.

Materials of outer pipes belonging to Class II are to be tested according to the Pt C, Ch 1, Sec 10, Tab 36.

2.7 Piping fabrication and joining details

2.7.1 *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.8

The Society may accept relaxations, based on recognized standards, from the requirements in IGC Code, 5.8 for piping inside cargo tanks and open ended piping.

Acceptance of types of piping connections other than those mentioned in IGC Code, 5.8 may be considered by the Society case by case.

2.8 Welding, post-weld heat treatment and non-destructive testing

2.8.1 *(1/1/2023)*

IGC CODE REFERENCE : Ch 5, 5.9

For post-weld heat treatments, the Society may waive the requirement for thermal stress relieving for pipes having a wall thickness less than 10 mm in relation to the design temperature and pressure of the concerned piping system.

For outer pipes of double wall cargo piping arrangements non-destructive testing are to be carried out according to IGC Code 5.9.3.

For butt-welded joints of pipes not covered by IGC Code 5.9.3.2 spot radiographic controls or other non-destructive controls are to be carried out at the discretion of the Society depending upon service, position and materials.

3 Tests of piping components and pumps prior to installation on board

3.1 Valves

3.1.1 Prototype Testing *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.13

For safey valves that are subject to IGC Code para. 8.2.5, the flow or capacity are to certified by the Society; for other types of valves, the manufacturer is to certify the flow properties of the valves based on tests carried out according to recognized standards.

For emergency shutdown valves, with materials having melting temperatures lower than 925°C, the type testing shall include a fire test to a standard acceptable to the Society.

3.1.2 Unit Production Testing *(1/1/2020)*

IGC CODE REFERENCE: Ch 5, 5.13

All valves are to be tested at the Manufacturer's plant in the presence of the Society's Surveyor.

Testing is to include a hydrostatic test of the valve body at a pressure equal to 1,5 times the design pressure for all valves, seat and stem leakage test at a pressure equal to 1,1 times the design pressure for valves other than safety valves. In addition, cryogenic testing consisting of valve operation and leakage verification for a minimum of 10% of each type and size of valve for valves other than safety valves intended to be used at a working temperature below -55°C. The set pressure of safety valves is to be tested at ambient temperature.

For valves used for isolation of instrumentation in piping not greater than 25 mm, unit production testing need not be witnessed by the surveyor. Records of testing are to be available for review.

As an alternative to the above, if so requested by the relevant Manufacturer, certification of a valve may be issued subject to the following:

- the valve has been approved as required by [3.1.1] for valves intended to be used at a working temperature below -55°C, and
- the Manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodical audits, and
- the quality control plan contains a provision to subject each valve to a hydrostatic test of the valve body at a pressure equal to 1,5 times the design pressure for all valves and seat and stem leakage test at a pressure equal to 1,1 times the design pressure for valves other than safety valves. The set pressure of safety valves is to be tested at ambient temperature. The Manufacturer is to maintain records of such tests, and
- cryogenic testing is performed, in the presence of the Society's representative, consisting of valve operation and leakage verification for a minimum of 10% of each type and size of valve for valves other than safety valves intended to be used at a working temperature below -55°C.

3.2 Cargo Pumps and Gas/Reliquefication/Refrigeration Compressors

3.2.1 General *(1/1/2025)*

Compressors and pumps are to be suitable for their intended purpose. All equipment and machinery are to be adequately designed to ensure suitability within a marine environment with due consideration to Pt C, Ch 3, Sec 8 and Pt C, Ch 1, Sec 1. Such items to be considered would include, but not be limited to:

a) environmental;

b) shipboard vibrations and accelerations;

c) effects of pitch, heave and roll motions, etc.; and

d) physical and chemical properties of product

The manufacturer is to submit documentation indicating the equipment has been designed to comply with the above criteria.

3.2.2 Cargo Pumps *(1/1/2025)*

Each size and type of pump is to be approved through design assessment and prototype testing. Prototype testing is to be witnessed in the presence of the Society's Surveyor.

For the design assessment of the pumps, ISO 13709:2009 and ISO 24490:2016, as applicable, can be used. Other applicable recognized standards acceptable to the Society may be considered.

a) Material Testing: Tests for pump materials need not be witnessed by the Classification Society's representative except for the boundary components, which are in direct contact with the medium and for a design temperature below – 55ºC in accordance with 6.2.2 of the IGC Code.

Note 1: The following pump components can, for example, be considered boundary components:

- For centrifugal type pump: impeller, inducer, guide vane, casing, shaft and coupling.
- For reciprocating type pump: cylinder cover, valve cover, cylinder liner, piston and piston rod, crankshaft, crank case.

b) Prototype Testing: Prototype testing is to include a hydrostatic test of the pump body equal to 1,5 times the design pressure and a capacity test. For submerged electric motor driven pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature. For shaft driven deep well pumps, the capacity test may be carried out with water. In addition, for shaft driven deep well pumps, a spin test to demonstrate satisfactory operation of bearing clearances, wear rings and sealing arrangements is to be carried out at the minimum design temperature. The full length of shafting is not required for the spin test, but must be of sufficient length to include at least one bearing and sealing arrangements. After completion of tests, the pump is to be opened out for examination.

   The vibration criteria of machinery and equipment are to be provided by the pump manufacturer. These are to be compared against an applicable internationally recognised standard (see Note 1), as applied to the design, and are to be accepted by the Society.

Note 2: The following standards can be used as guidance:

- ISO 7919-3:2009/AMD 1:2017, Mechanical vibration - Evaluation of machine vibration by measurements on rotating shafts – Part3 Coupled industrial machines
- ISO 10816-3:2009/AMD 1: 2017, Evaluation of machine vibration by measurements on non-rotating parts — Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15 000 r/min when measured in situ.
- ISO 10816-7:2009, Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 7: Rotodynamic pumps for industrial applications, including measurements on rotating shafts
- ISO 10816-8:2014, Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 8: Reciprocating compressor systems
- ISO 20816-1:2016, Mechanical vibration - Measurement and evaluation of machine vibration – Part 1: General Guidelines
- ISO 20816-8:2018, Mechanical vibration - Measurement and evaluation of machine vibration - Part 8: Reciprocating compressor systems.

c) Unit Production Testing:

   All pumps are to be tested at the Manufacturer's plant in the presence of the Society's Surveyor. Testing is to include a hydrostatic test of the pump body equal to 1,5 times the design pressure and a capacity test. For submerged electric motor driven pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature. For shaft driven deep well pumps, the capacity test may be carried out with water.

   As an alternative to the above, if so requested by the relevant Manufacturer, the certification of a pump may be issued subject to the following:

   - the pump has been approved as required by [3.2.2], a) and b) and
   - the Manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodical audits, and
   - the quality control plan contains a provision to subject each pump to a hydrostatic test of the pump body equal to 1,5 times the design pressure and a capacity test. The Manufacturer is to maintain records of such tests.

3.2.3 Gas Cargo and Reliquefication/Refrigeration Compressors *(1/1/2025)*

Each size and type of compressor is to be approved through design assessment and prototype testing. Prototype testing is to be witnessed in the presence of the Society's representative.

For the design assessment of the gas compressors, API standards. 617:2014 (w. Errata 1:2016), 618:2016 or 619:2010, as applicable, can be used. Other applicable recognized standards acceptable to the Society may be considered.

a) Material Testing: Tests for compressor materials need not be witnessed by the Society's representative except for the boundary components, which are in direct contact with the medium and for a design temperature below – 55 °C in accordance with 6.2.2 of the IGC Code.

Note 1: The following compressor components can, for example, be considered boundary components:

- For centrifugal type compressor: impeller, inducer, guide vane, casing, shaft and coupling.
- For reciprocating type compressor: cylinder cover, valve cover, cylinder liner, piston and piston rod, crankshaft, crank case.

b) Prototype Testing: Prototype testing is to be consistent with the applicable standard as applied for design assessment and is to include hydrostatic test of the compressor pressure boundary components, mechanical running test and a performance test. The hydrostatic test is to be carried out at a pressure equal to 1.5 times the design pressure (or 1.25 times the design pressure where the test fluid is compressible) and for, at least, 30 minutes. The mechanical running test and performance tests should include recording of the gas used, temperatures, pressures, testing of alarms and shut down, pressure relief devices and vibration measurements to ensure that the limits do not exceed those proposed by the manufacturer and that other features relating to the performance of the equipment are in accordance with the specification. Similarly, during the performance test, power consumption and the gas loads are to be recorded.

The vibration criteria of machinery and equipment are to be provided by manufacturers, consistent with the applicable recognized standard (see Note 1 in [3.2.2], b)) as applied to the design. Otherwise, when the data on the vibration criteria are not available, justification is to be submitted for criteria used as reference in terms of overall Root Mean Square (RMS) vibrational velocity value for normal operation conditions.

Alternative limits, demonstrated by fatigue calculations, may be accepted by the Society.

c) Unit Production Testing: Each compressor is to be tested at the plant of manufacture in the presence of the Society's representative. Testing is to include hydrostatic test of the compressor pressure boundary components. The hydrostatic test is to be carried out at a pressure equal to 1,5 times the design pressure (or 1,25 times the design pressure where the test fluid is compressible) and for, at least, 30 minutes.

As an alternative to the above, if so, requested by the relevant manufacturer, the certification of a compressor may be issued subject to the following:

- The compressor has been approved as required by [3.2.3], a) and b), and
- The manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodic audits, and
- The quality control plan contains a provision to subject each compressor to the hydrostatic test of the compressor body equal to 1,5 times the design pressure (or 1,25 times the design pressure where the test fluid is compressible) for, at least, 30 minutes, and a mechanical running and performance test. The manufacturer is to maintain records of such tests.

d) Installation: The complete compressor assembly connected to the vessel systems is to be subjected to a leak test using air or other suitable medium, to a pressure depending on the leak detection method applied. The test is to be performed in presence of the Society's representative and considered satisfactory when no joint leaks are observed.

4 Cargo system valving requirements

4.1 Cargo tank connections for gauging

4.1.1 Exemption *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.5.5

The requirements in paragraph 5.5.5 of the IGC Code relevant to cargo tank connections for pressure gauges and measuring devices do not apply to tanks with an MARVS not exceeding 0,07 MPa.

4.2 Emergency shutdown

4.2.1 Clarification on location of fusible elements *(1/1/2020)*

IGC CODE REFERENCE : Ch 18, 18.10

The cargo stations in way of which the fusible elements mentioned in paragraph 18.10.3.2 of the IGC Code are to be fitted are to be intended as the loading and unloading manifolds.

4.2.2 Fail-close action of Emergency Shut Down (ESD) valve *(1/1/2024)*

IGC CODE REFERENCE : Ch 18, 18.10.2.1.2

The following requirements specify the arrangements for emergency shut down valve (hereinafter referred to as ESD valve) installed in cargo piping of ships engaged in the carriage of liquefied gases to stop cargo flow in the event of an emergency, either internally within the ship, or during cargo transfer to other ships or shore facilities.

When ESD valve is actuated by hydraulic or pneumatic system, the following are to be complied with:

a) audible and visible alarm is to be given in the event of loss of pressure that causes activation of fail-close action. The alarm is to be provided in a normally manned control station (e.g. Cargo Control Room and/or the navigation bridge, etc.).

b) the following conditions are also to be complied to ensure the fail-close action:

   1) failure of hydraulic or pneumatic system is not to lead to loss of fail-close functionality (i.e. activated by spring or weight); or

   2) hydraulic or pneumatic system for fail-close action is to be arranged with stored power and separated from normal valve operation.

5 Cargo transfer methods

5.1 Discharge into common header

5.1.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.6

When two or more pumps located in different cargo tanks are operating at the same time discharging into a common header, the stopping of the pumps is to activate an alarm at the centralised cargo control location.

6 Bonding

6.1 Static electricity

6.1.1 Acceptable resistance *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.7.4

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than $10^6\,\Omega$.

6.1.2 Bonding straps *(1/1/2020)*

IGC CODE REFERENCE : Ch 5, 5.7.4

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

a) clearly visible so that any shortcoming can be clearly detected

b) designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint

c) easy to install and replace.

7 Integrated cargo and ballast system

7.1 General

7.1.1 *(1/1/2004)*

The requirements for integrated cargo and ballast systems are given in Ch 7, Sec 4, [3.5].

SECTION 6 MATERIALS FOR CONSTRUCTION

1 Material requirements

1.1 Tubes, forgings and castings for cargo and process piping

1.1.1 *(1/7/2022)*
IGC CODE REFERENCE: Ch 6, Tables 6.1, 6.2 and 6.3

The requirements in Pt D, Ch 2, App 7 apply.

1.1.2 *(1/4/2009)*
IGC CODE REFERENCE: Ch 6, Table 6.4

In general, impact tests for forgings, castings and welded and seamless pipes in stainless austenitic grades 304, 304L, 316, 316L, 321 and 347 are required when the design temperature is below -105°C and are to be carried out at -196°C.

1.2 Aluminium coatings

1.2.1 *(1/1/2020)*
IGC CODE REFERENCE : Ch 6, 6.4

The use of aluminium coatings containing more than 10% aluminium by weight in the dry film is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo gas may accumulate.

2 Welding and non-destructive testing

2.1 Welding consumables

2.1.1 *(1/1/2020)*
IGC CODE REFERENCE : Ch 6, 6.5.2.1

The content of paragraph 6.5.2.1 of the IGC Code is also to cover process pressure vessels and secondary barriers.

2.2 Test requirements

2.2.1 Bend tests *(1/1/2020)*
IGC CODE REFERENCE : Ch 6, 6.5.3.5.2

As an alternative to the bend test indicated in paragraph 6.5.3.5.2 of the IGC Code, a test over a mandrel having a diameter equal to 3 times the thickness with a bend angle up to 120° may be required.

3 Steels for hull structure

3.1 Grades of steel

3.1.1 *(1/7/2014)*
In addition to the requirements specified in Pt B, Ch 4, Sec 1, [2.4], the material grade or class as specified in Tab 1 and Tab 2 apply to the hull structure steels of membrane type liquefied gas carriers.

The material grade requirements for hull members of each class, depending on the thickness, are defined in Pt B, Ch 4, Sec 1, Tab 7.

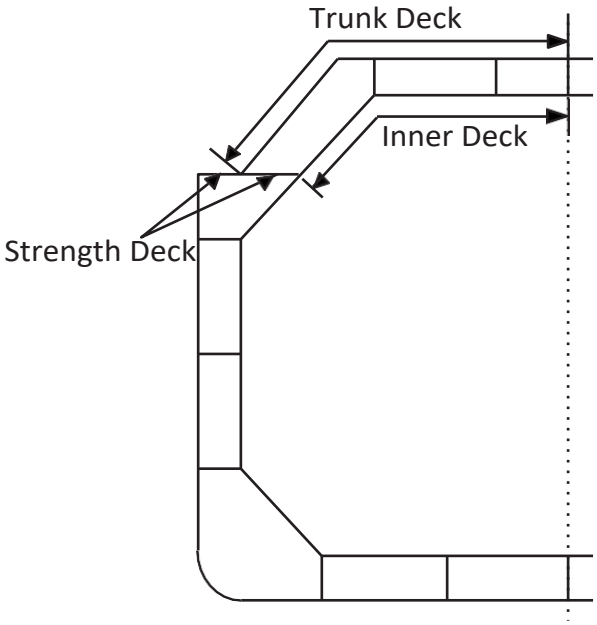
Table 1 : Material classes applicable to membrane type liquefied gas carriers of any length *(1/7/2014)*

Structural member category	Material class/grade
Trunk deck and inner deck plating at corners of openings for liquid and gas domes in membrane type liquefied gas carriers	• Class III within 0,6L amidships • Class II within rest of cargo region

Table 2 : Minimum Material grades for membrane type liquefied gas carriers with length exceeding 150 m *(1/7/2014)*

Structural member category	Material class/grade
Longitudinal plating of strength deck where contributing to the longitudinal strength	Grade B/AH within 0,4L amidships
Continuous longitudinal plating of strength members above the strength deck: Trunk deck plating	Class II within 0,4L amidships
Continuous longitudinal plating of strength members above the strength deck: • Inner deck plating • Longitudinal strength member plating between the trunk deck and inner deck	Grade B/AH within 0,4L amidships
Note 1: Tab 2 is applicable to membrane type liquefied gas carriers with deck arrangements as shown in Fig 1. Tab 2 may apply to similar ship types with a "double deck" arrangement above the strength deck.	

Figure 1 : Typical deck arrangement for membrane type Liquefied Natural Gas Carriers *(1/7/2014)*



SECTION 7 CARGO PRESSURE/TEMPERATURE CONTROL

1 General

1.1 Applicability

1.1.1 *(1/1/2020)*
This Section is void, as there are no additional class requirements.

SECTION 8 CARGO TANK VENTING SYSTEM

1 Pressure relief systems

1.1 Cargo tank

1.1.1 Size of pressure relief devices *(1/1/2020)*

IGC CODE REFERENCE : Ch 8, 8.4.1.2 and Figure 8.1

For application of the formula in paragraph 8.4.1.2 of the IGC Code, the following is to be applied for prismatic tanks:

- L_{min}, for non-tapered tanks, is the smaller of the horizontal dimensions of the flat bottom of the tank. For tapered tanks, as would be used for the forward tank, L_{min} is the smaller of the length and the average width.
- For prismatic tanks whose distance between the flat bottom of the tank and bottom of the hold space is equal to or less than $L_{min}/10$:

  A = external surface area minus flat bottom surface area.
- For prismatic tanks whose distance between the flat bottom of the tank and bottom of the hold space is greater than $L_{min}/10$:

  A = external surface area.

1.2 Interbarrier spaces

1.2.1 Protection of interbarrier spaces *(1/1/2020)*

IGC CODE REFERENCE : Ch 8, 8.2.2

a) The formula for determining the relieving capacity given in [1.2.2] is developed for interbarrier spaces surrounding independent type A cargo tanks, where the thermal insulation is fitted to the cargo tanks.

b) The relieving capacity of pressure relief devices of interbarrier spaces surrounding independent type B cargo tanks may be determined on the basis of the method given in [1.2.2]; however, the leakage rate is to be determined in accordance with 4.7.2 of the IGC Code.

c) The relieving capacity of pressure relief devices for interbarrier spaces of membrane and semi-membrane tanks is to be evaluated on the basis of specific membrane/semi-membrane tank design.

d) The relieving capacity of pressure relief devices for interbarrier spaces adjacent to integral type cargo tanks may, if applicable, be determined as for type A independent cargo tanks.

1.2.2 Size of pressure relief devices *(1/1/2020)*

IGC CODE REFERENCE : Ch 8, 8.4

The combined relieving capacity (in m^3/s) of the pressure relief devices for interbarrier spaces surrounding type A independent cargo tanks where the insulation is fitted to the cargo tanks may be determined by the following formula:

$$Q_{sa} = 3{,}4 \cdot A_C \cdot \frac{\rho}{\rho_v} \cdot \sqrt{h}$$

where:

Q_{sa} : Minimum required discharge rate of air in standard conditions of 273 K and 1.013 bar

A_C : Design crack opening area in (m^2)

$$A_c = \frac{\pi}{4} \cdot \delta \cdot l$$

with:

δ : Max. crack opening width in (m)

$$\delta = 0{,}2 \cdot t$$

t : Thickness of tank bottom plating in (m)

l : Design crack length in (m) equal to the diagonal of the largest plate panel of the tank bottom (see Fig 1)

h : Max. liquid height above tank bottom plus 10 × MARVS in (m)

ρ : Density of product liquid phase in kg/m^3 at the set pressure of the interbarrier space relief device

ρ_V : Density of product vapour phase in kg/m^3 at the set pressure of the interbarrier space relief device and a temperature of 273 K.

MARVS: max allowable relief valve setting of the cargo tank (bar)

1.3 Vents

1.3.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 8, 8.2.10

The height of vent exits as indicated in paragraph 8.2.10 of the IGC Code is also to be measured above storage tanks and cargo liquid lines, where applicable.

1.4 Segregation of vents

1.4.1 **Additional requirements on vent location** *(1/1/2020)*

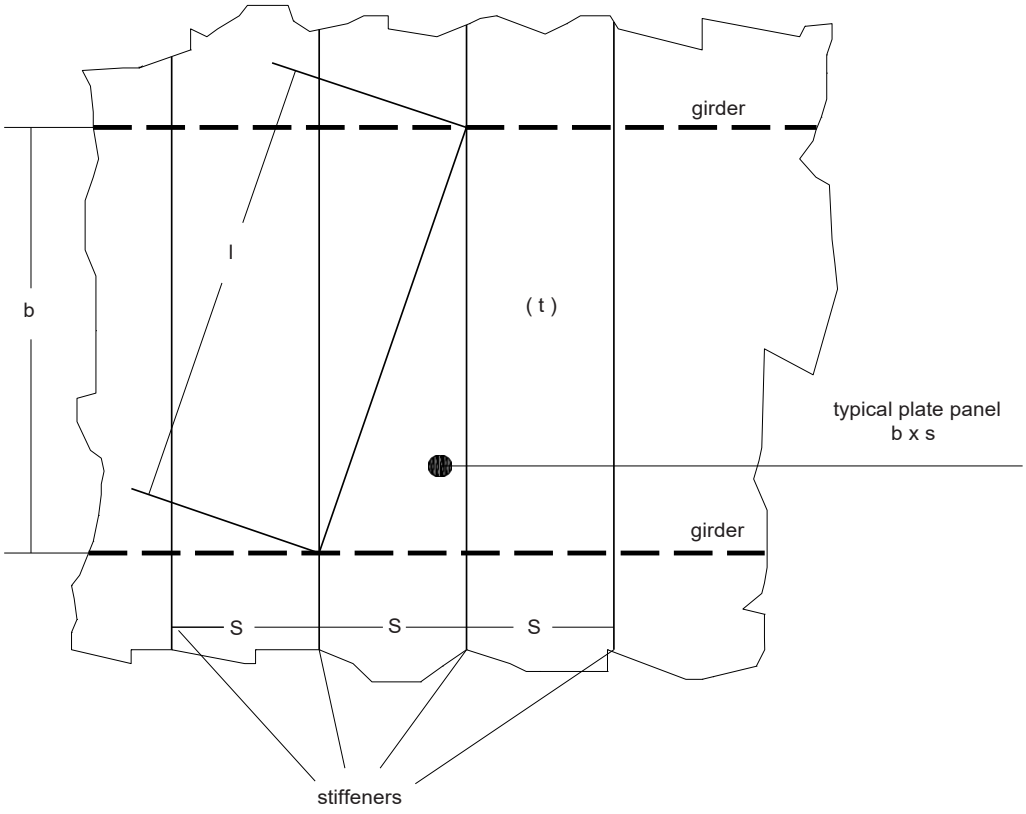
IGC CODE REFERENCE : Ch 8, 8.2.11.1 and 8.2.11.2

a) The distances of the vent exits are to be measured horizontally.

b) In the case of carriage of flammable and/or toxic products, the vent exits are to be arranged at a distance of at least 5 m from exhaust ducts and at least 10 m from intake ducts serving cargo pump rooms and/or cargo compressor rooms.

c) The distances are also intended to refer to outlets of ventilation ducts of safe spaces.

Figure 1 : Determination of l



2 Additional pressure relieving system for liquid level control

2.1 General

2.1.1 **Tank filling limits** *(1/1/2020)*

IGC CODE REFERENCE : Ch 13, 13.3.2

The words 'to prevent the tank from becoming liquid full' in paragraph 13.3.2 of the IGC Code have the following meaning:

At no time during the loading, transport or unloading of the cargo including fire conditions will the tank be more than 98% liquid full, except as permitted by 15.4.1 of the IGC Code. These requirements, together with those of 8.2.17 of the IGC Code, are intended to ensure that the pressure relief valves remain in the vapour phase.

SECTION 9 ENVIRONMENTAL CONTROL

1 Inerting

1.1 General

1.1.1 Dew point

IGC CODE REFERENCE : Ch 9, 9.4.1

As far as the IGC Code requirements relevant to the dew point are concerned, the following additional provisions apply:

a) where cargo tank insulation is not protected from water vapour penetration by means of an effective vapour barrier, accepted by the Society, the maximum value of the dew point is to be less than the design temperature

b) where cargo tank insulation is protected by an effective vapour barrier, accepted by the Society, the maximum value of the dew point is to be less than the minimum temperature which may be found on any surface within the spaces filled with dry inert gas or dry air

c) the temperature of the hull structures adjacent to cargo tanks is not to become lower than the minimum permissible working temperature, specified in Section 6, for the steel grade employed for such hull structures.

1.1.2 Precautions against fire

IGC CODE REFERENCE : Ch 9, 9.4.1

Precautions are to be taken to minimise the risk that static electricity generated by the inert gas system may become a source of ignition.

2 Inert gas production on board

2.1 Exemptions

2.1.1

IGC CODE REFERENCE : Ch 9, 9.5

a) Inert gas generating systems are to be considered as essential services and are to comply with the applicable Sections of the Rules, as far as applicable.

b) Where, in addition to inert gas produced on board, it is possible to introduce dry air into the above-mentioned spaces, where this is acceptable depending on the type of cargo tank adopted, or to introduce inert gas from a supply existing on board, it is not necessary that standby or spare components for the inert gas system are kept on board.

SECTION 10 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 The requirements in this Section apply, in addition to those contained in Part C, Chapter 2, to ships with the service notation gas carrier.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 *(1/1/2007)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

1.3.2 *(1/1/2007)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.3 *(1/7/2009)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

1.4 Earth detection

1.4.1 *(1/1/2007)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [1.3.1].

1.5 Precautions against inlet of gases or vapours

1.5.1 Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

1.6 Electrical equipment permitted in hazardous areas

1.6.1 *(1/1/2007)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5] and Pt C, Ch 2, Sec 3, [10.1.6].

1.6.2 *(1/1/2007)*

In addition to the requirements of [1.6.1], in Zone 1 and Zone 2 the installation of the following is permitted: hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of an impressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

1.6.3 *(1/1/2007)*

Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

2 Hazardous locations

2.1 Hazardous area classification

2.1.1 *(1/1/2007)*

For hazardous area classification see Tab 1.

2.2 Submerged cargo pumps

2.2.1 Exceptions

Submerged cargo pumps are not permitted in connection with the following cargoes:

- diethyl ether
- vinyl ethyl ether
- ethylene oxide
- propylene oxide
- mixtures of ethylene oxide and propylene oxide.

2.2.2 Submerged electric motors

a) Where submerged electric motors are employed, means are to be provided, e.g. by the arrangements specified in paragraph 17.6 of the IGC Code, to avoid the formation of explosive mixtures during loading, cargo transfer and unloading.

b) Arrangements are to be made to automatically shut down the motors in the event of low liquid level. This may be accomplished by sensing low pump discharge pressure, low motor current, or low liquid level. This shutdown is to be alarmed at the cargo control station. Cargo pump motors are to be capable of being isolated from their electrical supply during gas-freeing operations.

3 Product classification

3.1 Temperature class and explosion group

3.1.1

Tab 2 specifies temperature class and explosion group data for the products indicated in Chapter 19. The data shown in brackets have been derived from similar products.

Table 1 : Classification of hazardous areas for tankers carrying flammable liquefied gases *(1/1/2007)*

Spaces		Hazardous area
No.	Description	
1	Cargo containment systems	Zone 0
2	Hold spaces where cargo is carried in a cargo containment system requiring a secondary barrier	Zone 0
3	Hold spaces where cargo is carried in a cargo containment system not requiring a secondary barrier	Zone 1
4	Space separated from a hold space where cargo is carried in a cargo containment system requiring a secondary barrier by a single gas-tight steel boundary	Zone 1
5	Cargo pump and cargo compressor rooms	Zone 1
6	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump and cargo compressor room ventilation outlets and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation	Zone 1
7	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet	Zone 1
8	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5 m of cargo pump and cargo compressor room entrance, cargo pump and cargo compressor room ventilation inlet, openings into cofferdams or other zone 1 spaces	Zone 1
9	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck	Zone 1
10	Areas on open deck over all cargo tanks (including ballast tanks within the cargo tank area) where structure restricts natural ventilation and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck	Zone 1
11	Compartment for cargo hoses	Zone 1
12	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located	Zone 1
13	Enclosed or semi-enclosed spaces in which pipes containing cargo products for boil-off gas fuel burning systems are located, unless special precautions approved by the Society are provided to prevent product gas escaping into such spaces	Zone 1
14	Areas of 1,5 m surrounding open or semi-enclosed spaces of Zone 1 **(1)**	Zone 2
15	Areas 4 m beyond the cylinder and 4 m beyond the sphere defined in item 7	Zone 2
16	Spaces forming an air-lock	Zone 2
17	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service areas and 3m beyond these up to a height of 2,4m above the deck	Zone 2
18	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck surrounding open or semi-enclosed spaces of Zone 1	Zone 2

(1) For ships subject to the SOLAS Convention, an area within 2m beyond the 3m of cargo tank ventilation outlets which permit the flow of small volumes of vapour gas mixtures caused by thermal variation is to be considered Zone 2

Spaces		Hazardous area
No.	Description	
19	Spaces forward of the open deck areas to which reference is made in item 10 and item 18, below the level of the main deck, and having an opening on the main deck or at a level less than 0,5 m above the main deck, unless: a) the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilation system inlets and exhausts, are situated at least 5 m from the foremost cargo tank and at least 10 m measured horizontally from any cargo tank outlet or gas or vapour outlet; and b) the spaces are mechanically ventilated	Zone 2
20	Areas within 2,4 m of the outer surface of a cargo tank where such surface is exposed to the weather	Zone 2
(1) For ships subject to the SOLAS Convention, an area within 2m beyond the 3m of cargo tank ventilation outlets which permit the flow of small volumes of vapour gas mixtures caused by thermal variation is to be considered Zone 2		

Table 2 : Temperature class and explosion group of certain products *(1/1/2010)*

Product name	Temperature class	Explosion group	Product name	Temperature class	Explosion group
Acetaldehyde	T4	II A	Methane	T1	II A
Ammonia anhydrous	T1	II A	Methyl acetylene propadiene mixture	T4	II A
Butadiene	T2	II B	Methyl bromide	T3	II A
Butane	T2	II A	Methyl chloride	T1	II A
Butane/propane mixture	T2	II A	Monoethylamine	T2	II A
Butylenes	T3	II A	Nitrogen	NF	NF
Chlorine	NF	NF	Pentane (all isomers)	(T2)	(II A)
Diethyl ether	T4	II B	Pentene (all isomers)	(T3)	(II B)
Dimethylamine	T2	II A	Propane	T2	II A
Ethane	T2	II A	Propylene	T2	II B
Ethyl chloride	T2	II A	Propylene oxide	T2	II B
Ethylene	T2	II B	Refrigerant gases	NF	NF
Ethylene oxide	T2	II B	Sulphur dioxide	(T3)	(II B)
Ethylene oxide propylene oxide mixture (max. 30% mass/mass ethylene oxide)	T2	II B	Vinyl chloride	T2	II A
Isoprene	T3	II B	Vinyl ethyl ether	T3	II B
Isopropylamine	T2	II A	Vinylidene chloride	T2	II A

SECTION 11 FIRE PROTECTION AND FIRE EXTINCTION

1 General

1.1

1.1.1 *(1/1/2007)*
This Section is void, as the provisions of Chapter 11 of the IGC Code are not mandatory for the class.

SECTION 12 MECHANICAL VENTILATION IN THE CARGO AREA

1 Spaces required to be entered during normal cargo handling operations

1.1 Location of discharges from dangerous spaces

1.1.1 Ventilation duct arrangement *(1/1/2020)*

IGC CODE REFERENCE : Ch 12, 12.1.5

a) Ventilation ducts are to be fitted with metallic shut-off dampers provided with "open" and "closed" signs. These dampers are to be arranged in the open, in a readily accessible position.

b) Gas-dangerous spaces for the purpose of 1.1.1.a) are those mentioned in paragraph 12.1.1 of the IGC Code. For other spaces which are gas-dangerous only due to their position, some relaxation may be granted.

1.2 Recirculation prevention

1.2.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch 12, 12.1.5

a) Exhaust ducts from gas-dangerous spaces are to be arranged at a distance in the horizontal direction of at least 10 m from ventilation outlets of gas-safe spaces. Shorter distances may be accepted for ventilation outlets from safe spaces protected by air-locks.

b) Intakes of gas-dangerous spaces are to be arranged at a distance in the horizontal direction of at least 3 m from ventilation intakes and outlets and openings of accommodation spaces, control stations and other gas-safe spaces.

c) Exhaust and intake ducts for the same gas-dangerous space, or for the same space rendered safe by an air-lock, are to be arranged at a distance from each other in the horizontal direction of not less than 3 m.

1.3 Additional requirements for non-sparking fans

1.3.1 Non-sparking fans *(1/1/2020)*

IGC CODE REFERENCE : Ch 12, 12.1.7

a) A fan is considered as non-sparking if in both normal or abnormal conditions it is unlikely to produce sparks.

b) The air gap between the impeller and the casing is to be not less than 0,1 of the shaft diameter in way of the impeller bearing and not less than 2 mm. It need not be more than 13 mm.

1.3.2 Materials for non-sparking fans *(1/1/2020)*

IGC CODE REFERENCE : Ch 12, 12.1.7

a) The impeller and the housing in way of the impeller are to be made of materials as per list in the Code, with a production certificate.

b) Electrostatic charges both in the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation on board of the ventilation units is to be such as to ensure their safe bonding to the hull.

c) The following impellers and housings are considered as sparking and are not permitted:
   - impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance
   - housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
   - any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

1.3.3 Type test for non-sparking fans *(1/1/2020)*

IGC CODE REFERENCE : Ch 12, 12.1.7

Type tests on the finished product are to be carried out in accordance with the requirements of the Society or an equivalent national or international standard.

1.3.4 Motor shafting *(1/1/2020)*

IGC CODE REFERENCE : 12, 12.1.7

The shafting penetration of motors driving fans through bulkheads and decks of dangerous spaces or through ventilation ducts is to be fitted with a gas-tight sealing device, of the oil-seal type or equivalent, deemed suitable by the Society.

2 Spaces not normally entered

2.1 General requirements

2.1.1 Minimum number of air changes *(1/1/2020)*

IGC CODE REFERENCE : 12, 12.2

Both fixed and portable systems are to guarantee the efficient ventilation of such spaces in relation to the relative density, in respect of the air, and to the toxicity of the gases transported. The type of portable fans and their connection to the spaces served are to be approved by the Society. In no case are portable electrical fans acceptable.

SECTION 13 INSTRUMENTATION (GAUGING, GAS DETECTION)

1 General

1.1 Cargo tank instrumentation

1.1.1 The instrumentation is to be of a type approved by the Society.

1.2 Detection of leak through secondary barrier

1.2.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.7.1

Upon special approval, appropriate temperature indicating devices may be accepted by the Society instead of gas detecting devices when the cargo temperature is not lower than – 55 °C.

1.3 Indicator location

1.3.1 **Monitoring list** *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.1.2

The following information and alarms are to be concentrated in the positions specified in this requirement.

a) The following is to be transduced to the "cargo control room" and the "control position" as defined in 3.4.1 of the IGC Code:
   1) the indication signalling the presence of water and/or liquid cargo in holds or interbarrier spaces
   2) the cargo heater low temperature alarm
   3) the alarm signalling the presence of liquid cargo in the vent main as per 5.2.2.4 of the IGC Code
   4) the indication of the hull temperature and the hull structure low temperature alarm required in 13.7.2.2 of the IGC Code
   5) the alarm signalling the automatic shutdown of electrically driven submerged pumps required in 10.2.9 of the IGC Code
   6) the indication of the cargo level and the cargo tank high level alarm required in 13.3.1 of the IGC Code
   7) the indication of the vapour space pressure and the vapour space pressure gauges of each cargo tank and associated high and low pressure alarms required in 13.4.1 of the IGC Code
   8) the gas detection equipment alarm required in 13.6.13 of the IGC Code
   9) the cargo compressor high temperature alarm required in 17.4.2.2 of the IGC Code
   10) the alarm for automatic shutdown of the cargo compressor for high pressure or high temperature, as required in 17.16.4.4 of the IGC Code.

   When the cargo system is not remote controlled and therefore the aforesaid "control positions" are not required, the above-mentioned controls, information and alarms are to be located in a suitable, easily accessible location.

   If this position is an enclosed space, it is to comply with the requirements of 3.4 of the IGC Code. This position should preferably be located in the wheelhouse.

b) Independently of the above, the following is to be transduced to the wheelhouse:
   1) the alarm signalling the presence of water and/or liquid cargo in holds or interbarrier spaces
   2) the cargo heater low temperature alarm
   3) the alarm signalling the presence of liquid cargo in the vent main as per 5.2.2.4 of the IGC Code
   4) the indication of the pressure value in the vapour space of each cargo tank mentioned in 13.4.1 of the IGC Code; such indication is to give the setting pressure value of the relief valve and the minimum allowable pressure value in the cargo tank concerned
   5) the high pressure and low pressure alarms, when required, for cargo tanks as per 13.4.2 of the IGC Code
   6) the hull structure low temperature alarm required in 13.7.2.2 of the IGC Code

7) the gas detection equipment alarm required in 13.6.13 of the IGC Code

8) the cargo compressor high temperature alarm required in 17.4.2.2 of the IGC Code

9) the alarm for automatic shutdown of the cargo compressor for high pressure or high temperature, as required in 17.16.4.4 of the IGC Code.

c) Where the cargo control room is located within the accommodation spaces and is readily accessible, the alarms in (b) may be grouped in a single audible and visual alarm except for the indication and alarms in 4), 5) and 7), which are to be independent from each other.

d) The high level and high or low pressure audible and visual alarms for cargo tanks as per 13.3.1 to 13.3.3 and 13.4.1 to 13.4.3 of the IGC Code and the alarm signalling the presence of liquid in the vent main are to be located in such a position as to be clearly heard and identifiable by the personnel in charge of loading operation control.

2 Level indicators for cargo tanks

2.1 General

2.1.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.2.1 and 13.2.2

a) In order to assess whether or not one level gauge is acceptable, the wording "can be maintained" is to be interpreted to mean that any part of the level gauge other than passive parts can be overhauled while the cargo tank is in service.

Passive parts are those parts assumed not subject to failures under normal service conditions.

b) Where level gauges containing cargo are arranged outside the tank they serve, means are to be provided to shut them off automatically in the event of failure.

3 Overflow control

3.1 Overflow alarm and shutdown

3.1.1 **Shut-off valve for overflow control** *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.3.2

The sensor for automatic closing of the loading valve for overflow control may be combined with the liquid level indicators required by paragraph 13.2.1 of the IGC Code.

3.1.2 **Shut-off valve closing time** *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.3.1 to 13.3.3

The closing time of the valve referred to in 13.3.2 in seconds (i.e. time from shutdown signal initiation to complete valve closure) is to be not greater than:

$$\frac{3600 \cdot U}{LR}$$

where:

U : Ullage volume at operating signal level (m^3)

LR : Maximum loading rate agreed between ship and shore facility (m^3/h)

The loading rate is to be adjusted to limit surge pressure on valve closure to an acceptable level taking into account the loading hose or arm, and the ship and shore piping systems, where relevant.

4 Pressure gauges

4.1 Pressure gauges in cargo tanks

4.1.1

IGC CODE REFERENCE : Ch. 13, 13.4.1

The low pressure alarm indicated in paragraph 13.4.1 of the IGC Code is also to be located in the cargo control room.

5 Temperature indicating devices

5.1 General

5.1.1 Temperature recording

IGC CODE REFERENCE : Ch. 13, 13.5.1

The temperatures are to be continuously recorded at regular intervals. Audible and visual alarms are to be automatically activated when the hull steel temperature approaches the lowest temperature for which the steel has been approved.

6 Gas detection requirements

6.1 Gas Measurements

6.1.1 *(1/1/2007)*

In addition to the provisions of [6.2] to [6.3], the fitting of gas measuring equipment is subject to the those of Pt C, Ch 4, Sec 1, [5.2.4] b).

6.2 Position of sampling heads

6.2.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.6.12

Sampling heads in cargo holds are not to be located in positions where bilge water may collect.

6.3 Gas sampling lines

6.3.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.6.8

Gas sampling lines are to be located outside accommodation spaces, unless they are fitted within gas-tight pipes.

6.4 Protected spaces

6.4.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.6.2

In addition to the list in paragraph 13.6.2 of the IGC Code, the gas detection system is also to serve spaces adjacent to pump rooms and compressor rooms.

6.5 Portable gas detectors

6.5.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 13, 13.6.19

For ships intended to carry toxic and flammable gases, two sets for toxic gases and two sets for flammable gases are to be provided.

SECTION 14 PROTECTION OF PERSONNEL

1 Personnel protection requirements for individual products

1.1 Showers and eye wash

1.1.1 *(1/7/2020)*
IGC CODE REFERENCE : Ch 14, 14.4.3

The showers and eye wash are to be fitted with a heating system, or other suitable installation, in order to avoid any ice formation in their piping.

SECTION 15 FILLING LIMITS FOR CARGO TANKS

1 General

1.1 Applicability

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 15 of the IGC Code.

SECTION 16 USE OF CARGO AS FUEL

1 Gas fuel supply

1.1 Piping

1.1.1 Piping runs *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.4.1 to 16.4.3

a) The main gas line between the gas make-up station and the machinery space is to be as short as possible.

b) The gas piping is to be installed as high in the space as possible and at the greatest possible distance from the ship's hull.

1.1.2 Segregation of piping *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.4

Gas piping is to be independent of other systems and may only be used for the conveyance of gas. It is to be ensured by its arrangement that it is protected against external damage.

1.1.3 Earthing *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.4

Gas piping is to be suitably earthed.

1.1.4 Testing *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.4

Piping, valves and fittings are to be hydrostatically tested, after assembly on board, to 1,5 times the working pressure but to not less than 0,7 MPa. Subsequently, they are to be pneumatically tested to ascertain that all the joints are perfectly tight.

1.2 Valves

1.2.1 Automatic operation *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.4.5

It is to be possible to operate the valves indicated in paragraph 16.4.5 of the IGC Code locally and from each control platform. They are to close automatically under the following service conditions:

a) whenever the gas pressure varies by more than 10 % or, in the case of supercharged engines, if the differential pressure between gas and charging air is no longer constant

b) in the event of one of the following fault situations:

   1) Gas supply to boiler burners
      - insufficient air supply for complete combustion of the gas
      - extinguishing of the pilot burner for an operating burner, unless the gas supply line to every individual burner is equipped with a quick-closing valve that automatically cuts off the gas
      - low pressure of the gas
   2) Gas supply to internal combustion engines
      - failure of supply to pilot fuel injection pump, if any
      - drop of engine speed below the lowest service speed

2 Gas fuel plant and related storage tanks

2.1 General

2.1.1 Location of equipment for making up gas *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.5

Means for purging of flammable gases before opening are to be provided in the equipment for making up gas.

2.1.2 Equipment located on weather deck *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.5

Where the equipment (heaters, compressors, filters) for making up the gas for its use as fuel and the storage tanks are located on the weather deck, they are to be suitably protected from atmospheric agents and the sea.

2.2 Compressors

2.2.1 Miscellaneous requirements *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.5.2

a) The compressors are to be capable of being remotely stopped from an always and easily accessible, non-dangerous position in the open, and also from the engine room.

b) In addition, the compressors are to be capable of automatically stopping when the suction pressure reaches a certain value depending on the setting pressure of the vacuum relief valves of the cargo tanks.

c) The automatic shutdown device of the compressors is to have a manual resetting.

d) Piston-type compressors are to be fitted with relief valves discharging to a position in the open, such as not to give rise to hazards.

e) The compressors are to be fitted with shut-off valves and flame screens on both the suction and delivery sides.

2.3 Heaters

2.3.1 Additional miscellaneous requirements *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.5.3

a) Operation of the heaters is to be automatically regulated depending on the gas temperature at the heater outlet.

b) Before it is returned to the machinery space, the heating medium (steam or hot water) is to go through a degassing tank located in the cargo area.

c) Provisions are to be made to detect and signal the presence of gas in the tank. The vent outlet is to be in a safe position and fitted with a flame screen.

3 Special requirements for main boilers

3.1 Boiler arrangement

3.1.1 Forced air circulation *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.6

Boilers are to be located as high as possible in boiler spaces and are to be of the membrane wall type or equivalent, so as to create a space with forced air circulation between the membrane wall and the boiler casing.

3.2 Combustion chamber

3.2.1 Gas detectors in the combustion chamber *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.6.1.3

The Society may, at its discretion, require gas detectors to be fitted in those combustion chamber areas where gas could accumulate, as well as the provision of suitable air nozzles.

3.3 Burner system

3.3.1 Safety devices *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.6.2

A mechanical device is to be installed to prevent the gas valve from opening until the air and the fuel oil controls are in the ignition position. A flame screen, which may be incorporated in the burner, is to be fitted on the pipe of each gas burner.

4 Special requirements for gas fired internal combustion engines and gas fired turbines

4.1 Gas fuel supply to engine

4.1.1 Flame arresters *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

Flame arresters are to be provided at the inlet to the gas supply manifold for the engine.

4.1.2 Manual shut-off *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

Arrangements are to be made so that the gas supply to the engine can be shut off manually from the starting platform or any other control position.

4.1.3 Prevention of fatigue failure *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

The arrangement and installation of the gas piping are to provide the necessary flexibility for the gas supply piping to accommodate the oscillating movements of the engines without risk of fatigue failure.

4.1.4 Protection of gas line connections *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

The connecting of gas line and protection pipes or ducts as per [4.2.1] to the gas fuel injection valves is to provide complete coverage by the protection pipe or ducts.

4.2 Gas fuel supply piping systems

4.2.1 Fuel piping in machinery spaces *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

Gas fuel piping may pass through or extend into machinery spaces or gas-safe spaces other than accommodation spaces, service spaces and control stations provided that they fulfil one of the following conditions:

a) The system complies with paragraph 16.4.1.1 of the IGC Code, and in addition, with 1, 2 and 3 below:
   1) The pressure in the space between concentric pipes is monitored continuously. Alarm is to be issued and the automatic valves specified in 16.4.5 of the IGC Code (hereafter referred to as "interlocked gas valves") and the master gas fuel valves specified in 16.4.6 of the IGC Code (hereafter referred to as "master gas valves") are to be closed before the pressure drops to below the inner pipe pressure (however, an interlocked gas valve connected to the vent outlet is to be opened).
   2) The construction and strength of the outer pipes are to comply with the requirements of 5.2 of the IGC Code.
   3) It is to be so arranged that the inside of the gas fuel supply piping system between the master gas valve and the engine is automatically purged with inert gas when the master gas valve is closed; or

b) The system complies with paragraph 16.4.3 of the IGC Code, and in addition, with 1 to 4 below:
   1) The materials, construction and strength of protection pipes or ducts and mechanical ventilation systems are to be sufficiently durable against bursting and rapid expansion of high pressure gas in the event of gas pipe burst.
   2) The capacity of mechanical ventilating systems is to be determined considering the flow rate of gas fuel and construction and arrangement of protective pipes or ducts, as deemed appropriate by the Society.
   3) The air intakes of mechanical ventilating systems are to be provided with non-return devices effective for gas fuel leaks. However, if a gas detector is fitted at the air intakes, this requirement may be dispensed with.
   4) The number of flange joints of protective pipes or ducts is to be minimised; or

c) Alternative arrangements to those given in a) and b) will be specially considered by the Society based upon an equivalent level of safety.

4.2.2 Valves and expansion joints *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

All valves and expansion joints used in high pressure gas fuel supply lines are to be of an approved type.

4.2.3 Pipe joints *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

Joints on the entire length of the gas fuel supply lines are to be butt-welded joints with full penetration and to be fully radiographed, except where specially approved by the Society.

4.2.4 Non-welded pipe joints *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

Pipe joints other than welded joints at the locations specifically approved by the Society are to comply with the appropriate standards recognised by the Society, or with joints whose structural strength has been verified through test analysis as deemed appropriate by the Society.

4.2.5 Post-weld heat treatment *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

For all butt-welded joints of high pressure gas fuel supply lines, post-weld heat treatment is to be performed depending on the kind of material.

4.3 Shut-off of gas fuel supply

4.3.1 Fuel supply shut-off *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

In addition to the causes specified in 16.4.5 of the IGC Code, supply of gas fuel to engines is to be shut-off by the interlocked gas valves in the event of the following abnormalities:

a) abnormality specified in Pt C, Ch 1, App 2

b) engine stops due to any cause.

4.3.2 Master gas valve shut-off *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

In addition to the causes specified in 16.4.6 of the IGC Code, the master gas valve is to be closed in the event of any of the following:

a) the oil mist detector or bearing temperature detector detects abnormality

b) any kind of gas fuel leakage is detected

c) abnormality specified in Pt C, Ch 1, App 2.

4.3.3 Automatic operation *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

The master gas valve is to close automatically upon activation of the interlocked gas valves.

4.4 Emergency stop of dual fuel engines

4.4.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

Dual fuel engines are to be stopped before the gas concentration detected by the gas detectors specified in 16.3.2 of the IGC Code reaches 60% of the lower flammable limit.

4.5 Requirements on dual fuel engines

4.5.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 16, 16.7 and 16.8

Specific requirements on internal combustion engines supplied by gas are given in Pt C, Ch 1, App 2.

SECTION 17 SPECIAL REQUIREMENTS

1 Materials for construction

1.1 Materials exposed to cargo

1.1.1

IGC CODE REFERENCE : Ch. 17, 17.2

Materials "exposed to cargo" are those constituting systems, cargo appliances or arrangements which are in contact with (liquid or vapour) cargo in normal operating conditions.

2 Inhibition

2.1 Polymerisation prevention - Alternative requirement

2.1.1

IGC CODE REFERENCE : Ch. 17, 17.8.1

a) As an alternative to the addition of inhibited liquid, it may be accepted that, at the end of each refrigeration period, the liquid is completely removed from the refrigeration system by means of vapour from compressors or by means of inert gas. In such case, the following wording is to be entered on the Certificate of Fitness:

"At the end of each refrigeration period, the liquid is to be completely removed from the refrigeration system by means of vapour from compressors or by means of inert gas."

b) On the cargo compressor delivery side, a temperature switch is to be fitted, set at a suitable temperature, depending on the characteristics of the product carried (e.g. 60°C for butadiene), giving a visual and audible alarm on the navigation bridge and in the cargo control station, if any, which causes the compressor to stop when such temperature is exceeded.

3 Chlorine

3.1 Cargo containment system

3.1.1 **Relief valves** *(1/1/2020)*

IGC CODE REFERENCE : Ch. 17, 17.13.1.4

Chlorine discharge from pressure relief valves is to be led to an absorption device deemed suitable by the Society.

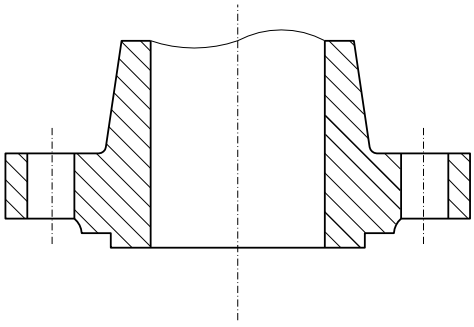
3.2 Cargo piping system

3.2.1 **Piping design and fabrication** *(1/1/2020)*

IGC CODE REFERENCE : Ch. 17, 17.13.2.2

A welding neck type flange deemed suitable is shown in Fig 1 as an example.

Figure 1 : Suitable neck type flange



3.3 Instrumentation - Safety devices

3.3.1 Gas detection system *(1/1/2020)*

IGC CODE REFERENCE : Ch. 17, 17.13.4.3

The gas detection system is to be permanently installed.

3.4 Protection of personnel

3.4.1 Additional equipment *(1/1/2020)*

IGC CODE REFERENCE : Ch. 17, 17.13.5

In addition to the source of uncontaminated air, two complete and independent air breathing apparatuses, not employing oxygen supplies, each having a capacity of at least 1200 litres of non-compressed air and two sets of protective equipment, complete with gas-tight boots, gloves and eye protection, are to be provided. The above mentioned equipment and clothing are to be kept in the space indicated in paragraph 17.13.5 of the IGC Code and are additional to those required in other parts of this Chapter.

3.5 Filling limits for cargo tanks

3.5.1 *(1/1/2020)*

IGC CODE REFERENCE : Ch. 17, 17.13.6.1

When determining the filling limits of the cargo tanks for the transport of chlorine, the effect of the refrigeration plant is not to be considered.

SECTION 18 OPERATING REQUIREMENTS

1 General

1.1 Applicability

1.1.1 *(1/1/2021)*

The provisions of Chapter 18 of the IGC Code are operating requirements which are not mandatory for the class, with exception of:

- 18.10.1 to 18.10.4 applicable to emergency shut down (ESD) systems; and
- 18.10.2.1.4 which is referred to in Sec 13, [3.1.2].

SECTION 19 SUMMARY OF MINIMUM REQUIREMENTS

1 Additional information on products

1.1 List of additional products

1.1.1

IGC CODE REFERENCE - CHAPTER 19

Table 1 lists some additional information for those products which are listed in the table in Chapter 19 of the IGC Code.

The list shown in Table 1 gives properties for pure products. The specific gravity to be taken into account for the design of a ship might be altered considering the actual properties of the commercial product.

Information on temperature classes and explosion groups for electrical equipment in connection with the products to be carried is indicated in Sec 10, Tab 2.

Table 1

Product name	Boiling temperature (°C)	Specific gravity at boiling point (kg/m^3)	Ratio vapour/air density
Acethaldehyde	20,8	780	1,52
Ammonia, anhhydrous	- 33,4	680	0,60
Butadiene	- 4,5	650	1,87
Butane	-0,5/11,7	600	2,02
Butylenes	- 6,3/- 7	625	1,94
Chlorine	- 34	1560	2,49
Diethyl ether	34,6	640	2,55
Dimethylamine	6,9	670	1,55
Ethane	- 88,6	549	1,04
Ethyl chloride	12,4	920	2,22
Ethylene	- 104	570	0,97
Ethylene oxide	-10,7	870	1,52
Isoprene	34,5	680	2,35
Isopropylamine	32,5	700	2,03
Methane (LNG)	-161,5	420	0,55
Methyl bromide	4,5	1730	3,27
Methyl chloride	-23,7	1000	1,78
Monoethylamine	16,6	690	1,56
Nitrogen	-196	808	0,97
Pentanes (all isomers)	36,1	610	2,6
Pentene (all isomers)	30,1/37	610	2,6
Propane	-42,3	580	1,56
Propylene	-47,7	610	1,50
Propylene oxides	34,5	860	2.00
Refrigerant gases			
Dichlorodifluoromethane (R12)	-30	1486	4,26
Dichloromonofluoroethane (R21)	8,9	1480	3,9
Dichlorotetrafluoroethane (R114)	3,8	1510	1,31
Monochlorodifluoromethane (R22)	-42	1420	2,98
Monochlorotetrafluoroethane (R124)	-	-	4,70
Monochlorotrifluoromethane (R13)	-81,4	1520	3,60
Sulphur dioxide	-10	1460	2,3

Product name	Boiling temperature (°C)	Specific gravity at boiling point (kg/m^3)	Ratio vapour/air density
Vinyl chloride	-13,9	970	2,15
Vinyl ethyl ether	35,5	754	2,50
Vinylidene chloride	31,7	1250	3,45

APPENDIX 1 LNG BUNKER OR AMMONIA BUNKER SHIPS

1 General

1.1 Application

1.1.1 *(1/10/2025)*

The requirements of this Appendix apply to Liquified Gas Carriers complying with Chapter 9, and intended to load:

a) LNG from land based or offshore terminals, gas carriers or trucks and transfer it to LNG fueled ships

b) anhydrous ammonia from land based or offshore terminals, gas carriers or trucks and transfer it to ammonia fueled ships.

Ships complying with the requirements of this Appendix will be granted the additional service features **LNG bunker** or **ammonia bunker** as follows:

a) LNG bunker which may be complemented by one or more of the following:

- **IG-Bunker** (Inert Gas Bunker), where the LNG bunker ship is designed to also supply inert gas, to ensure gas freeing and aeration, to a LNG fueled ship
- **BT** (Bunker Trust) where the LNG bunker ship is designed with arrangement for the verification of the LNG quality and quantity delivered to the receiving ship
- **VCS-Bunker** (Vapour Control System Bunker) where the LNG bunker ship is designed with systems for control of vapour emission from cargo tanks from receiving ship during bunkering
- **NH3 Tank Ready** where the LNG bunker ship is fitted with LNG cargo tanks designed also for ammonia storage
- **NH3 Tank** where the LNG bunker ship is fitted with LNG cargo tanks designed, built and tested also for ammonia storage

b) ammonia bunker which may be complemented by one or more of the following:

- **IG-Bunker** (Inert Gas Bunker), where the ammonia bunker ship is designed to also supply inert gas, to ensure gas freeing and aeration, to an ammonia fueled ship
- **BT** (Bunker Trust) where the ammonia bunker ship is designed with arrangement for the verification of the ammonia quality and quantity delivered to the receiving ship
- **VCS-Bunker** (Vapour Control System Bunker) where the ammonia bunker ship is designed with systems for control of vapour emission from cargo tanks from receiving ship during bunkering.

1.1.2 *(1/12/2020)*

The requirements of this Appendix supplement those in Chapter 9.

In general, this Appendix does not address cargo containment and handling systems and the interfaces between these systems and the other parts of the ship, which are to comply with the applicable Sections of the Rules.

1.2 Scope

1.2.1 *(1/10/2025)*

This Appendix addresses:

- the design and installation of the piping system of the LNG or ammonia bunker ship intended to transfer LNG or ammonia from land based or offshore terminals, Liquified Gas Carriers or trucks and to transfer LNG or ammonia to the LNG or ammonia fueled ship and the vapour transfer system to/from these units.
- the safety arrangements.

1.2.2 *(1/10/2025)*

Ships intended to load, carry and transfer gases other than LNG or ammonia will be considered on a case by case basis, and the Society reserves the right to establish additional requirements.

2 Definitions

2.1 Bunker emergency shut-down system (ESD)

2.1.1 *(1/10/2025)*
A bunker ESD is a system that safely and effectively stops the transfer of LNG or ammonia (and vapour as applicable) between the receiving ship and the bunker ship in the event of an emergency during the bunkering operation, and puts the system in a safe condition.

2.2 Bunkering connections

2.2.1 *(1/10/2025)*
Bunkering connections correspond to the end of the fixed piping of the LNG or ammonia bunker ship (i.e. manifold for a system with flexible hose and before the swivel for a system with transfer arm).

2.3 Custody Transfer Metering system

2.3.1 *(1/10/2025)*
Custody Transfer Metering system in fluid measurement is a measuring point (location) where the fluid is being measured for sale from one party to another.

2.4 Emergency release coupling (ERC) or breakaway coupling (BRC)

2.4.1 *(1/10/2025)*
A breakaway coupling or emergency release coupling (ERC) is a coupling located in the LNG or ammonia transfer system (at one end of the transfer system, either the receiving ship end or the LNG or ammonia bunker ship end, or in the middle of the transfer system), which separates at a predetermined section when required, each separated section containing a self-closing shut-off valve, which seals automatically.

An emergency release coupling can be activated:

- by external forces applied to the predetermined section exceeding a predetermined value, and/or
- by manual, remote or automatic control, in case of emergency.

2.5 ESD link system or Ship-ship link (SSL)

2.5.1 *(1/10/2025)*
ESD link system or Ship-ship or ship-shore link (SSL) is a communication system to transmit ESD signals and other signals between two different ESD systems (ship to shore/ship or vice versa) via compatible system technologies such as pneumatic, electric, fiber-optic or radio transmission .

2.5.2 *(1/10/2025)*
ESD bunkering concept is a document describing the safety philosophy of the LNG or ammonia bunkering arrangement and procedure. It describes how risks associated with this type of fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures. The results of the risk analysis (see [4.1]) shall be reflected in the safety concept.

2.6 LNG or ammonia bunkering station

2.6.1 *(1/10/2025)*
LNG or ammonia bunkering station means the following equipment and the area where they are fitted:

- bunkering connections for hoses and piping used for liquid and vapour return lines
- isolating valves and emergency shut-down valves
- drip trays, draining arrangement and other arrangements such as water curtain intended for the protection of the ship structure from cold leakages
- gas detection system through thermal camera or gas detectors for enclosed space
- bunkering system ESD indication
- inerting and purging system connections
- pressure relieving system for the bunkering manifold.

2.7 LNG or ammonia transfer system

2.7.1 *(1/10/2025)*

A LNG or ammonia transfer system is a system used to connect the LNG or ammonia bunker ship and the receiving ship in order to transfer LNG or ammonia and their vapours.

The LNG or ammonia transfer system includes:

- loading arms and transfer hoses, as applicable
- manifold including valves and instrumentation
- QCDC
- breakaway coupling (BRC) or Emergency release coupling (ERC)
- isolation flanges.

2.8 Measuring Instruments Directive (MID)

2.8.1 *(1/10/2025)*

The Measuring Instruments Directive (MID) for Custody Transfer metering for liquids, is the European directive that sets down the essential requirements for a wide range of measuring instruments. It provides options for the manufacturer as to how the requirements are met and which organizations to apply to for conformity assessment.

2.9 OIML R117-1

2.9.1 *(1/12/2020)*

OIML R117-1 is a recommendation issued by the ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE (OIML). The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States. R117-1 addresses the Dynamic measuring systems for liquids other than water.

2.10 Pendant

2.10.1 *(1/12/2020)*

Pendant for ESD system is a portable device provided by one ship to another ship or shore terminal or provided by the shore to the ship for the manual tripping of its ESD system by the other party in the absence of a compatible ship-ship link (SSL).

2.11 Quick connect and disconnect coupling (QCDC)

2.11.1 *(1/10/2025)*

A QCDC is a manual or powered mechanical device used to connect the LNG or ammonia transfer system to the receiving ship manifold. The coupling consists of a nozzle (male) and a receptacle (female). The nozzle allows quick connection and disconnection of the fuel supply hose to the receptacle, mounted on the LNG or ammonia manifold.

2.12 Safety zone

2.12.1 *(1/10/2025)*

The safety zone is a zone around the LNG or ammonia bunker ship, the bunkering station of the receiving ship and the LNG or ammonia transfer system, where the only activities to be performed are the bunkering operations and related activities and where safety measures are taken to cope with a possible leakage of LNG or ammonia.

2.13 Transfer arm

2.13.1 *(1/12/2020)*

Transfer arm refers to any system allowing supporting transfer hoses or rigid pipes during bunkering operations.

3 Document to be submitted

3.1 General

3.1.1 *(1/10/2025)*

The drawings and related information to be submitted are listed in Tab 1.

3.1.2 *(1/12/2020)*

The operating manuals and procedures to be submitted are listed in Tab 2.

Table 1 : Documents to be submitted *(1/10/2025)*

No	A/I	Documents
1	A	Arrangement of the ship showing the location of the bunkering station and bunkering control station
2	I	Risk assessment report including operational constraints for the bunkering operation such as minimum visibility, day/night, maximum wind and wave, weather condition.
3	I	List of all bunkering equipment with their technical specification (including hoses)
4	A	Details of LNG or ammonia transfer system and vapor return line system (including their capacity)
5	A	Details of Purging and Inerting system supplying inert gas to the bunker station and bunkering equipment (including their capacity)
6	I	Details of Custody Transfer Metering system (Including evidence of approval according to MID or OIML R117-1 requirements)
7	A	ESD Bunkering Concept including cause and effect matrix
8	A	Block diagram of Control, Monitoring and Safety System
9	A	ESD link system (SSL) description and list of communication devices used for the bunkering operation with their specification
10	A	Drip trays and water curtain arrangement
11	I	Instrumentation list and relevant Safety certificates for electrical equipment located in hazardous areas and concerning the bunkering, where applicable
12	A	Drawings of transfer arm
13	I	Fender and mooring arrangement for bunkering operation with mooring analysis
14	A	Bunkering station manifold specification and drawings, with strength calculation including values of maximum allowable working pressure and allowable loads at manifold flange
15	A	Access and walkway arrangement to bunkering station
Note 1: A = to be submitted for approval I = to be submitted for information		

Table 2 : Operating manuals and procedures to be submitted *(1/12/2020)*

No	A/I	Documents
1	I	Operational manual including bunkering procedure (with details of maximum allowable bunkering flow and maximum allowable working pressure), all information required in IGF Code 18.4.2 and IGC Code 18.2 and procedure for the boil off gas and vapour return management
2	I	Bunkering Safety Checklist according to IGF Code 18.4.3
3	I	Safety Zones Layout for the bunkering operation
4	I	Maintenance and storage instruction manual for the bunkering equipment
Note 1: A = to be submitted for approval I = to be submitted for information		

4 General design requirements

4.1 Risk Assessment

4.1.1 LNG or ammonia transfer system *(1/10/2025)*

A risk assessment shall be conducted according to IGC Code 1.1.11 and IGF Code 4.2 as far as applicable.

The goal of the risk assessment is to identify all safety, environmental and asset hazards associated to the LNG or ammonia transfer system during bunkering operation and their possible mitigation where required. The risk analysis can be of qualitative or semi-quantitative type and shall be based on international recognized standards and TASNEEF Guide for Risk Analysis.

4.1.2 *(1/10/2025)*

The risk assessment is to be performed using the most appropriate techniques such HAZID (Hazards Identification), FMEA (Failure Mode and Effect Analysis) or HAZOP (Hazard and Operability study) as far as applicable and at least the following items shall be assessed:

- Bunkering station including manifold arrangement and drip tray or coaming
- ESD Bunkering System
- Bunkering Equipment
- ESD Link system (SSL)
- Voice communication System between LNG or ammonia bunker ship and receiving ship
- Monitoring, Control and Safety System of bunkering operation
- Fender and mooring arrangement

taking into account the following operations:

- Arrival, approach and mooring of LNG or ammonia bunker ship close to the receiving ship
- Connection and testing of LNG or ammonia transfer system including ESD link system (SSL) and bunker ESD system
- LNG or ammonia bunkering procedure (including hose handling, hose connection, gassing up, cooling down)
- LNG or ammonia bunkering in parallel with other activities (SIMOPs)
- Disconnection of the LNG or ammonia bunker hose in normal and emergency condition (including draining, purging and inerting).

4.1.3 *(1/12/2020)*

The SIMOPs shall be defined with reference to international recognized standards or guidelines such as IACS Rec. 142, SGMF FP08-01 "Simultaneous Operations (SIMOPS) during LNG Bunkering" and other activities identified by the risk assessment experts considering the expected port operations of the receiving ship.

4.1.4 *(1/10/2025)*

The risk assessment study is to include a vapor/liquid LNG or ammonia release and toxicity analysis (e.g. gas dispersion analysis) and is to define safety zones taking into account the concentration limits relevant to fire, explosion and toxic exposure.

4.2 Hazardous area

4.2.1 General *(1/10/2025)*

In general, safety and security zones are to comply with IACS Rec. 142, Section 2 and they are to be addressed during the risk assessment for the LNG or ammonia bunkering operation taking into account the toxicity of ammonia.

4.2.2 *(1/10/2025)*

For LNG bunker, in addition to the hazardous areas in accordance with IGC Code, the following Zone 1 are to be included:

- LNG bunkering stations and 3 m beyond these, up to a height of 2,4 m above the deck
- areas on the open deck within spillage coamings surrounding LNG bunkering connections and manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck
- when applicable, transfer arm operating area extended by 3 m on either direction.

4.2.3 *(1/10/2025)*
For ammonia bunker, in addition to the hazardous areas in accordance with IGC Code, the following toxic zones are to be considered:

- ammonia bunkering stations and 10 m beyond these
- areas on the open deck within spillage coamings surrounding ammonia bunkering connections and manifold valves and 10 m beyond these
- when applicable, transfer arm operating area extended by 10 m on either direction.

4.3 Materials

4.3.1 *(1/10/2025)*
Materials used in LNG or ammonia transfer systems, piping system for LNG or ammonia and other systems or components in contact with LNG or ammonia are to be in accordance with IGC Code, Chapter 6 and, for ammonia only, IGC Code 17.12.

4.4 Arrangement of bunkering system

4.4.1 LNG or ammonia bunkering station *(1/10/2025)*

The LNG or ammonia bunkering station is to be located on open deck so that sufficient natural ventilation is provided. Closed or semi-enclosed bunkering stations will be subject to special consideration and are subject to risk assessment as specified in [4.1]. Access to closed or semi-enclosed bunkering station from other non-hazardous closed or semi-enclosed space shall be granted via airlock.

The LNG bunkering station when not located in the cargo area shall be separated from accommodation and control stations through gas tight divisions and the layout is subject to risk assessment.

LNG bunkering station may be accepted at the ship bow and stern provided that the relevant requirements of IGC Code 3.8 are complied with.

The ammonia bunkering station is to be located in the cargo area; bow or stern loading and unloading lines that are led past accommodation spaces, service spaces or control stations are not to be used for the ammonia bunkering operations.

The maximum allowable loads are to be indicated on a warning plate fitted on the manifold or nearby.

The manifold shall be arranged at least with the following instruments and fittings:

- Pressure gauge
- Pressure transmitter
- Temperature gauge
- Temperature transmitter
- Sampling point for gas detection
- Safety relief valve fitted in between the presentation flange and ESD bunkering valve.

4.4.2 Drip trays and protection of ship hull *(1/10/2025)*

Drip trays are to be fitted below the liquid bunkering connections and where leakage may occur which can cause damage to the ship structure.

Thermal sensors are to be positioned in the drip trays.

The drip trays are to be made of stainless steel and can be drained overboard.

When LNG boiling point at atmospheric pressure is lower than design temperature of the hull steel, a water piping system is to be fitted, providing a low-pressure water curtain in way of the hull under the bunkering manifold for additional protection of the hull steel and the ship's structure; other solutions will be considered on a case by case basis.

When ammonia boiling point at atmospheric pressure is lower than design temperature of the hull steel, suitable arrangements are to be made for additional protection of the hull steel and the ship's structure.

The operating platforms in way of the manifold operating position are to be fitted with raised gratings made of a material suitable for the LNG or ammonia boiling point at atmospheric pressure.

4.4.3 Bunkering control station *(1/10/2025)*

Control of the bunkering operation should be possible from a bunkering control station that is placed in a safe location with regards to bunkering operations. The bunkering control station may be within the cargo control room. At this location, overfilling alarm and automatic and manual shutdown are to be indicated.

Unobstructed direct or camera view of the LNG or ammonia bunkering station is to be available from the bunkering control station.

A LNG or ammonia system schematic/piping and instrumentation diagram (P&ID) shall be reproduced and permanently mounted in the bunkering control station.

4.4.4 LNG or ammonia transfer tystems *(1/10/2025)*

The manifold for transfer of liquid shall be fitted with manually operated stop valve and a remotely/automatically operated valve (ESD valve) fitted in series.

The LNG or ammonia transfer system is to include at least an emergency release coupling (ERC or BRC) and an insulation flange. A Quick Connect Disconnect Coupling (QCDC) may be installed together with above mentioned components.

The ERC or BRC is to be fitted on the receiving ship side, but may be accepted also fitted on LNG or ammonia transfer system side provided that the relevant scenario is considered during the risk analysis required in [4.1].

In case the ERC is fitted on the LNG or ammonia transfer system side, the nearest pressure relief valve on the receiving ship shall have sufficient capacity to accommodate the trapped liquid in the bunkering hose or pipe.

The hoses are to be adequately supported and protected to prevent potential damage or sparks in the event of activation of the ERC or BRC.

The manifolds are to be capable to withstand the allowable loads as defined in an international recognized standard or guideline such as SGMF TGN-06-04 "Technical Guidance Manifold" or equivalent.

The LNG transfer system is to be designed to avoid the release of gas to the atmosphere during bunkering operations.

The bunkering transfer rate is to be capable of being controlled to match with the capabilities and requirements of the receiving ship.

The maximum LNG or ammonia transfer rate is to be declared and justified, taking into consideration:

- The management of the BOG generated during bunkering operation
- The temperature of the LNG or ammonia supplied to the ship
- The maximum flow permitted by the ERC or BRC
- The maximum flow permitted by the hose
- The maximum flow permitted by the QCDC
- The maximum allowable working pressure of the receiving ship bunkering station.

The LNG or ammonia velocity in the piping system is not to exceed 10 m/s in order to avoid the generation of static electricity and to limit the heat transfer due to friction inside the pipes; higher velocity may be considered provided they are duly justified.

In order to prevent cryogenic liquid spills, the design of the transfer system is to be such that the lines can be drained and purged by nitrogen after a normal or emergency disconnection.

Any pipeline or component containing liquid, which may be isolated due to the ESD activation, is to be provided with pressure relief valve.

4.4.5 LNG or ammonia Bunkering ESD system *(1/10/2025)*

A bunkering ESD system is to be installed in addition to the ESD required by IGC Code, if a separate transfer system is provided.

All electrical components of the ESD systems are to be of suitable safe type taking into account the hazard categorization of the area where they are located.

4.4.6 Vapour return handling *(1/10/2025)*

If the LNG or ammonia bunker ship is requested to be capable of handling all or part of the vapours from the receiving ship generated during the LNG or ammonia bunkering operation, its vapour handling capacity is to be indicated and justified.

4.4.7 Lighting *(1/10/2025)*

Lighting is to be installed to illuminate the bunker station area, and if installed in a hazardous area is to be compliant with applicable hazardous area equipment requirements. Lighting is to adequately illuminate the bunkering operation work area as follows:

- LNG or ammonia bunker hose(s)
- Connection and couplings on both receiving ship and bunkering ship
- ESD system call points

- Communication systems
- Fire-fighting equipment
- Passage ways / gangways intended to be used by the personnel in charge of the bunkering operation
- Vent mast(s).

4.5 Mooring and fendering

4.5.1 *(1/10/2025)*

Steel to steel contact between LNG or ammonia bunker ship and receiving ship e.g. via mooring lines, ladders, gangways, chains for fender support etc. shall be avoided through the use of insulation. Bunker hoses/pipes shall be supported and isolated to prevent electrical contact with the receiving ship.

4.5.2 *(1/10/2025)*

The rubber fenders used for keeping the distance between the LNG or ammonia bunkering ship and receiving ship shall be built according to an international recognized standard such as ISO 17357-2 or equivalent. The dimensions and arrangement of fenders shall be verified during risk assessment as required in [4.1] taking into consideration the interferences of the hazardous areas of both ships and the minimum bend radius of the bunkering hose.

5 Hoses and pumps

5.1 Hose design requirements

5.1.1 General *(1/12/2020)*

The hoses used for bunkering are to comply with the requirements in IGC Code 5.11.7.

For bunkering hoses the following characteristics are to be defined by the designer and submitted to the Society:

- Minimum/Maximum Allowable Working Temperature
- Maximum Allowable Working Pressure
- Minimum Bend Radius
- Maximum Allowable Crush Load
- Maximum Allowable Axial Load.

5.1.2 Hose Maximum Working Pressure and Strength *(1/10/2025)*

The maximum working pressure specified by manufacturer is not to be less than 1 MPa in accordance with IGC Code 5.11.7.3.

The strength of the hoses is to be compatible with the maximum release forces of the ERC or BRC.

5.1.3 Materials *(1/10/2025)*

All materials of hose assembly are to be suitable for marine environment, compatible with each other and with the fluid conveyed (LNG or ammonia and LNG or ammonia vapours).

5.1.4 End connection and coupling *(1/12/2020)*

The end fittings are to be made of corrosion resistant material and in accordance with IGC Code Table 6.4.

5.2 Type approval, testing and certification of LNG or ammonia bunkering hoses

5.2.1 *(1/10/2025)*

Bunkering hoses are to be type approved by the Society.

Flexible hoses intended for the handling of LNG are to be in compliance with design and testing requirements standards EN1474-2, or EN21012 or equivalent standards and IGC Code 5.11.7.

Flexible hoses intended for the handling of ammonia are to be compatible with the fuel and suitable for the fuel temperature and in compliance with the design and testing requirements of a recognised standard to the satisfaction of the Society (e.g. ISO 5771 or equivalent standards) and IGC Code 5.11.7.

5.2.2 *(1/12/2020)*

All hoses are to be individually certified by the Society at satisfactory outcome of testing according to [5.3], carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

5.3 Testing of Hoses at workshop

5.3.1 **Pressure test** *(1/12/2020)*

Each hose assembly is to be subjected to a hydraulic pressure test at ambient temperature to a pressure not less than 1,5 times the maximum operating (nominal) pressure, to demonstrate that the hose assembly is capable of withstanding pressure without leaking.

5.3.2 **Non destructive testing of welding** *(1/12/2020)*

Welds of the hose assembly are to be subjected to non destructive testing (NDT) according to international recognized standards.

5.4 Hoses documentation

5.4.1 *(1/12/2020)*

A hose technical file containing the following information is to be kept on board:

- Hose identification number
- Type approval certificate issued by Society
- Product test certificate issued by Society
- Overall weight of the hose and end fittings assembly
- Date of entry into service
- Inspection intervals and lifetime
- Instructions for the handling, storage and installation of hose

5.5 Marking of products

5.5.1 *(1/12/2020)*

Each hose is to be permanently marked according to a recognized international standard or the following information:

- Manufacturer's name or logo
- Hose designation and size
- Maximum Allowable Working Pressure
- Maximum and minimum allowable working temperature
- Date of manufacture
- Marking from Society

5.6 Transfer pumps

5.6.1 *(1/12/2020)*

The transfer pumps if different from cargo pumps shall comply with requirements specified in Sec 5, [3.2] and they shall be type approved.

All pumps are to be pressure tested in the presence of the Surveyor.

6 Quick Connect Disconnect Coupler (QCDC)

6.1 Type approval, testing and certification of QCDC

6.1.1 *(1/12/2020)*

QCDC are to be type approved by the Society.

6.1.2 *(1/12/2020)*

All QCDC are to be individually certified by the Society at satisfactory outcome of testing according to [6.3] carried out by the manufacturer in the presence of the Surveyor, unless an alternative certification scheme is agreed with the Society.

6.2 Type testing

6.2.1 *(1/12/2020)*

The QCDC is to be subjected to a type test to confirm the release performance under ice built up condition according to an international recognized standard such as ISO 21593, ISO 16904 or equivalent.

6.3 Workshop testing

6.3.1 **Pressure test** *(1/12/2020)*

The QCDC is to be subjected to a hydrostatic pressure test, at ambient temperature, to a pressure not less than 1,5 times the Maximum Allowable Working Pressure to demonstrate that the QCDC is capable of withstanding pressure without leakage.

7 Emergency release coupling (ERC) and breakaway coupling (BRC)

7.1 Type approval, testing and certification of QCDC

7.1.1 General *(1/10/2025)*

Transfer arms and hoses shall be fitted with an emergency release coupling (ERC) or breakaway coupling (BRC) designed to minimize the release of LNG or ammonia on emergency disconnection. The emergency release coupling is to be designed as breakaway coupling i.e. with automatic disconnection in case the design loads are exceeded. The design load of the ERC or BRC are not to be greater that the manifold allowable loads as defined in [4.4.4]. Additionally the emergency release coupling may be designed with manual or remote and automatic activation by the ESD bunkering system.

7.1.2 *(1/12/2020)*

Each separate section is to contain a self-closing shut-off valve, which seals automatically on disconnection.

7.1.3 *(1/12/2020)*

All electrical components of the emergency release coupling are to be certified of a suitable safe type.

When applicable, the availability of power to the ERC is to be monitored and arranged so that bunkering operation is automatically stopped in case of loss of power supply to the ERC.

7.1.4 *(1/12/2020)*

The bunkering line is to be designed and arranged to withstand the surge pressure that may result from the activation of the ERC.

7.2 Type approval, testing and certification of ERC

7.2.1 *(1/12/2020)*

ERC are to be type approved by the Society.

7.2.2 *(1/12/2020)*

All ERCs are to be individually certified by the Society at satisfactory outcome of testing according to [7.4] carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

7.3 Type testing

7.3.1 *(1/10/2025)*

The ERC and BRC are to be subjected to a type test according to an international recognized standard such as ISO 18683 or equivalent to confirm the values of axial and shear forces at which it automatically separates. Additionally the tightness of the self-closing shut-off valves after separation is to be tested.

7.3.2 *(1/10/2025)*

The ERC and BRC are to be subjected to a type test to confirm the release performance under ice built up condition.

7.3.3 *(1/10/2025)*

When applicable, the ERC and BRC are to be subjected to a type test to confirm the release in case of remote or automatic activation.

7.4 Workshop testing

7.4.1 **Pressure test** *(1/10/2025)*

The ERC and BRC are to be subjected to a hydrostatic pressure test, at ambient temperature, to a pressure not less than 1,5 times the Maximum operating (nominal) pressure, to demonstrate that the ERC and BRC are capable of withstanding pressure without leaking.

8 Electrical insulation flanges

8.1 General

8.1.1 *(1/12/2020)*

Each insulation flange is to be subjected to a test of electrical resistance in air and the resistance is to be of at least 1000 Ω but less than 1 MΩ.

8.1.2 *(1/10/2025)*

The resistance of each insulation flange is to be measured after installation in the complete LNG or ammonia transfer system and the resistance is to be not less than 1000 Ω.

9 Hose Supports and transfer arms

9.1 General

9.1.1 *(1/10/2025)*

Arrangements are to made so that the hoses can be be suitably supported in such a way that the minimum allowable bending radius is complied with.

9.1.2 *(1/12/2020)*

Arrangements such as cranes or winches are to be available for the handling of hoses whose size or weight does not allow a safe manual handling.

9.1.3 *(1/12/2020)*

Non electrical equipment located in hazardous area and belonging to items such as cranes, winches, etc. is to be suitable for explosive atmosphere according to international recognized standard (e.g. ISO 80079-36 or equivalent).

9.1.4 *(1/12/2020)*

Electrical equipment located in hazardous area is to comply with IGC Code 10.2.

9.2 Transfer arms

9.2.1 *(1/12/2020)*

Transfer arms are to be approved by the Society.

9.2.2 *(1/12/2020)*

Transfer arms are to be designed and constructed in accordance with a recognized national or international standards acceptable to the Society as EN1474-1.

9.2.3 *(1/10/2025)*

The maximum allowable operating amplitude and forces acting on the loading arm during the bunkering operations are to be defined and compatible with the hoses and ERC. The exceeding of loading arm envelope is to activate two stages alarms in bunker control station and on the navigation bridge.

The initiation of the first stage is to activate a visual and audible alarm.

The initiation of the second stage is to activate the ESD and ERC system.

9.2.4 *(1/10/2025)*

All loading arms are to be individually certified by the Society at satisfactory outcome of tests, as required for lifting appliances and operational tests, or per recognized international standards, carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

9.2.5 *(1/12/2020)*

The operational test per [9.2.4] is to give evidence of compliance with the design criteria per [9.2.3].

10 Inert Gas System

10.1 Installation and inerting capacity

10.1.1 *(1/12/2020)*

An inert gas system is to be fitted on board, to enable purging and inerting of the bunkering lines; the system is to be in compliance with IGC Code 9.4 and 9.5.

10.1.2 *(1/12/2020)*

The inerting capacity is to be designed according the bunkering operations and when based on inert gas storage on board, the capacity is not to be less than 5 times the volume of the hose and pipes to be purged.

11 Gas detection

11.1 Gas detection in enclosed spaces

11.1.1 *(1/10/2025)*

Permanently installed gas detectors are to be fitted in all hazardous areas and toxic zones including bunkering station if of enclosed or semi-enclosed type, LNG or ammonia process room and other enclosed spaces containing LNG or ammonia piping or other equipment not equipped with double walled piping.

11.1.2 *(1/12/2020)*

The number of detectors in each space is to be considered taking into account the size, layout and ventilation of the space. At least two independent gas detectors are required in each hazardous area.

11.1.3 *(1/10/2025)*

The detection equipment is to be located where gas may accumulate and in the ventilation outlets. Gas/vapour dispersion analysis or a physical smoke test is to be used to find the best arrangement.

11.1.4 *(1/10/2025)*

An audible and visual alarm is to be activated before the vapour concentration reaches 20% of the lower explosive limit (LEL).

11.1.5 *(1/10/2025)*

An audible and visual alarm is to be activated before the ammonia vapour concentration reaches 110 ppm.

11.1.6 *(1/12/2020)*

Audible and visual alarms from the gas detection equipment are to be located on the bridge and in the bunkering control station.

11.2 Gas detection in open spaces

11.2.1 *(1/10/2025)*

The installation of thermal imaging camera is to be evaluated on the basis of the risk assessment as defined in [4.1], for open spaces classed as hazardous or toxic areas (e.g. bunkering station, hose handling areas).

Monitoring of thermal imaging camera is to be available in the bunkering control station.

12 Control and safety systems

12.1 General

12.1.1 *(1/12/2020)*

Appropriate segregation shall be maintained between control, monitoring/alarm and safety functions to limit the effects of single failures during bunkering.

Failure of one part of the integrated system shall not affect the functionality of other parts, except for those functions directly dependent on the defective part.

Being the bunkering control system combined with the cargo control system all relevant requirements specified in the IGC Code 13.9 are to be complied with.

12.2 Emergency shut-down systems (ESD)

12.2.1 *(1/10/2025)*

An ESD system is to be fitted to safely and effectively stop the transfer of LNG or ammonia (and vapour as applicable) between the receiving ship and the bunkering ship in the event of an emergency during the bunkering operation and in general it is to be in compliance with IGC Code 18.10.

The ESD safety system is to be designed so as to limit the consequence of failures. It is to be constructed on the fail-to safety principle.

The ESD system is to be of the self-check type; as a rule, failure within the ESD including the outside connection, is to activate an alarm.

The control systems involved in the ESD, which is a linked system to allow both parties (on board receiving ship and the LNG or ammonia bunkering ship) to shut down the transfer in an emergency situation, is to be capable of being activated automatically or manually.

The ESD system normally includes two stages:

- ESD-stage 1, a stage in which the LNG or ammonia transfer process is shut down in a controlled manner
- ESD-stage 2, a stage in which decoupling of the transfer system between the LNG or ammonia bunker ship and receiving ship is activated.

The ESD-1 and ESD-2 logic shall be verified and agreed among stakeholders during the risk assessment as required in [4.1] also considering applicable international recognized standard or guidelines (e.g. SIGTTO ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers).

Where provided, override command of ESD system has to be clearly indicated in the Bunkering control station.

The ESD-1 and ESD-2 trips are to trigger visual and audible alarms in the navigation bridge, engine control room, cargo and bunkering control room and manifold area.

12.2.2 *(1/10/2025)*

At least one local manual activation position for the ESD system is to be made available for the LNG or ammonia fueled ship being bunkered, this may be in the form of an ESD System pendant with sufficient length of cable or an ESD link system (SSL ship/shore link or ship/ship link). The SSL may be various type (e.g.: electric, fibre-optic, radio transmission, pneumatic). The SSL is to have an adequate reliability and redundancy level according to a recognized international standard or guideline (e.g.: SIGTTO ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers).

12.2.3 *(1/12/2020)*

At least one local manual activation position for the ESD system is to be fitted in a place that has a clear view of the manifold area (the 'clear view' may be provided via CCTV) but is at a safe distance from the manifold.

12.2.4 *(1/10/2025)*

Any activation of the ESD systems is to be implemented simultaneously on both **LNG** or ammonia bunker vessel and receiving ship.

12.2.5 *(1/10/2025)*

The timing sequence is to ensure that the involved pumps and vapour compressors (if any) are given a stop command not later than the closing command to the manifold valve.

12.2.6 *(1/12/2020)*

The bunkering lines are to be designed and arranged to withstand the surge pressure that may result from the activation of the emergency release coupling and quick closing of ESD valves. If not demonstrated to be required at a higher value due to pressure surge considerations, a default time of 5 seconds from the trigger of the alarm to full closure of the ESD valves is to be arranged.

12.2.7 *(1/12/2020)*

The components of the ESD system located in hazardous and safety zones are to be of a suitable safe type.

12.2.8 *(1/10/2025)*

All electrical components of the emergency release coupling actuator and of the ESD systems are to be approved and certified by the Society.

12.3 Alarms and safety actions

12.3.1 *(1/12/2020)*

The alarms and safety function/actions required for the transfer system are given in Tab 3 and they are additional to those required in the IGC Code Table 18.1. The extent of alarms and safety functions may be reconsidered on the basis of outcome from risk assessment.

The receiving ship is expected to be capable of transmitting at least an ESD signal via an hardwired system.

Table 3 : Alarms and safety actions required for the transfer system *(1/10/2025)*

Parameters	Alarm	Activation of the Bunker ESD systems (ESD-1)	Automatic activation of the emergency release coupling (ESD-2) **(1)**
Fire Detection in way of tank domes or manifold area for receiving ship and LNG or ammonia bunker ship **(1)**	X	X	
Shutdown signal from shore or receiving ship	X	X	
Loss of ESD linked system **(1)**	X	X	
Loss of power supply to LNG or ammonia bunkering control system	X	X	
ESD logic failure	X	X	
Low Pressure in cargo valve remote control system	X		
Low Low Pressure in cargo valve remote control system	X	X	
Stop of the ventilation of enclosed or semi-enclosed bunkering station	X	X	
Loss of actuating power to the common loading arm maneuvering system or to the ERC of individual loading arms	X	X	
High level in surge drum (where provided)	X		
High High level in surge drum (where provided)	X	X	
Low pressure in the supply cargo tank	X		
Low Low pressure in the supply cargo tank	X	X	
Sudden pressure drop at the transfer pump discharge	X	X	
High level in the LNG or ammonia storage tank of receiving ship **(1)**	X		
High High level in the LNG or ammonia storage tank of receiving ship **(1)**	X	X	
High pressure in the LNG or ammonia storage tank of receiving ship **(1)**	X		
High High pressure in the LNG or ammonia storage tank of receiving ship **(1)**	X	X	
High pressure in the manifold vapor return system	X		
High high pressure in the manifold vapor return system (if any)	X	X	
High pressure in the manifold of liquid supply system	X		
High High pressure in the manifold of liquid supply system	X	X	
LNG or ammonia cold leakage in the manifold drip tray/coamings	X	X	
Gas detection in bunkering station of receiving ship **(1)**	X	X	
(1) when the receiving ship is equipped with an SSL compatible with the LNG or ammonia bunkering ship SSL			

Parameters	Alarm	Activation of the Bunker ESD systems (ESD-1)	Automatic activation of the emergency release coupling (ESD-2) **(1)**
Gas detection in bunkering station of bunkering ship	X	X	
Excessive movement of ship from berth/ship	X	X	X
Disconnection of the ERC	X	X	
(1) when the receiving ship is equipped with an SSL compatible with the LNG or ammonia bunkering ship SSL			

12.4 Communication systems

12.4.1 *(1/10/2025)*

A two-way voice communication system is to be provided between the LNG or ammonia bunkering ship and the receiving ship.

12.4.2 *(1/12/2020)*

The components of the communication system located in hazardous and safety zones are to be of a suitable safe type.

13 Testing of the LNG or ammonia transfer system at workshop

13.1 Pressure test

13.1.1 *(1/10/2025)*

All piping and tanks of the LNG or ammonia transfer system are to be subjected to a hydraulic pressure test in the presence of a Society Surveyor, at ambient temperature, to a pressure not less than 1,5 times the nominal pressure, to demonstrate the capability to withstand pressure without leaking.

13.2 Inspection of welds

13.2.1 *(1/10/2025)*

When applicable, the welds of the LNG or ammonia transfer system are to be subjected to a non-destructive testing and all butt welds are to be subjected to a 100% radiographic or ultrasonic examination.

14 Testing and trials of the LNG or ammonia transfer system at yard

14.1 Onboard tests and trials

14.1.1 *(1/12/2020)*

After assembly on board, the following tests and trials are to be carried out in the presence of a Surveyor.

14.2 Piping leak test

14.2.1 *(1/10/2025)*

A leak test, using air or water or other suitable medium, of the completely assembled and equipped LNG or ammonia transfer and vapour return systems, in steps of 10-20% up to 90% of the operational pressure of the LNG or ammonia/gas system is to be carried out in the presence of a Society Surveyor, to detect leakage with soap/leak detection spray. Holding time is depending of the volume/part of the installation being leak tested.

14.3 Inerting

14.3.1 *(1/10/2025)*

Inerting of the total LNG or ammonia/gas system including LNG or ammonia storage tank(s), following the inerting procedure included in the operational manual is to be carried out in the presence of a Society Surveyor.

15 Implementation survey

15.1 Survey at the first LNG bunkering

15.1.1 *(1/10/2025)*

Upon issuance of the additional service feature **LNG bunker** or **ammonia bunker**, a dedicated survey is to be carried out on occasion of the first LNG or ammonia bunkering, as follows:

a) the first LNG or ammonia bunkering is to be carried out according to the LNG or ammonia bunkering procedure included in the operational manual.

15.1.2 *(1/10/2025)*

During the survey the following is to be carried out:

a) Examination of transfer piping systems including supporting arrangements.

b) Verification of satisfactory operation of:
- Control and monitoring systems
- Connections systems (QCDC)
- ESD system
- piping purging and inerting systems.

16 Additional features

16.1 IG-Bunker (Inert Gas Bunker)

16.1.1 General *(1/10/2025)*

The additional feature **IG-Bunker** (Inert Gas Bunker) is assigned to LNG or ammonia bunker ship designed to also supply inert gas to a LNG or ammonia fueled ship to ensure inerting of the receiving ship systems, and complying with the following requirements.

16.1.2 **Inert Gas system** *(1/12/2020)*

The inert gas system is to comply with IGC Code 9.4 and 9.5 and Chapter 9.

16.1.3 **Piping system** *(1/10/2025)*

The lines used for the inert gas are to be separate from the LNG or ammonia liquid and vapour lines used for normal operation.

16.1.4 **Document to be submitted** *(1/12/2020)*

The following documents are to be submitted to the Society for approval in addition to the information required in [3]:

- Diagram of the Inert gas system
- Procedure for supplying inert gas to the receiving ship.

16.2 BT (Bunker Trust)

16.2.1 General *(1/10/2025)*

The additional feature **BT** (Bunker Trust) is assigned to LNG or ammonia bunker ship designed with arrangement for the verification of the LNG or ammonia quality and quantity delivered to the receiving ship according to international recognized standard (e.g. ISO 23306) or equivalent or according to a gas fuel specification agreed among the stakeholders.

16.2.2 **Documents to be submitted** *(1/10/2025)*

The following documents are to be submitted to the Society for approval in addition to the information required in [3]:

- Diagram of the LNG or ammonia sampling arrangement
- Technical specification of LNG or ammonia analyzer
- LNG or ammonia sampling procedure
- Evidence of approval of the measuring system according to MID or OIML R117-1.

16.2.3 Sampling System *(1/10/2025)*

The ship has to be fitted with a sampling system in accordance with international recognized standard (e.g. ISO 8943) or equivalent. Other type of system or piping arrangement are subject to special consideration and they are evaluated case by case.

The sampling connections are to be in compliance with requirements specified in IGC Code 5.6.5.

The sampling procedure is to be in compliance with requirements specified in IGC Code 18.9 and included in the risk assessment as required in [4.1.2].

The LNG or ammonia analyzer is to be type approved.

16.2.4 Custody Transfer Measuring System *(1/10/2025)*

A Custody Transfer Measuring System is to be installed on the LNG or ammonia bunker ship.

A recognized thirty party should approve the design and instruments against MID or OIML R117-1; evidence of this is required to be supplied to the Society.

16.3 VCS-Bunker (Vapour Control System Bunker)

16.3.1 General *(1/10/2025)*

The additional feature **VCS-Bunker** (Vapour Control System Bunker) is assigned to LNG or ammonia bunker ship in compliance with Pt F, Ch 13, Sec 7 for the assignment of notation **VCS-TRANSFER**.

16.3.2 Vapour return handling *(1/10/2025)*

The LNG or ammonia bunker ship is to be capable of handling all or part of the vapours from receiving ship generated during the LNG or ammonia bunkering operation, in addition to its own boil-off gas (BOG), without release to the atmosphere. The vapour handling capacity of the LNG or ammonia bunker ship is to be indicated and justified.

Different ways to dispose of the vapours may be considered, such as:

- re-liquefaction
- utilization by the gas consuming equipment of the LNG or ammonia bunkering ship (e.g. gas or dual-fuel engines or boilers)
- gas combustion unit.

A combination of these means is possible and other solutions may be accepted if they are duly justified to the Society.

16.4 NH3 Tank Ready and NH3 Tank

16.4.1 General *(1/1/2024)*

The additional features **NH3 Tank Ready** and **NH3 Tank** are assigned to LNG bunker ship:

- fitted with LNG cargo tanks designed also for ammonia storage (**NH3 Tank Ready**)
- fitted with LNG cargo tanks designed, built and tested also for ammonia storage (**NH3 Tank**).

16.4.2 NH3 Tank Ready *(1/1/2024)*

The drawings of the tank are to be verified considering both LNG and ammonia cargoes.

The protocol to be used for testing the tank material is to be submitted for information.

The applicable design criteria are to be documented and submitted by the tank manufacturer and will be specially considered by the Society on a case-by-case basis.

16.4.3 NH3 Tank *(1/1/2024)*

The drawings of the tank are to be verified considering both LNG and ammonia cargoes.

The documents related to the tests campaign carried out for the tank material are to be provided for review.

The applicable design criteria are to be documented and submitted by the tank manufacturer and will be specially considered by the Society on a case-by-case basis.

APPENDIX 2 REGASIFICATION SYSTEMS, PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR AND PRESSURE PIPING SYSTEMS

1 Regasification systems

1.1 General

1.1.1 *(1/1/2021)*

These are systems where the cargo is regasified from a liquid to a vapour and then sent ashore via a pipeline for use as a gaseous fuel. The vapour may or may not be treated on board the installation dependent on the requirements of the end user.

The vaporisers are to be selected to satisfy the heaviest demand of the end user and should be able to function during all motions of the installation.

Selection of the vaporisers is to consider environmental impact in terms of air emissions, use of biocides or changes in seawater temperature.

The availability of auxiliary systems serving the process system and on which the process system may depend is also to be considered in selection of design code and specification of such systems.

The design is to ensure that cross contamination of auxiliary systems with hydrocarbons will be adequately protected against.

1.2 Design and construction

1.2.1 *(1/1/2021)*

The design and construction of regasification systems are to be in accordance with a recognized Standard and with the requirement of this section. The standards are to be adhered to in their entirety.

Use of other standards is subject to the approval by the Society.

1.3 Documentation to be submitted

1.3.1 *(1/1/2021)*

Sec 1, Table 1 lists the plans, information, analysis, etc. which are to be submitted in addition to the information required in the other Parts of the Rules for the parts of the unit not affected by the cargo, as applicable.

Table 1 : Documents to be submitted *(1/1/2021)*

No.	A/I	Documents
1	A	Details of process pressure vessels and relative valving arrangement
2	I	Regasification system

2 Process pressure vessels

2.1 Class of pressure vessels and maximum temperature of media

2.1.1 *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.1.2

Process pressure vessels handling cargo are to be considered at least as class 2 pressure vessels, in accordance with Pt C, Ch 1, Sec 3, [1.4.1].

2.1.2 *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.1

The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

3 Regassification process piping

3.1 General requirements

3.1.1 Cargo import and export system *(1/1/2021)*

Provisions for cargo import and export systems are given in [5] too.

3.1.2 Provisions for protection of piping against thermal stress *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.7.1

Expansion joints are to be protected from extensions and compressions greater than the limits fixed for them and the connected piping is to be suitably supported and anchored. Bellow expansion joints are to be protected from mechanical damage.

3.1.3 Segregation of high temperature piping *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.7.2

High temperature pipes are to be thermally isolated from the adjacent structures. In particular, the temperature of pipelines is not to exceed 220 °C in gas-dangerous zones.

3.1.4 Pressure relief valve setting *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.5.6 and 5.5.7

Pressure relief valves are to be set to discharge at a pressure not greater than the design pressure such that the overpressure during discharge does not exceed 110% of the design pressure.

3.1.5 Protection against leakage *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.2

Where the piping system is intended for liquids having a boiling point lower than - 30 °C, permanent means to avoid possibility of contact between leaks and hull structures are to be provided in all those locations where leakage might be expected, such as shore connections, pump seals, flanges subject to frequent dismantling, etc.

3.1.6 Means for detecting the presence of liquid cargo *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.2

The means to detect the presence of liquid cargo may be constituted by electrical level switches whose circuit is intrinsically safe. The alarm signals given by the level switches are to be transmitted to the wheelhouse and to the cargo control station, if provided.

3.1.7 Connections of relief valve discharges to cargo tanks *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.2

The connections, if any, to the cargo tanks of relief valve discharges fitted on the liquid phase cargo piping are not to be fitted with shut-off valves, but are to be provided with non-return valves in the proximity of the tanks.

3.1.8 Centrifugal pumps *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.2

Overpressure relief valves on cargo pumps may be omitted in the case of centrifugal pumps having a maximum delivery head, the delivery valve being completely closed, not greater than that permitted for the piping.

3.2 Design pressure

3.2.1 Design pressure definition *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.4.1

For each piping section, the maximum pressure value among those applicable in paragraph 5.11.2.2 of the IGC Code is to be considered.

3.3 Flanges

3.3.1 Flanges not complying with standards *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.6.2

For flanges not complying with a standard, the dimensions and type of gaskets are to be to the satisfaction of the Society.

3.4 Stress analysis

3.4.1 Calculations in accordance with recognised standards *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

When such an analysis is required, it is to be carried out in accordance with the requirements listed below. Subject to this condition, calculations in accordance with recognised standards are accepted by the Society.

3.4.2 Calculation cases *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The calculations are to be made for every possible case of operation, but only those leading to the most unfavourable results are required to be submitted.

3.4.3 Loads to be taken for calculation *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The calculations are to be carried out taking into account the following loads:

a) piping not subject to green seas:
   - pressure
   - weight of the piping and of the internal fluid
   - contraction

b) piping subject to green seas that is liable to be in opera- tion at sea and in port:
   - pressure
   - weight of the piping and of the internal fluid
   - green seas
   - contraction
   - unit motion accelerations

c) piping subject to green seas that is in operation only in port; the more severe of the following two combinations of loads:
   - pressure
   - weight of the piping and of the internal fluid
   - contraction
   - weight of the piping
   - green seas
   - expansion, assuming that the thermal stresses are fully relaxed.

3.4.4 Green sea directions *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

When green seas are considered, their effects are to be stud- ied, unless otherwise justified, in the following three directions:

- axis of the unit
- vertical
- horizontal, perpendicular to the axis of the unit.

3.4.5 Stress intensity *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The stress intensity is to be determined as specified in the formulae in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures:

a) for primary stresses resulting from:
   - pressure
   - weight
   - green seas

b) for primary stresses and secondary stresses resulting from contraction.

3.4.6 Stress intensity limits *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

a) For the first case, the stress intensity is to be limited to the lower of:
   0,8 R_e and 0,4 R_m

b) for the second case, the stress intensity is to be limited to the lower of:
   1,6 R_e and 0,8 R_m.

3.4.7 Piping with expansion devices *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

For piping fitted with expansion devices, their characteristics are to be submitted to the Society. Where these characteristics are such that the forces and moments at the ends of the devices are negligible for the contraction they must absorb, the calculation of the loads due to contraction in the corresponding piping is not required. It is, however, to be checked that the stress intensity corresponding to the primary stresses does not exceed the limits given in [3.4.6].

3.4.8 Flexibility coefficient *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

The flexibility coefficient of elbows is to be determined from the formulae given in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures.

3.4.9 Local stresses *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.11.5

Particular attention is to be paid to the calculation of local stresses in the assemblies subjected to axial forces and bending moments. The Society reserves the right to request additional justifications or local strengthening where considered necessary.

3.5 Aluminised pipes

3.5.1 *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.12

Aluminised pipes may be fitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

4 Cargo system valving requirements

4.1 Cargo tank connections for gauging

4.1.1 Exemption *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.5.5

The requirements in paragraph 5.5.5 of the IGC Code relevant to cargo tank connections for pressure gauges and measuring devices do not apply to tanks with an MARVS not exceeding 0,07 MPa.

4.2 Emergency shutdown

4.2.1 Clarification on location of fusible elements *(1/1/2021)*

IGC CODE REFERENCE : Ch 18, 18.10

The cargo stations in way of which the fusible elements mentioned in paragraph 18.10.3.2 of the IGC Code are to be fitted are to be intended as the loading and unloading manifolds.

The system may be integrated into the fire and gas systems and appropriate level of redundancy based on risk analysis in these locations.

The need to enhance the reliability of the system and of process shutdowns may require the use of different technologies for this system or the use of voting duplicated systems.

4.2.2 Fail-close action of Emergency Shut Down (ESD) valve *(1/1/2024)*

IGC CODE REFERENCE : Ch 18, 18.10.2.1.2

The following requirements specify the arrangements for emergency shut down valve (hereinafter referred to as ESD valve) installed in cargo piping of ships engaged in the carriage of liquefied gases to stop cargo flow in the event of an emergency, either internally within the ship, or during cargo transfer to other ships or shore facilities.

When ESD valve is actuated by hydraulic or pneumatic system, the following are to be complied with:

a) audible and visible alarm is to be given in the event of loss of pressure that causes activation of fail-close action. The alarm is to be provided in a normally manned control station (e.g. Cargo Control Room and/or the navigation bridge, etc.).

b) the following conditions are also to be complied to ensure the fail-close action:

   1) failure of hydraulic or pneumatic system is not to lead to loss of fail-close functionality (i.e. activated by spring or weight); or

   2) hydraulic or pneumatic system for fail-close action is to be arranged with stored power and separated from normal valve operation.

5 Cargo transfer methods

5.1 Discharge into common header

5.1.1 *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.6

When two or more pumps located in different cargo tanks are operating at the same time discharging into a common header, the stop of the pumps is to activate an alarm at the centralised cargo control location.

Equipment for liquefied gas transfer (e.g. hoses, loading arms) is to be certified for its intended use.

6 Bonding

6.1 Static electricity

6.1.1 **Acceptable resistance** *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.7.4

To avoid the hazard of a discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the unit is not to be greater than $10^6\ \Omega$.

6.1.2 **Bonding straps** *(1/1/2021)*

IGC CODE REFERENCE : Ch 5, 5.7.4

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the unit, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the unit

c) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

a) clearly visible so that any shortcoming can be clearly detected

b) designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint

c) easy to install and replace.

7 Materials for construction

7.1 Material requirements

7.1.1 **Tubes, forgings and castings for cargo and process piping** *(1/1/2021)*

IGC CODE REFERENCE : Ch 6, Table 6.4

In general, impact tests for forgings, castings and welded and seamless pipes in stainless austenitic grades 304, 304L, 316, 316L, 321 and 347 are required when the design temperature is below -105°C and are to be carried out at -196°C.

7.1.2 **Aluminium coatings** *(1/1/2021)*

IGC CODE REFERENCE : Ch 6, 6.4

The use of aluminium coatings is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo gas may accumulate.

7.2 Welding and non-destructive testing

7.2.1 Welding consumables *(1/1/2021)*

IGC CODE REFERENCE : Ch 6, 6.5.2.1

The content of paragraph 6.5.2.1 of the IGC Code is also to cover process pressure vessels and secondary barriers.

7.2.2 Test requirements - bend tests *(1/1/2021)*

IGC CODE REFERENCE : Ch 6, 6.5.3.5.2

As an alternative to the bend test indicated in paragraph 6.5.3.5.2 of the IGC Code, a test over a mandrel having a diameter equal to 3 times the thickness with a bend angle up to 120° may be required.

8 Electrical installations

8.1 General

8.1.1 *(1/1/2021)*

A FMEA or equivalent analysis is to be carried out according to IGC Code, 10.2.6 and submitted to the Society for approval.

8.2 Hazardous location classification and permitted electrical equipment

8.2.1 General *(1/1/2021)*

The hazardous location classification is to be the result of an interdisciplinary activity that takes into account the results of the risk assessment. In particular, it is to include e.g. properties of flammable materials, process and related electrical and safety equipment. The rationale of the hazardous area selection is to be properly documented and sent to the Society for information.

8.3 Process plant location classification and permitted electrical equipment

8.3.1 *(1/1/2021)*

Hazardous location classification is to be carried out in accordance with the following requirements and IEC 60079-10, or, alternatively, with an acceptable Code or Standard providing an equivalent safety.

8.3.2 *(1/1/2021)*

It is to be taken into consideration that the horizontal extent of the hazardous areas at ground level will increase with increasing relative density of the gas or vapour which may be released and the vertical extent above the source will increase with decreasing the gas or vapour relative density.

8.3.3 *(1/1/2021)*

Zone 0 hazardous location normally include areas or spaces:

a) within process apparatus developing flammable gas or vapours;

b) within enclosed pressure vessels or storage tanks;

c) around vent pipes which discharges continually or for long periods;

d) over/near surface of flammable liquids in general.

9 Safety system and fire protection

9.1 General requirements and definitions

9.1.1 *(1/1/2021)*

The safest conditions for the systems on board are to be defined.

9.1.2 *(1/1/2021)*

All equipment and systems are to be equipped with indicating or monitoring instruments and devices necessary for safe operation.

9.1.3 *(1/1/2021)*
Emergency shutdown systems are to be provided against hazardous events.

Production systems are to be equipped with shutdown systems.

Systems that could jeopardize safety if they fail or operate outside pre-set conditions are to be provided with automatic shutdown.

9.1.4 *(1/1/2021)*
An emergency shutdown system (ESD) includes:

a) manual input devices (push buttons)

b) interfaces towards other safety systems, e.g.:
- fire detection system
- gas detection system
- alarm and communication systems
- process shutdown system
- fire-fighting systems
- ventilation systems
- blowdown systems, venting systems and High integrity pressure protection systems, as applicable.

9.2 Basic design principles

9.2.1 *(1/1/2021)*
Intertrips between process systems are to be initiated as a result of any initial event which could cause undesirable cascade effects in other parts of the plant before operator intervention can be realistically expected.

9.2.2 *(1/1/2021)*
Emergency shutdown is to initiate a process shut-down.

9.2.3 *(1/1/2021)*
The shutdown system is to be completely independent of control systems used for normal operation. See also Pt C, Ch 3, Sec 2, [1.1.4].

9.2.4 *(1/1/2021)*
The shutdown system is to be capable to monitor critical parameters and bring the system to a safe condition if specified conditions are exceeded. See also Pt C, Ch 3, Sec 2, [5].

10 Instrumentation (gauging, gas detection)

10.1 Indicator location

10.1.1 **Monitoring list** *(1/1/2021)*
IGC CODE REFERENCE : Ch. 13

A "cargo control room" as dealt with in 3.4.1 of IGC Code is to be provided.

The information and alarms relevant to the containment, handling and process systems are to be transferred in the cargo control room.

10.2 Protected spaces

10.2.1 *(1/1/2021)*
IGC CODE REFERENCE : Ch. 13, 13.6.2

In addition to the list in paragraph 13.6.2 of the IGC Code, the gas detection system is also to serve:
- spaces adjacent to pump rooms and compressor rooms
- areas where process equipment is located including gas compressors areas
- air locks and doorways to enclosed non hazardous areas;
- intakes for ventilation air, and

- ventilation outlets from hazardous areas mechanically ventilated.

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **tanker**, as defined in Pt A, Ch 1, Sec 2, [4.5.7] and Pt A, Ch 1, Sec 2, [4.3.7].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of this Chapter, which are specific to tankers.

1.1.3 The liquid cargoes which are allowed to be carried by such ships are specified in Ch 7, App 4.

1.2 Summary table

1.2.1 Table 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to tankers.

Table 1

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Section 2
Machinery and cargo system	Section 3
Electrical installations	**(1)**

Main subject	Reference
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for tankers are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 General arrangement design

1.1 Compartment arrangement

1.1.1 General *(1/7/2008)*

Tankers may be built with independent or integral tanks.

In the case of carriage of edible liquids it is assumed that cargo tanks are not used for any other purposes than transport of edible liquids, except under emergency conditions.

Specification of tank coating with certificate of acceptance for toxicity and tainting testing by recognized laboratory or health authority is to be submitted.

1.1.2 Integral tanks

Cofferdams are to be fitted between tanks and compartments intended for liquids likely to alter edible liquids carried.

Tanks are to be separated from any compartment containing heat sources by cofferdams or duly heat-insulated bulkheads.

1.1.3 Arrangement of tanks

In general, each tank is to be fitted with:

- a graduated metal gauge rod or any other equivalent sounding device
- an inspection door of adequate size fitted with a watertight metal cover secured by wing bolts or any other device offering equivalent safety
- an expansion system intended to avoid any excessive pressure and any risk of overflow due to a rise in temperature or occasional fermentation; the expansion capacity is to be about 0,5% of the tank cubic capacity
- a drain well that may be suppressed where precautions are taken to improve the running of liquids towards the suction pipes.

2 Stability

2.1 Intact stability

2.1.1 General

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.3] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

In general, a representative sample of loading conditions intended to be used for the ship is also to be submitted. The additional loading conditions are also to be in compliance with the requirements of Pt B, Ch 3, Sec 2.

3 Structure design principles

3.1 Materials

3.1.1 Steels for hull structure

For ships having a poop, the steel type used for the strength deck plating in way of the poop front is to be extended forward to cover any pump room openings.

4 Design loads

4.1 Hull girder loads

4.1.1 Still water loads

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1.2], still water loads are to be calculated for the following loading conditions:

- homogeneous loading conditions (excluding tanks intended exclusively for segregated ballast tanks) at maximum draft
- partial loading conditions
- any specified non-homogeneous loading condition
- light and heavy ballast conditions
- mid-voyage conditions relating to tank cleaning or other operations where, at the Society's discretion, these differ significantly from the ballast conditions.

5 Hull scantlings

5.1 Plating

5.1.1 Minimum net thicknesses *(1/7/2002)*

The net thickness of the strength deck and bulkhead plating within or bounding the longitudinal extension of the cargo area is to be not less than the values given in Tab 1.

Table 1 : Minimum net thickness of the strength deck and bulkhead plating

Plating	Minimum net thickness (mm)
Strength deck	$(5,5 + 0,02\ L)\ k^{1/2}$ for $L < 200$ $(8 + 0,0085\ L)\ k^{1/2}$ for $L \geq 200$
Tank bulkhead	$L^{1/3}\ k^{1/6} + 4,5\ s$ for $L < 275$ $1,5\ k^{1/2} + 8,2 + s$ for $L \geq 275$
Watertight bulkhead	$0,85\ L^{1/3}\ k^{1/6} + 4,5\ s$ for $L < 275$ $1,5\ k^{1/2} + 7,5 + s$ for $L \geq 275$
Wash bulkhead	$0,8 + 0,013\ L\ k^{1/2} + 4,5\ s$ for $L < 275$ $3\ k^{1/2} + 4,5 + s$ for $L \geq 275$

Note 1:

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3].

s : Length, in m, of the shorter side of the plate panel.

5.2 Ordinary stiffeners

5.2.1 Minimum net thicknesses

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

$t_{MIN} = 0,75\ L^{1/3}\ k^{1/6} + 4,5\ s$ for $L < 275$

$t_{MIN} = 1,5\ k^{1/2} + 7,0 + s$ for $L \geq 275$

where s is the spacing, in m, of ordinary stiffeners.

5.3 Primary supporting members

5.3.1 Minimum net thicknesses

The net thickness of plating which forms the webs of primary supporting members is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = 1,45\ L^{1/3}\ k^{1/6}$

5.4 Scantlings of independent tank structure

5.4.1 Structure in way of the connection between the tank and the hull structure

The tanks are to be locally strengthened in way of their connection to the hull structure and of their securing points, if any.

The structure of the ship is to be strengthened so as to avoid excessive deformations, due to the weight of the full tanks and inertia forces caused by motions of the ship, specified in Part B, Chapter 5.

5.5 Strength check with respect to stresses due to the temperature gradient

5.5.1 *(1/7/2018)*

Direct calculations of stresses induced in the hull structures by the temperature gradient are to be performed for ships intended to carry cargoes at temperatures exceeding 90°C. In these calculations, the water temperature is to be assumed equal to 0°C.

The calculations are to be submitted to the Society for review.

5.5.2 The stresses induced in the hull structures by the temperature gradient are to comply with the checking criteria in Pt B, Ch 7, Sec 3, [4.3].

6 Other structures

6.1 Machinery space

6.1.1 Extension of the hull structures within the machinery space

Longitudinal bulkheads carried through cofferdams are to continue within the machinery space and be used preferably as longitudinal bulkheads for liquid cargo tanks. In any case, such extension is to be compatible with the shape of the structures of the double bottom, deck and platforms of the machinery space.

7 Protection of hull metallic structures

7.1 Coating of tank shells

7.1.1 Coating of the inside of tanks is to be obtained by means of an appropriate composition, unless the size and type of the tank allows baked enamelling.

Coatings are to be applied according to the Manufacturer’s specifications. Arrangements are to be made in order to remove solvents completely before using the tanks.

Coatings are to have appropriate shock-resisting qualities and be able to withstand any foreseeable working of the structure of the ship or tank without risking crack formation.

SECTION 3 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Documents to be submitted

1.1.1 The documents listed in Tab 1 are to be submitted for approval.

2 Piping systems

2.1 General

2.1.1 Materials

a) Materials used for piping systems are to comply with the provisions of Pt C, Ch 1, Sec 10, [2.1].

b) Attention is drawn to any national standards or regulations which might restrict the use of materials in contact with edible substances.

2.1.2 Independence of piping systems

a) The cargo piping system is to be entirely separated from other piping systems serving the ship.

b) In the case of carriage of edible substances, arrangements are to be made to avoid any inadvertent contamination of the cargo. In particular, the filling and discharge connections serving the cargo tanks are to be located remote from those serving the machinery piping systems.

2.1.3 Passage of pipes through tanks

Cargo tanks containing edible substances are not to be passed through by pipes conveying other liquids.

2.2 Cargo piping and pumping

2.2.1 Cargo pumps *(1/7/2008)*

At least two cargo pumps are to be provided for transferring the cargo.

In the case of carriage of edible liquids, submerged cargo pumps may be used provided that they are fitted with a double barrier between the driving oil and cargo; oil or cargo leakages into the double barrier are to be detectable.

Hydraulically operated valves are not to be located inside cargo tanks unless the hydraulic fluid used is harmless to the edible liquid quality in case of a leakage of hydraulic fluid.

2.2.2 Level gauging systems

Level gauging systems of tanks containing edible substances are to be so designed as to avoid any contamination of the cargo.

2.3 Air pipes

2.3.1

a) Air pipes of cargo tanks are to be fitted with automatic closing appliances. Refer to Pt C, Ch 1, Sec 10, [9.1].

b) Air pipes of tanks containing edible substances are to be led as far as practicable from:

- air pipes of sewage or flammable oil tanks
- machinery ventilation outlets.

2.4 Refrigerating installations

2.4.1

a) Where the cargo needs to be kept refrigerated for conservation purposes, the refrigerating installation is to comply with the applicable provisions of Part F, Chapter 8.

b) Provisions are to be made to avoid any contamination of the cargo by the refrigeration fluid.

2.5 Cargo tank cleaning systems

2.5.1 Adequate means are to be provided for cleaning the cargo tanks.

2.6 Additional requirements for ships carrying category Z substances

2.6.1 Tankers carrying category Z substances are to comply with the provisions of Ch 7, Sec 4, [8.2].

2.7 Integrated cargo and ballast system

2.7.1 *(1/1/2004)*
The requirements for integrated cargo and ballast systems are given in Ch 7, Sec 4, [3.5].

Table 1 : Documents to be submitted

Item No.	Description of the document **(1)**
1	Diagram of the cargo piping system
2	Diagram of the cargo tank venting system
3	Diagram of the cargo tank level gauging system
4	Diagram of the cargo tank cleaning system
5	Diagram of the bilge and ballast systems serving the cargo spaces
6	Diagram of the cargo heating and refrigerating systems
(1) Diagrams are also to include, where applicable: • the (local and remote) control and monitoring systems and automation systems • the instructions for the operation and maintenance of the piping system concerned (for information).	

Chapter 11
PASSENGER SHIPS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **passenger ship**, as defined in Pt A, Ch 1, Sec 2, [4.6.2].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of this Chapter, which are specific to passenger ships.

1.2 Summary table

1.2.1 Table 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to passenger ships.

Table 1

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery and systems	Sec 4
Electrical installations	Sec 5
Automation	**(1)**
Fire protection, detection and extinction	**(2)**

(1) No specific requirements for passenger ships are given in this Chapter.
(2) The specific requirements for passenger ships are given in Pt C, Ch 4.

SECTION 2 SHIP ARRANGEMENT

1 General

1.1 Definitions

1.1.1 Subdivision load line

Subdivision load line is a waterline used in determining the subdivision of the ship.

1.1.2 Deepest subdivision load line

Deepest subdivision load line is the waterline which corresponds to the greatest draught permitted by the subdivision requirements which are applicable.

1.1.3 Length L_S

Length L_S *is the length measured between perpendiculars taken at the extremities of the deepest subdivision load line.*

The length referred to in [2] is the length L_S.

1.1.4 Bulkhead deck

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

1.1.5 Margin line

Margin line is a line drawn at least 76 mm below the upper surface of the bulkhead deck at side.

1.1.6 Passenger spaces

Passenger spaces are those spaces which are provided for the accommodation and use of passengers, excluding baggage, store, provision and mail rooms.

In all cases volumes and areas are to be calculated to moulded lines.

2 General arrangement design

2.1 Arrangement of the collision bulkhead

2.1.1 *(1/7/2018)*

For the arrangement of the collision bulkhead, see Pt B, Ch 2, Sec 1, [2.1].

2.2 After peak bulkhead, machinery space bulkheads and sterntubes

2.2.1 *An after peak bulkhead, and bulkheads dividing the machinery space from the cargo and passenger spaces forward and aft, are to also be fitted and made watertight up to the bulkhead deck. The after peak bulkhead may, however, be stepped below the bulkhead deck, provided the degree of safety of the ship as regards subdivision is not thereby diminished.*

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

2.3 Openings in watertight bulkheads below the bulkhead deck

2.3.1 Openings in machinery spaces

Not more than one door apart from the doors to bunkers and shaft tunnels may be fitted in each main transverse bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion and all permanent bunkers. Where two or more shafts are fitted the tunnels are to be connected by an inter-communicating passage. Only one door is to be provided between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors are to be of the sliding type and are to be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck is to be situated outside the spaces containing the machinery.

Portable plates on bulkheads are not permitted except in machinery spaces. Such plates are always to be in place before the ship leaves port, and are not to be removed during navigation except in the case of urgent necessity at the discretion of the Master. The times of removal and replacement of any such portable plates are to be recorded in the log-book, and the necessary precautions are to be taken in replacing them to ensure that the joints are watertight. The Society may permit not more than one power-operated sliding watertight door in each main transverse bulkhead larger than 1,20 m to be substituted for these portable plates, provided these doors are closed before the ship leaves port and remain closed during navigation except in the case of urgent necessity at the discretion of the Master. These doors need not meet the requirements of complete closure by hand-operated gear in 90 seconds (see [2.5.3] e). The time of opening and closing these doors, whether the ship is at sea or in port, is to be recorded in the log-book.

2.3.2 Openings in cargo spaces

Watertight doors complying with the requirements of [2.5.1] *may be fitted in watertight bulkheads dividing cargo between deck spaces. Such doors may be hinged, rolling or sliding doors but are not to be remotely controlled. They are to be fitted at the highest level and as far from the shell plating as practicable, but in no case are the outboard vertical edges to be situated at a distance from the shell plating which is less than one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line. The doors accessible during the voyage are to be fitted with a device which prevents unauthorised opening. Manholes, or access in transverse watertight bulkheads dividing a cargo space from an adjoining cargo space or from a permanent reserve bunker, may also be accepted by the Society.*

2.3.3 Openings in passenger ships carrying goods vehicles and accompanying personnel

This requirement applies to passenger ships designed or adapted for the carriage of goods vehicles and accompanying personnel where the total number of persons on board, other than passengers as defined in Pt A, Ch 1, Sec 2, [4.6.2], exceeds 12.

If in such a ship the total number of passengers which include personnel accompanying vehicles does not exceed:

$$N = 12 + \frac{A}{25}$$

where:

N : the maximum number of passengers for which the ship is certified

A : the total deck area, in m^2, of spaces available for the stowage of goods vehicles,

and where the clear height at the stowage position and at the entrance to such spaces is not less than 4 m, the provisions of [2.3.2] in respect of watertight doors apply except that the doors may be fitted at any level in watertight bulkheads dividing cargo spaces.

Additionally, indicators are required on the navigating bridge to show automatically when each door is closed and all door fastenings are secured.

2.3.4 Trunks and tunnels

Where trunkways or tunnels for access from crew accommodation to the stokehold, for piping, or for any other purpose are carried through main transverse watertight bulkheads, they are to be watertight and in accordance with the requirements of Pt B, Ch 4, Sec 7, [1.3]. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, is to be through a trunk extending watertight to a height sufficient to permit access above the margin line. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels are not to extend through the first subdivision bulkhead abaft the collision bulkhead.

Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings are to be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

2.3.5 Additional requirements

In addition to [2.3.1], [2.3.2], [2.3.3], and [2.3.4], the requirements reported in [2.5.3] are to be complied with.

2.4 Openings in bulkheads above the bulkhead deck

2.4.1 General

Measures such as the fitting of partial bulkheads or diaphragms are to be taken to limit the entry and spread of water above the bulkhead deck. When partial watertight bulkheads and diaphragms are fitted on the bulkhead deck, above or in the immediate vicinity of main subdivision bulkheads, their connections with the shell and bulkhead deck are to be watertight so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the

partial watertight bulkhead does not line up with the bulkhead below, the bulkhead deck between is to be made effectively watertight.

Table 1 : Doors

			Sliding type			Hinged type			Rolling type (cargo between deck spaces)
			remote operation indication on the bridge	indicator on the bridge	local operation only	remote operation indication on the bridge	indicator on the bridge	local operation only	
watertight	below the bulkhead deck	open at sea	X						
		normally closed **(4)**	X						
		remain closed **(4)**					X **(1)**		X **(1) (3)**
weathertight / semi-watertight **(2)**	above bulkhead deck	open at sea	X			X			
		normally closed **(4)**		X			X		
		remain closed **(4)**						X	

(1) The door is to be closed before the voyage commences.
(2) Semi-watertight doors are required when they are located below the waterline at the equilibrium of the intermediate stages of flooding.
(3) If the door is accessible during the voyage, a device which prevents unauthorised opening is to be fitted.
(4) Notice to be affixed on both sides of the door: “to be kept closed at sea”.

The bulkhead deck or a deck above it is to be weathertight. The coamings of all openings in the exposed weather deck are to be of ample height and strength and are to be provided with efficient means for expeditiously closing them weathertight. Freeing ports, open rails and scuppers are to be fitted as necessary for rapidly cleaning the weather deck of water under all weather conditions.

Sidescuttles, gangway, cargo and coaling ports and other means for closing openings in the shell plating above the margin line are to be of efficient design and construction and of sufficient strength (see Pt B, Ch 9, Sec 9) having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision load line.

Efficient inside deadlights, so arranged that they can be easily and effectively closed and secured watertight, are to be provided for all sidescuttles to spaces below the first deck above the bulkhead deck.

2.4.2 Open end of air pipes

The open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15 degrees, or the maximum angle of heel during intermediate stages of flooding, as determined by direct calculation, whichever is the greater. Where no information regarding the above angle of heel is available, the open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15° or 0,5 m above the waterline when the ship heels to an angle of 15° from the bulkhead deck, whichever is the greater.

Alternatively, air pipes from tanks other than oil tanks may discharge through the side of the superstructure. The provisions of this paragraph are without prejudice to the provisions of the International Convention on Load Lines in force.

2.4.3 Additional requirements

In addition to [2.4.1], [2.4.2], the requirements in [2.5.4] are to be complied with.

2.5 Doors

2.5.1 Requirements for doors

The requirements relevant to the degree of tightness, as well as the operating systems, for doors complying with the prescriptions in [2.5.2] and [2.5.3] are specified in Tab 1.

2.5.2 Construction of watertight doors

The design, materials and construction of all watertight doors are to be to the satisfaction of the Society.

The frames of vertical watertight doors are to have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

2.5.3 Doors in watertight bulkheads below the bulkhead deck

a) Watertight doors are to be capable of being closed simultaneously from the central operating console at the navigation bridge in not more than 60 s with the ship in the upright position.

b) The means of operation whether by power or by hand of any power-operated sliding watertight door are to be capable of closing the door with the ship listed to 15° either way. Consideration is to also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door.

c) Watertight door controls, including hydraulic piping and electrical cables, are to be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimise the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls are to be such that if the ship sustains damage within one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line, the operation of the watertight doors clear of the damaged portion of the ship is not impaired.

d) All power-operated sliding watertight doors are to be provided with means of indication which show at all remote operating positions whether the doors are open or closed. Remote operating positions are only to be located at the navigating bridge and at the location where hand operation above the bulkhead deck is required by e).

e) Each power-operated sliding watertight door:

- *is to move vertically or horizontally;*
- *is to be normally limited to a maximum clear opening width of 1,20 m. The Society may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:*
  - *special consideration is to be given to the strength of the door and its closing appliances in order to prevent leakages;*
  - *the door is to be located outside the damage zone B/5;*
  - *the door is to be kept closed when the ship is at sea, except for limited periods when absolutely necessary as determined by the Society.*
- *is to be fitted with the necessary equipment to open and close the door using electrical power, hydraulic power, or any other form of power that is acceptable to the Society;*
- *is to be provided with an individual hand-operated mechanism. It is to be possible to open and close the door by hand at the door itself from either side and, in addition, close the door from an accessible position above the bulkhead deck with an all round crank motion or some other movement providing the same degree of safety acceptable to the Society. Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, may not exceed 90 s with the ship in the upright position;*
- *is to be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console at the navigation bridge;*
- *is to be provided with an audible alarm, distinct from any other alarm in the area, which is to sound whenever the door is closed remotely by power and which is to sound for at least 5 s but no more than 10 s before the door begins to move and is to continue sounding until the door is completely closed. In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving. Additionally, in passenger areas and areas of high ambient noise, the Society may require the audible alarm to be supplemented by an intermittent visual signal at the door;*
- *is to have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position, is to in no case be less than 20 s or more than 40 s with the ship in the upright position.*

f) The electrical power required for power-operated sliding watertight doors is to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck. The associated control, indication and alarm circuits are to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by a transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power.

The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the

discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to control, indication and alarm circuits at least for half an hour.

g) Power-operated sliding watertight doors are to have either:

- *a centralised hydraulic system with two independent power sources each consisting of a motor and pump capable of simultaneously closing all doors. In addition, there are to be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. The power operating system is to be designed to minimise the possibility of having a single failure in the hydraulic piping adversely affect the operation of more than one door. The hydraulic system is to be provided with a low-level alarm for hydraulic fluid reservoirs serving the power-operated system and a low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators. These alarms are to be audible and visual and are to be situated on the central operating console at the navigating bridge; or*
- *an independent hydraulic system for each door with each power source consisting of a motor or pump capable of opening and closing the door. In addition, there is to be a hydraulic accumulator of sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. A low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators is to be provided at the central operating console on the navigation bridge. Loss of stored energy indication at each local operating position is to also be provided; or*
- *an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source is to be capable of being automatically supplied by the transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°.*

  The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to watertight doors, but not necessarily all of them simultaneously, unless an independent source of stored energy is provided.

For the systems specified above, provision is to be made as follows:

Power systems for power-operated watertight sliding doors are to be separate from any other power system. A single failure in the electrical or hydraulic power-operated systems excluding the hydraulic actuator may not prevent the hand operation of any door.

h) Control handles are to be provided at each side of the bulkhead at a minimum height of 1,6 m above the floor and are to be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidently. The direction of movement of the handles in opening and closingthe door is to be in the direction of door movement and is to be clearly indicated.

i) As far as practicable, electrical equipment and components for watertight doors are to be situated above the bulkhead deck and outside hazardous areas and spaces.

j) The enclosures of electrical components necessarily situated below the bulkhead deck are to provide suitable protection against the ingress of water.

k) Electric power, control, indication and alarm circuits are to be protected against faults in such a way that a failure in one door circuit may not cause a failure in any other door circuit. Short-circuits or other faults in the alarm or indicator circuits of a door may not result in a loss of power operation of that door. Arrangements are to be such that leakage of water into the electrical equipment located below the bulkhead deck may not cause the door to open.

l) A single electrical failure in the power operating or control system of a power-operated sliding watertight door may not result in a closed door opening. Availability of the power supply is to be continuously monitored at a point in the electric circuit as near as practicable to each of the motors required in g). Loss of any such power supply is to activate an audible and visual alarm at the central operating console at the navigation bridge.

m) The central operating console at the navigation bridge is to have a "master mode" switch with two modes of control:

- *a "local control" mode which is to allow any door to be locally opened and locally closed after use without automatic closure, and*
- *a "doors closed" mode which is to automatically close any door that is open. The "doors closed" mode is to permit doors to be opened locally and is to automatically reclose the doors upon release of the local control mechanism.*

The "master mode" switch is to normally be in the "local control" mode. The "doors closed" mode is to only be used in an emergency or for testing purposes. Special consideration is to be given to the reliability of the "master mode" switch.

n) The central operating console at the navigation bridge is to be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light is to indicate a door is fully open and a green light is to indicate a door is fully closed. When the door is closed remotely the red light is to indicate the intermediate position by flashing. The indicating circuit is to be independent of the control circuit for each door.

o) It is not to be possible to remotely open any door from the central operating console.

p) All watertight doors are to be kept closed during navigation. Certain watertight doors may be permitted to remain open during navigation only if considered absolutely necessary; that is, being open is determined essential to the safe and effective operation of the ship's machinery or to permit passengers normally unrestricted access throughout the passenger area. Such determination is to be made by the Society only after careful consideration of the impact on ship operations and survivability. A watertight door permitted to remain thus open is to be clearly indicated in the ship's stability information and the damage control documentation *and is always to be ready for immediate closure.*

2.5.4 Doors in watertight bulkheads above the bulkhead deck

a) General

Doors are to be capable of being opened and closed by hand locally from both sides of the doors with the ship listed to 15° to either side. If the ship is allowed to heel up to 20°, during intermediate stages of flooding, then the doors are to be capable of operation by hand with the ship listed to 20° to either side.

Position indicators are to be provided on the bridge as well as locally on both sides of the doors to show that the doors are open or closed and that the dogs are fully and properly engaged.

Where the doors also serve as fire doors they are to be provided with position indicators at the fire control station and audible alarms as required for fire doors, as well as for weathertight doors. Where two doors are fitted they must be capable of independent operation remotely and from both sides of each door.

b) Doors normally closed at sea

In addition to a), doors not required for frequent access while at sea are to be kept normally closed and may be of either hinged or sliding type.

Doors kept normally closed are to have local operation from both sides of the doors and are to be labelled on both sides: "to be kept closed at sea".

c) Doors normally open at sea

Where fitted in public spaces for the passage of passengers and crew, the doors may be kept normally open at sea and may be either hinged or sliding type.

In addition to a), doors kept normally open at sea are to have local power operation from both sides of the door and remote closing from the bridge. Operation of these doors is to use a "master mode" switch on the bridge, local control can override the remote closing feature after which the door is automatically remotely reclosed upon release of the local control mechanism.

Doors kept normally open at sea are to have audible alarms, distinct from any other alarm in the area, which sound whenever the doors are closed remotely. The alarms are to sound for at least 5 s but not more than 10 s before the doors begins to move and continue sounding until the doors are completely closed. In passenger areas and areas of high ambient noise, the audible alarms are to be supplemented by visual signals at both sides of the doors.

2.6 Compartment arrangement

2.6.1 Ballast compartments

Water ballast may not in general be carried in tanks intended for fuel oil. In ships in which it is not practicable to avoid putting water in fuel oil tanks, oily-water separating equipment to the satisfaction of the Society is to be fitted, or other alternative means, such as discharge to shore facilities, acceptable to the Society is to be provided for disposing of the oily-water ballast (see Pt C, Ch 1, Sec 10, [7]).

2.6.2 Machinery compartments *(1/1/2011)*

When longitudinal bulkheads are fitted in the machinery space, adequate self-operating arrangements are to be provided in order to avoid excessive heel after damage.

Where such arrangements are cross-flooding systems, their area is to be calculated in accordance with the requirements of IMO Res. MSC.245(83).

SECTION 3 HULL AND STABILITY

1 Stability

1.1 Intact stability

1.1.1 General *(1/1/2009)*

Every passenger ship regardless of size is to be inclined upon its completion and the elements of its stability determined. The Master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service. A copy of the stability information is to be furnished to the Society.

Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

1.1.2 Standard requirements

In addition to Pt B, Ch 3, Sec 2, [2] the requirements in [1.1.3] to [1.1.5] are to be complied with for the loading conditions defined in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.9].

1.1.3 **Crowding of passengers** *(1/7/2024)*

The angle of heel due to crowding of passengers (see [1.1.6]) to one side is not to exceed 10° and the freeboard deck is not to be immersed.

For ships lesser than 20 m in length, the angle of heel is not to be greater than the angle corresponding to a freeboard of 0,1 m before the deck's immersion, or 12° if less.

In elaborating the stability booklet, the following is to be assumed:

- A minimum weight of 75 kg for each passenger except that this value may be increased subject to the approval of the Society. In addition, the mass and distribution of the luggage is to be approved by the Society.
- The height of the centre of gravity for passengers shall be assumed equal to:
  - 1 m above deck level for passengers standing upright. Account may be taken, if necessary, of camber and sheer of deck; and
  - 0,3 m above the seat in respect of seated passengers.
- *Passengers and luggage shall be considered to be in the spaces normally at their disposal, when assessing compliance with the criteria given in* Pt B, Ch 3, Sec 2, [2.1.2] to [2.1.5].
- Passengers without luggage shall be considered as distributed to produce the most unfavourable combination of passenger heeling moment and/or initial metacentric height, which may be obtained in practice, when assessing compliance with the criteria given in [1.1.6], respectively. In this connection, a value higher than four persons per square metre is not necessary.

1.1.4 **Maximum turning angle** *(1/7/2010)*

The angle of heel on account of turning may not exceed 10° when calculated using the following formula:

$$M_R = 0,200 \frac{V_0^2}{L_{WL}} \Delta \left(KG - \frac{d}{2} \right)$$

where:

M_R *: Heeling moment, in kNm*

V_0 *: Service speed, in m/s*

L_{WL} *: Length of ship at waterline, in m*

Δ *: Displacement, in t*

d *: Mean draught, in m*

KG *: Height of centre of gravity above keel, in m.*

1.1.5 *Where anti-rolling devices are installed in a ship, the Society is to be satisfied that the above criteria can be maintained when the devices are in operation.*

1.1.6 Ships engaged in still waters *(1/7/2024)*

a) Loading conditions

In addition to the loading conditions considered in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.9], the loading condition at arrival, without cargo, with necessary water ballast, with all passengers, on all decks assigned to them, crowded on the same side of the ship, is also to be considered.

If in any real loading condition the stability of the ship is less favourable than in the requested conditions, the stability requirements are also to be checked in such real condition.

In elaborating the stability booklet, the following is to be assumed:

- weight of each person equal to 75 kg;
- centre of gravity of each person, both standing and sitting, equal to 0,90 m above the upper surface of the relevant deck;
- maximum allowable number of persons equal to the number of sitting places plus two passengers/m^2 in the areas available for passengers, clear from the persons seated.

A higher number of standing persons may be assumed provided that the competent authority agrees.

In calculating the area in which the passengers are crowded among the benches, the distance between two of them may be reduced by 0,3 m x l (length of the bench) to exclude the area obstructed by sitting passengers.

b) Stability requirements in all required loading conditions

The following stability requirements are to be complied with:

1) (r-a) to be not less than 0,30 m.

To this end passengers are to be considered accommodated taking all the sitting places and areas assigned to them with 4 passengers/m^2, starting from the highest deck and proceeding to lower decks until the maximum allowable number of passengers is exceeded;

2) Distance between the upper surface of the main deck, at side, from the waterline in the final equilibrium status of heeled ship (residual minimum freeboard) to be not less than 0,20 m. For this purpose, passengers are to be considered accommodated on one side of the ship only, from the ship's centreline, taking all the sitting places and areas assigned to them with 4 passengers/m^2, starting from the highest deck and proceeding to lower decks until the maximum allowable number of passengers is exceeded.

If the number of all the passengers on one side of the ship does not reach the maximum allowable number, the surplus of passengers is to be ignored in calculating the transversal heeling of the ship.

3) The maximum allowable number of passengers is to be the lower of 1 and 2 above. Such number may be further reduced taking into account the following:

- if the value calculated according to 1 leads to a value of (r-a) less than 0,30 m and this cannot be avoided by the use of ballast of the ship, or by other suitable operations, such number is to be decreased in the calculation by unloading a suitable number of passengers, starting from the lower deck, until (r-a) not less than 0,30 m is reached. Therefore, the resulting reduced number of passengers is to replace the one resulting from 1
- if the residual freeboard, calculated through the passenger distribution according to 2, is less than 0,20 m and it cannot be increased by ballasting the ship, or by other suitable operations, the number of passengers calculated according to 2 is to be decreased in the calculation by unloading a suitable number of passengers, starting from those standing closest to the midship plane on the lower deck. Obviously, in such operation an upper deck is not affected by unloading of passengers as far as first all those standing, and then those sitting, in the lower deck are unloaded.

  The resulting reduced number of passengers is to replace the one resulting from 2.

4) Chains, railings or similar devices, fitted to segregate deck areas to prevent the presence of passengers during navigation, may be accepted by the Society on condition that the safe access to life saving appliances and essential service of the ship (e.g. toilets, bar, etc.) is not impeded.

Such devices are not to obstruct escape routes, muster stations and embarkation points; are not to interfere with the safe abandonment of the ship; and are to be in place at all times during navigation. During boarding, these devices can be temporarily removed to ensure homogeneous distribution of boarding passengers, and are to be reinstalled before the voyage starts.

5) To facilitate the calculations, it is permissible not to take into account both the shear and the camber of the ship, but to evaluate the vertical positions of all the centres of gravity referring to the section at ½ L.

6) Any opening sidescuttles located below the upper deck which, because of the transversal heeling of the ship, may have their lowest point less than 0,20 m above the final waterline, are to be fitted with efficient devices such

that they can be effectively closed and secured, under the Master's responsibility, while the passengers are on board. Such condition is to be noted in the ship's logbook. It is allowable in the calculations that such sidescuttles are partially or fully submerged at the end of the heeling.

7) In the case of decked ships of length less than 20 m, item b) applies and the required residual freeboard on the side of passenger crowding, to be not less than 0,20 m, is to correspond to a heeling angle not more than 15°. In the case of ships without decks, the residual freeboard after heeling due to the crowding of passengers on one side of the ship is to be not less than 0,30 m with an angle of heel not greater than 15°.

2 Structure design principles

2.1 Hull structure

2.1.1 Framing

In general, the strength deck and the bottom of passenger ships of more than 100 m in length are to be longitudinally framed.

Where a transverse framing system is adopted for such ships, it is to be considered by the Society on a case-by-case basis.

3 Hull girder strength

3.1 Basic criteria

3.1.1 Strength deck

In addition to the requirements in Pt B, Ch 6, Sec 1, [2.2], the contribution of the hull structures up to the strength deck to the longitudinal strength is to be assessed through a finite element analysis of the whole ship in the following cases:

- when the size of openings in the side shell and/or longitudinal bulkheads located below the deck assumed by the Designer as the strength deck decrease significantly the capability of the plating to transmit shear forces to the strength deck
- when the ends of superstructures which are required to contribute to longitudinal strength may be considered not effectively connected to the hull structures in way.

4 Hull scantlings

4.1 Plating

4.1.1 Minimum net thicknesses *(1/7/2015)*

The net thickness of the inner bottom, side, weather strength deck and external balcony plating is to be not less than the values given in Tab 1.

5 Other structures

5.1 Side doors and stern doors

5.1.1 Side doors may be either below or above the freeboard deck.

Stern doors are to be situated above the freeboard deck.

5.1.2 The requirements applicable to side doors and stern doors are defined in Pt B, Ch 9, Sec 6.

Table 1 : Minimum net thickness of the inner bottom, side, weather strength deck and external balcony plating *(1/7/2015)*

Plating	Minimum net thickness, in mm
Inner bottom outside engine room	$2,0 + 0,02\ L\ k^{1/2} + 4,5\ s$
Side • below freeboard deck • between freeboard deck and strength deck	 $2,1 + 0,028\ L\ k^{1/2} + 4,5\ s$ $2,1 + 0,013\ L\ k^{1/2} + 4,5\ s$
Weather strength deck and trunk deck	$2,2\ k^{1/2} + 2,1 + s$
External balconies	$2,2\ k^{1/2} + 1,6 + s$
Note 1: k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]. s : Length, in m, of the shorter side of the plate panel.	

Table 2 : Equipment

Equipment number EN A < EN ≤ B		Stockless anchors		Stud link chain cables for anchors			
		N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Q1	Q2	Q3
19	22	1	21	65	7		
22	25	1	27	70	7		
25	30	1	32	70	8		
30	35	1	37	75	8		
35	40	1	43	75	9		
40	45	1	53	80	10		
45	50	1	64	82,5	11		
50	60	1	80	82,5	11	10	
60	70	1	90	82,5	12,5	11	
70	80	1	100	110	12,5	11	10
80	90	1	120	110	14	12,5	11
90	100	1	140	110	14	12,5	11
100	110	1	160	110	16	14	12,5
110	120	1	180	110	16	14	12,5
120	130	1	200	110	16	14	12,5
130	140	1	240	110	17,5	16	14
140	150	1	260	137,5	17,5	16	14
150	175	1	300	137,5	19	17,5	16
175	205	1	360	137,5	20,5	17,5	16
205	240	1	420	137,5	22	19	17,5
240	280	1	480	137,5	24	20,5	19
280	320	1	575	165	26	22	20,5
320	360	1	660	165	28	24	22
360	400	1	700	165	30	26	22
400	450	1	780	165	30	26	24
450	500	1	900	192,5	32	28	26
500	550	1	1020	192,5	34	30	26
550	600	1	1140	192,5	36	32	28
600	660	2	1200	385	38	32	30
660	720	2	1295	385	40	34	30
720	780	2	1440	440	42	36	32

Equipment number EN A < EN ≤ B		Stockless anchors		Stud link chain cables for anchors			
		N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Q1	Q2	Q3
780	840	2	1500	440	42	36	32
840	910	2	1595	440	44	38	34
910	980	2	1740	440	46	40	36
980	1060	2	1920	440	48	42	36

6 Hull outfitting

6.1 Equipment

6.1.1 Number of mooring lines

The specific requirements in Pt B, Ch 10, Sec 4, [3.5] for ships with the service notation **passenger ship** are to be complied with.

6.1.2 Ships having L ≤ 30 m and navigation notation other than unrestricted navigation

For ships having L ≤ 30 m and navigation notation other than **unrestricted navigation**:

- the equipment in stockless anchor and chain cables (or ropes according to Pt B, Ch 10, Sec 4, [3.3.5]) may be obtained from Tab 2
- the equipment in mooring lines of wire or natural fibre may be obtained from Tab 3.

Table 3 : Mooring lines *(1/1/2022)*

Equipment number EN A < EN ≤ B		Mooring lines		
A	B	N	Length of each line, in m	Ship Design Minimum Breaking Load, in kN
19	50	2	40	32
50	70	3	40	34
70	90	3	50	37
90	110	3	55	39
110	130	3	55	44
130	150	3	60	49
150	175	3	60	54

7 Windows and sidescuttles

7.1 Application

7.1.1 *(1/7/2011)*

The requirements in [7.2] apply to windows and sidescuttles, located in positions which are exposed to the action of sea and/or bad weather.

7.2 Thickness of glasses

7.2.1 General *(1/7/2011)*

The minimum thickness t, in mm, of glasses is to be obtained from the formula in [7.2.2] and [7.2.3], where:

b : length of the shorter window side, in mm

p : design pressure, in kN/m², defined in [7.2.4]

d : diameter of the window, in mm

$\beta = 0,54A_r - 0,078A_r^2 - 0,17$ for $(A_r < 3)$

$\beta = 0,75$ for $A_r \geq 3$

$A_r = \frac{a}{b}$

a : length of the longer window side, in mm

7.2.2 Rectangular windows *(1/7/2011)*

$t = \frac{b}{200}\sqrt{\beta p}$

7.2.3 Circular windows *(1/7/2011)*

$t = \frac{d}{400}\sqrt{p}$

7.2.4 Design pressure *(1/7/2020)*

The design pressure p, in KN/m^2, is to be obtained from Tab 4, where:

where:

f_w : 12,5 in way of sides and ends of superstructures

f_w : 7,5 in way of house fronts

Z_1 : vertical distance, in m, from the base line to the point where the calculated pressure p_0 is 15 kN/m^2

Z_2 : vertical distance, in m, from the base line to the deck immediately above Z_1

Z_w : vertical distance, in m, from the base line to the point under consideration

H_{td} : sum of the two 'tweendeck heights, in m, above Z_2

$p_0 = 10ac[bf - (z - T)]$

a : Coefficient defined in Tab 5 to be taken not greater than the maximum value, a_{max}, specified in Tab 5

c : Coefficient taken equal to:

$$c = 0,3 + 0,7\frac{b_1}{B_1}$$

Table 4 : Design pressure *(1/7/2011)*

Window or sidescuttle location	Design pressure, in kN/m^2
Between the summer waterline and a point located at a distance Z_1, in m, above the base line	$p = p_0$
Between the points located at a distance Z_1 and Z_2 m above the waterline	p = 15
Above Z_2 for the next two 'tweendecks	$p = 15 - f_w\left(\frac{Z_w - Z_2}{H_{td}}\right)$
For subsequent decks to the top of the navigation bridge	p= 2,5 sides and aft ends p= 7,5 house fronts
From the top of the navigation bridge to the uppermost deck, for house front s	p= 7,5 at top of navigation bridge p=2,5 at uppermost continuous deck, with linear variation between pressure at the top of the navigation bridge and pressure at the uppermost continuous deck.
From the top of the navigation bridge to the uppermost deck, at side and aft ends	p = 2,5

Table 5 : Coefficient a *(1/7/2020)*

Type of bulkhead	Location	a	a_{max}
Unprotected front	Lower tier	$2 + \frac{L}{120}$	4,5
	Second tier	$1 + \frac{L}{120}$	3,5
	Third tier	$0,5 + \frac{L}{150}$	2,5
Protected front		$0,5 + \frac{L}{150}$	2,5
Side		$0,5 + \frac{L}{150}$	2,5
Aft end of amidships	All tiers, when: x/L ≤ 0,5	$0,7 + \frac{L}{1000} - 0,8\frac{x}{L}$	1-0.8x/L
Aft end forward of amidships	All tiers, when: x/L > 0,5	$0,5 + \frac{L}{1000} - 0,4\frac{x}{L}$	0,8-0,4x/L

b_1 : Breadth of deckhouse, in m, at the position considered, to be taken not less than 0,25 B_1

B_1 : Actual maximum breadth of ship on the exposed weather deck, in m, at the position considered

b : Coefficient defined in Tab 6

f : Coefficient defined in Tab 7

z : distance between base line and the position considered, in m

T : summer waterline in m.

X : indicated in Tab 5 and Tab 6 is the co-ordinate, in m, of the calculation point with respect to the reference co-ordinate system defined in Pt B, Ch 1, Sec 2, [4].

Table 6 : Coefficient b *(1/7/2011)*

$\frac{x}{L} \leq 0,45$	$1 + \left(\frac{\frac{x}{L} - 0,45}{C_B + 0,2}\right)^2$
$\frac{x}{L} > 0,45$	$1 + 1,5\left(\frac{\frac{x}{L} - 0,45}{C_B + 0,2}\right)^2$
(1) For deckhouse sides, the deckhouse is to be subdivided into parts of approximately equal length, not exceeding 0,15L each, and x is to be taken as the co-ordinate of the centre of each part considered. **Note 1:** C_B : Block coefficient, with 0,6 ≤ CB ≤ 0,8	

Table 7 : Coefficient f *(1/7/2011)*

Length of ship, in m	f
L < 150	$\frac{L}{10}e^{-L/300} - \left[1 - \left(\frac{L}{150}\right)^2\right]$
150 ≤ L < 300	$\frac{L}{10}e^{-L/300}$
L ≥ 300	11,03

The design pressure p, in kN/m^2 is in any case not to be taken less than p_{min} as defined in Tab 8 where arrangement is in accordance to Pt B, Ch 9, Sec 9 or where arrangement is in accordance to [7.3].

Table 8 : p_{min} *(1/7/2020)*

Type of bulkhead	location	p_{min} in KN/m^2
Unprotect front	Lowest tier	$30 \le 25+0.1L \le 50$
	Second tier	$15 \le 12.5+0.05L \le 25$
	third tier	15
Protect front, side and aft end	Lowest and second tiers	$15 \le 12.5+0.05L \le 25$

Table 9 : p_{min} for "alternative to deadlights / storm covers" arrangement and scantling in [7.3] *(1/7/2020)*

tier	p_{min} in KN/m^2
2nd	35
3rd and above	15

7.3 Alternative to deadlights/storm covers

7.3.1 *(1/7/2020)*

In case the freeboard exceeds the minimum required according to the applicable International Convention on Load Lines, windows in the second tier and above may be fitted with a more robust glazing arrangement in alternative to the deadlights/storm covers required in Pt B, Ch 9, Sec 9. The more robust glazing arrangement is to be either:

- one glazing of a thickness increased by at least 40% with respect to the value t calculated according to [7.2]; or
- two glazing, each one of a thickness t calculated according to [7.2].

The supporting frames are to be strengthened comparably.

Other alternative arrangements of equivalent strength can be considered on case by case basis.

7.3.2 *(1/7/2020)*

The Client is to ensure that the glazing arrangement in alternative to the deadlights/storm covers is acceptable to the Administration.

8 External glass balustrades

8.1 Application

8.1.1 *(1/1/2020)*

The requirements of this paragraph apply solely to external glass balustrades, intended as barriers constructed with glass used on exposed decks.

8.2 Design considerations

8.2.1 *(1/1/2020)*

External glass balustrades are not to be located in areas deemed essential for the operation of the ship. Such areas include mooring decks, lifeboat decks, external muster stations and in the vicinity of davits. Where external glass balustrades are not to be used, more traditional bulwarks or guard rails are to be fitted in accordance with Pt B, Ch 10, Sec 2.

8.2.2 *(1/1/2020)*

External glass balustrades are to be not less than 1,0 m in height.

8.2.3 *(1/1/2020)*

External glass balustrades are to provide water freeing areas in accordance with Pt B, Ch 9, Sec 9, [5].

8.3 Balustrade glasses

8.3.1 *(1/1/2020)*

Railing with glass elements can be used provided they are made of either:

- monolithic glass with a minimum thickness of 6.0 mm, or
- laminated glass with a minimum thickness for each glass pane equal to 4 mm.

8.3.2 *(1/7/2024)*

The thickness of the glass pane shall be calculated according to [7.2.2] using the design pressures as specified in [7.2.4] multiplied by 0.5.

When the glass is continuously supported only along two opposite sides, the coefficient β in [7.2.2] is to be taken equal to 0.75.

8.4 Balustrade stanchions minimum requirements

8.4.1 *(1/10/2022)*

Stanchions are to be fitted, not more than 1.5 m apart for monolithic glass and 3.0 m apart for laminated glass. The stanchions are to have a minimum section modulus of 16 cm^3 for a glass railing with 1.5 m stanchion distance and a minimum section modulus of 32 cm^3 for a glass railing with 3.0 m stanchion distance. For intermediate distances, linear interpolation is to be applied.

The stanchions are to be rigidly fixed at their lower ends to resist rotational displacements.

These minimum requirements are intended for Grade A steel; for different metallic materials, an equivalent section modulus is to be calculated.

8.5 Balustrade top rail minimum requirements

8.5.1 *(1/1/2020)*

Balustrade top rail is to be effectively attached to balustrade stanchions.

8.5.2 *(1/10/2022)*

The top rail is to have a minimum section modulus Z in cm^3 calculated as follows:

$Z = 1.06\ l^2$

where l is the span of the top rail between stanchions, in m.

These minimum requirements are intended for Grade A steel; for different metallic materials, an equivalent section modulus is to be calculated.

8.6 Glass supporting structures yielding check

8.6.1 *(1/7/2024)*

For external glass balustrades, the glass supporting structures shall be calculated by direct calculations using the design pressures as specified in [7.2.4] and allowable stresses according to Pt B, Ch 7, Sec 3.

As an alternative to direct calculations, the glass supporting structures shall be accepted upon issuance of Type Approval Certificate (TA) based on testing. The balustrade glass pane for testing shall be supported with a similar arrangement as the actual arrangement on board the ship. The test pressure shall be the design pressure specified in [7.2.4] multiplied by 1.1. The test is considered successful if no visible damage occurs to the glass or its supporting arrangements.

8.7 Impact Resistance and Containment

8.7.1 *(1/7/2024)*

External glass balustrades are to be subject to a prototype pendulum impact test in accordance with "EN 13049:2003 Windows - Soft and heavy body impact - Test method, safety requirements and classification" or an equivalent National or International Standard, utilizing a drop height of not less than 1.2 m. The test specimens including the retaining arrangements are to be the same as the finished installation.

SECTION 4 MACHINERY AND SYSTEMS

1 Bilge system

1.1 General

1.1.1 *(1/7/2021)*

a) *The bilge pumping system required in Pt C, Ch 1, Sec 10, [6] shall be capable of operation under all practicable conditions after a casualty, whether the ship is upright or listed. For this purpose, wing suctions shall generally be fitted except in narrow compartments at the end of the ship where one suction may be sufficient. In compartments of unusual form, additional suctions may be required.*

b) *Arrangements shall be made whereby water in the compartment may find its way to the suction pipes.*

c) *Where, for particular compartments, the Society is satisfied that the provisions of drainage may be undesirable, it may allow such provision to be dispensed with if damage stability calculations show that the survival capability of the ship will not be impaired.*

1.2 Bilge pumps

1.2.1 **Number and capacity of bilge pumps** *(1/1/2011)*

Any passenger ship shall be provided with at least three power bilge pumps connected to the bilge main, one of which may be driven by the propulsion machinery. Where the bilge pump numeral is 30 or more one additional independent power pump shall be provided.

The bilge pump numeral shall be calculated as follows:

where P_1 is greater than P:

$$\text{bilge pump numeral} = 72 \cdot \left[\frac{M + 2P_1}{V + P_1 - P}\right]$$

in other cases:

$$\text{bilge pump numeral} = 72 \cdot \left[\frac{M + 2P}{V}\right]$$

where:

L : the length of the ship (metres), as defined in the International Convention on Load Lines in force;

M : the volume of the machinery space (cubic metres), that is below the bulkhead deck; with the addition thereto of the volume of any permanent oil fuel bunkers which may be situated above the inner bottom and forward of, or abaft, the machinery space. For the purpose of this item *machinery spaces are spaces between the watertight boundaries of a space containing the main and auxiliary propulsion machinery, including boilers, generators and electric motors primarily intended for propulsion. In the case of unusual arrangements, the Administration may define the limits of the machinery spaces;*

P : the whole volume of the passenger and crew spaces below the bulkhead deck (cubic metres), which are provided for the accommodation and use of passengers and crew, excluding baggage, store, provision and mail rooms;

V : the whole volume of the ship below the bulkhead deck (cubic metres);

P_1 : KN,

where:

N : the number of passengers for which the ship is to be certified; and

K : 0,056 L

However, where the value of KN is greater than the sum of P and the whole volume of the actual passenger spaces above the bulkhead deck, the figure to be taken as P_1 is that sum or two-thirds KN, whichever is the greater.

Each of the above pumps is to have a capacity not less than that required in Pt C, Ch 1, Sec 10, [6.7.4].

For use of ejectors in lieu of bilge pumps, see Pt C, Ch 1, Sec 10, [6.7.2].

1.2.2 Location of bilge pumps

Where practicable, the power bilge pumps shall be placed in separate watertight compartments and so arranged or situated that these compartments will not be flooded by the same damage. If the main propulsion machinery, auxiliary machinery and boilers are in two or more watertight compartments, the pumps available for bilge service shall be distributed as far as is possible throughout these compartments.

1.2.3 Availability of pumps *(1/1/2011)*

On a ship of 91,5 m in length and upwards or having a bilge pump numeral of 30 or more, as stated in *[1.2.1], the arrangements shall be such that at least one power bilge pump will be available for use in all flooding conditions which the ship is required to withstand, as follows:*

a) one of the required bilge pumps shall be an emergency pump of a reliable submersible type having a source of power situated above the bulkhead deck, or

b) the bilge pumps and their sources of power shall be so distributed throughout the length of the ship that at least one pump in an undamaged compartment will be available.

1.2.4 Draining capability

With the exception of additional pumps which may be provided for peak compartments only, each required bilge pump shall be so arranged as to draw water from any space required to be drained.

1.3 Direct bilge suction

1.3.1

a) In passenger ships subject to subdivision regulations*, independent power bilge pumps situated in machinery and/or boiler spaces shall have direct suctions from these spaces, except that not more than two such suctions shall be required in any one space.*

b) Where two or more such suctions are provided in one compartment, there shall be at least one on each side of the ship.

c) The Society may require independent power bilge pumps situated in other spaces to have separate direct suctions.

1.4 Control location

1.4.1

a) The spindles of the sea inlet and direct suction valves shall extend well above the engine room platform.

b) Where the circulating pumps are driven by electric motors, their starting equipment shall be located at, or above, the level of the motors.

1.5 Provision against bilge system damage

1.5.1 Damage to the bilge system

Provision shall 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 ship than one fifth of the breadth of the ship (measured at right angles to the centreline at the level of the deepest subdivision load line), or is in a duct keel, a non-return valve shall be fitted to the pipe in the compartment containing the open end.

1.5.2 Operation in the case of flooding

a) Distribution boxes, cocks and valves in connection with the bilge pumping system shall be so arranged that, in the event of flooding, one of the bilge pumps may be operative on any compartment; in addition, damage to a pump or its pipe connecting to the bilge main outboard of a line drawn at one fifth of the breadth of the ship shall not put the bilge system out of action.

b) If there is only one system of pipes common to all the pumps, the necessary valves for controlling the bilge suctions must be capable of being operated from above the bulkhead deck.

c) Where in addition to the main bilge pumping system an emergency bilge pumping system is provided, it shall be independent of the main system and so arranged that a pump is capable of operating on any compartment under flooding condition; in that case only the valves necessary for the operation of the emergency system need be capable of being operated from above the bulkhead deck.

1.5.3 Valve controls

All cocks and valves referred in [1.5.2] which can be operated from above the bulkhead deck shall have their controls at their place of operation clearly marked and shall be provided with means to indicate whether they are open or closed.

1.6 Bilge system for small ships *(1/1/2001)*

1.6.1 *(1/1/2001)*

For passenger ships not subject to subdivision regulations, less than 25 tons gross tonnage and assigned with a restricted navigation notation or engaged on voyages on which they are no farther from the nearest port than a distance corresponding to one hour's navigation, the bilge system will be specially considered by the Society in each single case.

2 Ballast system

2.1 Carriage of water ballast in fuel oil tank

2.1.1 *Water ballast should not in general be carried in tanks intended for fuel oil. In ships in which it is not practicable to avoid putting water in fuel oil tanks, oily-water separating equipment to the satisfaction of the Society shall be fitted, or other alternative means, such as discharge to shore facilities shall be provided for disposing of the oily-water ballast.*

3 Miscellaneous requirements

3.1 Steering gear

3.1.1 For steering gear arrangements without auxiliary means for steering, see Pt C, Ch 1, Sec 11, [3.5.2].

3.2 Oil-level gauges

3.2.1 For oil-level gauges, see Pt C, Ch 1, Sec 10, [11.6.7].

3.3 Watertight doors

3.3.1 For watertight doors, see Sec 2.

SECTION 5 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/7/2007)*

As stated in Note 1 of Pt A, Ch 1, Sec 1, [1.1.2], the statutory requirements of the SOLAS Convention and/or national safety regulations, as applicable, regarding fire protection, detection and extinction (hereinafter referred to as "fire protection statutory requirements") are no longer mandatory for the purpose of classification, except where the Society carries out surveys relevant to fire protection statutory requirements on behalf of the flag Administration. In such cases, fire protection statutory requirements are considered a matter of class and therefore compliance with these requirements is also verified by the Society for classification purposes.

1.2 Documentation to be submitted

1.2.1 The documentation dealing with the electrical system for watertight door and fire door systems (see [1.1.1]) is to be submitted for approval.

1.3 Electrical distribution and protection

1.3.1 *In a passenger ship, distribution systems shall be so arranged that fire in any main vertical zone as defined in* Part C, Chapter 4 *will not interfere with services essential for safety in any other such zone.*

This requirement will be met if main and emergency feeders passing through any such zone are separated both vertically and horizontally as widely as is practicable.

1.3.2 For generators arranged to operate in parallel and for individually operating generators, arrangements are to be made to disconnect automatically the excess load when the generators are overloaded in such a way as to prevent a sustained loss of speed. The operation of such device is to activate a visual and audible alarm.

1.3.3 *(1/7/2010)*

In passenger ships, supplementary lighting shall be provided in all cabins to clearly indicate the exit so that occupants will be able to find their way to the door. Such lighting, which may be connected to an emergency source of power or have a self-contained source of electrical power in each cabin, shall automatically illuminate when power to the normal cabin lighting is lost and remain on for a minimum of 30 min.

1.3.4 *(1/7/2025)*

For passenger ships carrying 36 or more persons, a flooding detection system for watertight spaces below the bulkhead deck in compliance with the provisions in IMO MSC.1/Circ.1291 *is to be provided.*

2 Emergency source of electrical power and emergency installations

2.1 General

2.1.1 *A self-contained emergency source of electrical power shall be provided.*

2.1.2 *Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits.*

Exceptionally, whilst the vessel is at sea, is understood to mean conditions such as:

a) blackout situation

b) dead ship situation

c) routine use for testing

d) short-term parallel operation with the main source of electrical power for the purpose of load transfer.

Unless instructed otherwise by the Society, the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements of Pt C, Ch 2, Sec 3, [2.4] are complied with.

2.1.3 *The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously.*

2.1.4 *The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the services stated in* [2.2.3] *for the period specified, if they depend upon an electrical source for their operation.*

2.1.5 *The transitional source of emergency electrical power, where required, is to be of sufficient capacity to supply at least the services stated in* [2.2.7] *for the periods specified therein, if they depend upon an electrical source for their operation.*

2.1.6 *An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in* Pt C, Ch 2, Sec 3, [2.3.13] *and* Pt C, Ch 2, Sec 3, [2.3.14] *are being discharged.*

2.1.7 If the services which are to be supplied by the transitional source receive power from an accumulator battery by means of semiconductor converters, means are to be provided for supplying such services also in the event of failure of the converter (e.g. providing a bypass feeder or a duplication of converter).

2.1.8 *Where electrical power is necessary to restore propulsion, the capacity of the emergency source shall be sufficient to restore propulsion to the ship in conjunction to other machinery as appropriate, from a dead ship condition within 30 min. after blackout.*

For the purpose of this requirement only, the dead ship condition and blackout are both understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation and in restoring the propulsion, no stored energy for starting the propulsion plant, the main source of electrical power and other essential auxiliaries is to be assumed available. It is assumed that means are available to start the emergency generator at all times.

The emergency generator and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes of blackout/dead ship condition as defined above. Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and/or other essential auxiliaries (emergency generator excluded).

For steam ships, the 30 minute time limit given in SOLAS can be interpreted as the time from blackout/dead ship condition defined above to light-off of the first boiler.

2.1.9 *Provision shall be made for the periodical testing of the complete emergency system and shall include the testing of automatic starting arrangements.*

2.1.10 For starting arrangements of emergency generating sets, see Pt C, Ch 1, Sec 2, [5.1].

2.1.11 *The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the provisions of* [2.1.12] *or* [2.1.13]*, respectively.*

2.1.12 *Where the emergency source of electrical power is a generator, it shall be:*

(a) driven by a suitable prime mover with an independent supply of fuel having a flashpoint (closed cup test) of not less than 43°C;

(b) started automatically upon failure of the electrical supply to the emergency switchboard *from the main source of electrical power and shall be automatically connected to the emergency switchboard; those services referred to in* [2.2.7] *shall then be transferred automatically to the emergency generating set. The automatic starting system and the characteristic of the prime mover shall be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 s; and*

(c) provided with a transitional source of emergency electrical power according to [2.1.14].

2.1.13 *Where the emergency source of electrical power is an accumulator battery, it shall be capable of:*

(a) carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage;

(b) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

(c) immediately supplying at least those services specified in [2.2.7].

2.1.14 *The transitional source of emergency electrical power required by* [2.1.12] (c) *shall consist of an accumulator battery which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the services in* [2.2.7] *if they depend upon an electrical source for their operation.*

2.2 Distribution of electrical power

2.2.1 *The emergency switch board shall be supplied during normal operation from the main switchboard by an interconnector feeder which shall be adequately protected at the main switchboard against overload and short-circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power.*

Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

2.2.2 *In order to ensure ready availability of the emergency source of electrical power, arrangements shall be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power shall be available to the emergency circuits.*

2.2.3 *(1/1/2023)*

The emergency source of electrical power shall be capable of supplying simultaneously at least the following services for the periods specified hereafter, if they depend upon an electrical source for their operation:

a) for a period of 36 hours, emergency lighting:

1) at every muster and embarkation station and over the sides;

2) in alleyways, stairways and exits giving access to the muster and embarkation stations;

3) in all service and accommodation alleyways, stairways and exits, personnel lift cars;

4) in the machinery spaces and main generating stations including their control positions;

5) in all control stations, machinery control rooms, and at each main and emergency switchboard;

6) at all stowage positions for firemen's outfits;

7) at the steering gear; and

8) at the fire pump, the sprinkler pump and the emergency bilge pump referred to in (d) below and at the starting position of their motors;

9) in all cabins, unless this supplementary lighting has a self-contained source of electrical power in each cabin (see [1.3.3])

b) for a period of 36 hours:

1) the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force; and

2) on ships constructed on or after 1 February 1995 the VHF radio installation required by Regulation IV/7.1.1 and IV/7.1.2 of SOLAS Consolidated Edition 1992, and, if applicable:

- *the MF radio installation required by Regulations IV/9.1.1, IV/9.1.2, IV/10.1.2 and IV/10.1.3;*
- *the ship earth station required by Regulation IV/10.1.1; and*
- *the MF/HF radio installation required by Regulations IV/10.2.1, IV/10.2.2 and IV/11.1;*

c) for a period of 36 hours:

1) all internal communication equipment required in an emergency (see [2.2.4]*);*

2) the shipborne navigational equipment as required by Regulation V/12; where such provision is unreasonable or impracticable the Head Office may waive this requirement for ships of less than 5,000 tons gross tonnage;

3) the fire detection and fire alarm system, the fire door holding and release system (see [1.1.1]); and

4) intermittent operation of the daylight signalling lamp, the ship's whistle, the manually operated call points and all internal signals (see [2.2.5]) *that are required in an emergency;*

unless such services have an independent supply for the period of 36 hours from an accumulator battery suitably located for use in an emergency;

d) for a period of 36 hours:

1) one of the fire pumps required by the relevant provisions of Part C, Chapter 4 (see [1.1.1]*);*

2) the automatic sprinkler pump, if any [1.1.1]); and

3) *the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves;*

e) *for the period of time required in* Pt C, Ch 1, Sec 11, [2]*, the steering gear if required to be so supplied;*

f) *for a period of half an hour:*

1) *any watertight doors required by Regulation II-1/15 to be power operated together with their indicators and warning signals;*

2) *the emergency arrangements to bring the lift cars to deck level for the escape of persons. The passenger lift cars may be brought to deck level sequentially in an emergency.*

Note 1: For ships having navigation notation "sheltered area" or "special navigation" having an area of operation at not more than 6 miles from the shore (see Pt C, Ch 2, Sec 1, [1.1.3]) and not subject to the SOLAS convention, the Society may accept that the emergency source of electrical power is capable of supplying, for a period of not less than 2 times the expected duration of the longest voyage, but not less than:

- *3 hours, or*
- *30 minutes for ships having navigation notation "sheltered area",*

only the following services:

- *emergency lighting*
- *navigation lights;*
- *radio installation;*
- *internal communication equipment and general alarm system;*
- *fire detection and alarm system;*
- *the steering gear pump (where it is required to be so supplied);*
- *one of the fire pumps;*
- *power to the control, indication and alarm circuits of watertight and fire doors (where provided);*
- *the sprinkler pump;*
- *the emergency bilge pump.*

2.2.4 *(1/1/2026)*

Internal communication equipment required in an emergency generally includes:

a) the means of communication between the navigating bridge and the steering gear compartment

b) the means of communication between the navigating bridge and the position in the machinery space or control room from which the engines are normally controlled

c) the means of communication which is provided between the bridge and the radio telegraph or radio telephone stations, where separately arranged outside the bridge.

d) the general emergency alarm system (as required in [3.2])

e) the means of communication which is provided between the officer of the watch and the person responsible for closing any watertight door which is not capable of being closed from a central control station as defined in SOLAS II-2/3.9

f) the public address system as required in [3.3]

g) the means of communication between the navigating bridge and the main fire control station.

2.2.5 *(1/7/2007)*

Internal signals required in an emergency generally include:

a) general alarm (see [1.1.1])

b) watertight door indication

c) fire door indication (see [1.1.1]).

2.2.6 *(1/7/2003)*

In a ship engaged regularly in voyages of short duration, i.e. voyages where the route is not greater than 20 nautical miles offshore or where the vessel has a class notation "Coastal Service"*, the Society if satisfied that an adequate standard of safety would be attained may accept a lesser period than the 36-hour period specified in [2.2.3] (b) to (e) but not less than 12 hours.*

Note 1: In ships for which SOLAS is not applicable, a reduced period of time may be accepted, but not less than three hours.

2.2.7 *The transitional source of emergency electrical power required is to supply at least the following services if they depend upon an electrical source for their operation:*

a) for half an hour:

1) the lighting required by [2.2.3] (a) and (b1)*;*

2) all services required by [2.2.3] (c1, 3 and 4) *unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.*

b) It is also to supply power to close the watertight doors as required by Regulation II-1/15.7.3.3, but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided. Power to the control, indication and alarm circuits as required by Regulation II-1/15.7.2, for half an hour.

3 General emergency alarm and public address systems

3.1 Application

3.1.1 *(1/7/2007)*

For the application of this item [3], see [1.1.1].

3.2 General emergency alarm system

3.2.1 An electrically operated bell or klaxon or other equivalent warning system installed in addition to the ship's whistle or siren for sounding the general emergency alarm signal is to comply with the following requirements.

3.2.2 The general emergency alarm system is to be supplemented by either a public address system complying with the requirements in [3.3] or other suitable means of communication.

3.2.3 The entertainment sound system is to be automatically turned off when the general alarm system is activated.

3.2.4 The system is to be continuously powered and is to have an automatic change-over to a standby power supply in case of loss of the normal power supply.

An alarm is to be given in the event of failure of the normal power supply.

3.2.5 The system is to be powered by means of two circuits, one from the ship's main supply and the other from the emergency source of electrical power required by [2.1] and [2.2].

3.2.6 *(1/7/2002)*

The system is to be capable of operation from the navigation bridge and, except for the ship’s whistle, also from other strategic points.

Note 1: Other strategic points are taken to mean those locations, other than the navigation bridge, from where emergency situations are intended to be controlled and the general alarm system can be activated. A fire control station is normally to be regarded as strategic points.

3.2.7 The alarm is to continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system.

3.2.8 The alarm system is to be audible throughout all the accommodation and normal crew working spaces and on all open decks.

3.2.9 The minimum sound pressure level for the emergency alarm tone in interior and exterior spaces is to be 80 dB (A) and at least 10 dB (A) above ambient noise levels existing during normal equipment operation with the ship underway in moderate weather.

3.2.10 In cabins without a loudspeaker installation, an electronic alarm transducer, e.g. a buzzer or similar, is to be installed.

3.2.11 The sound pressure level at the sleeping position in cabins and in cabin bathrooms is to be at least 75 dB (A) and at least 10 dB (A) above ambient noise levels.

3.2.12 For cables used for the general emergency alarm system, see Pt C, Ch 2, Sec 3, [9.6], Pt C, Ch 2, Sec 11, [5.2.1] and Pt C, Ch 2, Sec 11, [5.2.4].

3.2.13 Electrical cables and apparatus for the general emergency alarm system and their power supply are to be arranged so that the loss of the system in any one area due to localised fire is minimised.

3.2.14 Where the fire alarm to summon the crew operated from the navigating bridge or fire control station is part of the ship's general alarm system, it is to be capable of being sounded independently of the alarm in the passenger spaces.

3.3 Public address system

3.3.1 The public address system is to be one complete system consisting of a loudspeaker installation which enables simultaneous broadcast of messages from the navigation bridge, and at least one other location on board for use when the navigation bridge has been rendered unavailable due to the emergency, to all spaces where crew members or passengers, or both, are normally present (accommodation and service spaces and control stations and open decks), and to assembly stations (i.e. muster stations).

In spaces such as under deck passageways, busun's locker, hospital and pump room, the public address system is/may not be required.

3.3.2 *(1/7/2002)*

The public address system is to be arranged to operate on the main source of electrical power, the emergency source of electrical power and transitional sources of electrical power as required by [2.2].

3.3.3 The controls of the system on the navigation bridge are to be capable of interrupting any broadcast on the system from any other location on board.

3.3.4 Where an individual loudspeaker has a device for local silencing, an override arrangement from the control station(s), including the navigating bridge, is to be in place.

3.3.5 The system is not to require any action by the addressee.

3.3.6 It is to be possible to address crew accommodation and work spaces separately from passenger spaces.

3.3.7 In addition to any function provided for routine use aboard the ship, the system is to have an emergency function control at each control station which:

a) is clearly indicated as the emergency function,

b) is protected against unauthorised use,

c) automatically overrides any other input system or program, and

d) automatically overrides all volume controls and on/off controls so that the required volume for the emergency mode is achieved in all spaces.

3.3.8 The system is to be installed with regard to acoustically marginal conditions, so that emergency announcements are clearly audible above ambient noise in all spaces where crew members or passengers, or both, are normally present (accommodation and service spaces and control stations and open decks), and at assembly stations (i.e. muster stations).

3.3.9 With the ship underway in normal conditions, the minimum sound pressure level for broadcasting emergency announcements is to be:

a) in interior spaces 75 dB (A) and at least 20 dB (A) above the speech interference level, and

b) in exterior spaces 80 dB (A) and at least 15 dB (A) above the speech interference level.

3.3.10 The system is to be arranged to prevent feed-back or other interference.

3.3.11 The system is to be arranged to minimise the effect of a single failure so that the emergency messages are still audible (above ambient noise levels) also in the event of failure of any one circuit or component.

3.3.12 Each loudspeaker is to be individually protected against short-circuits.

3.3.13 For cables used for the public address system, see Pt C, Ch 2, Sec 3, [9.6], Pt C, Ch 2, Sec 11, [5.2.1] and Pt C, Ch 2, Sec 11, [5.2.4].

3.3.14 All areas of each fire zone are to be served by at least two dedicated loops of flame-retardant cables which are to be sufficiently separated throughout their length and supplied by two separate and independent amplifiers.

3.4 Combined general emergency alarm - Public address system

3.4.1 Where the public address system is the only means for sounding the general emergency alarm signal and the fire alarm, in addition to the requirements of [3.2] and [3.3], the following are to be satisfied:

- the system automatically overrides any other input system when an emergency alarm is required
- the system automatically overrides any volume control provided to give the required output for the emergency mode when an emergency alarm is required
- the system is arranged to minimise the effect of a single failure so that the alarm signal is still audible (above ambient noise levels) also in the event of failure of any one circuit or component, by means of the use of more than one device for generating an electronic sound signal.

4 Installation

4.1 Section and distribution boards

4.1.1 Cubicles and cupboards in areas which are accessible to any passenger are to be lockable.

5 Type approved components

5.1 Type approval and case by case approval

5.1.1 Components for Low-Location Lighting systems (LLL) in passenger ship escape routes are to be type approved or in accordance with [5.1.2].

5.1.2 Case-by-case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

Chapter 12
RO-RO PASSENGER SHIPS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **ro-ro passenger ship**, as defined in Pt A, Ch 1, Sec 2, [4.6.3].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of this Chapter, which are specific to ro-ro passengerships.

1.2 Summary table

1.2.1 Table 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to ro-ro passenger ships.

Table 1 *(1/7/2011)*

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery and systems	Sec 4
Electrical installations	Sec 5 and Ch 11, Sec 5
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for ro-ro passenger ships are given in this Chapter.	

SECTION 2 SHIP ARRANGEMENT

1 General

1.1 Application

1.1.1 The requirements of Ch 11, Sec 2 and Ch 11, Sec 3 apply to multi-deck ships, with double bottom and, in some cases, with wing tanks up to the lowest deck above the full load waterline, intended for the carriage of:

- passengers
- vehicles which embark and disembark on their own wheels, and/or goods in or on pallets or containers which can be loaded and unloaded by means of wheeled vehicles
- railway cars, on fixed rails, which embark and disembark on their own wheels.

1.2 Definitions

1.2.1 Subdivision load line

Subdivision load line is a waterline used in determining the subdivision of the ship.

1.2.2 Deepest subdivision load line

Deepest subdivision load line is the waterline which corresponds to the greatest draught permitted by the subdivision requirements which are applicable.

1.2.3 Length L_S

Length L_S *of the ship is the length measured between perpendiculars taken at the extremities of the deepest subdivision load line.*

The length referred to in [2] is the length L_S.

1.2.4 Bulkhead deck

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

1.2.5 Margin line

Margin line is a line drawn at least 76 mm below the upper surface of the bulkhead deck at side.

1.2.6 Passenger spaces

Passenger spaces are those spaces which are provided for the accommodation and use of passengers, excluding baggage, store, provision and mail rooms.

In all cases volumes and areas are to be calculated to moulded lines.

1.2.7 Ro-ro cargo spaces *(1/1/2005)*

Ro-ro cargo spaces are spaces not normally subdivided in any way and normally extending for either a substantial length or the entire length of the ship, in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles [including road or rail tankers], trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction.

1.2.8 Special category spaces *(1/1/2005)*

Special category spaces are those enclosed vehicle spaces above or below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be arranged on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.

2 General arrangement design

2.1 Number and disposition of transverse watertight bulkheads

2.1.1 Where there are less transverse bulkheads than those specified in Pt B, Ch 2, Sec 1, [1.1] or where the distance between them is considered excessive by the Society, ships are to be fitted with a system of partial bulkheads, side transverse frames and deck transverses such as to provide equivalent transverse strength.

2.2 Arrangement of the collision bulkhead

2.2.1 *(1/7/2018)*
For the arrangement of the collision bulkhead, see Pt B, Ch 2, Sec 1, [2.1].

2.3 After peak bulkhead, machinery space bulkheads and sterntubes

2.3.1 *An after peak bulkhead, and bulkheads dividing the machinery space from the cargo and passenger spaces forward and aft, are to also be fitted and made watertight up to the bulkhead deck. The after peak bulkhead may, however, be stepped below the bulkhead deck, provided the degree of safety of the ship as regards subdivision is not thereby diminished.*

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

2.4 Openings in watertight bulkheads below the bulkhead deck

2.4.1 Openings in machinery spaces

Not more than one door apart from the doors to bunkers and shaft tunnels may be fitted in each main transverse bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion and all permanent bunkers. Where two or more shafts are fitted the tunnels are to be connected by an inter-communicating passage. Only one door is to be provided between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors are to be of the sliding type and are to be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck is to be situated outside the spaces containing the machinery.

Portable plates on bulkheads are not permitted except in machinery spaces. Such plates are always to be in place before the ship leaves port, and are not to be removed during navigation except in the case of urgent necessity at the discretion of the Master. The times of removal and replacement of any such portable plates are to be recorded in the log-book, and the necessary precautions are to be taken in replacing them to ensure that the joints are watertight. The Society may permit not more than one power-operated sliding watertight door in each main transverse bulkhead larger than 1,20 m to be substituted for these portable plates, provided these doors are closed before the ship leaves port and remain closed during navigation except in the case of urgent necessity at the discretion of the Master. These doors need not meet the requirements of complete closure by hand-operated gear in 90 seconds (see [2.6.3] e). The time of opening and closing these doors, whether the ship is at sea or in port, is to be recorded in the log-book.

2.4.2 Openings in cargo spaces

Watertight doors complying with the requirements of [2.6.1] *may be fitted in watertight bulkheads dividing cargo between deck spaces. Such doors may be hinged, rolling or sliding doors but are not to be remotely controlled. They are to be fitted at the highest level and as far from the shell plating as practicable, but in no case are the outboard vertical edges to be situated at a distance from the shell plating which is less than one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line. The doors accessible during the voyage, are to be fitted with a device which prevents unauthorised opening. Manholes, or access in transverse watertight bulkheads dividing a cargo space from an adjoining cargo space or from a permanent reserve bunker, may also be accepted by the Society.*

2.4.3 Openings in ships carrying goods vehicles and accompanying personnel

This requirement applies to ships designed or adapted for the carriage of goods vehicles and accompanying personnel where the total number of persons on board other than passengers as defined in Pt A, Ch 1, Sec 2, [4.6.2], exceeds 12. If in such a ship the total number of passengers which include personnel accompanying vehicles does not exceed:

$$N = 12 + \frac{A}{25}$$

where:

N : the maximum number of passengers for which the ship may be certified.

A : the total deck area, in m^2, of spaces available for the stowage of goods vehicles,

and where the clear height at the stowage position and at the entrance to such spaces is not less than 4 m, the provisions of [2.4.2] in respect of watertight doors apply except that the doors may be fitted at any level in watertight bulkheads dividing cargo spaces.

Additionally, indicators are required on the navigating bridge to show automatically when each door is closed and all door fastenings are secured.

2.4.4 Trunks and tunnels

Where trunkways or tunnels for access from crew accommodation to the stokehold, for piping, or for any other purpose are carried through main transverse watertight bulkheads, they are to be watertight and in accordance with the requirements of Pt B, Ch 4, Sec 7, [1.3]. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, is to be through a trunk extending watertight to a height sufficient to permit access above the margin line. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels are not to extend through the first subdivision bulkhead abaft the collision bulkhead.

Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings are to be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

Where a ventilation trunk passing through a structure penetrates the bulkhead deck, the trunk is to be capable of withstanding the water pressure that may be present within the trunk, after having taken into account the maximum heel angle allowable during intermediate stages of flooding.

In the absence of information regarding the above maximum angle of heel, the water pressure relevant to the transverse location of the ventilation trunk is to be linearly interpolated between 0,5 m at the centreline and a height corresponding to an angle of 15° from the bulkhead deck plus 0,5 m at the side shell.

2.4.5 Additional requirements

In addition to [2.4.1], [2.4.2], [2.4.3], and [2.4.4], the requirements reported in [2.6.3] are to be complied with.

2.5 Openings in bulkheads above the bulkhead deck

2.5.1 General

Measures such as the fitting of partial bulkheads or diaphragms are to be taken to limit the entry and spread of water above the bulkhead deck. When partial watertight bulkheads and diaphragms are fitted on the bulkhead deck, above or in the immediate vicinity of main subdivision bulkheads, their connections with the shell and bulkhead deck are to be watertight so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the partial watertight bulkhead does not line up with the bulkhead below, the bulkhead deck between is to be made effectively watertight.

The bulkhead deck or a deck above it is to be weathertight. The coamings of all openings in the exposed weather deck are to be of ample height and strength and are to be provided with efficient means for expeditiously closing them weathertight. Freeing ports, open rails and scuppers are to be fitted as necessary for rapidly cleaning the weather deck of water under all weather conditions.

Sidescuttles, gangway, cargo and coaling ports and other means for closing openings in the shell plating above the margin line are to be of efficient design and construction and of sufficient strength (see Pt B, Ch 9, Sec 9) having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision load line.

Efficient inside deadlights, so arranged that they can be easily and effectively closed and secured watertight, are to be provided for all sidescuttles to spaces below the first deck above the bulkhead deck.

2.5.2 Watertight integrity from the ro-ro deck (bulkhead deck) to spaces below

In ships subject to the provisions of [2.5.3], the lowest point of all accesses that lead to spaces below the bulkhead deck is not to be less than 2,5 m above the bulkhead deck.

2.5.3 Vehicle ramps and other accesses

Where vehicle ramps are installed to give access to spaces below the bulkhead deck, their openings are to be closed weathertight to prevent ingress of water below, alarmed and indicated to the navigation bridge.

The Society may permit the fitting of particular accesses to spaces below the bulkhead deck provided they are necessary for the essential working of the ship, e.g. the movement of machinery and stores, subject to such accesses being made watertight, alarmed and indicated to the navigation bridge.

2.5.4 Open end of air pipes

The open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15 degrees, or the maximum angle of heel during intermediate stages of flooding, as determined by direct calculation, whichever is the greater. Where no information regarding the above angle of heel is available, the open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15° or 0,5 m from the bulkhead deck, whichever is the greater.

Alternatively, air pipes from tanks other than oil tanks may discharge through the side of the superstructure. The provisions of this paragraph are without prejudice to the provisions of the International Convention on Load Lines in force.

2.5.5 Additional requirements

In addition to [2.5.1], [2.5.2], [2.5.3] and [2.5.4], the requirements in [2.6.4] are to be complied with.

2.6 Doors

2.6.1 Requirements for doors

The requirements relevant to the degree of tightness, as well as the operating systems, for doors complying with the prescriptions in [2.6.2] and [2.6.3] are specified in Tab 1.

2.6.2 Construction of watertight doors

The design, materials and construction of all watertight doors are to be to the satisfaction of the Society.

The frames of vertical watertight doors are to have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

Table 1 : Doors

			Sliding type			Hinged type			Rolling type (cargo between deck spaces)
			remote operation indication on the bridge	indicator on the bridge	local operation only	remote operation indication on the bridge	indicator on the bridge	local operation only	
watertight	below the bulkhead deck	open at sea	X						
		normally closed **(4)**	X						
		remain closed **(4)**					X **(1)**		X **(1) (3)**
weathertight / semi-watertight **(2)**	above bulkhead deck	open at sea	X			X			
		normally closed **(4)**		X			X		
		remain closed **(4)**						X	

(1) The door is to be closed before the voyage commences.
(2) Semi-watertight doors are required when they are located below the waterline at the equilibrium of the intermediate stages of flooding.
(3) If the door is accessible during the voyage, a device which prevents unauthorised opening is to be fitted.
(4) Notice to be affixed on both sides of the door: “to be kept closed at sea”.

2.6.3 Doors in watertight bulkheads below the bulkhead deck

a) *Watertight doors are to be capable of being closed simultaneously from the central operating console at the navigation bridge in not more than 60 s with the ship in the upright position.*

b) *The means of operation whether by power or by hand of any power-operated sliding watertight door are to be capable of closing the door with the ship listed to 15° either way. Consideration is to also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door.*

c) *Watertight door controls, including hydraulic piping and electrical cables, are to be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimise the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls are to be such that if the ship sustains damage within one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line, the operation of the watertight doors clear of the damaged portion of the ship is not impaired.*

d) *All power-operated sliding watertight doors are to be provided with means of indication which show at all remote operating positions whether the doors are open or closed. Remote operating positions are only to be located at the navigating bridge and at the location where hand operation above the bulkhead deck is required by e).*

e) *Each power-operated sliding watertight door:*

- *is to move vertically or horizontally;*
- *is to be normally limited to a maximum clear opening width of 1,20 m. The Society may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:*
  - *special consideration is to be given to the strength of the door and its closing appliances in order to prevent leakages;*
  - *the door is to be located outside the damage zone B/5;*
  - *the door is to be kept closed when the ship is at sea, except for limited periods when absolutely necessary as determined by the Society.*
- *is to be fitted with the necessary equipment to open and close the door using electrical power, hydraulic power, or any other form of power that is acceptable to the Society;*
- *is to be provided with an individual hand-operated mechanism. It is to be possible to open and close the door by hand at the door itself from either side and, in addition, close the door from an accessible position above the bulkhead deck with an all round crank motion or some other movement providing the same degree of safety acceptable to the Society. Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, may not exceed 90 s with the ship in the upright position;*
- *is to be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console at the navigation bridge;*
- *is to be provided with an audible alarm, distinct from any other alarm in the area, which is to sound whenever the door is closed remotely by power and which is to sound for at least 5 s but no more than 10 s before the door begins to move and is to continue sounding until the door is completely closed. In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving. Additionally, in passenger areas and areas of high ambient noise, the Society may require the audible alarm to be supplemented by an intermittent visual signal at the door;*
- *is to have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position, is to in no case be less than 20 s or more than 40 s with the ship in the upright position.*

f) *The electrical power required for power-operated sliding watertight doors is to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck. The associated control, indication and alarm circuits are to be supplied from the emergency switchboards either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by a transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power.*

The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to control, indication and alarm circuits at least for half an hour.

g) *Power-operated sliding watertight doors are to have either:*

- *a centralised hydraulic system with two independent power sources each consisting of a motor and pump capable of simultaneously closing all doors. In addition, there are to be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. The power operating system is to be designed to minimise the possibility of*

having a single failure in the hydraulic piping adversely affect the operation of more than one door. The hydraulic system is to be provided with a low-level alarm for hydraulic fluid reservoirs serving the power-operated system and a low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators. These alarms are to be audible and visual and are to be situated on the central operating console at the navigating bridge; or

- *an independent hydraulic system for each door with each power source consisting of a motor and pump capable of opening and closing the door. In addition, there is to be a hydraulic accumulator of sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. A low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators is to be provided at the central operating console on the navigation bridge. Loss of stored energy indication at each local operating position is to also be provided; or*
- *an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source is to be capable of being automatically supplied by the transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°.*

  The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to watertight doors, but not necessarily all of them simultaneously, unless an independent source of stored energy is provided.

For the systems specified above, provision is to be made as follows:

Power systems for power-operated watertight sliding doors are to be separate from any other power system. A single failure in the electrical or hydraulic power-operated systems excluding the hydraulic actuator may not prevent the hand operation of any door.

h) Control handles are to be provided at each side of the bulkhead at a minimum height of 1,6 m above the floor and are to be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidently. The direction of movement of the handles in opening and closingthe door is to be in the direction of door movement and is to be clearly indicated.

i) As far as practicable, electrical equipment and components for watertight doors are to be situated above the bulkhead deck and outside hazardous areas and spaces.

j) The enclosures of electrical components necessarily situated below the bulkhead deck are to provide suitable protection against the ingress of water.

k) Electric power, control, indication and alarm circuits are to be protected against fault in such a way that a failure in one door circuit may not cause a failure in any other door circuit. Short-circuits or other faults in the alarm or indicator circuits of a door may not result in a loss of power operation of that door. Arrangements are to be such that leakage of water into the electrical equipment located below the bulkhead deck may not cause the door to open.

l) A single electrical failure in the power operating or control system of a power-operated sliding watertight door may not result in a closed door opening. Availability of the power supply is to be continuously monitored at a point in the electric circuit as near as practicable to each of the motors required in g). Loss of any such power supply is to activate an audible and visual alarm at the central operating console at the navigation bridge.

m) The central operating console at the navigation bridge is to have a “master mode” switch with two modes of control:

- *a “local control” mode which is to allow any door to be locally opened and locally closed after use without automatic closure, and*
- *a “doors closed” mode which is to automatically close any door that is open. The “doors closed” mode is to permit doors to be opened locally and is to automatically reclose the doors upon release of the local control mechanism.*

The “master mode” switch is to normally be in the “local control” mode. The “doors closed” mode is to only be used in an emergency or for testing purposes. Special consideration is to be given to the reliability of the “master mode” switch.

n) The central operating console at the navigation bridge is to be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light is to indicate a door is fully open and a green light is to indicate a door is fully closed. When the door is closed remotely the red light is to indicate the intermediate position by flashing. The indicating circuit is to be independent of the control circuit for each door.

o) It is not to be possible to remotely open any door from the central operating console.

p) All watertight doors are to be kept closed during navigation. Certain watertight doors may be permitted to remain open during navigation only if considered absolutely necessary; that is, being open is determined essential to the safe and effective operation of the ship's machinery or to permit passengers normally unrestricted access throughout the passenger area. Such determination is to be made by the Society only after careful consideration of the impact on ship operations and survivability. A watertight door permitted to remain thus open is to be clearly indicated in the ship's stability information and the damage control documentation *and is always to be ready for immediate closure.*

2.6.4 **Doors in watertight bulkheads above the bulkhead deck** *(1/1/2007)*

a) General

Doors are to be capable of being opened and closed by hand locally from both sides of the doors with the ship listed to 15° to either side. If the ship is allowed to heel up to 20°, during intermediate stages of flooding, then the doors are to be capable of operation by hand with the ship listed to 20° to either side.

Position indicators are to be provided on the bridge as well as locally on both side of the doors to show that the doors are open or closed and that the dogs are fully and properly engaged.

Where the doors also serve as fire doors they are to be provided with position indicators at the fire control station and audible alarms as required for fire doors, as well as for weathertight doors. Where two doors are fitted they must be capable of independent operation remotely and from both sides of each door.

b) Doors normally closed at sea

In addition to a), doors not required for frequent access while at sea are to be kept normally closed and may be of either hinged or sliding type.

Doors kept normally closed are to have local operation from both sides of the doors and are to be labelled on both sides: "to be kept closed at sea".

c) Doors normally open at sea

Where fitted in public space for the passage of passengers and crew, the doors may be kept normally open at sea and may be either hinged or sliding type.

In addition to a), doors kept normally open at sea are to have local power operation from both sides of the door and remote closing from the bridge. Operation of these doors is to use a "master mode" switch on the bridge, so that the local control can override the remote closing feature after which the door is automatically remotely reclosed upon release of the local control mechanism.

Doors kept normally open at sea are to have audible alarms, distinct from any other alarm in the area, which sound whenever the doors are closed remotely. The alarms are to sound for at least 5 s but not more than 10 s before the doors begins to move and continue sounding until the doors are completely closed. In passenger areas and areas of high ambient noise, the audible alarms are to be supplemented by visual signals at both sides of the doors.

d) The following doors, located above the margin line, are to be provided with adequate means of closure and locking devices according to a) and b) above and the requirements of Pt B, Ch 9, Sec 6, [6]:

- *cargo loading doors in the shell or the boundaries of enclosed superstructures,*
- *bow visors fitted in the shell or the boundaries of enclosed superstructures,*
- *cargo loading doors in the collision bulkhead;*
- *weathertight ramps forming an alternative closure to those previously defined.*

2.7 Integrity of the hull and superstructure, damage prevention and control

2.7.1 *Indicators are to be provided on the navigation bridge for all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Society, lead to flooding of a special category space or ro-ro cargo space. The indicator system is to be designed on the fail-safe principle and is to show by visual alarms if the door is not fully closed or if any of the securing arrangements are not in place and fully locked and by audible alarms if such door or closing appliances become open or the securing arrangements become unsecured. The indicator panel on the navigation bridge is to be equipped with a mode selection function "harbour/sea voyage" so arranged that an audible alarm is given on the navigation bridge if the ship leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator system is to be independent of the power supply for operating and securing the doors and is to be provided with a backup power supply.*

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

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

2.7.2 *Television surveillance and a water leakage detection system are to be arranged to provide an indication to the navigation bridge and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors which could lead to flooding of special category spaces or ro-ro cargo spaces.*

2.7.3 *Special category spaces and ro-ro cargo spaces are to be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorised access by passengers thereto can be detected whilst the ship is underway.*

2.7.4 *Documented operating procedures for closing and securing all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Society, lead to flooding of a special category space or ro-ro cargo space, are to be kept on board and posted at an appropriate place.* The operating procedures may be included in the stability information or in the damage control booklet.

2.7.5 A closing indicator is to be fitted for the inner bow doors which constitute a prolongation of the collision bulkhead above the bulkhead deck as requested in [2.7.1].

2.8 Compartment arrangement

2.8.1 Ballast compartments

Water ballast may not in general be carried in tanks intended for fuel oil. In ships in which it is not practicable to avoid putting water in fuel oil fuel, oily-water separating equipment to the satisfaction of the Society is to be fitted, or other alternative means, such as discharge to shore facilities, acceptable to the Society is to be provided for disposing of the oily-water ballast (see Pt C, Ch 1, Sec 10, [7]).

2.8.2 Machinery compartments *(1/1/2011)*

When longitudinal bulkheads are fitted in the machinery space, adequate self-operating arrangements are to be provided in order to avoid excessive heel after damage.

Where such arrangements are cross-flooding systems, their area is to be calculated in accordance with the requirements of IMO Res. MSC.245(83).

2.8.3 Passenger spaces in ro-ro ships

No passenger spaces are permitted within the enclosed ro-ro decks.

3 Patrolling and monitoring

3.1 Ro-ro spaces and special category spaces

3.1.1 *(1/1/2005)*

Ro-ro cargo spaces and special category spaces are to be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorised access by passengers thereto can be detected whilst the ship is underway.

SECTION 3 HULL AND STABILITY

1 Stability

1.1 Intact stability

1.1.1 General

Every ro-ro passenger ship regardless of size is to be inclined upon its completion and the elements of its stability determined. The Master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service. A copy of the stability information is to be furnished to the Society.

Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

The Society may allow the inclining test of an individual ship to be dispensed with provided basic stability data are available from the inclining test of a sister ship and it is shown to the satisfaction of the Society that reliable stability information for the exempted ship can be obtained from such basic data.

1.1.2 Periodical lightweight check

At periodical intervals not exceeding five years, a lightweight survey is to be carried out on all ro-ro passenger ships to verify any changes in lightship displacement and longitudinal centre of gravity. The ship 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 L_s is found, or anticipated.

1.1.3 Standard requirements

In addition to Pt B, Ch 3, Sec 2, [2] the requirements in [1.1.4] to [1.1.7] are to be complied with for the loading conditions defined in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.9].

1.1.4 Crowding of passengers *(1/7/2010)*

The requirements of Ch 11, Sec 3, [1.1.3] apply.

1.1.5 Maximum turning angle *(1/7/2010)*

The requirements of Ch 11, Sec 3, [1.1.4] apply.

1.1.6 Anti-rolling devices

Where anti-rolling devices are installed in a ship, the Society is to be satisfied that the above criteria can be maintained when the devices are in operation.

1.1.7 Stability booklet for ro-ro ships

The stability booklet of ro-ro ships is to contain information concerning the importance of securing and maintaining all closure watertight integrity, due to the rapid loss of stability which may result when water enters the vehicle deck and the fact that capsize can rapidly occur.

2 Structure design principles

2.1 General

2.1.1 Wood sheathing is recommended for caterpillar trucks and unusual vehicles.

It is recommended that a piece of wood of suitable thickness should be fitted under each crutch in order to distribute the mass over the plate and the nearest stiffeners.

2.2 Hull structure

2.2.1 Framing

In general, the strength deck and the bottom are to be longitudinally framed.

Where a transverse framing system is adopted for such ships, it is to be considered by the Society on a case by case basis.

2.2.2 Side structures

Where decks are fitted with ramp openings adjacent to the ship's side, special consideration is to be given to the supports for the side framing.

3 Design loads

3.1 Wheeled loads

3.1.1 The wheeled loads induced by vehicles are defined in Pt B, Ch 5, Sec 6, [6].

3.2 Accommodation

3.2.1 Lowest 0,5 m of bulkheads forming vertical division along escape routes

The still water and inertial pressures transmitted to the structures *belonging to lowest 0,5 m of bulkheads and other partitions forming vertical divisions along escape routes* are to be obtained, in kN/m^2, as specified in Pt B, Ch 5, Sec 6, [7], where the value p_S is to be taken not less than 1,5 kN/m^2 *to allow them to be used as walking surfaces from the side of the escape route with the ship at large angles of heel.*

4 Hull girder strength

4.1 Basic criteria

4.1.1 Strength deck

In addition to the requirements in Pt B, Ch 6, Sec 1, [2.2], the contribution of the hull structures up to the strength deck to the longitudinal strength is to be assessed through a finite element analysis of the whole ship in the following cases:

- when the size of openings in the side shell and/or longitudinal bulkheads located below the deck assumed by the Designer as the strength deck decrease significantly the capability of the plating to transmit shear forces to the strength deck
- when the ends of superstructures which are required to contribute to longitudinal strength may be considered not effectively connected to the hull structures in way.

5 Hull scantlings

5.1 Plating

5.1.1 Minimum net thicknesses *(1/7/2015)*

The net thickness of the inner bottom, side, weather strength deck and external balcony plating is to be not less than the values given in Tab 1.

Table 1 : Minimum net thickness of the inner bottom, side, weather strength deck and external balcony plating *(1/7/2015)*

Plating	Minimum net thickness, in mm
Inner bottom outside engine room	$2,0 + 0,02\ L\ k^{1/2} + 4,5\ s$
Side • below freeboard deck • between freeboard deck and strength deck	 $2,1 + 0,028\ L\ k^{1/2} + 4,5\ s$ $2,1 + 0,013\ L\ k^{1/2} + 4,5\ s$
Weather strength deck and trunk deck	$2,2\ k^{1/2} + 2,1 + s$
External balconies	$2,2\ k^{1/2} + 2,1 + s$
Note 1: k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]. s : Length, in m, of the shorter side of the plate panel.	

5.1.2 Deck plating in way of side doors and stern doors *(1/12/2008)*

The plating net thickness of all decks in way of the position of side doors and stern doors is to be increased over a length of at least 1/3 of the door width.

This increase in net thickness is to be not less than 50% and the resulting thickness is not required to be greater than 8,0 mm.

5.1.3 Plating under wheeled loads

The net thickness of plating subjected to wheeled loads is to be obtained according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable.

5.1.4 Lowest 0,5 m of bulkheads forming vertical division along escape routes

The net thickness of plating belonging to the lowest 0,5 m of bulkheads and other partitions forming vertical divisions along escape routes is to be obtained according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable, where the loads are defined in Part B, Chapter 5 or Pt B, Ch 8, Sec 1, as applicable, and in [3.2.1].

5.2 Ordinary stiffeners

5.2.1 Stiffeners under wheeled loads

The net scantlings of ordinary stiffeners subjected to wheeled loads are to be obtained according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as applicable.

5.2.2 Lowest 0,5 m of bulkheads forming vertical division along escape routes

The net scantlings of ordinary stiffeners belonging to the lowest 0,5 m of bulkheads and other partitions forming vertical divisions along escape routes are to be obtained according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as applicable, where the loads are defined in Part B, Chapter 5 or Pt B, Ch 8, Sec 1, as applicable, and in [3.2.1].

5.3 Primary supporting members

5.3.1 Double bottom structures

In ships where pillars are widely spaced and transmit very high loads to the double bottom, the net scantlings of double bottom structures are to be considered by the Society on a case-by-case basis, taking into account the results of direct calculations to be carried out according to the criteria in Pt B, Ch 7, App 1.

Where deemed necessary, on the basis of the above results, additional floors and bottom girders may be required.

5.3.2 Primary supporting members under wheeled loads

The net scantlings of primary supporting members subjected to wheeled loads are to be obtained according to Pt B, Ch 7, Sec 3 and Pt B, Ch 7, App 2 or Pt B, Ch 8, Sec 5, as applicable.

5.3.3 Lowest 0,5 m of bulkheads forming vertical division along escape routes

The net scantlings of primary supporting members belonging to the lowest 0,5 m of bulkheads and other partitions forming vertical divisions along escape routes are to be obtained according to Pt B, Ch 7, Sec 3 or Pt B, Ch 8, Sec 5, as applicable, where the loads are defined in Part B, Chapter 5 or Pt B, Ch 8, Sec 1, as applicable, and in [3.2.1].

6 Other structures

6.1 Superstructures and deckhouses

6.1.1 *(1/7/2010)*

Where a ventilation trunk passing through a structure penetrates the bulkhead deck, the trunk is to be capable of withstanding the water pressure that may be present within the trunk, after having taken into account the maximum heeling angle allowable during intermediate stages of flooding, in accordance with Reg. II-1/7-2 of SOLAS Convention.

6.1.2 *Where all or part of the penetration of the bulkhead deck is on the main ro-ro deck, the trunk is to be capable of withstanding impact pressure due to internal water motions (sloshing) of water trapped in the ro-ro deck,* to be calculated according to the applicable formulae in Pt B, Ch 5, Sec 6, [2].

6.2 Bow doors and inner doors

6.2.1 The requirements applicable to bow doors and inner doors are defined in Pt B, Ch 9, Sec 5.

6.3 Side doors and stern doors

6.3.1 Side doors may be either below or above the freeboard deck.

Stern doors are to be situated above the freeboard deck.

6.3.2 The requirements applicable to side doors and stern doors are defined in Pt B, Ch 9, Sec 6.

6.3.3 The requirements in [6.3.4] to [6.3.7] apply to doors in the boundary of ro-ro cargo spaces or special category spaces, as defined in Sec 2, [1.2.7] and Sec 2, [1.2.8] respectively, through which such spaces may be flooded.

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

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

Table 2 : Equipment

Equipment number EN A < EN ≤ B		Stockless anchors		Stud link chain cables for anchors			
		N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Q1	Q2	Q3
19	22	1	21	65	7		
22	25	1	27	70	7		
25	30	1	32	70	8		
30	35	1	37	75	8		
35	40	1	43	75	9		
40	45	1	53	80	10		
45	50	1	64	82,5	11		
50	60	1	80	82,5	11	10	
60	70	1	90	82,5	12,5	11	
70	80	1	100	110	12,5	11	10
80	90	1	120	110	14	12,5	11
90	100	1	140	110	14	12,5	11
100	110	1	160	110	16	14	12,5
110	120	1	180	110	16	14	12,5
120	130	1	200	110	16	14	12,5
130	140	1	240	110	17,5	16	14
140	150	1	260	137,5	17,5	16	14
150	175	1	300	137,5	19	17,5	16
175	205	1	360	137,5	20,5	17,5	16
205	240	1	420	137,5	22	19	17,5
240	280	1	480	137,5	24	20,5	19
280	320	1	575	165	26	22	20,5
320	360	1	660	165	28	24	22
360	400	1	700	165	30	26	22
400	450	1	780	165	30	26	24
450	500	1	900	192,5	32	28	26
500	550	1	1020	192,5	34	30	26
550	600	1	1140	192,5	36	32	28

Equipment number EN A < EN ≤ B		Stockless anchors		Stud link chain cables for anchors			
		N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Q1	Q2	Q3
600	660	2	1200	385	38	32	30
660	720	2	1295	385	40	34	30
720	780	2	1440	440	42	36	32
780	840	2	1500	440	42	36	32
840	910	2	1595	440	44	38	34
910	980	2	1740	440	46	40	36
980	1060	2	1920	440	48	42	36

6.3.5 The indicator system is to be designed on the fail-safe principle and is to show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured.

The power supply for the indicator system is to be independent of the power supply for operating and closing the doors and is to be provided with a backup power supply.

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

6.3.6 The indication panel on the navigation bridge is to be equipped with a mode selection function “harbour/sea voyage”, so arranged that an audible alarm is given if the vessel leaves harbour with the doors not closed and with any of the securing devices not in the correct position.

6.3.7 A water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the inner door.

6.4 Movable decks and inner ramps

6.4.1 The requirements applicable to movable decks and inner ramps are defined in Pt B, Ch 9, Sec 8, [1].

6.5 External ramps

6.5.1 The requirements applicable to external ramps are defined in Pt B, Ch 9, Sec 8, [2].

7 Hull outfitting

7.1 Equipment

7.1.1 Number of mooring lines

The specific requirements in Pt B, Ch 10, Sec 4, [3.5] for ships with the service notation **ro-ro passenger ship** are to be complied with.

7.1.2 Ships having L ≤ 30 m and navigation notation other than unrestricted navigation

For ships having L ≤ 30 m and navigation notation other than **unrestricted navigation**:

- the equipment in stockless anchor and chain cables (or ropes according to Pt B, Ch 10, Sec 4, [3.3.5]) may be obtained from Tab 2
- the equipment in mooring lines of wire or natural fibre may be obtained from Tab 3.

Table 3 : Mooring lines *(1/1/2022)*

Equipment number EN A < EN ≤ B		Mooring lines		
A	B	N	Length of each line, in m	Ship Design Minimum Breaking Load, in kN
19	50	2	40	32
50	70	3	40	34
70	90	3	50	37
90	110	3	55	39
110	130	3	55	44
130	150	3	60	49
150	175	3	60	54

SECTION 4 MACHINERY AND SYSTEMS

1 Application

1.1 Restricted navigation

1.1.1 *(1/7/2011)*

The application of item [3] to ships classed for restricted navigation will be specially considered by the Society in each single case.

2 Bilge system

2.1 General

2.1.1 *(1/7/2011)*

In addition to the requirements of the following paragraphs, ro-ro passenger ships are to comply with the requirements set out in Ch 11, Sec 4.

3 Scuppers and sanitary discharges

3.1 Drainage of vehicle, ro-ro spaces and special category spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion

3.1.1 **Prevention of build-up of free surfaces** *(1/7/2011)*

In cargo spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, when fixed pressure water-spraying systems are fitted, in view of the serious loss of stability which could arise due to large quantities of water accumulating on the deck or decks during the operation of the fixed pressure water-spraying system, the following arrangements are to be provided:

a) in the spaces above the bulkhead deck, scuppers are to be fitted so as to ensure that such water is rapidly discharged directly overboard, taking into account the requirements contained in the guidelines developed by IMO (see Note 1);

b) in ro-ro passenger ships, discharge valves for scuppers, fitted with positive means of closing operable from a position above the bulkhead deck in accordance with the requirements of the International Convention on Load Lines in force, are to be kept open while the ships are at sea;

c) any operation of valves referred to in paragraph b) is to be recorded in the log-book;

d) in the spaces below the bulkhead deck, the Society may require pumping and drainage facilities to be provided additional to the requirements of Pt C, Ch 1, Sec 10;

In such case, the drainage system is to be sized to remove no less than 125% of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles, taking into account the guidelines developed by IMO (see Note 2). The drainage system valves are to be operable from outside the protected space at a position in the vicinity of the extinguishing system controls. Bilge wells are to be of sufficient holding capacity and are to be arranged at the side shell of the ship at a distance from each other of not more than 40 m in each watertight compartment;

e) for closed vehicles and ro-ro spaces and special category spaces, where fixed pressure water-spraying systems are fitted, means are to be provided to prevent the blockage of drainage arrangements, taking into account the guidelines developed by IMO (see Note 1).

Note 1: see Resolution MSC.1/Circ. 1320 "Guidelines for the drainage of fire-fighting water from closed vehicle and ro-ro spaces and special category spaces of passenger and cargo ships"

Note 2: see Resolution A.123(V) "Recommendation On Fixed Fire-Extinguishing Systems For Special Category Spaces".

3.2 Scupper draining

3.2.1 *(1/7/2011)*
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.

4 Sounding pipes

4.1 General

4.1.1 *(1/7/2011)*
Requirements stipulated in Pt C, Ch 1, Sec 10, [9.2] apply except that sounding pipes used in flammable (except lubricating) oil systems may terminate in the ro-ro space on condition that the following provisions are satisfied:

a) an oil-level gauge meeting the provisions in Pt C, Ch 1, Sec 10, [2.9.2] is additionally fitted;

b) the sounding pipes terminate in locations remote from ignition hazards unless precautions are taken, such as the fitting of effective screens, to prevent the fuel oil from coming into contact with a source of ignition in the case of spillage through the terminations of the sounding pipes;

c) the terminations of sounding pipes are fitted with self-closing blanking devices and with a small diameter self-closing control cock located below the blanking device for the purpose of ascertaining before the blanking device is opened that fuel oil is not present. Provision is to be made so as to ensure that any spillage of fuel oil through the control cock involves no ignition hazard.

Where sounding pipe termination is above the bulkhead or freeboard deck, a flush type sounding head may be accepted by the Society on a case-by-case basis.

SECTION 5 ELECTRICAL INSTALLATIONS

1 General

1.1 Documentation to be submitted

1.1.1 In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of indicator systems for shell doors, loading doors and similar appliances, television surveillance or water leakage detection systems

d) diagrams of the supplies to the supplementary emergency lighting systems.

1.2 Safety characteristics

1.2.1 The explosion group and temperature class of electrical equipment of a certified safe type for use with explosive petrol-air mixtures are to be at least IIA and T3.

1.3 Electrical distribution and protection

1.3.1 *(1/7/2025)*

For ro-ro *passenger ships carrying 36 or more persons, a flooding detection system for watertight spaces below the bulkhead deck* in compliance with the provisions in IMO MSC.1/Circ.1291 *is to be provided.*

2 Supplementary emergency lighting

2.1 Installation of supplementary lighting

2.1.1 *In addition to the emergency lighting required in* Ch 11, Sec 5, [2.2]*, on every passenger ship with ro-ro cargo spaces or special category spaces:*

a) all passenger public spaces and alleyways shall be provided with supplementary electric lighting that can operate for at least three hours when all other sources of electrical power have failed and under any condition of heel. The illumination provided shall be such that the approach to the means of escape can be readily seen. The source of power for the supplementary lighting shall consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard. Alternatively, any other means of lighting which is at least as effective may be accepted by the Society. The supplementary lighting shall be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided shall be replaced at intervals having regard to the specified service life in the ambient conditions that they are subject to in service;

b) a portable rechargeable battery operated lamp shall be provided in every crew space alleyway and recreational space and every working space which is normally occupied unless supplementary emergency lighting, as required in (a), is provided.

3 Installation

3.1 Installations in special category spaces situated above the bulkhead deck

3.1.1 On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment and cables are to be installed at least 450 mm above the deck or platform.

Electrical equipment is to be as stated in Pt C, Ch 2, Sec 3, [10.1.6] and electrical cables as stated in Pt C, Ch 2, Sec 3, [10.2.3].

3.1.2 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 ship, the electrical equipment is to be of a certified safe type as stated in Pt C, Ch 2, Sec 3, [10.1.5] and the electrical cables are to be as stated in Pt C, Ch 2, Sec 3, [10.2.2].

3.1.3 Electrical equipment and cables in exhaust ventilation ducts are to be as stated in [3.1.2].

3.1.4 The requirements in this item are summarised in Tab 1.

Table 1 : Electrical equipment permitted in special category spaces above the bulkhead deck *(1/1/2022)*

Hazardous area	Spaces		Electrical equipment
	No.	Description	
Zone 1	1	Areas at less than 450 mm above the deck or platforms for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward.	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category “ib” not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, d) certified flameproof Ex(d) e) certified pressurised Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: • a non-metallic impervious sheath in combination with braiding or other metallic covering • copper or stainless steel sheath (for mineral insulated cables only).
Zone 1	2	Exhaust ventilation ducts.	As stated under item 1.
Zone 2	3	• areas above a height of 450 mm from the deck • areas above a height of 450 mm from each platform for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward • areas above platforms for vehicles, if fitted, with openings of sufficient size permitting penetration of petrol gases downward.	a) any type that may be considered for zone 1 b) tested specially for zone 2 (e.g. type “n” protection) c) pressurised, d) encapsulated e) the type which ensures the absence of sparks and arcs and of “hot spots” during its normal operation (electrical equipment having an enclosure of at least IP55) f) cables sheathed with at least a non-metallic external impervious sheath.

3.2 Installations in special category spaces situated below the bulkhead deck

3.2.1 Any electrical equipment installed is to be as stated in Pt C, Ch 2, Sec 3, [10.1.5] and electrical cables are to be as stated in Pt C, Ch 2, Sec 3, [10.2.2].

3.2.2 Electrical equipment and cables in exhaust ventilation ducts are to be as stated in [3.2.1].

3.2.3 The requirements in this item are summarised in Tab 2.

3.3 Installations in cargo spaces other than special category spaces intended for the carriage of motor vehicles

3.3.1 The requirements for installations in special category spaces situated below the bulkhead deck, as stated in [3.2], apply.

3.3.2 All electric circuits terminating in cargo holds are to be provided with multipole linked isolating switches located outside the holds. Provision is to be made for locking in the off position.

This requirement does not apply to safety installations such as fire, smoke or gas detection systems.

4 Type approved components

4.1 Type approval and case by case approval

4.1.1 Accumulator lamps for the supplementary electric lighting, alarm systems for closing devices of openings and water leakage detection systems if of electronic type, and television surveillance systems are to be type approved or in accordance with [4.1.2].

4.1.2 Case-by-case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

Table 2 : Electrical equipment permitted in special category spaces below the bulkhead deck

Hazardous area	Spaces		Electrical equipment
	No.	Description	
Zone 1	1	Special category spaces.	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category “ib” not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, d) certified flameproof Ex(d) e) certified pressurised Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: • a non-metallic impervious sheath in combination with braiding or other metallic covering • copper or stainless steel sheath (for mineral insulated cables only).
Zone 1	2	Exhaust ventilation ducts.	As stated under item 1.

Chapter 13
SHIPS FOR DREDGING ACTIVITY

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of one of the following service notations:

- **dredger**
- **hopper dredger**
- **hopper unit**
- **split hopper dredger**
- **split hopper unit**

as defined in Pt A, Ch 1, Sec 2, [4.7].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of this Chapter, which are specific to ships for dredging activities.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to ships for dredging activities.

Table 1

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and dredging system	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for ships for dredging activities are given in this Chapter.	

SECTION 2 HULL AND STABILITY

Symbols

T : Navigation draught, in m, corresponding to the international freeboard

T_D : Dredging draught, in m, corresponding to the dredging freeboard

C : Wave parameter defined in Pt B, Ch 5, Sec 2 or Pt B, Ch 8, Sec 1, as applicable

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

n, n_1 : Navigation coefficients, defined in Pt B, Ch 5, Sec 1, [2.6] or Pt B, Ch 8, Sec 1, [1.5], as applicable

n_D : Navigation coefficient in dredging situation, defined in [3.3.1]

s : Spacing, in m, of ordinary stiffeners

δ : Specific gravity of the mixture of sea water and spoil, taken equal to:

$$\delta = \frac{P_D}{V_D}$$

P_D : Maximum mass, in t, of the spoil contained in the hopper space

V_D : Volume of the hopper space, in m^3, limited to the highest weir level

g : Gravity acceleration, in m/s^2:

$g = 9,81\ m/s^2$

ℓ_p : Length, in m, of the hopper well

a : Distance from the bottom to the sealing joint located at the lower part of the hopper well, in m

h_1 : Distance, in m, from spoil level to base line when working at the dredging freeboard (see Fig 8)

h_2 : Distance, in m, from spoil level to base line when working at the international freeboard (see Fig 8)

h_4 : Distance, in m, from the lowest weir level to base line

T_3 : Navigation draught, in m, with well filled with water up to waterline

T_4 : Navigation draught, in m, with well filled with water up to the lowest weir level

R_{eH} : Minimum yield stress, in N/mm^2, of the material

R_m : Minimum ultimate tensile strength, in N/mm^2, of the material.

1 Stability

1.1 Intact stability

1.1.1 General *(1/7/2006)*

In addition to the requirements of Pt B, Ch 3, Sec 2, dredgers are to comply with the provisions of [1.1.2] and [1.1.3] as applicable.

1.1.2 Intact stability *(1/7/2006)*

a) Loading conditions

In the working condition, dredging equipment is to be considered positioned so as to produce the most severe combination of inclining moment and/or initial metacentric height. In particular, for grab dredgers, the mass, in **t**, of the dredged materials contained in the grab of volume **V**, in m^3, is to be considered equal to 1,6 **V**; for bucket dredgers the mass, in **t**, contained in each bucket of volume **V**, in m^3, of the top of the chain is to be considered equal to 2 **V**. For suction pipes of trailing suction dredgers, the mass of the dredged spoil is to be considered equal to 1,3 t/m^3.

Bucket dredgers are generally not allowed to proceed to sea without first dismantling the dredging equipment.

For the calculation of displacement, the volumes of hoppers and wells intended for the carriage of sand and spoil, even if closed in their lower part by means of non-watertight doors, are to be considered as part of the ship's body and the weight of the water within, when there is no cargo, is to be considered as additional cargo. On the other hand, wells for the arrangement of bucket chains, cutter heads or ladder pumps are to be considered as buoyancy losses.

b) Influence of free surfaces

1) In the calculation of initial metacentric height, the effects of free surfaces may be disregarded when the mass density of spoil is greater than 1 t/m^3; otherwise, they are assumed to be fluid cargoes.

2) In the calculation of righting levers, account is to be taken of the shifting of cargo that occurs in way of the various angles of heel of the dredger, considering any variation in displacement and the position of the centre of gravity due to the discharge of mud and the re-entry of sea water. The angle of shifting of the cargo θ_R is to be assumed as a function of the angle of heel θ_G and the mass density γ, in t/m^3, according to the following formulas:

$$\theta_R = \theta_G \quad \text{for } \gamma \leq 1$$

$$\theta_R = (3 - \gamma) \cdot \theta_G / 2 \quad \text{for} \quad 1 < \gamma < 3$$

$$\theta_R = 0 \quad \text{for } \gamma \geq 3$$

For $\gamma \geq 3$, righting levers are to be calculated with constant displacement and without considering the shifting of the centre of gravity of the dredged materials contained in the wells.

In the case of emptied dredgers, when the well is kept in communication with the sea, the calculations are to be carried out without taking into account the water level in the well or the associated free surface.

With reference to Fig 1, an example is given of the calculation of righting levers.

The righting lever is obtained from the following formula:

$$\mathbf{NK} \sin\theta_G - \mathbf{G'K} \sin\theta_G$$

where:

NK sin θ_G = righting lever obtained from the cross-curves

$$\mathbf{G'K} \sin\theta_G = \frac{\Delta \cdot \mathbf{GK} \sin\theta_G + P_c \cdot b + A_M \cdot a}{\Delta + P_c + A_M}$$

Δ : displacement of the dredger ready to take the load, in t

GK : vertical position of the centre of gravity for the displacement Δ from the under keel (adjusted to take into account any free surfaces in the tanks), in m

$\mathbf{P_c}$: mass of the cargo embarked (γ x **V**), in t

V : volume of the cargo, in m^3

b : lever of the cargo **P** in respect of **K**, in m

a : lever of the centre of gravity of the mass of water shipped in respect of **K**, in m

$\mathbf{A_M}$: mass of water shipped, in t

$\mathbf{G_P}$: position of the centre of gravity of the cargo at the angle of heel θ_G (see Fig 1)

A : position of the centre of gravity of the water shipped (see Fig 1).

1.1.3 **Dredging mark** *(1/7/2006)*

a) General

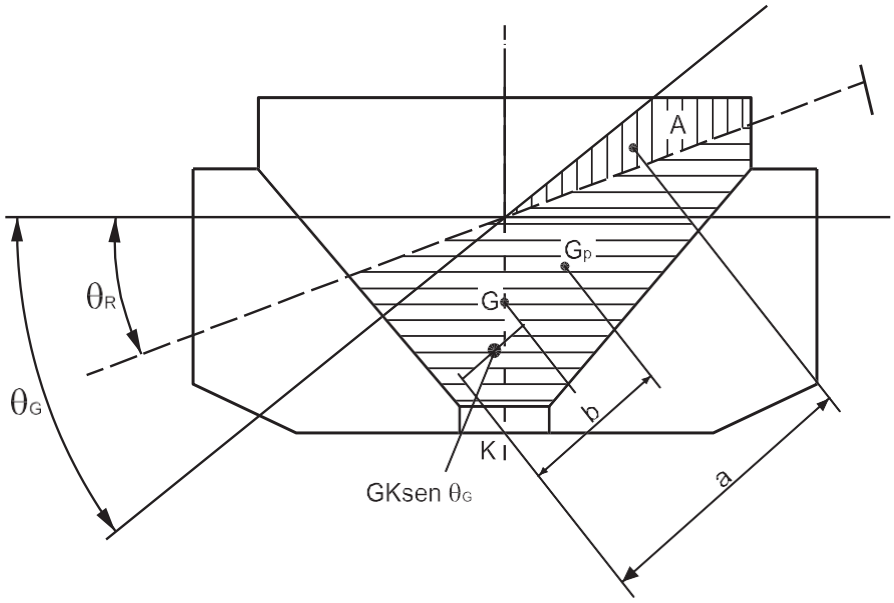
In the case of dredging units fitted with wells and doors or similar means on the bottom for discharging spoil, at the request of the Interested Parties, a declaration may be issued stating that such units are suitable for operation at a draught greater than that based on the limitations in the International Convention on Load Lines, when they are classed for international service, or in the national load line regulations, when they are classed for national service, provided that:

1) the strength of the structures is adequate for the requested draught;

2) discharge doors on the bottom of the well can be opened in less than a minute and, unless they are gravity doors, can also be opened without the supply of power. In any case, suitable emergency arrangements are to be provided.

Both control positions enabling the doors to be opened are to be located on main deck and suitable measures are to be adopted to prevent asymmetrical discharge. For dredging units of length **L** less than 90 m, engaged in service less than 6 nautical miles from the coast, some relaxation of these provisions may be agreed upon;

Figure 1 *(1/7/2006)*



θ_G = angle of heel of the dredging unit

θ_R = angle of shifting stress of the cargo

3) a draught indicator is installed on the bridge;

4) any watertight doors considered in the calculation and located below the freeboard deck are of the sliding type, operated locally from both sides and from a point situated above the freeboard deck, and indication of their opening and closure is provided on the bridge. Their operation is to be of the hydraulic type and manual operation is also to be possible;

5) doors on the sides of deckhouses are made of steel or other equivalent material, permanently and effectively connected to the bulkheads, strengthened, stiffened and arranged locally such that the structure as a whole is of equivalent strength to that of a bulkhead without openings, and that the doors are weathertight when closed; this is obtained by means of gaskets, clamping devices or other equivalent means, permanently secured to the bulkheads or the doors themselves; the doors are designed so that they are operable from both sides of the bulkhead and their sill heights are not less than 380 mm above the deck;

6) in addition to the conditions stipulated above, the stability characteristics fulfil those given below.

b) Maximum permitted draught

The maximum permitted draught, which is to be indicated by means of the special dredging mark, is in any case not to exceed that corresponding to 50% of the freeboard for a type B-100 ship calculated according to the 1966 International Convention on Load Lines.

c) Loading conditions

The stability characteristics are to be calculated in the full loading condition corresponding to the dredging mark with:

1) well completely filled, up to the top of the well or to the overflow pipes, where fitted, with spoil having homogeneous mass density;

2) well partially filled with spoil having homogeneous mass density equal to 2,2 t/m^3;

3) well partially filled with spoil having homogeneous mass density equal to that in item 1) increased by 0,2 t/m^3;

The calculation is to be repeated with step-by-step 0,2 t/m^3 increases in the mass density of the spoil up till the value as per item 2) above.

The following assumptions are to be taken into account in the calculations:

- the vessel in the upright condition with no trim;
- the vertical position of the centre of gravity as the resultant of the loading condition specified in [1.1.2] a) with the addition of the cargo in the well indicated above;
- the longitudinal position of the centre of gravity as the resultant of the vessel in the upright condition;
- the actual shifting of cargo that occurs in way of the various angles of heel of the dredging unit as stated in [1.1.2] a);
- the discharge of cargo due to the heel and, if applicable,the shipping of water from the top of the well;

- the effects of free surfaces of spoil, assumed to be fluid cargoes in the calculation of initial metacentric height.

d) Stability requirements

In the loading conditions given in [1.1.3] c), the intact stability requirements laid down in Pt B, Ch 3, Sec 2 are to be fulfilled (see also the example of calculation of righting levers given in [1.1.2] b) as are the damage stability requirements in [1.1.3] e).

e) Damage stability

1) General

It is to be verified that in the damage cases in 2), at the draught corresponding to the dredging mark, the survival capability requirements in 3) are satisfied.

2) Damage cases

Dredging units which operate with a draught corresponding to a freeboard less than 50% of that for a type B-60 ship are to be capable of withstanding the flooding of the machinery space as well as of any two adjacent compartments, neither of which is the machinery space.

Dredging units which operate with a draught corresponding to a freeboard equal to or greater than 50% of that for a type B-60 ship but less than 50% of that for a type B ship are to be capable of withstanding the flooding of the machinery space or of any one compartment.

In the damage calculations it is to be assumed that all the cargo is lost as a result of the damage and that the bottom doors remain open leaving the spaces in communication with the sea.

The dimensional characteristics given in items below are to be taken into consideration for the damage as is any damage of a lesser extent which may have more serious effects.

- Longitudinal extent equal to the lower of the following: (3 + 0,03 **L**) m or 11 m.
- Vertical extent equal to the height of the dredging unit in way of the flooded space.

Note 1: The effect of superstructures or deckhouses located above the flooded compartment is not to be taken into account.

- Transverse extent of the damage or penetration equal to **B**/5, measured from the shell plating towards the inner hull, perpendicular to the plane of symmetry, at the waterline corresponding to the maximum draught level.

3) Survival capability requirements

It is to be verified that in the damage cases in 2) the dredging unit in still water has sufficient residual buoyancy and positive stability such that the following conditions are simultaneously satisfied:

- the metacentric height after symmetrical flooding is equal to or greater than 0,05 m;
- the final waterline is below the lower edge of any opening on the hull, superstructure or deckhouse through which progressive flooding could take place;
- the angle of heel of the vessel after flooding is less than 15°, or 17° if no part of the deck is immersed.

In addition, the dynamic stability is to be examined and will be deemed acceptable if the positive residual righting lever curve, with the dredging unit flooded, has a range of at least 20° beyond the angle of equilibrium and a righting lever within this range of at least 0,1 m.

2 Structure design principles

2.1 General

2.1.1 The attention of Designers is drawn to the fact that structural arrangement of ships for dredging activities involves discontinuities and that particular care is to be taken to avoid cracks or fractures.

2.1.2 Where dredgers are likely to work in association with hopper barges, the sheerstrake is to be protected, slightly below the deck, by a fender efficiently secured to the shell plating and extending over at least two thirds of the ship's length. Compensation is to be provided in way of the gangway port in raised deck, if fitted.

2.1.3 Where dredgers are likely to work in association with hopper barges, the shell plating is to be protected by a fender extending from the load waterline to the lowest waterline.

Additional structural reinforcements are to be provided in way of fenders and submitted to the Society for approval.

2.1.4 On bucket dredgers, in order to prevent dangerous flooding in the event of damage to the shell plating by metal debris (e.g. anchors), a watertight compartment is to be provided at the lower part of the caissons on either side of the bucket well in the area of the buckets. The compartment is to be of adequate size to allow surveys to be carried out.

2.1.5 Reinforcements are to be provided at locations where the hull is heavily stressed, such as:

- beneath the suction pipe gallows
- in way of the gallow frame on bucket dredgers
- points where tow ropes are secured
- connections of piles, etc.

2.1.6 The strengthening of the flat bottom at ends is to be examined by the Society on a case-by-case basis.

2.1.7 Weirs are to be provided in the hopper spaces. Their sectional area is to be large enough, taking into account the density of the water-spoil mixture to be drained off.

The disposition and location of the weirs are to be such that:

- they prevent the maximum authorised draught from being exceeded during loading
- trim and stability are always in accordance with the reviewed loading conditions
- draining off is made without any overflowing on the decks.

2.1.8 In trailing suction hoppers, where (B+D) is greater than 21 m, a double bottom is to be provided between the collision bulkhead and the fore bulkhead of the closest hopper space. The double bottom may, however, be interrupted in way of the dredging pump.

2.1.9 The corners of the cut-outs in the bottom plating are to be rounded and the radius is to be as large as possible, especially near the bottom doors.

The shape and the radius of cut-out corners are to be in accordance with Pt B, Ch 4, Sec 6.

2.1.10 Where hopper barges and suction dredgers are intended for deep sea navigation, it is recommended, as far as possible, that sidescuttles should not be fitted in the shell plating.

2.1.11 The brackets are generally to be of a swept shape. A flange is to be fitted on the free edge if the length of this edge exceeds 60 times the web thickness.

2.1.12 For ships with either of the service notations **split hopper dredger** and **split hopper unit**, where panting beams are provided as stated in Pt B, Ch 9, Sec 1, [2.7], stringers and web frames are to be fitted on the centreline bulkheads of the two half-hulls to take up the reactions.

2.2 Longitudinal members in the area of the hopper well

2.2.1 The scantlings of the midship region are generally to be kept over the full length of the hopper well.

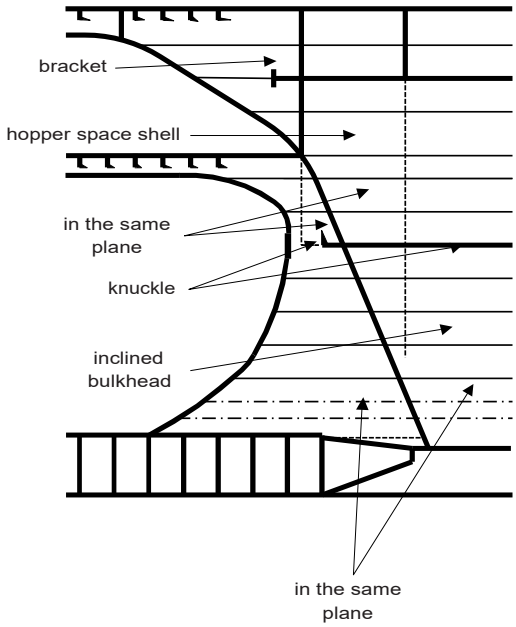
2.2.2 Attention is to be paid to the structural continuity of longitudinal members, especially coaming and hopper well bulkheads.

2.2.3 The upper deck stringer plate is to extend to the longitudinal bulkhead over the full length of the hopper well.

2.2.4 The fore and aft ends of the longitudinal bulkheads of the hopper spaces are to be extended by large brackets generally having a length and a width equal to D/4. It is recommended that a swept shape should be provided for these brackets (see Fig 2).

The upper bracket is to be welded to the deck and extended by a longitudinal deck girder.

Figure 2 : Brackets at fore and aft ends of longitudinal bulkheads of the hopper spaces

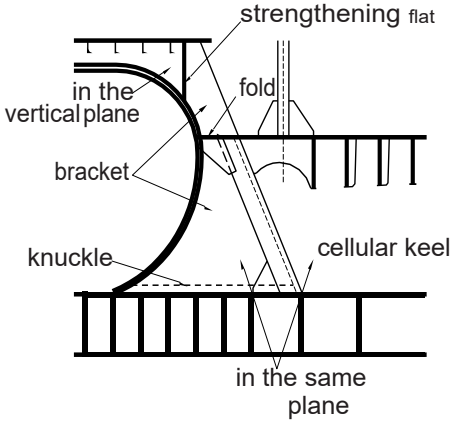


The lower bracket, which is generally oblique, is to be welded to the bottom or to the tank top. In the latter case, the lower bracket is to be extended inside the double bottom by means of a solid keelson extending at least over three frame spaces beyond the end of the bracket.

2.2.5 The fore and aft ends of the centreline cellular keel are to be extended by means of brackets having a length at least equal to the depth of this keel.

In areas where a double bottom is provided, the brackets may be arranged in accordance with Fig 3.

Figure 3 : Brackets at fore and aft ends of cellular keel



2.2.6 The vertical sides of the trunks are to be extended beyond the end of the hopper spaces over a distance of at least 1,5 times their height.

2.2.7 The Society may, on a case-by-case basis, require that longitudinal members of the double bottom structure are extended, by means of brackets, inside the side compartments bounding the hopper spaces.

2.2.8 Arrangements other than those described in [2.2.4] to [2.2.7] are to be considered by the Society on a case-by-case basis.

2.3 Transverse members in the area of the hopper well

2.3.1 Transverse primary supporting rings

Within the hopper well area, transverse primary supporting rings are to be provided and are to involve:

- deep floors inside hopper spaces

- side vertical primary supporting members
- hopper well vertical primary supporting members
- strong beams inside hopper spaces, at deck or trunk level
- where necessary, cross-ties connecting either the side vertical primary supporting members to the hopper well vertical primary supporting members or the floor to the hopper well vertical primary supporting members.

The spacing of the transverse rings is generally to be taken not greater than five frame spaces.

2.3.2 The cellular keel is to be rigidly connected to the transverse rings required in [2.3.1].

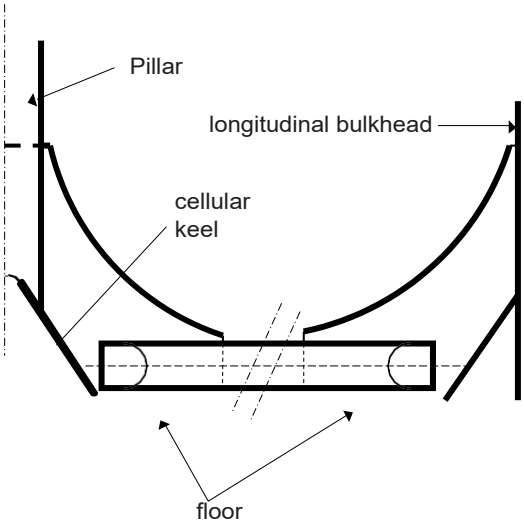
2.3.3 The upper part of the cellular keel may be connected to the deck or trunk structure by means of axial or inclined pillars in association with strong beams, or by a centreline wash bulkhead.

2.3.4 The connection of hopper space floors with the longitudinal bulkheads and the cellular keel is to be arranged such that the continuity of the strength is ensured.

Where the floor is made of a box with sloping sides, particular attention is to be paid to the continuity of the lower flange. Fig 4 shows an example of possible connection.

2.3.5 The connection between the flanges of the strong beams and the adjacent structure is generally to be made by means of brackets having the thickness of these flanges and extending inside the adjacent structure.

Figure 4 : Example of connection with floor made of box with sloping sides



2.4 Arrangements relating to suction pipes

2.4.1 Where a cut-out is necessary in the side shell plating to fit the suction pipe guides, continuity of members is to be restored, for example by means of knuckled plates as thick as the side shell plating and with a knuckle angle as small as possible.

The knuckles are to be stiffened by reinforced vertical primary supporting members and intercostal girders of the same web height (see Fig 5 and Fig 6).

The fillet welding between the web of vertical primary supporting members and the knuckled plates is not to be made onto the knuckles, but about 50 mm apart.

Figure 5 : Transversely framed side - Cut-out reinforced by means of knuckled plate

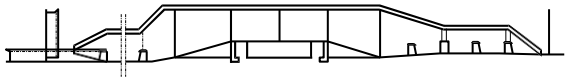
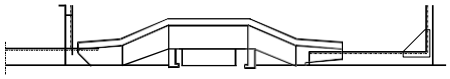


Figure 6 : Longitudinally framed side - Cut-out reinforced by means of knuckled plate



2.4.2 The suction pipe guides are to be fitted as far as possible from the hopper space ends or from any cut-out in the bottom or deck plating.

A 60% reinforced deck plate, not exceeding 38 mm, is to be provided in way of the cut-out of the guides. This plate is to extend over at least one frame space forward and aft of the vertical primary supporting members provided for in [2.4.1].

2.4.3 In areas where, during suction pipe operations, the drag head and the joint may run against the hull, one or several of the following arrangements are generally to be provided:

- thickness plating in excess of thickness obtained according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable, for bilge and side shell
- reinforcement of the structure by means of vertical primary supporting members, girders, intermediate frames or longitudinals, depending on the construction type
- fenders to be provided outside the hull; these fenders together with the bilge shape are not to impede the suction pipe operation
- cofferdam to be provided to limit the possible flooding of side compartments.

2.4.4 The suction pipes are generally to be fitted with:

- auxiliary devices able to lift the suction pipe, in addition to the suction pipe davits
- a sufficient number of attachment points on the suction pipe itself, to facilitate handling
- a load limiting device to avoid any overload, if the suction pipe is equipped with cutting teeth
- accessories fitted onto the suction pipe built in several parts to facilitate partial replacements in case of damage.

2.5 Chafing areas

2.5.1 Some parts of the structure subjected to heavy wear, such as longitudinal bulkheads of hopper spaces, may be protected or reinforced to avoid frequent replacement.

2.5.2 If protection is provided by means of removable plates, called chafing plates, attention is to be paid to avoid corrosion between the facing sides of these plates and the hopper space plating.

2.5.3 If reinforcement is made by increasing the thickness, the section moduli may be determined taking into account the extra thickness, provided that the chafing limits, beyond which the plates are to be replaced, are determined according to the extra thickness values.

If this extra thickness is disregarded in the section moduli calculation, this is to be clearly indicated on the midship section drawing.

2.6 Reinforcements for grounding

2.6.1 If grounding is considered for normal operation of the ship, the bottom plating and the bottom structure are to be reinforced as indicated in [2.6.2] to [2.6.5].

2.6.2 Along the full length of the ship, in the area of flat bottoms, the bottom net thickness obtained according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable, is to be increased by 2,5 mm.

2.6.3 Where the ship has a transversely framed double bottom, floors are to be fitted at each frame space and associated with intercostal longitudinal girders, the mean spacing of which is to be not greater than 2,10 m.

Moreover, intercostal longitudinal ordinary stiffeners located at mid-spacing of bottom girders are to be provided.

2.6.4 Where the ship has a longitudinally framed double bottom, the floor spacing may not exceed three frame spaces and the bottom girder spacing may not exceed three longitudinal ordinary stiffener spaces.

Intercostal transverse stiffeners are to be provided at mid-span of longitudinal ordinary stiffeners.

Floors are to be stiffened by vertical stiffeners having the same spacing as the longitudinal ordinary stiffeners.

2.6.5 Where the ship is built with open hopper spaces (bottom doors provided on the bottom), reinforcements as required in [2.6.3] or [2.6.4] are to be provided within the side compartments, the cellular keel and, in general, within the limits of the flat bottom area.

2.7 Bolted structures

2.7.1 Where the dredger is made of several independent members connected by bolting, the connection is to be examined by the Society on a case-by-case basis.

3 Design loads

3.1 General

3.1.1 Design loads are to be determined for the various load cases in the following two situations:

- navigation situation, considering the draught T
- dredging situation, considering the dredging draught T_D.

3.1.2 For dredgers made of bolted structure, the Society may require the hull girder loads calculated with the maximum length of the unit when mounted to be applied to each individual element.

3.2 Still water hull girder loads

3.2.1 Loading conditions

In addition to the requirements in Pt B, Ch 5, Sec 2, [2.1] or Pt B, Ch 8, Sec 1, [2.2], as applicable, still water loads are to be calculated for the following loading conditions:

- homogeneous loading at maximum dredging draught if higher than the maximum service draught
- partial loading conditions
- any specified non-homogeneous loading condition, in particular where dredgers are fitted with several hopper spaces
- navigation conditions with hopper space(s) filled with water up to the load line
- working conditions at international freeboard with the hopper space(s) filled with spoil
- ballast navigation conditions, with empty hopper space(s), if applicable.

Calculation of the still water bending moment and shear force for any loading case corresponding to a special use of the ship may be required by the Society on a case-by-case basis. In particular, in the case of stationary dredgers, the curve of the still water bending moment, where the suction pipe is horizontal, is to be submitted to the Society.

3.2.2 Vertical still water bending moments in dredging situation

In addition to the vertical still water bending moments $M_{SW,H}$ and $M_{SW,\,S}$ in navigation situation, defined in Pt B, Ch 5, Sec 2, [2.2] or Pt B, Ch 8, Sec 1, [2.2], as applicable, the vertical still water bending moments in dredging situation $M_{SW,H,D}$ and $M_{SW,S,D}$ are also to be considered, in hogging and sagging conditions, respectively.

If the design vertical still water bending moments in dredging situation are not defined at a preliminary design stage, at any hull transverse section, the longitudinal distributions shown in Pt B, Ch 5, Sec 2, Fig 4 may be considered, where M_{SW} is the vertical design still water bending moment amidships, in dredging hogging or sagging conditions, whose absolute values are to be taken not less than the values obtained, in kN.m, from the following formulae:

- in hogging conditions:
$$M_{SWM,H,D} = 175 n_1 C L^2 B (C_B + 0,7) 10^{-3} - M_{WV,H,D}$$
- in sagging conditions:
$$M_{SWM,S,D} = 175 n_1 C L^2 B (C_B + 0,7) 10^{-3} + M_{WV,S,D}$$

where $M_{WV,H,D}$, $M_{WV,S,D}$ are the vertical wave bending moments in dredging situation, in kN.m, defined in [3.3.1].

3.3 Wave hull girder loads

3.3.1 Vertical wave bending moments in dredging situation

In addition to the vertical wave bending moments $M_{WV,H}$ and $M_{WV,\,S}$ in navigation situation, defined in Pt B, Ch 5, Sec 2, [3.1] or Pt B, Ch 8, Sec 1, [2.3], as applicable, the vertical wave bending moments in dredging situation at any hull transverse section are to be obtained, in kN.m, from the following formulae:

- in hogging conditions:
$$M_{WV,H,D} = 190 F_M n_D C L^2 B C_B 10^{-3}$$
- in sagging conditions:
$$M_{WV,S,D} = -110 F_M n_D C L^2 B (C_B + 0,7) 10^{-3}$$

where:

F_M : Distribution factor defined in Pt B, Ch 5, Sec 2, Tab 1 or Pt B, Ch 8, Sec 1, Tab 2, as applicable (see also Pt B, Ch 5, Sec 2, Fig 5 or Pt B, Ch 8, Sec 1, Fig 1, as applicable)

n_D : Operating area coefficient defined in Tab 1 depending on H_S, without being taken greater than n

H_S : Maximum significant wave height, in m, for operating area in dredging situation, according to the operating area notation assigned to the ship (see Pt A, Ch 1, Sec 2, [4.7.3]).

Table 1 : Operating area coefficients in dredging situation

H_S , in m	Operating area coefficient n_D
$H_S < 2,5$	1/3
$2,5 \leq H_S < 4$	2/3
$H_S \geq 4$	1

3.4 Additional hull girder loads for split hopper dredgers and split hopper units

3.4.1 Application

The provisions in [3.4.3] to [3.4.6] apply to ships with one of the service notations **split hopper dredger** and **split hopper unit**, in addition to the requirements in Part B, Chapter 5.

3.4.2 General

Horizontal bending moments are to be calculated assuming that the hopper well is simply supported at each end.

The clearance between the two half-hulls is to be large enough not to be suppressed when the hopper well is full up.

Details of the calculation of the necessary clearances are to be submitted to the Society for review.

However, the calculation of the horizontal moments is carried out assuming that both ends of the hopper well are partly clamped, on condition that at deck and bottom level chocks are provided forward and aft of the well so that:

- the clearance between the two half-hulls is nil
- the chocks are long enough to withstand the end moments due to the horizontal forces developed along the hopper well.

3.4.3 Horizontal still water bending moment

The horizontal still water bending moment to be applied on one half-hull, in navigation and dredging situations, is to be obtained, in kN.m, from the formulae given in Tab 2.

Table 2 : Split hopper dredgers and split hopper units - Horizontal still water bending moment on half-hulls

Condition of attachment of hopper well ends	Horizontal still water bending moment M_{SHH}, in kN.m	
	Midship area	Hopper well ends
Partly clamped	$-\alpha_1 p \ell_p^2$	$\alpha_1 p \ell_p^2$
Simply supported	$-\left(\frac{1}{8} + \frac{c_1}{2L_p}\right) p \ell_p^2$	0

Note 1:

α_1 : Coefficient defined in Tab 3,depending on c_1/ℓ_p

p : Load per metre, in kN/m, applied along the hopper well, defined in Tab 4 depending on the loading condition

c_1 : Distance, in m, from deck hinges to ends of hopper well (see Fig 7).

Table 3 : Coefficient α_1

c_1/ℓ_p	α_1
0,005	0,0850
0,010	0,0867
0,015	0,0884
0,020	0,0899
0,025	0,0916
0,030	0,0932
0,035	0,0948
0,040	0,0964
0,045	0,0980
0,050	0,0996
0,055	0,1013
0,060	0,1028

Figure 7 : Definitions of dimensions in hopper well area

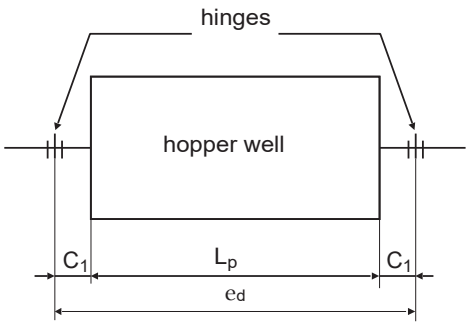


Table 4 : Load per metre applied along the hopper well

Loading condition	p, in kN/m
Maximum loading at dredging draught	$\frac{\delta(h_1 - a)^2 - 1{,}025(T_D - a)^2}{2}g$
Loading corresponding to international freeboard with well full of spoil	$\frac{\delta(h_2 - a)^2 - 1{,}025(T - a)^2}{2}g$
Service condition with well filled with water up to the waterline	0
Service condition with well filled with water up to the highest weir level	$\frac{1{,}025[(h_4 - a)^2 - (T_4 - a)^2]}{2}g$

Table 5 : Split hopper dredgers and split hopper units - Horizontal wave bending moment on half-hulls

Condition of attachment of hopper well ends	Horizontal wave bending moment M_{WHH}, in kN.m	
	Midship area	Hopper well ends
Partly clamped	$(\alpha_2 T + \alpha_3 F k_F)\frac{M_{WV}}{B}$	$-(\alpha_4 T + \alpha_5 F k_F)\frac{M_{WV}}{B}$
Simply supported	$(T + \alpha_6 F k_F)\frac{M_{WV}}{B}$	0

Note 1:

$\alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6$: Coefficients defined in Tab 6, depending on ℓ_D/L

T : Draught, in m, corresponding to the loading condition considered

k_F : Coefficient taken equal to:

$k_F = 0,128\ n_D\ (C_B + 0,7)$

M_{WV} : Vertical wave bending moment, in kN.m, defined in:

- Pt B, Ch 5, Sec 2, [3.1] for the navigation situation
- [3.3.1] for the dredging situation.

Table 6 : Coefficients α_2, α_3, α_4, α_5, α_6

ℓ_D/L	α_2	α_3	α_4	α_5	α_6
0,25	0,050	0,037	0,097	0,046	-0,309
0,30	0,071	0,052	0,135	0,062	-0,247
0,35	0,095	0,070	0,178	0,080	-0,185
0,40	0,122	0,090	0,224	0,098	-0,123
0,45	0,151	0,111	0,271	0,116	-0,062
0,50	0,182	0,134	0,318	0,134	0
0,55	0,214	0,158	0,364	0,151	0,062
0,60	0,248	0,184	0,407	0,168	0,123
0,65	0,282	0,211	0,445	0,186	0,185
0,70	0,316	0,239	0,478	0,204	0,247
0,75	0,350	0,269	0,504	0,225	0,309
0,80	0,383	0,300	0,521	0,247	0,370

3.4.4 Horizontal wave bending moment

The horizontal wave bending moment to be applied on one half-hull, in navigation and dredging situations, is to be obtained, in kN.m, from the formulae given in Tab 5.

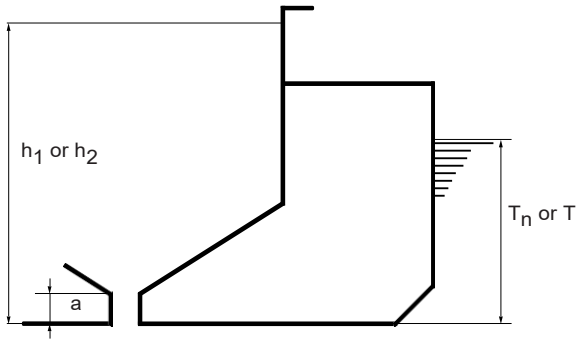
3.4.5 Combined still water and wave vertical bending moment

In the midship area, the total vertical bending moment M_V to be applied on half-hull is to be obtained, in kN.m, from Tab 7.

At hopper well ends, the total bending moment M_V is to be determined in accordance with Tab 7 considering:

- for the still water vertical bending moment: the greater of the values at the fore and aft hopper well ends
- for the vertical wave bending moment: the longitudinal distribution defined in Pt B, Ch 5, Sec 2, Tab 1 or Pt B, Ch 8, Sec 1, Tab 2, as applicable.

Figure 8 : Definitions of distances for calculation of the load applied along the hopper well



3.4.6 Combined still water and wave horizontal bending moment

The total horizontal bending moment M_H applied on half-hull, in midship area and at hopper well ends, is to be obtained, in kN.m, from the following formulae:

- in navigation situation: $M_H = M_{SHH} + n\, M_{WHH}$
- in dredging situation: $M_H = M_{SHH} + n_D\, M_{WHH}$

where:

M_{SHH} : Horizontal still water bending moment, defined in [3.4.3] in midship area and at hopper well ends

M_{WHH} : Horizontal wave bending moment, defined in [3.4.4] in midship area and at hopper well ends.

3.5 Internal pressures for hopper well in dredging situation

3.5.1 Still water pressure for hopper well

The still water pressure to be used in connection with the inertial pressure in [3.5.2] is to be obtained, in kN/m^2, from the following formula:

$p_S = 0{,}9\delta_1 d_D$

where:

Table 7 : Vertical bending moment applied on half-hull

Condition	Vertical bending moment M_V, in kN.m	
	Navigation situation	Dredging situation
Hogging	$\frac{M_{SW,H} + M_{WV,H}}{2}$	$\frac{M_{SW,H,D} + M_{WV,H,D}}{2}$
Sagging	$\frac{M_{SW,S} + M_{WV,S}}{2}$	$\frac{M_{SW,S,D} + M_{WV,S,D}}{2}$

Note 1:

$M_{SW,H}$, $M_{SW,S}$:Still water vertical bending moment in navigation situation in hogging and sagging condition, respectively, defined in Pt B, Ch 5, Sec 2, [2.2] or Pt B, Ch 8, Sec 1, [2.2], as applicable

$M_{WV,H}$, $M_{WV,S}$:Wave vertical bending moment in navigation situation in hogging and sagging condition, respectively, defined in Pt B, Ch 5, Sec 2, [3.1] or Pt B, Ch 8, Sec 1, [2.3], as applicable

$M_{SW,H,D}$, $M_{SW,S,D}$:Still water vertical bending moment in dredging situation, in hogging and sagging condition, respectively, defined in[3.2.2]

$M_{WV,H,D}$, $M_{WV,S,D}$:Wave vertical bending moment in dredging situation, in hogging and sagging condition, respectively, defined in[3.3.1].

δ_1 : Coefficient equal to:

$\delta_1 = \delta$ for $\delta < 1{,}35$

$\delta_1 = \delta + (1{,}35 - \delta)(\sin\alpha)^2$ for $\delta \geq 1{,}35$

d_D : Vertical distance, in m, from the calculation point to the highest weir level with the corresponding specific gravity of the mixture of sea water and spoil

α : Angle, in degrees, between the horizontal plane and the surface of the hull structure to which the calculation point belongs.

3.5.2 Inertial pressure for hopper well

The inertial pressure is to be obtained from Tab 8.

4 Hull girder strength

4.1 General

4.1.1 The hull girder strength of:

- ships with one of the service notations **dredger**, **hopper dredger** and **hopper unit**
- ships with either of the service notations **split hopper dredger** or **split hopper unit**, considered with the two half-hulls connected,

is to be checked for navigation situation and dredging situation according to the criteria of Part B, Chapter 6 or Pt B, Ch 8, Sec 2, as applicable.

4.1.2 In addition, the hull girder strength of each half-hull of ships with either of the service notations **split hopper dredger** or **split hopper unit** is to be checked according to the criteria of [5].

Table 8 : Ships for dredging activities - Inertial pressure for hopper well

Ship condition	Load case	Inertial pressure p_W, in kN/m^2
Upright condition	"a"	No inertial pressure
	"b"	$0,9\delta_1 a_{Z1} d_D$
Inclined condition	"c"	$0,45\delta_1 a_{Z2} d_D$
	"d"	$0,63\delta_1 a_{Z2} d_D$
Note 1: The accelerations a_{Z1} and a_{Z2} are to be determined according to Pt B, Ch 5, Sec 3, [3.4], considering the ship in dredging situation, i.e. considering the draught equal to the dredging draught T_D.		

4.1.3 For dredgers made of bolted structure, the Society may require the hull girder strength criteria to be applied to each individual element, considering the loads calculated according to [3.1.2].

4.2 Section modulus

4.2.1 In the determination of the hull midship section modulus according to Pt B, Ch 6, Sec 1, [2.3] or Pt B, Ch 8, Sec 2, [1.3], as applicable, account is to be taken of:

- 85 % of the sectional area of the cellular keel
- 60 % of the sectional area of deck girders in way of the hopper spaces
- 60 % of the centreline wash plate, provided that its connection to the deck has a length equal to at least 1,5 times its depth.

4.2.2 Where cut-outs in the side shell are needed to fit the suction pipe guides, a section modulus calculation not taking account of the side shell plating may be required by the Society on a case-by-case basis, if the structural continuity is not correctly achieved.

5 Additional requirements for hull girder strength of split hopper dredgers and split hopper units

5.1 General

5.1.1 For ships with either of the service notations **split hopper dredger** or **split hopper unit**, the yielding check of each half-hull is to be carried out according to [5.1] to [5.4] considering:

- each half-hull as being subjected to independent bending
- the deck hinges and the hydraulic jacks acting as supports at the ends of the hopper well.

5.1.2 Both the vertical bending moment and horizontal bending moment acting within the well area are to be taken into account.

5.2 Definitions

5.2.1 Co-ordinate system

The hull girder strength is defined with reference to the following co-ordinate system, as shown in Fig 9:

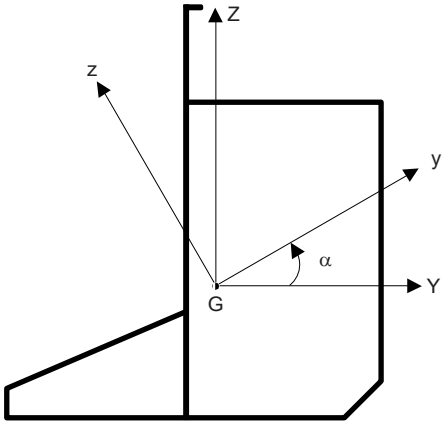
G : Centre of gravity of the transverse section

GY : Transverse axis, parallel to Y defined in Pt B, Ch 1, Sec 2, [4] and crossing through G

GZ : Vertical axis, parallel to Z defined in Pt B, Ch 1, Sec 2, [4] and crossing through G

Gy, Gz : Main axes of the transverse section, defined in [5.2.2].

Figure 9 : Half-hull co-ordinate system



5.2.2 Main axes

The main axes Gy and Gz are obtained from the axes GY and GZ by a rotation around the centre of gravity G of an angle α obtained from the following formula:

$$\alpha = \frac{1}{2}\text{atan}\left(\frac{2I_{YZ}}{I_Z - I_Y}\right)$$

where:

I_Y : Moment of inertia, in m^4, of the transverse section around the axis GY

I_Z : Moment of inertia, in m^4, of the transverse section around the axis GZ

I_{YZ} : Inertia product, in m^4, of the transverse section, in the reference (G, GY, GZ).

5.2.3 Bending moments

The bending moments M_y and M_z in relation to the main axes Gy and Gz, respectively, are to be obtained, in kN.m, from the following formulae:

$$M_y = M_V \cos\alpha + M_H \sin\alpha$$

$$M_z = -M_V \sin\alpha + M_H \cos\alpha$$

where:

M_V : Vertical bending moment defined in [3.4.5], in kN.m, to be considered in hogging and sagging conditions, for the navigation and dredging situations

M_H : Horizontal bending moment defined in [3.4.6], in kN.m, to be considered in hogging and sagging conditions, for the navigation and dredging situations

α : Angle defined in [5.2.2].

As the main inertia axes of each half-hull are oblique, the bending of each half-hull is a deviated bending.

5.3 Hull girder stress

5.3.1 At any point of the transverse section of each half-hull, the hull girder normal stresses are to be obtained, in N/mm^2, from the following formula:

$$\sigma_{X1} = \left(z\frac{M_y}{I_{yM}} - y\frac{M_z}{I_{zM}} \right) 10^{-3}$$

where:

M_y, M_z : Bending moments, in kN.m, in hogging and sagging conditions, for the navigation and dredging situations, defined in [5.2.3]

I_{yM}, I_{zM} : Moments of inertia, in m^4, of the transverse section around its main axes

y, z : y and z coordinates, in m, of the calculation point with respect to the main axes Gy and Gz.

5.3.2 In the case of partly clamped ends of the hopper well (see [3.4.2]), the hull girder normal stresses are to be calculated in the midship area and at hopper well ends.

In this case, the stresses are also to be calculated in the midship area assuming the ends supported as regards the horizontal moment. This calculation relates to the beginning of the hopper well drainage by opening of the two half-hulls.

5.3.3 In the case of supports at hopper well ends, the calculation of the hull girder normal stress is to be carried out in the midship area.

5.3.4 For each section of calculation, the most unfavourable combination of moments is to be considered.

5.4 Checking criteria

5.4.1 It is to be checked that the normal stresses calculated according to [5.3.1] are in compliance with the following formula:

$\sigma_1 \leq \sigma_{1,ALL}$

where:

$\sigma_{1,ALL}$: Allowable normal stress:

$\sigma_{1,ALL} = 200/k$ N/mm^2

6 Hull scantlings

6.1 General

6.1.1 Hull scantlings are to be checked according to the applicable requirements of Part B, Chapter 7 or Part B, Chapter 8, as applicable, for the following two situations:

- navigation situation, considering the draught T
- dredging situation, considering the dredging draught T_D.

6.2 Minimum net thicknesses of plating

6.2.1 The net thickness of plating is to be not less than the greater of the following values:

- 5 mm
- thickness, in mm, obtained from Tab 9.

Table 9 : Ships for dredging activities - Minimum net thicknesses of plating

Plating	Minimum net thickness, in mm
Keel	5,1 + 0,040 L $k^{1/2}$ + 4,5 s
Bottom • transverse framing • longitudinal framing	 4,3 + 0,036 L $k^{1/2}$ + 4,5 s 3,4 + 0,036 L $k^{1/2}$ + 4,5 s
Inner bottom outside hopper spaces	2,0 + 0,025 L $k^{1/2}$ + 4,5 s
Side • below freeboard deck • between freeboard deck and strength deck	 2,5 + 0,031 L $k^{1/2}$ + 4,5 s 2,5 + 0,013 L $k^{1/2}$ + 4,5 s

Plating	Minimum net thickness, in mm
Strength deck within 0,4L amidships • transverse framing • longitudinal framing	 2,5 + 0,040 L $k^{1/2}$ + 4,5 s 2,5 + 0,032 L $k^{1/2}$ + 4,5 s
Hopper well • transverse and longitudinal bulkheads • cellular keel plating	 2,7 + 0,034 L $k^{1/2}$ + 4,5 s 2,7 + 0,034 L $k^{1/2}$ + 4,5 s

6.2.2 When no protection is fitted on the deck areas where heavy items of dredging equipment may be stored for maintenance, the net thickness of the deck plating is to be not less than the value obtained, in mm, from the following formula:

$t = 5,1 + 0,040\ L\ k^{1/2} + 4,5\ s$

6.3 Bottom plating

6.3.1 Where the bottom is longitudinally framed and the bilge is made of a transversely framed sloped plate, the bottom is to be assumed as being transversely framed when calculating the plating thickness.

6.3.2 The net thickness of the bottom strake, to which the longitudinal bulkheads of the hopper space are connected, is to be not less than the greater of the following thicknesses:

- bottom plating thickness increased by 15%
- keel thickness.

6.4 Well bulkhead and cellular keel platings

6.4.1 The net thickness of hopper well bulkhead plating and cellular keel plating is to be not less than the net thickness obtained:

- in dredging situation, considering the internal pressures defined in [3.5].
- in navigation situation, where the hopper well bulkheads limit tank compartments, considering the internal pressures defined in Pt B, Ch 5, Sec 6, [1] or Pt B, Ch 8, Sec 1, [5], as applicable.

6.4.2 The net thickness of the longitudinal bulkhead above the deck or within 0,1D below the deck is to be not less than the net thickness of the strength deck abreast of the hatchways.

6.4.3 The net thickness of the transverse and longitudinal bulkhead of a dredgepipe well is to be determined as for the side shell net thickness.

6.5 Transversely framed bottoms

6.5.1 Floors

The scantlings of floors located inside large compartments, such as pump rooms, are to be obtained from a direct calculation, according to Pt B, Ch 7, App 1 as applicable, and taking into account the following assumptions:

- floors are simply supported at ends
- local discontinuities in strength, due to the presence of wells, are to be considered.

6.6 Buckling check of plating and ordinary stiffeners for split hopper dredgers and split hopper units

6.6.1 Buckling

For ships with either of the service notations **split hopper dredger** or **split hopper unit**, the buckling check of plating and ordinary stiffeners subjected to compression stresses is to be carried out according to Pt B, Ch 7, Sec 1, [5], Pt B, Ch 8, Sec 3, [5], Pt B, Ch 7, Sec 2, [4] or Pt B, Ch 8, Sec 4, [4], as applicable, considering the maximum compression stresses calculated according to [5.3], in hogging and sagging conditions, for the navigation and dredging situations.

7 Hopper dredgers and hopper units: checking of hopper well structure

7.1 General

7.1.1 The requirements in [7.1] to [7.5] apply to ships with either of the service notations **hopper dredger** or **hopper unit**.

7.1.2 At the ends of the hopper spaces, the transverse bulkheads are to extend over the full breadth of the ship. Where this is not the case, web rings with special scantlings are to be provided.

7.2 Floors

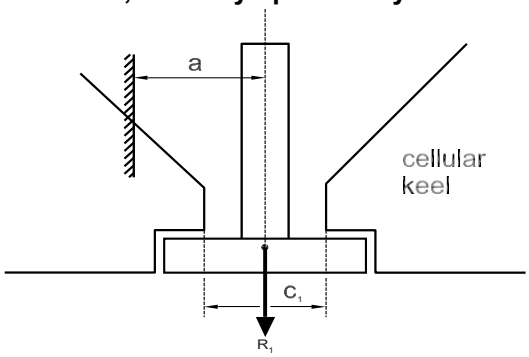
7.2.1 The scantlings of floors of ships with open wells fitted with bottom doors are to be obtained from a direct calculation, according to Pt B, Ch 7, App 1 as applicable, and taking into account the following assumptions:

- the span is equal to half the sum of the upper face plate length and the distance between lower ends of the hopper well sloped bulkheads
- the floors have fixed ends
- the floors are subject to the uniform and concentrated loads detailed in [7.2.3]
- the central box (cellular keel) is supported by the floors.

  However, where this box has sufficient dimensions and scantlings to support a part of the loads, this may be taken into account if a relevant calculation of grid type is submitted to the Society.
- In addition to the loads laid down in [7.2.3], the floor may support differential loads, for example when all the valves are not simultaneously opened, or compression loads when the well is empty
- the web cut-out section is deducted for the calculations of shear stresses and normal stresses (tension or compression)
- for the calculation of normal stresses and bending stresses, the face plate cross-section is taken into account only if these face plates are correctly offset on the adjacent structure.

7.2.2 The different types of bottom doors and valves generally used, as well as the relevant symbols, are defined in Fig 10 to Fig 14.

Figure 10 : Bottom valve, centrally operated by a vertical shaft (Type 1)



7.2.3 The loads borne by floors are a combination, according to the type of bottom doors, of the elementary loads [a], [b], [c], [d], [e] and [f], obtained, in kN, from the following formulae:

[a] : Uniform load of spoils, to be taken equal to:

$$Q_1 = g\delta(D + h_D)S_a\ell$$

[b] : External hydrostatic pressure, to be taken equal to:

$$Q_2 = g(T_D - 0{,}5h_0)S_a\ell$$

In the course of calculations, P_r is the reduced pressure, evenly distributed, to be taken equal to:

$$P_r = \delta(D + h_D) - (T_D - 0{,}5h_0)$$

The resultant load is to be taken equal to:

$$Q = Q_1 - Q_2 = gP_rS_a\ell$$

[c] : Load acting directly on a valve (to be deducted), to be taken equal to:

$$q = gP_rA_{bd}$$

This load is assumed to be evenly distributed along the length c_1. It is to be cut off from the load Q.

In the case of type 5 bottom doors (see Fig 14), q = 0

Figure 11 : Single bottom door, with hinges at one side (either cellular keel side or lower wing tank side) and operated by a vertical shaft at the other side (Type 2)

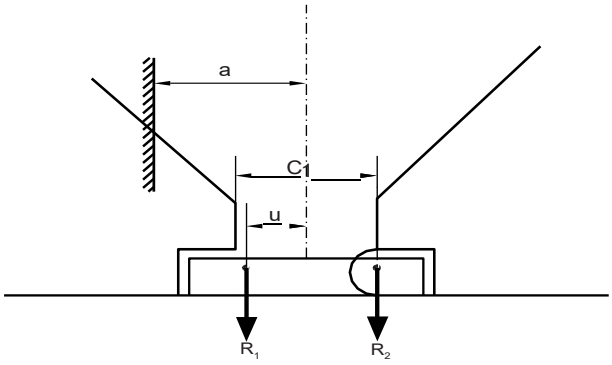


Figure 12 : Double bottom doors, with hinges at both sides and operated by one central vertical shaft connected to the doors by means of two rods (Type 3)

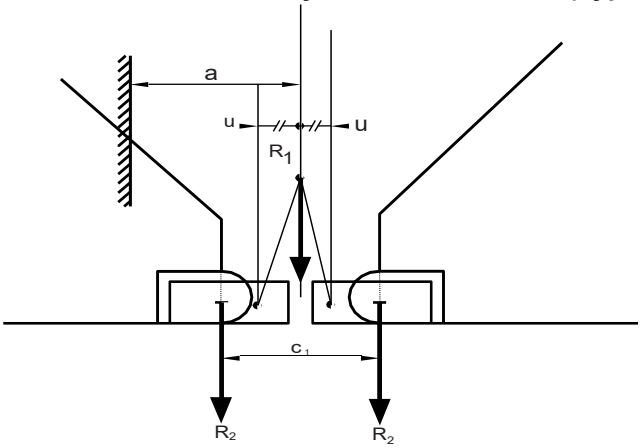


Figure 13 : Longitudinal sliding bottom doors (Type 4)

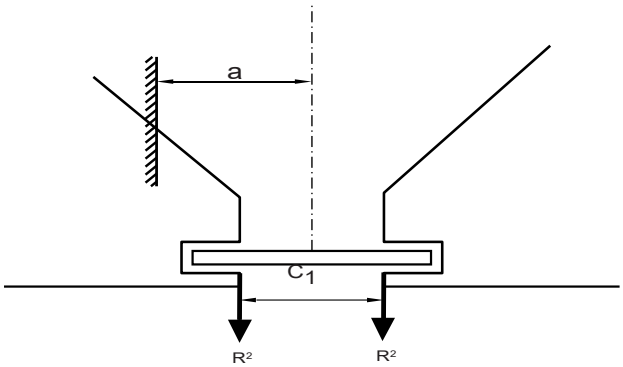
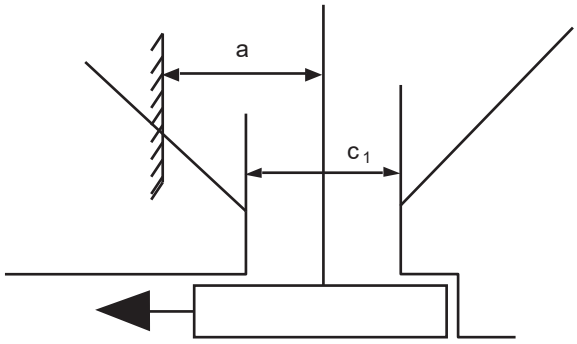


Figure 14 : Transverse sliding bottom doors, guides being supported by floors (Type 5)



[d] : Reactions R_2 of the bottom doors on the floor (to be added), the absolute values and abscissae of which are indicated in Tab 10.

Reactions R_1 on the rods of the hydraulic jacks of bottom doors type 1 (see Fig 10), type 2 (see Fig 11) and type 3 (see Fig 12) are given in Tab 10 for further calculations but they are not borne by the floors.

[e] : Axial force due to the lack of spoils in the volume occupied by the cellular keel (to be deducted), to be taken equal to:

$$F_1 = g\delta S_a A$$

[f] : Axial force due to a possible transmission of the resultant reaction R_1 to the cellular keel, through a strong beam, an axial pillar or inclined pillars, to be taken equal to:

- with one axial pillar:

$$F_2 = 4\frac{vR_1}{\ell_0}$$

- with two inclined pillars:

$$F_2 = 2R_1$$

For determination of the scantlings of strong beams, girders and pillars, R_1 is to be replaced by F_M, in kN, when calculating F_2, if F_M is higher than R_1, F_M being the maximum force induced by the bottom door hydraulic jack.

where:

h_D : Distance, in m, from the highest weir level, corresponding to the draught T_D, to the deck-line (h_D is to be counted negatively where the level is located below the deck-line at side)

S_a : Transverse primary supporting ring spacing, in m

ℓ : Stiffener span, in m.

In the case of floors, the span is equal to half the sum of the length of the upper flange plate and the distance between the lower ends of the sloping sides of the hopper space.

h_0 : Ship relative motion, in m, defined in Pt B, Ch 5, Sec 3, [3.3] or Pt B, Ch 8, Sec 1, [3.3], as applicable

A_{bd} : Whole sectional area, in m^2, of the bottom door whatever its type may be

A : Area, in m^2, enclosed by the contour of the cellular keel

v : Distance, in m, from the hydraulic jack centreline to the end of the strong beam span

ℓ_0 : Span, in m, of the strong beam bearing the reactions of the hydraulic jacks.

Table 10 : Reactions R_1 and R_2 for elementary load [d]

Bottom door type (see Fig 10 to Fig 14)	Reactions R_2			Reactions R_1
	No.	Value, in kN	Abscissae	Value, in kN
1		0		$gA_{bd}P_r$
2	1	$gA_{bd}P_r\left(\frac{2u}{c_1+2u}\right)$	$(a + 0,5\ c_1)$ or $(a - 0,5\ c_1)$	$gA_{bd}P_r\left(\frac{c_1}{c_1+2u}\right)$
3	2	$0,25gA_{bd}P_r\left(\frac{c_1-4u}{c_1-2u}\right)$	$(a + 0,5\ c_1)$ and $(a - 0,5\ c_1)$	$0,5gA_{bd}P_r\left(\frac{c_1}{c_1-2u}\right)$
4	2	$0,5gA_{bd}P_r$	$(a + 0,5\ c_1)$ and $(a - 0,5\ c_1)$	0
5		0		0

Note 1:

a : Distance, in m, from either end of the floor span to the centreline of the bottom door closest to that end

c_1 : Width of a bottom door, in m

u : Distance, in m, from the fixing point of the hydraulic jack rod (or of the two rod hydraulic jack) to the centreline of the bottom door.

7.2.4 The shear force diagrams corresponding to each elementary load defined in [7.2.3] are given in Fig 15 to Fig 20. The total shear force, at abscissa X, equal to the algebraical sum of the elementary shear forces corresponding to each type of bottom doors, is indicated in Tab 11.

7.2.5 The bending moments for each elementary load defined in [7.2.3] are given in Tab 12, at span ends and at mid-span.

7.2.6 The resultant bending moment is the sum of the elementary moments for each type of valve.

The total moment value at abscissa X is determined by deducting algebraically from the total moment value at the span ends the value of the area bounded by the total shear force curve.

Figure 15 : Shear force diagram for elementary load [a] - Load Q_1

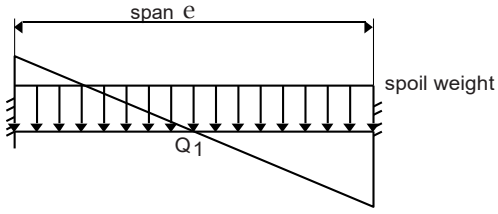


Figure 16 : Shear force diagram for elementary load [b] - Load Q_2

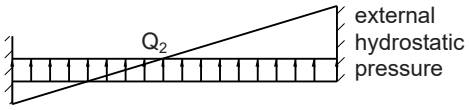


Figure 17 : Shear force diagram for elementary load [c] - Load q

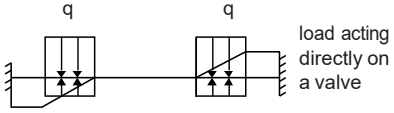


Figure 18 : Shear force diagram for elementary load [d] - Reactions R_2

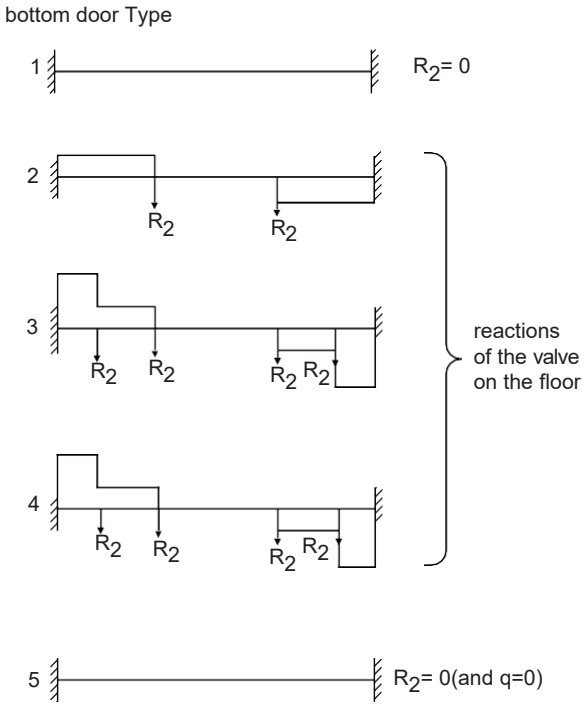


Figure 19 : Shear force diagram for elementary load [e] - Force F_1

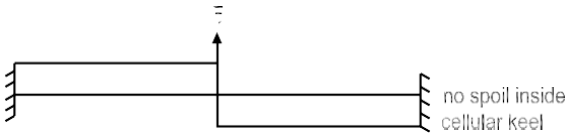


Figure 20 : Shear force diagram for elementary load [f] - Force F_2

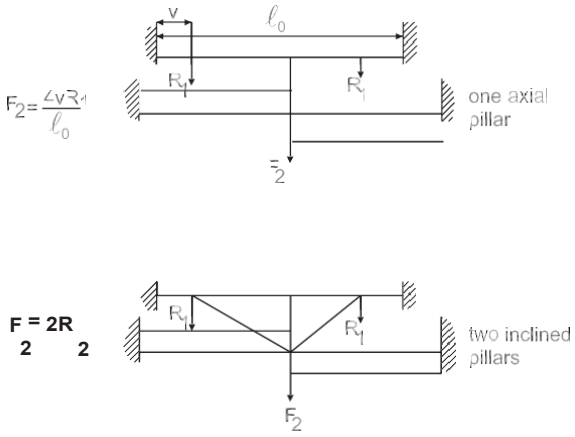


Table 11 : Shear force values

Bottom door type (see Fig 10 to Fig 14)	Total shear force T(x) at abscissa X, in kN
1	T_0
2	$T_0 + R_2$
3	$T_0 + 2R_2$
4	$T_0 + 2R_2$
5	$T_0 + q - 0,5F_2$

Note 1:

X : Distance, in m, from the cross-section under consideration to the end of the floor span

T_0 : Total shear force, in kN, at the left end of the span, to be taken equal to:

$$T_0 = \frac{1}{2}(Q_1 - Q_2 - 2q - F_1 + F_2)$$

7.2.7 The normal load is to be obtained, in kN, from the following formula:

$F_N = F_{N1} - F_{N2}$

where:

$$F_{N1} = \frac{3,3S_a\delta}{2D - h_V}(D + h_D)^2(2D - h_D)$$

$$F_{N2} = \frac{3,3S_a}{2D - h_V}(T_D - 0,5h_0)^2(3D - T_D + 0,5h_0)$$

h_V : Mean floor depth, in m.

7.2.8 In the case of a differential opening of the valves, the stresses induced by the bending moments and the shear forces are determined as follows:

- the upper flange is assumed to be simply supported at ends; its span ℓ_S is measured between the longitudinal bulkhead and the cellular keel
- the lower flange is assumed to have fixed ends and its span is taken equal to c_1
- the transverse section moduli of the flanges are determined with respect to a vertical axis located in the plane of the floor web
- for the upper flange, the transverse bending moment at mid-span is obtained, in kN.m, from the following formula:
  $$M_S = 0,05\delta h^2[3\ell_V^2 - (\ell_S - c_S)^2]_1$$
- for the upper flange, the maximum shear force at ends of span ℓ_S is obtained, in kN.m, from the following formula:
  $$T_S = 0,3\delta h_V^2(\ell_S + c_1)$$
- for the lower flange, the maximum bending moment and shear force, in kN at span ends are obtained, in kN.m, from the following formulae:
  $$M_i = 1,33\left(\frac{c_1}{\ell_S}\right)^2 M_S$$
  $$T_i = 2\left(\frac{c_1}{\ell_S}\right) T_S$$

Table 12 : Values of bending moments

Elementary load	Bending moment, in kN.m, at span ends	Bending moment, in kN.m, at mid-span
[a]	$-\frac{Q_1\ell}{12}$	$\frac{Q_1\ell}{24}$
[b]	$\frac{Q_2\ell}{12}$	$-\frac{Q_2\ell}{24}$
[c]	$q___a___(__\ell____-____a\quad\quad)_$ ℓ	$-\frac{qa^2}{\ell}$
[d]	• Types 1 or 5 bottom valves: 0 • Type 2 bottom valve **(1)**: $-R_2\frac{(2a+c_1)(2\ell-2a-c_1)}{4\ell}$ • Type 3 or 4 bottom valves: $-R_2\left[\frac{4a(\ell-a)-c_1^2}{2\ell}\right]$	• Types 1 or 5 bottom valves: 0 • Type 2 bottom valve: $R^{2}\frac{(2a+c_1)_2}{4\ell}$ • Type 3 or 4 bottom valves: $R_2\left[\frac{4a^2+c_1^2}{2\ell}\right]$
[e]	$\frac{F_1\ell}{8}$	$-\frac{F_1\ell}{8}$
[f]	$-\frac{F_2\ell}{8}$	$\frac{F_2\ell}{8}$
(1) Formula valid for a hinge on cellular keel. In the case of a hinge on lateral wing tank, replace (2a + c_1) with (2a - c_1)		

7.2.9 When the ship is to navigate with empty hopper space(s), the buckling of the upper flange is to be checked, using the formulae given in [7.3] for strong beams and assuming that:

$$F_R = \frac{-3{,}3S_a}{2D-h_V}(T_2+0{,}5h_0)^2(3D-T_2-0{,}5h_0)\frac{A_S}{A_V}$$

where:

T_2 : Maximum draught for navigation with empty hopper space(s), in m

A_S : Sectional area, in cm², of the upper flange

A_V : Sectional area, in cm², of the floor, cut-outs in web deducted.

7.3 Strong beams at deck level

7.3.1 Where strong beams are fitted at deck level, the forces acting on them are to be obtained, in kN, from the following formulae:

- tension force due to the spoil pressure onto the longitudinal bulkheads of the well:

$$F_T = \frac{1{,}6\delta s(D+h_D)^2}{2D-h_V}[2(D+h_D)-3h_V]$$

- compression force due to the external hydrostatic pressure:

$$F_{C1} = \frac{1{,}6s(T_D-0{,}5h)_0^2}{2D-h_V}(2T_D-h_0-3h_V)$$

- compression force due to moment at floor ends:

$$F_{C2} = \frac{2M(0)}{2D-h_V}$$

- compression force due to floor reaction at span ends:

$$F_{C3} = \frac{d_1+2b_1}{2D-h_V}T(0)$$

where:

s : Spacing of strong beams, in m

d_1 : Distance, in m, from the side plating to the longitudinal bulkhead of the hopper well

b_1 : Distance, in m, between the fixed end of the floor and the hopper well longitudinal bulkhead or its extension

M(0), T(0): Total bending moment and shear force at fixed ends, determined, respectively, according to [7.2.5] and [7.2.4], for X = 0.

For strong beams with a large web depth, the upper flange of which is located at deck level, the term D may be replaced by $(D - 0,5h_{WS})$, where h_{WS} is the web depth, in m, of strong beams.

The resultant of the forces is to be obtained, in kN, from the following formula:

$$F_R = F_T - F_{C1} - F_{C2} - F_{C3}$$

F_R is a tension load when positive, a compression load when negative.

7.3.2 The sectional area of strong beams, after deduction of possible cut-outs, is to be obtained, in cm^2, from Tab 13.

7.4 Brackets for trunks

7.4.1 Brackets for trunks are to be provided in way of the strengthened transverse rings. They are to be securely fixed at their lower ends.

7.4.2 In order to check the stresses according to [7.4.3], the value of the bending moment at the lower end, in kN.m, and the value of the corresponding shear stress, in kN, may be obtained, respectively, from the following formulae:

$$M_P = 1,64\delta sh_T^3$$

$$T_P = 4,9\delta sh_T^2$$

where:

h_T : Height, in m, of the trunk above the deck-line.

7.4.3 It is to be checked that the normal stress, in N/mm^2, and the shear stress are respectively in compliance with the following formulae:

$$\sigma \leq 0,65\frac{R_{eH}}{k}$$

$$\tau \leq 0,45\frac{R_{eH}}{k}$$

Table 13 : Sectional area of strong beams

Condition	Sectional area A_T, in cm^2
$F_R \geq 0$	$0,08\ F_R$
$F_R < 0$	• when $\ell_F/r \leq 1,15$: $\left[0,085 + 0,064\left(\frac{\ell_F}{r}\right)^2\right]F_R$ • when $\ell_F/r > 1,15$: $0,1\left(\frac{\ell_F}{r}\right)^2 F_R$

Note 1:

ℓ_F : Buckling length, in m, of the strong beam considered as fixed at ends, to be taken equal to $0,5\ \ell_0$

r : Minimum gyration radius, in cm, to be taken equal to:

$$r = \sqrt{\frac{I}{A_T}}$$

I : Moment of inertia, in cm^4, equal to the minimum of I_{XX} and I_{YY}

I_{XX} : Moment of inertia, in cm^4, with respect to the axis perpendicular to the plane of the web

I_{YY} : Moment of inertia, in cm^4, with respect to the axis parallel to the plane of the web.

7.5 Girders supporting the hydraulic cylinder in the hopper spaces (bottom door types 1, 2 and 3)

7.5.1 In order to check the stresses according to [7.5.2], the local bending stress due to the cylinder reaction and the corresponding shear stress, in N/mm^2, may be obtained, respectively, from the following formulae:

$$\sigma_{LX} = \frac{125F\ell}{w}$$

$$\tau_{XY} = \frac{5F}{A_a}$$

where:

F : Maximum value, in kN, of R_1 and F_M defined in [7.2.3]

w : Girder web modulus, in cm^3

A_a : Girder web sectional area, in cm^2, possible cut-outs deducted.

7.5.2 It is to be checked that the normal stress, in N/mm^2, and the shear stress are respectively in compliance with the following formulae:

$$\sigma \leq 0{,}65\frac{R_{eH}}{k}$$

$$\tau \leq 0{,}45\frac{R_{eH}}{k}$$

8 Split hopper dredgers and split hopper units: superstructure hinges

8.1 General

8.1.1 For ships with either of the service notations **split hopper dredger** or **split hopper unit**, a check of the superstructure hinges according to [8.5] is to be carried out considering the forces defined in [8.4].

8.2 Arrangements

8.2.1 Chocks able to withstand the longitudinal forces induced by the superstructures are generally to be fitted on the deck located below the superstructures.

8.2.2 When the chocks are fitted on one side only, attention is to be paid to the longitudinal take over of forces by the hinges located on the side opposite to the chocks.

8.2.3 Chocks are to be able to work when the half-hulls swing apart to discharge the spoil.

8.2.4 Special attention is to be paid to the reinforcement below the deck in way of the hinges and chocks, as well as to the fixing of the hinge to the strength members of the superstructures.

The scantlings of these members are to be calculated considering the forces given in [8.4.3] applied at the level of the hinge pin.

8.2.5 Generally, no cut-out is to be fitted immediately near to hinges or chocks.

8.3 Materials used for the hinges

8.3.1 Grades of hull steel plates

In normal service conditions, the hull steel plates are to be of the grade defined in Tab 14.

Table 14 : Material grade requirements for superstructure hinges

Gross thickness, in mm	Normal strength steel	Higher strength steel
$t \leq 20$	A	AH
$20 < t \leq 25$	D	DH
$25 < t \leq 30$	E	DH
$t > 30$	E	EH

Moreover, in low temperature service conditions, the choice of the steel grade is to be made with the Society on a case-by-case basis, according to the actual service conditions and to the design detail of the welded assembly.

8.3.2 Grades of steel castings and steel forgings

The steel grade of the steel castings and steel forgings is to be defined according to the service temperature of the part and to the weld location on the part.

8.3.3 Grades of steel for hinge pins

The hinge pins are generally to be made of forged steel.

In addition to the rule checks defined in Part D, Chapter 2, a series of impact tests is to be carried out on three Charpy V test pieces and the minimum mean value of impact energy KVL is to be equal to or greater than 27 J at 0° C.

8.3.4 Inspections and tests of weld connections

For welds concerning the main members of the hinges, non-destructive examinations are to be carried out along the full length of the joint:

- for butt welds: 100% radiographic and ultrasonic examination
- for fillet welds with deep penetration: 100% ultrasonic examination and 100% magnetic particle inspection or penetrant fluid test
- for fillet welds with small penetration: 100% magnetic particle inspection or penetrant fluid tests.

8.4 Forces

8.4.1 The forces defined in [8.4.2] to [8.4.4] may be replaced by results from model tests or by representative calculations.

In such case, the method used and the assumed conditions for model tests or calculation are to be submitted to the Society for information.

8.4.2 The forces applied on superstructures are to be obtained, in kN, from the following formulae:

- in x direction:
  $F_X = F_{W,X}$
- in y direction:
  $F_Y = F_{W,Y}$
- in z direction:
  $F_Z = F_S + F_{W,Z}$

where F_S, $F_{W,X}$, $F_{W,Y}$, $F_{W,Z}$ are to be obtained from the formulae in Pt B, Ch 5, Sec 6, [5] or Pt B, Ch 8, Sec 1, [5.4], as applicable, in which M is, in t, the mass of the superstructures.

8.4.3 In the case of superstructures connected to the ship by means of two simple hinges and two hinges with connecting tie-rods (as shown in Fig 21 and Fig 22), the forces are to be obtained, in kN, from the following formulae:

- force in line with a tie-rod:
$$F = \frac{1}{\cos\beta}\left(\frac{1}{2} + \frac{\varepsilon_L}{d_L}\right)\left[\left(\frac{1}{2} - \frac{\varepsilon_T}{d_T}\right)F_Z + \frac{d_V}{d_T}F_Y\right]$$
- vertical force in a simple hinge:
$$F = \left(\frac{1}{2} + \frac{\varepsilon_L}{d_L}\right)\left[\left(\frac{1}{2} + \frac{\varepsilon_T}{d_T}\right)F_Z + \frac{d_V}{d_T}F_Y\right]$$
- transverse force in a hinge:
$$F = \left(\frac{1}{2} + \frac{\varepsilon_L}{d_L}\right)\left[\left(\frac{1}{2} - \frac{\varepsilon_T}{d_T}\right)F_Z \tan\beta + \left(1 - \frac{d_V}{d_T}\tan\beta\right)F_Y\right]$$
- longitudinal force for each chock:
$$F = \frac{F_X}{n_B}$$

where:

β : Angle of tie-rods with respect to the vertical line, in degrees

d_T : Transverse distance between a simple hinge and a tie-rod hinge, in m

d_V : Vertical distance from the centre of gravity of the superstructures to the horizontal plane passing through the hinge centreline, in m

d_L : Longitudinal distance between the fore and aft hinges, in m

ε_T : Transverse eccentricity of the centre of gravity of the superstructures (taken as positive if the centre of gravity is on the side of the simple hinges, and as negative otherwise), in m

ε_L : Longitudinal eccentricity of the centre of gravity of the superstructures (positive), in m

n_B : Number of longitudinal chocks.

Where a longitudinal chock is provided on one side only, the hinges are to be able to withstand the longitudinal force F_X.

The distribution of forces in the case of other arrangements is to be examined by the Society on a case-by-case basis.

Figure 21 : Connection between superstructure and ship - Transverse direction

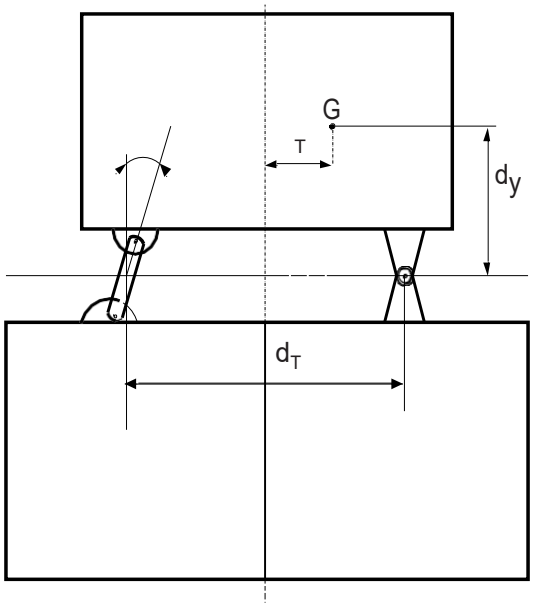
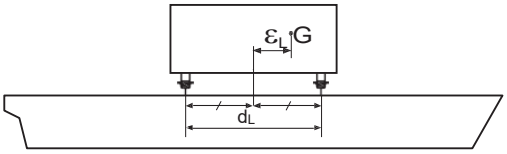


Figure 22 : Connection between superstructure and ship - Longitudinal direction



8.4.4 The force F to be considered for the check of the hinge scantlings is to be taken equal to:

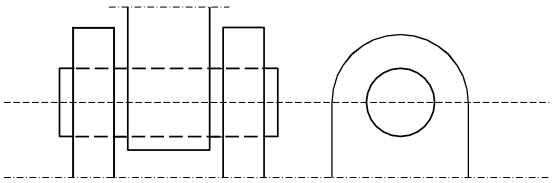
- for a simple hinge: the resultant of the horizontal and vertical forces
- for a hinge with tie-rod: the force in the tie-rod centreline

Moreover, the horizontal force in the hinges due to withstanding of the longitudinal force F_X in the case of a horizontal chock on one side only is to be considered alone.

8.5 Scantlings of the hinges

8.5.1 The hinges consist generally of two side straps and a centre eye connected by a pin, as shown in Fig 23.

Figure 23 : Superstructure hinge arrangement



The two main types of hinges are generally the following:

- type I: welded assembly made of plates, as shown in Fig 24,
- type II: welded assembly made of plates and of cast steel or forged steel parts, as shown in Fig 25.

The check of scantlings in [8.5.2] applies to the case of direct bearing of the pin on the side straps and the centre eye (see Fig 26) and to the case of load transfer by bearings (see Fig 27). In the second case, the designer is to demonstrate that the bearings can withstand the calculated forces.

Hinges whose manufacture is different from these two cases are to be examined by the Society on a case-by-case basis.

8.5.2 For the pins, centre eye and side straps of the hinges, the applied forces are to comply with the formulae given in Tab 15.

Figure 24 : Type I superstructure hinges

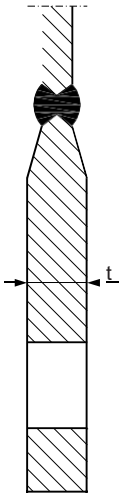


Figure 25 : Type II superstructure hinges

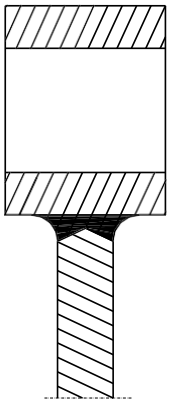


Figure 26 : Superstructure hinges: case of direct bearing

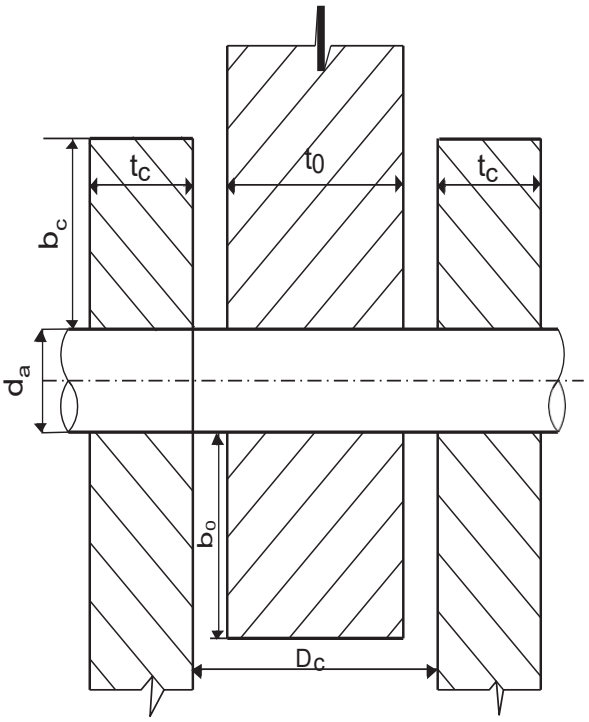


Figure 27 : Superstructure hinges: case of load transfer by bearings

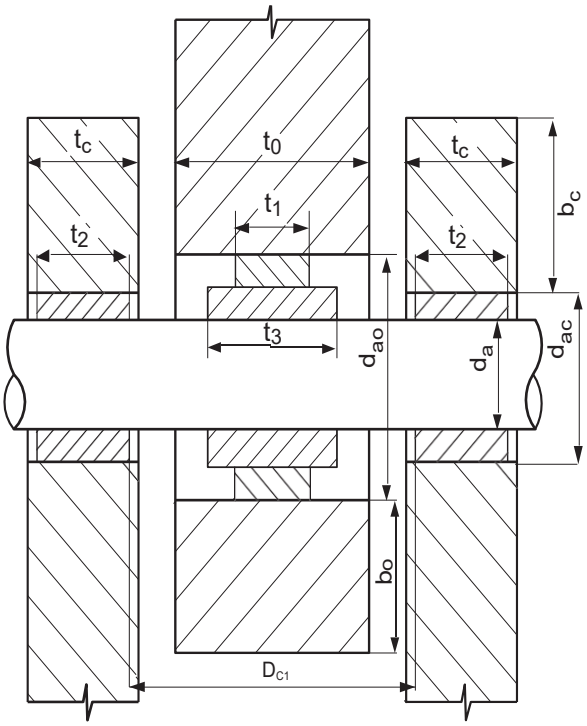


Table 15 : Scantling check of superstructures hinges

Case	Elements to be checked		
	Pins	Centre eye	Side straps
Direct bearing	$F < \frac{d_a^2 R_m}{5,76} 10^{-3}$ $F < \frac{2}{3} d_a t_0 R_{eH} \ 10^{-3}$ • if $t_0 < d_a$: $F < \frac{d_a^3}{2D_C - t_0} \frac{R_m}{5} 10^{-3}$ • if $t_0 \geq d_a$: $F < \frac{d_a^3}{2D_C - 2t_0 + d_a} \frac{R_m}{5} 10^{-3}$	$F < \frac{b_0 t_0 R_{eH}}{2,27} 10^{-3}$ $F < d_a t_0 R_{rad} \ 10^{-3}$	$F < \frac{b_C t_C R_{eH}}{1,14} 10^{-3}$ $F < 2 d_a t_C R_{rad} \ 10^{-3}$
Load transfer by bearings	$F < \frac{d_a^2 R_m}{5,76} 10^{-3}$ $F < \frac{2}{3} d_a t_3 R_{eH} \ 10^{-3}$ • if $t_3 < d_a$: $F < \frac{d_a^3}{2D_{C1} - t_3} \frac{R_m}{5} 10^{-3}$ • if $t_3 \geq d_a$: $F < \frac{d_a^3}{2D_{C1} - 2t_3 + d_a} \frac{R_m}{5} 10^{-3}$	$F < \frac{b_0 t_0 R_{eH}}{2,27} 10^{-3}$ $F < \frac{2}{3} d_{a0} t_1 R_{eH} \ 10^{-3}$	$F < \frac{b_C t_C R_{eH}}{1,14} 10^{-3}$ $F < \frac{4}{3} d_{aC} t_2 R_{eH} \ 10^{-3}$
Note 1: R_{rad} : Admissible radial pressure on the bearing, to be taken equal to 100 N/mm^2.			

9 Split hopper dredgers and split hopper units: decks hinges, hydraulic jack connections and chocks

9.1 General

9.1.1 For ships with either of the service notations **split hopper dredger** or **split hopper unit**, the scantlings of the deck hinges and the hydraulic jack attachments connecting the two half-hulls are to be determined by direct calculation.

The loads to be considered are the result of the most unfavourable combination of simultaneous static and dynamic forces (see [9.3] and [9.4]), calculated for the loading conditions in [3.2.1].

9.1.2 The locking devices of the two half-hulls, if any, are to be examined by the Society on a case-by-case basis.

9.2 Arrangements

9.2.1 Transverse chocks to be used upon closing the two half-hulls are to be provided in the bottom area, preferably in way of the hydraulic cylinders. These chocks may consist of heavy plates inserted in the bottom plating. They are to be arranged to come into contact before the end of the stroke of the jack, upon closing.

Moreover, if the calculation of the longitudinal strength is carried out assuming the hopper well ends are partly fixed, transverse chocks are to be provided at deck level.

9.2.2 Longitudinal chocks are to be provided at bottom and deck level, to prevent relative displacement of the two half-hulls.

Deck longitudinal chocks must also act in the open position.

For units of a capacity less than 700 m^3, longitudinal deck chocks need not be provided; in such case, one of the two deck hinges is to be designed to fulfil the function of a chock. The other hinge is then to have sufficient clearance.

9.3 Static forces

9.3.1 The method of calculation in [9.3.2] to [9.3.9] enables the determination of the static forces in the hydraulic jack, in the chocks and in the deck hinges only if the following conditions are met:

- the total number of hydraulic jacks connecting the two half-hulls is even
- there are no superposed jacks in the same section
- there is a deck hinge at each end of the hopper well.

Any other arrangement is to be examined by the Society on a case-by-case basis.

9.3.2 In the case of maximum loading corresponding to the dredging freeboard, the forces exerted on a half-hull to be considered to calculate the static forces in the hinges, transverse bottom chocks and jacks are shown in Fig 28 as well as their lever arm in relation to the λdeck hinge pins.

9.3.3 The horizontal static forces to be considered are the following:

- horizontal hydrostatic buoyancy F_h on the full length of the well, in kN. This force takes into account the hydrostatic buoyancy due to the water located between the two half-hulls below the sealing joint situated at the lower part of the hopper well, taken equal to:

  $F_h = 5{,}026\ (T_D - a)^2\ \ell_p$
- horizontal pressure of the spoil F_d, in kN, taken equal to:

  $F_d = 4{,}904\ \delta\ (h_1 - a)^2\ \ell_p$
- force F_{CY} in each jack, in kN, equal to the greater of F_{MC} and F_p
- force F_{CH} in each hinge, in kN, taken equal to:

$$F_{CH} = 0{,}5\left[F_h + n_1\left(1 - \frac{a_3}{a_4}\right)F_{CY} + \frac{M}{a_4}\right]$$

- force F_B in each bottom transverse chock, in kN, taken equal to:

$$F_B = \frac{n_1 a_3 F_{CY} - M}{n_2 a_4}$$

where:

F_{MC} : Minimum force required to keep the dredger closed in the loading case considered, obtained from the following formula:

$F_{MC} = M/n_1 a_3$

For a tendency to close, F_{MC} is negative and is not to be taken into account to determine F_{CY}.

F_p : Force in the jack corresponding to a pressure on the rod side equal to the maximum pressure P_p of the pumps and of their pressure limiting device

M : Moment with respect to the hinge chocks, positive for a tendency to open, negative in the opposite case, taken equal to:

$$M = -F_h a_1 + F_d a_2 + \frac{1}{2}(\Delta b_1 - \Delta_1 l \alpha b_2 - Q b_3)$$

n_1 : Number of jacks

n_2 : Number of bottom transverse chocks

Δ, $\Delta_{1\ell}$, Q: Vertical forces, defined in [9.3.4]

a_1, a_2, a_3, a_4: Lever arms of horizontal forces, as shown in Fig 28

b_1, b_2, b_3: Lever arms of vertical forces, as shown in Fig 28.

9.3.4 The vertical static forces to be considered are the following:

- vertical hydrostatic buoyancy $\Delta/2$ on a half-hull, in kN
- weight $\Delta_{1\ell}/2$ of the half-hull without spoil, in kN
- weight Q/2 of the half spoil loading, in kN

where:

Δ : Total displacement of the ship with spoil

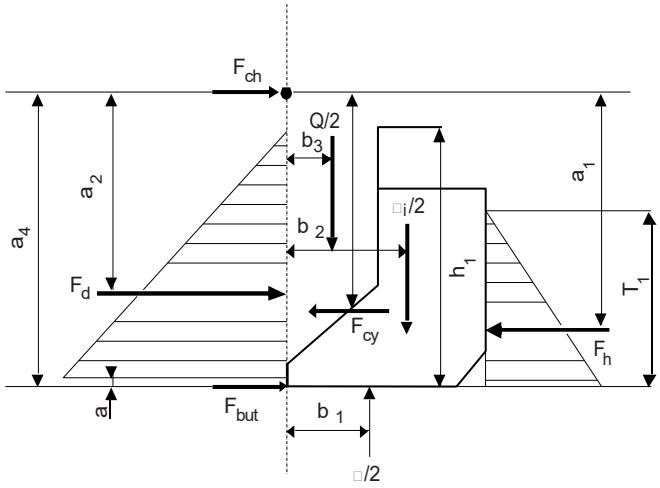
$\Delta_{1\ell}$: Total displacement of the ship without spoil, including superstructures

Q : Total weight of the spoil in the well.

The following relation between vertical static forces is to be verified:

$\Delta = \Delta_{1\ell} + Q$

Figure 28 : Forces exerted on a half-hull



9.3.5 For every other loading case, the forces F_{CY}, F_{CH} and F_B are to be calculated according to [9.3.4], by replacing:

- a_1, a_2, b_1, b_2, b_3, Δ, $\Delta_{1\ell}$ and Q by the corresponding values for the loading case considered
- T_D, δ and h_1 by values of external draught, density of water or spoils in the well and level inside the well for the loading case considered, i.e.:
  - in working condition, at the international freeboard: T, δ and h_2
  - in navigation condition with the well filled up to the waterline: T_3, 1,025 and h_3 taken equal to T_3
  - in navigation condition with well filled with water to the lowest weir level: T_4, 1,025 and h_4.

9.3.6 If, in the maximum loading condition corresponding to the dredging freeboard or the international freeboard, densities of spoil higher than δ may be considered with reduced heights (for constant mass of spoils), calculation of F_{CY}, F_{CH} and F_B is also to be carried according to [9.3.4], using the parameters corresponding to the maximum densities of spoil likely to be considered with draughts T_D and T.

9.3.7 The maximum static force F_S, actually developed by the jack, is the greatest of the values obtained for F_{CY} for the various loading cases and calculated according to [9.3.4], [9.3.5] and [9.3.6].

9.3.8 Where the hopper well ends are partly fixed, the end moments result in additional forces in the deck hinges, jacks, deck and bottom chocks, forward and aft of the well.

The distribution of these forces is to be determined by a direct calculation to be submitted to the Society for approval.

9.3.9 The Designer is to give the value of the horizontal lever arm b_2 and the hull weight for the various loading cases as stated in [9.3.4]. In each case, the value to be taken into account is the most unfavourable one according to the distribution of the compartments, considering the tendency to open or to close.

However, the attention of the Owner and of the Designer is drawn to the fact that side tank ballasting can noticeably reduce the static forces necessary in the jacks to act against opening of the two half-hulls in the above operating conditions.

9.4 Dynamic forces

9.4.1 The Designer is to give the dynamic forces applied on the deck hinges and on the hydraulic jack attachments by means of a calculation to be submitted to the Society for approval.

9.4.2 The dynamic forces are generally to be calculated by means of a long-term statistical analysis, under the conditions defined in Tab 16.

9.4.3 For each rule loading case, the results of the calculation are to give:

- the dynamic force F_{DCY} in each jack, in kN
- the horizontal dynamic force F_{DHC} in each hinge, in kN

- the vertical dynamic force F_{DVC} in each hinge, in kN.

Table 16 : Probability for the determination of dynamic forces

Condition	Probability
Dredging and navigation with spoil, with sea state limited to H_S = 3 m **(1)**	10^{-5} for jacks and hinges
Navigation without spoil, without limitation on sea state **(2)**	10^{-7} for jacks 10^{-5} for hinges
(1) H_S : Significant wave height, in m. **(2)** In sailing condition without spoil, a different probability level may be adopted for the calculation of dynamic forces on the cylinders, subject to the Society's agreement, when a device intended to restore the pressure to the cylinders after opening of the safety valves is fitted (see also [10.3.1]). **Note 1:** Different calculation conditions are to be justified by the Designer.	

9.4.4 If loading cases other than those defined in [3] are considered, calculations for such additional cases are to be defined in agreement with the Society on a case-by-case basis.

9.4.5 In the case of dredgers with a capacity of less than 700 m^3, the dynamic forces in the jacks and hinges may be taken into account without long-term statistical calculations. The calculations for jacks and hinges are to be justified to the Society.

9.4.6 For ships with either of the navigation notations **coastal area** and **sheltered area**, the dynamic forces in the cylinders and the hinges may be reduced by 10% in the case of navigation without spoil.

9.5 Scantlings

9.5.1 The maximum total force in the jack is to be taken equal to the greatest value, from all the loading cases foreseen, obtained, in kN, from the following formula:

$F_m = F_{CY} + F_{DCY}$

The jack is to be capable of developing a force at least equal to F_m, at the setting pressure of the safety valve of the jack considered as isolated.

9.5.2 The scantlings of the jack lugs are to comply with [8.5] considering the force F_m as determined in [9.5.1]. Cases where the force developed by the jack, at the setting pressure of the safety valve of the jack considered as isolated, is noticeably higher than F_m are to be examined by the Society on a case-by-case basis.

9.5.3 The scantlings of the deck hinges are to comply with [8.5], considering the resultant of the total horizontal force and the total vertical force, obtained, in kN, from the following formula:

$$F_{Res} = \sqrt{(F_{CH} + F_{DCH})^2 + F_{DVC}^2}$$

9.5.4 The scantling load of the transverse bottom chocks is to be defined in agreement with the Society.

9.5.5 The scantlings of the longitudinal bottom chocks provided for in [9.2.2] are to be determined considering for each chock the force obtained, in kN, from the following formula:

$$F = 0{,}15\frac{\Delta_m}{n_3}$$

where:

Δ_m : Maximum displacement of the ship, in kN, with the well loaded with spoil

n_3 : Total number of chocks (at deck and bottom).

The scantlings of the longitudinal deck chocks mentioned in [9.2.2] are to be determined considering for each chock the force obtained, in kN, from the following formula:

$$F = 0{,}15\frac{\Delta_n}{n_4}$$

where:

Δ_n : Displacement of the ship with the well filled with water up to the waterline

n_4 : Number of longitudinal deck chocks.

The permissible shear stress for bottom and deck chocks is to be obtained, in N/mm^2, from the following formula:

$$\tau = 0,9 \frac{R_{eH}}{\sqrt{3}}$$

For the calculation of the shear stress in the deck chocks, a reduced sectional area corresponding to the efficient sectional area of the chocks when the well is open is to be considered.

9.5.6 The lugs of the jacks and the deck hinges may be calculated using a finite element model.

In such case, the finite element model and the applied loadings are to be preliminarily agreed upon by the Society.

The permissible stress is to be defined in agreement with the Society, depending on the finite element model and on the characteristics of the materials.

10 Split hopper dredgers and split hopper units: hydraulic jacks and associated piping systems

10.1 General

10.1.1 For ships with either of the service notations **split hopper dredger** and **split hopper unit**, the check of hydraulic jacks and associated piping systems intended for closing the two half-hulls of the ship is to be carried out according to [10.1] to [10.6].

10.1.2 Hydraulic jack design and construction are to be in accordance with the applicable requirements of Pt C, Ch 1, Sec 11, [2], while associated piping systems are generally to fulfil the relevant requirements of Pt C, Ch 1, Sec 10.

Materials used are to be in accordance with the applicable requirements of Part D.

10.2 Definitions

10.2.1 For the checking of hydraulic jacks and associated piping systems, the following definitions are to be considered:

P_m : Pressure on the rod side of the jack resulting from the extreme foreseen ambient conditions corresponding to the maximum force F_m, defined in [9.5.1]

P_C : Maximum pressure on the bottom side of the cylinder equal to the setting value of the safety valves protecting the bottom side of the cylinder

P_P : Maximum pressure which can be delivered through the pumps and their associated pressure limiting devices

P_S : Pressure on the rod side of the jack corresponding to the greatest of forces F_S, defined in [9.3.7], and F_P, defined in [9.3.3].

10.3 Arrangements

10.3.1 When large ships are concerned, the following arrangements are generally to be provided:

- for each hydraulic jack, a measuring system of the pressure in the cylinder is to be supplied
- this system, in addition to the indication of the pressure at the bridge and at the dredging room, is to comprise a visual and audible alarm at the same locations, to be activated when a certain limit is exceeded
- the measuring system, the alarm activating limit as well as the instructions to be followed after the alarm occurs are to be submitted to the Society for approval.

10.3.2 Special attention is to be paid to protection against corrosion.

10.4 Scantling of jacks

10.4.1 For the pressure parts of hydraulic jacks made of steel, the permissible stress related to the loading conditions resulting in pressure P_P or P_S (whichever is the greater) acting on the cylinder rod side without pressure on the other side is to be taken as the smaller of $R_{eH}/1,8$ and $R_m/2,7$.

The allowable stress applicable to the cylindrical envelope, for the loading conditions resulting in pressure P_m , may be taken as the smaller of $R_{eH}/1,5$ and $R_m/2,25$.

10.4.2 The scantlings of the jack end cover on the rod side are to be determined using P_m as design pressure.

The scantlings of the jack end cover on the bottom side as well as the mechanical connections (for example the bolts between the cover and the cylinder or between the piston and the rod) are to be based on F_m.

The calculations justifying the proposed scantlings and, as the case may be, the pre-stresses are to be submitted to the Society for approval.

10.4.3 The scantlings of the rod are to be based on F_m and on the smaller value of $R_{eH}/2$ and $R_m/2,4$, for the mean permissible stress in traction. A calculation proving the adequate buckling strength of the rod is to be submitted to the Society for approval.

10.4.4 The scantlings of the lugs and the pins at each end of the hydraulic cylinder are to be based on F_m.

10.5 Inspection and testing

10.5.1 In addition to inspections required in [10.1.2], where applicable, welded joints connecting parts subject to the load F_m are to fulfil the requirements for class 1 pressure vessels or equivalent.

10.5.2 Completed cylinders and attached piping up to and including the first isolating valve are to undergo, at works, a pressure test at the greater of the values $1,4P_S$ and $1,2P_m$ applied on the rod side and a pressure test at $1,4P_C$ on the bottom side for the fully extended position.

10.5.3 The completed hydraulic circuit is to be subjected, on board, to pressure tests at 1,4 times the relevant maximum service pressure for normal conditions or static loads, for the part of the circuit considered.

10.6 Relief valve setting

10.6.1 At least one relief valve of appropriate capacity is to protect each part of the circuit which may be subject to overpressure due to external loads or due to pump action; in general, relief valves on the rod side of each cylinder or group of cylinders are to be set at P_m, while P_C applies to the bottom side for relief valve setting purposes.

Parts of the circuit possibly subject to overpressure from pumps only are to be protected by relief valves set at pressure P_P.

11 Rudders

11.1 General

11.1.1 The rudder stock diameter obtained from Pt B, Ch 10, Sec 1, [4] is to be increased by 5%.

11.2 Additional requirements for split hopper dredgers and split hopper units

11.2.1 Each half-hull of ships with either of the service notations **split hopper unit** or **split hopper dredger** is to be fitted with a rudder complying with the requirements of Pt B, Ch 10, Sec 1.

11.2.2 An automatic system for synchronising the movement of both rudders is to be fitted.

12 Equipment

12.1 General

12.1.1 The requirements of this Article apply to ships having normal ship shape of the underwater part of the hull.

For ships having unusual ship shape of the underwater part of the hull, the equipment is to be considered by the Society on a case-by-case basis.

12.1.2 The equipment obtained from [12.1.4] or [12.1.5] is independent of anchors, chain cables and ropes which may be needed for the dredging operations.

12.1.3 The Equipment Number EN is to be obtained from the following formula:

$$EN = 1,5(LBD)^{2/3}$$

When calculating EN, bucket ladders and gallows may not be included.

12.1.4 For ships equal to or greater than 80 m in length and for ships with EN, calculated according to [12.1.3], equal to or greater than 795, the equipment is to be obtained from Pt B, Ch 10, Sec 4, [3], with EN calculated according to Pt B, Ch 10, Sec 4, [2] and not being taken less than 795, considering the following:

- to apply the formula, the displacement considered is that of the navigation draught, taking into account the cylinder housings and the free space between the two half-hulls
- the chain cable diameter is to be read off after moving to the next line below in the applicable Table.

12.1.5 For ships other than those defined in [12.1.4], the equipment is to be obtained from Tab 17.

Where such ships are assigned one of the following navigation notations:

- **summer zone**
- **tropical zone**
- **coastal area**,

the equipment is to be obtained by consulting Tab 17 one line higher.

Where such ships are assigned the navigation notation **sheltered area**, the equipment is to be obtained by consulting Tab 17 two lines higher.

Table 17 : Ships for dredging activities - Equipment

Equipment number EN A< EN ≤ B		Stockless anchors		Stud link chain cables for anchors	
A	B	N	Mass per anchor, in kg	Total length, in m	Diameter, in mm
35	45	2	120	110,0	16,0
45	60	2	140	110,0	17,5
60	80	2	220	110,0	19,0
80	92	2	260	137,5	20,5
92	102	2	290	137,5	22
102	112	2	320	165,0	24
112	130	2	350	165,0	24
130	155	2	430	165,0	26
155	185	2	500	165,0	28
185	210	2	600	165,0	30
210	250	2	700	165,0	32
250	285	2	800	220,0	34
285	315	2	900	220,0	36
315	350	2	1000	220,0	38
350	385	2	1100	220,0	38
385	415	2	1200	220,0	40
415	450	2	1300	220,0	40
450	485	2	1400	220,0	42
485	515	2	1500	220,0	44
515	550	2	1600	220,0	46
550	585	2	1700	220,0	48
585	635	2	1800	275,0	48
635	685	2	2000	275,0	50
685	715	2	2100	275,0	52
715	750	2	2200	275,0	54
750	795	2	2300	275,0	54

12.1.6 *(1/7/2024)*
Dredgers with unusual design of the underwater part of the hull are not covered by alternative methodology using direct force calculation for anchoring equipment described in Pt B, Ch 10, App 4.

12.2 Additional requirements for split hopper dredgers and split hopper units

12.2.1 Arrangements of ships with either of the service notations **split hopper dredger** or **split hopper unit** are to be in accordance with [12.2.2] to [12.2.5].

12.2.2 One chain locker and one complete mooring chain cable are generally to be provided for each half-hull.

12.2.3 If the mass of the anchor permits, only one windlass needs to be provided on either of the half-hulls. In this case, in addition to the requirements in Pt B, Ch 10, Sec 4, [3], a chain stopper is to be fitted on the half-hull which is not equipped with a windlass.

12.2.4 Fairleads or rollers are to be located in suitable places between the windlass and the hawse pipe so that the dropping and the housing of the anchor are satisfactorily ensured.

12.2.5 Arrangements are to be made to avoid jamming of the cable during the opening and closing operations of the two half-hulls.

12.3 Towlines and mooring lines

12.3.1 For ships equal to or greater than 80 m in length and ships with EN, calculated according to [12.1.3], greater than 795, the characteristics of towlines and mooring lines are to be obtained from Pt B, Ch 10, Sec 4, [3] with EN calculated according to Pt B, Ch 10, Sec 4, [2], considering the displacement at navigation draught, taking into account the cylinder housings and the free space between the two half-hulls, the latter value of EN not being less than 795.

12.3.2 For ships other than those defined in [12.3.1], the characteristics of towlines and mooring lines are to be obtained from Tab 18.

Table 18 : Ships for dredging activities - Towlines and mooring lines *(1/1/2022)*

Equipment number EN A< EN ≤ B		Towline **(1)**		Mooring lines		
A	B	Minimum length, in m	Ship Design Minimum Breaking Load, in kN	N	Length of each line, in m	Ship Design Minimum Breaking Load, in kN
35	45	120	88	2	90	59
45	60	120	93	2	90	64
60	80	120	98	2	90	68
80	92	130	107	2	90	73
92	102	130	117	2	110	78
102	112	130	127	2	110	83
112	130	140	137	2	110	88
130	155	140	147	2	135	93
155	185	140	156	2	135	98
185	210	150	166	2	135	102
210	250	150	176	2	135	107
250	285	150	186	2	135	112
285	315	150	196	2	135	117
315	350	160	215	2	160	122
350	385	160	240	2	160	127
385	415	160	265	2	160	132

(1) The towline is not compulsory. It is recommended for ships having length not greater than 180 m.

Equipment number EN A< EN ≤ B		Towline **(1)**		Mooring lines		
A	B	Minimum length, in m	Ship Design Minimum Breaking Load, in kN	N	Length of each line, in m	Ship Design Minimum Breaking Load, in kN
415	450	160	295	2	160	137
450	485	160	320	2	160	142
485	515	160	340	3	160	147
515	550	160	365	3	160	152
550	585	160	390	3	160	157
585	635	160	415	3	160	161
635	685	160	440	4	160	166
685	715	160	465	4	160	170
715	750	160	490	4	160	175
750	795	180	515	4	160	180

(1) The towline is not compulsory. It is recommended for ships having length not greater than 180 m.

SECTION 3 MACHINERY AND DREDGING SYSTEMS

1 General

1.1 Application

1.1.1 This Section provides requirements for ships having the service notation **dredger**, **hopper dredger**, **hopper unit**, **split hopper unit** and **split hopper dredger**. These requirements are only applicable at the request of an Owner.

1.1.2 This Section does not cover the other aspects of the system and equipment design, in particular in respect of their performance.

1.1.3 The requirements for bottom doors and valves fitted on ships having the notation **hopper dredger**, **hopper unit**, **split hopper unit** and **split hopper dredger** are given in Sec 2.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted for approval.

2 Dredging system

2.1 General

2.1.1 Mechanical strength

The systems intended for dredging operations and their components are to be of sufficient mechanical strength based on the maximum loads expected in service, as specified by the Designer.

2.1.2 Piping systems

The piping systems intended for:

- suction or discharge of spoils or dredged materials
- the hydraulic supply of bottoms doors or valve actuators, cutting teeth, etc.

are to be designed, constructed and tested in accordance with the applicable provisions of Pt C, Ch 1, Sec 10.

2.1.3 Pressure vessels

Where provided, pressure vessels are to be designed, constructed and tested in accordance with the applicable provisions of Pt C, Ch 1, Sec 3.

2.2 Design of the dredging system components

2.2.1 Dredging pump units

a) In order to take into account the impact of the pump impeller on the dredged materials, diesel engines driving dredging pumps are to be designed considering an additional torque of 15% of the nominal torque.

b) The flexible couplings fitted to dredging pump units are to be so designed as to withstand the maximum torque expected in service.

c) Where their power is 110 kW or more, dredging pump units are to comply with the provisions of Pt C, Ch 1, Sec 9 related to torsional vibrations.

d) Dredging pump impellers are to be made of a weldable material.

2.2.2 Suction and discharge dredging piping

a) Valves provided on the suction and discharge pipes of the dredging system are to be of a type approved by the Society.

b) Suction and discharge pipes of the dredging system are to be of extra-reinforced thickness. For steel pipes, refer to Pt C, Ch 1, Sec 10, Tab 5.

c) A sufficient number of attachment points are to be provided on the suction pipe itself, to facilitate handling.

d) Accessories fitted onto the suction pipe are to be built in several parts to facilitate partial replacements in case of damage.

Table 1 : Documents to be submitted

No.	Document **(1)**
1	General arrangement of the dredging equipment
2	Design loads on all components of the dredging equipment
3	Structural plans of all components of the dredging equipment, including pressure vessels, hydraulic systems, etc., as applicable
4	Diagram of the piping system intended for dredging and, where applicable, for the transfer of spoils or dredged materials
5	Torsional vibration calculations of the dredging pump units, where their power is 110 kW or more
(1) Diagrams are also to include, where applicable: • the (local and remote) control and monitoring systems and automation systems • the instructions for the operation and maintenance of the piping system concerned (for information).	

2.2.3 Cutting teeth

a) If the suction pipe is equipped with cutting teeth, a load limiting device is to be provided to avoid any overload.

b) Where cutting teeth are driven by means of a hydraulic motor, an alarm is to be activated in the event of hydraulic oil leakage and the oil supply to the motor is to be stopped.

2.2.4 Discharge pipes

Arrangements are to be made to avoid collapse of the pipes used for the discharge of spoils or dredged materials to reception facilities when the discharge pump is stopped.

2.3 Attachment of dredging equipment to the hull

2.3.1 The scantlings of the structure for attachment of the equipment intended for dredging operations (e.g. connection of the suction pipe to the hull, foundation of the suction pipe davits) are to be based on the service load of such equipment, as specified by the Designer.

In determining the above service load, the Designer is to take account of additional loads imposed by ship movements (in particular pitch and heave) in the most unfavourable sea and weather conditions expected during service.

3 Steering gear of split hopper dredgers and split hopper units

3.1 General

3.1.1 The rudder fitted to each half-hull of ships having the service notations **split hopper dredger** or **split hopper unit** (see Sec 2, [11.2.1]) is to be served by its own steering gear.

3.2 Design of the steering gear

3.2.1 The steering gear referred to in [3.1.1] is to consist of a control system and a power actuating system capable to operate the relevant rudder as required in Pt C, Ch 1, Sec 11, [3.3.1] or Pt C, Ch 1, Sec 11, [4.3.1], as appropriate.

3.2.2 An auxiliary steering gear or a duplicated power actuating system need not be fitted.

3.3 Synchronisation

3.3.1 An automatic system for synchronising the movement of both rudders is to be fitted. It is to comply with the provisions of Pt C, Ch 1, Sec 11, [5.2.2].

4 Testing of dredging equipment

4.1 Workshop testing

4.1.1 General

The dredging equipment is to be tested in compliance with the following requirements, with the exception of prime movers and pressure vessels (in particular hydraulic accumulators), which are to be tested in compliance with the applicable requirements of the relevant Sections of Part C.

4.1.2 Testing of materials and components of the machinery

a) In general, testing is required for shafts, gearing, pressure parts of pumps and hydraulic motors, and plates of foundations of welded construction.

b) As far as mechanical tests of materials are concerned, internal works' certificates submitted by the Manufacturer may be accepted by the Society at its discretion. In such cases, testing operations may be limited to visual external inspection associated, where necessary, with non-destructive examinations and hardness tests.

4.1.3 Hydrostatic tests

Pressure parts are to be subjected to hydrostatic tests in accordance with the relevant requirements of Pt C, Ch 1, Sec 3 or Pt C, Ch 1, Sec 10, as appropriate.

4.1.4 Tests on electrical components

The tests required in Part C, Chapter 2 are to be carried out as applicable.

4.1.5 Running tests

a) Running tests are to be carried out whenever possible at the Manufacturer's works. As an alternative the above tests may be performed on board during the trials required after installation of machinery.

b) During the running tests, the suitability of all the arrangements concerned is to be checked in relation to the various expected service conditions.

c) On completion and subject to the result of the above tests, the inspection of components may be required, with dismantling where deemed necessary by the Surveyor in charge of the testing.

4.2 On board testing

4.2.1 Ship trials

a) Upon completion of construction, in addition to the conventional sea trials required in Pt C, Ch 1, Sec 15, specific tests may be required at the Society's discretion in relation to the particular service for which the ship is intended or the specific characteristics of machinery and equipment fitted on board.

b) In particular, as regards propulsion and steering systems, tests may be required to check the manoeuvring capability and the speed of the ship whilst operating.

4.2.2 Equipment trials

As far as the dredging system is concerned, tests are to be carried out to verify the proper operation of all relevant equipment in different sea and weather conditions.

Chapter 14

TUGS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of one of the following service notations:

- **tug**
- **salvage tug**
- **escort tug**

as defined in Pt A, Ch 1, Sec 2, [4.8.2].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to tugs.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to tugs.

Table 1 *(1/1/2026)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery	**(2)**
Electrical installations	**(2)**
Automation	**(2)**
Fire protection, detection and extinction	**(2)**
Integrated tug/barge combination	Sec 3

(1) The only specific difference in the requirements is that Pt B, Ch 2, Sec 2, [2.1.4] is not applicable to tugs less than 500 GT (i.e. no cofferdam is required between spaces intended for the carriage of flammable liquids and accommodations and/or service spaces).

(2) No specific requirements for tugs are given in this Chapter.

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 *(1/1/2026)*

The requirements of this Section apply to ships with one of the following service notations:

- **tug**, mainly intended for towing services, which are to comply with the requirements in [3]
- **salvage tug**, having specific equipment for salvage services, which are to comply with the requirements in [3] and [4]
- **escort tug**, mainly intended for escort services such as for steering, braking and otherwise controlling escorted ships, which are to comply with the requirements in [3] and [5].

Ships with the additional service feature **barge combined** (units designed to be connected with barges) are to comply with the applicable requirements in Sec 3.

Ships with the additional service feature **rescue** (units specially equipped for the rescue of shipwrecked persons and for their accommodation) are to comply with the requirements given in [3.11].

Ships with the additional service feature **standby vessel** (units specially intended to perform rescue and standby services) are to comply with the requirements given in [3.12].

Ships with the additional service feature **anchor handling** (units specially designed for anchor handling operations) are to comply with the requirements given in Ch 15, Sec 2, [2.10] and [8.3].

Ships with the additional service feature **anchor handling stab** (units specially designed and equipped for anchor handling operation and also fulfilling specific stability requirements related to this service) are to comply with the requirements given in Ch 15, Sec 2, [2.10], [3.4] and [8.3].

2 Definitions

2.1 Design bollard pull

2.1.1 *(1/1/2025)*

The design bollard pull T_{BP}, in kN, is the maximum sustained towline force the tug is capable of generating at zero forward speed, to be initially specified by the designer and to be verified by a full scale test, generally referred to as bollard pull test (see [3.10.1]).

2.1.2 *(1/1/2025)*

Where the value of the design bollard pull is not provided, the following default values may be used for preliminary design review:

- for tugs with propellers fitted with nozzles:

  $T_{BP} = 0{,}204 \cdot N \cdot P$
- for tugs with propellers not fitted with nozzles or with Voith-Schneider type cycloidal propulsion units:

  $T_{BP} = 0{,}176 \cdot N \cdot P$

where:

N : Number of propellers

P : Maximum continuous power per propeller shaft, in kW.

2.2 Calculation load

2.2.1 *(1/1/2025)*

The calculation load CL, in kN, is the force taken into consideration for the strength assessment and testing of the towing equipment and the associated supporting structures, and is to be taken as not less than:

$CL=DAF \cdot T_{BP}$ for the service notations **tug** and **salvage tug**

$CL=DAF \cdot T_{H,\ MAX}$ for the service notations **escort tug** ($T_{H,\ MAX}$ is defined in [2.3.4]);

where:

DAF : Dynamic amplification factor taking into consideration inertial effects

The CL is to be calculated as reported in:

- Tab 6 for the service notations **tug** and **salvage tug**
- Tab 7 for the service notations **escort tug**.

2.3 Escort forces and speed

2.3.1 *(1/1/2025)*

The steady towline force during escorting, T_H, in kN, is the towline force associated with the considered (quasi-static) equilibrium in escorting towing mode, excluding short time-duration dynamic effects, for a given loading condition and escort speed V, see Fig 2. The steady towline force is applied by the tug on the stern of the escorted ship.

2.3.2 *(1/1/2025)*

The steady towline force T_H has a component in the athwartship direction with respect to the escorted ship that can be identified as the steering force Ty, in kN.

2.3.3 *(1/1/2025)*

The following rated values of the above defined escort forces are to be specified by the designer:

- The rated steady towline force $T_{H,R}$, in kN, is the highest anticipated steady towline force T_H, as obtained from the evaluation of the escort forces for a particular loading condition and escort speed (the range of speeds is, in general, to be comprised between 8 and 10 knots)
- The rated steering force T_{YR}, in kN, is the highest anticipated steering force T_Y, as obtained from the evaluation of the escort forces for a particular loading condition and escort speed (the range of speeds is, in general, to be comprised between 8 and 10 knots).

2.3.4 *(1/1/2025)*

The following maximum values of the above defined rated escort forces are to be specified by the designer:

- The design maximum steady towline force $T_{H,MAX}$, in kN, is the highest rated steady towline force $T_{H,R}$ over the applicable range of loading conditions and escort speeds
- The design maximum steering force $T_{Y,MAX}$, in kN, is the highest rated steering force $T_{Y,R}$ over the applicable range of loading conditions and escort speeds.

2.3.5 *(1/1/2025)*

The list of the rated steady towline forces $T_{H,R}$ and the steering forces $T_{Y,R}$ is to be initially specified by the Designer and to be later confirmed on the basis of the results of full-scale tests (see [5.5]), of the results of model-scale tests (see [5.5]) or it may be evaluated by computer model simulation as indicated in [5.6.1].

2.3.6 *(1/1/2025)*

Emergency release system: refers to the mechanism and associated control arrangements that are used to release the load on the towline in a controlled manner under both normal and black out conditions.

2.3.7 *(1/1/2025)*

Maximum design load: is the maximum load that can be held by the winch as defined by the manufacturer (the manufacturer's rating).

2.3.8 *(1/1/2025)*

Fleet angle: is the angle between the applied load (towline force) and the towline as it is wound onto the winch drum (see Fig 1).

Figure 1 : Towline 'fleet angle' *(1/7/2021)*

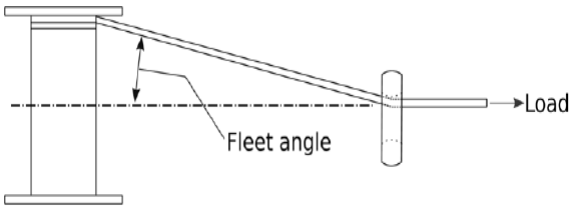
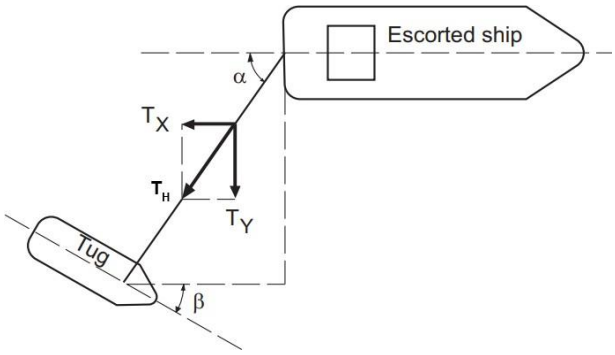


Figure 2 : Typical escort configuration *(1/1/2025)*



3 Tugs, salvage tugs and escort tugs

3.1 General

3.1.1 In general, tugs are completely decked ships provided with an ample drift surface and, where intended for service outside sheltered areas, with a forecastle or half forecastle, or at least with a large sheer forward.

Tugs of unusual design are to be considered by the Society on a case-by-case basis.

3.2 Stability

3.2.1 Openings *(1/1/2021)*

a) Openings which cannot be closed weathertight:

Openings in the hull, superstructures or deckhouses which cannot be closed weathertight are to be considered as unprotected openings and, consequently, as down-flooding points for the purpose of stability calculations (the lower edge of such openings is to be taken into account).

b) Ventilation openings of machinery space and emergency generator room:

It is recognised that for tugs, due to their size and arrangement, compliance with the requirements of ICLL Reg. 17(3) for ventilators necessary to continuously supply the machinery space and the emergency generator room may not be practicable. Lesser heights of the coamings of these particular openings may be accepted if the openings:

- are positioned as close to the centreline and as high above the deck as practicable in order to maximise the down-flooding angle and to minimise exposure to green water
- are provided with weathertight closing appliances in combination with suitable arrangements, such as separators fitted with drains
- are equipped with efficient protective louvers and mist eliminators
- have a coaming height of not less than 900 mm above the deck
- are considered as unprotected openings and, consequently, as down-flooding points for the purpose of stability calculations.

3.2.2 Stability booklet *(1/1/2021)*

The stability booklet for ships engaged in harbour, coastal or ocean going towing operations and/or escort operations is to contain additional information on:

- maximum bollard pull
- details on the towing arrangement, including location and type of the towing point(s) such as towing hook, staple, fairlead or any other point serving that purpose

- recommendations on the use of roll reduction systems
- If any wire, etc. is included as part of the lightship weight, clear guidance on the quantity and size is to be given
- maximum and minimum draught for towing and escort operations
- instructions on the use of the quick-release device

3.2.3 Intact stability

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.11] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

3.2.4 Additional intact stability criteria *(1/1/2021)*

All the loading conditions reported in the trim and stability booklet which are intended for towing operations are also to be checked in order to investigate the ship's capability to withstand the effect of the transverse heeling moments induced by the combined action of the towline force and the thrust vector (self-tripping, see [3.2.5]), and induced by the hydrodynamic resistance of the hull (tow-tripping, see [3.2.6]).

3.2.5 Self-tripping *(1/1/2021)*

Self-tripping A tug may be considered as having sufficient stability to withstand the self-tripping heeling moment if the following condition is complied with (see Fig 3):

$A \geq B$

where:

A : Area, in m·rad, contained between the righting arm and the heeling arm curves, measured from the heeling angle θ_C to the heeling angle θ_D

B : Area, in m·rad, contained between the heeling arm and the righting arm curves, measured from zero heel ($\theta = 0$) to the heeling angle θ_C.

θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms curves.

θ_D : Heeling angle, to be taken as the lesser of:

- heeling angle corresponding to the second intersection between heeling and righting arm curves
- the angle of downflooding,

The self-tripping heeling arm curve is to be calculated as follows:

$$b_H = \sum b_{Hi}$$

where:

b_{Hi} : Heeling arm induced by one thruster or group of thrusters i, in m, calculated as follows:

$$b_{Hi} = \frac{T_{BPi} \cdot c_i \cdot (h_i \cdot \cos\theta - r \cdot \sin\theta)}{9,81 \cdot \Delta}$$

T_{BPi} : Amount of thrust, in kN, generated by one thruster or group of thrusters i. The sum of all the individual thrusts is to be equal to the design Bollard Pull, as defined in Ch 1, Sec 2, [2.1].

h_i : Vertical distance, in m, between the towing point (fairlead, staple, towing hook or equivalent fitting) and the horizontal centreline of the propulsion unit or group of units i, as relevant for the considered towing situation

r : Transverse offset, in m, between the towing point and the ship's centerline. The towing point is the location where the towline force is applied to the ship (fairlead, staple, towing hook or equivalent fitting). When the towing point is not at the center line, the most unfavourable tow line position is to be considered.

c_i : Coefficient to be taken equal to:

- $c = 0,90 / (1 + d_i / L_{LL})$ for a group of 2 azimuthing thrusters, but is in no case to be taken less than:
  0,70 for ASD tugs towing over the stern and tractor tugs towing over the bow;
  0,50 for ASD tugs towing over the bow and tractor tugs towing over the stern.
- $c = 1 / (1 + d_i / L_{LL})$ for a single azimuthing thruster
- $c = 0,50$ for non-azimuth propulsion unit or group of units

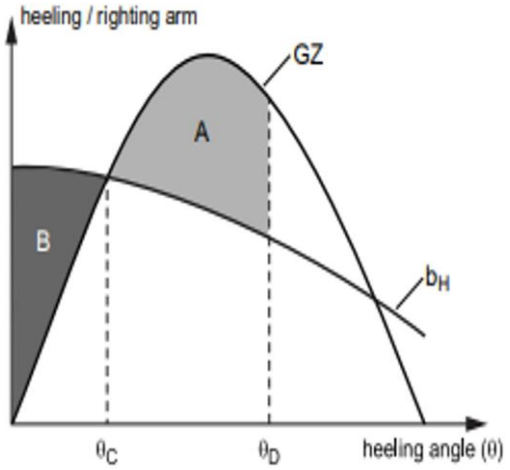
Δ : Loading condition displacement, in tons.

θ : Angle of heel, in degrees

d_i : Longitudinal distance, in m, between the towing point (fairlead, staple, towing hook or equivalent fitting) and the vertical centreline of the propulsion unit or group of units i, as relevant for the considered towing situation

L_{LL} : Load line length, in m, defined in Pt B, Ch 1, Sec 2, [3.2].

Figure 3 : Heeling and righting arms curves *(1/1/2021)*



3.2.6 Tow-tripping *(1/1/2021)*

A tug may be considered as having sufficient stability to withstand the tow-tripping heeling moment if the first intersection between the righting arm curve and the tow-tripping heeling arm curve for tow-tripping occurs at an angle of heel less than the angle of downflooding. The tow-tripping heeling arm curve is to be calculated as follows:

$$b_H = \frac{C_1 \cdot C_2 \cdot \gamma \cdot V^2 \cdot A_p \cdot (h \cdot \cos\theta - r \cdot \sin\theta + C_3 \cdot T)}{19,62 \cdot \Delta}$$

Where:

C_1 : Lateral traction coefficient, taken equal to:

$$C_1 = 2,8 \cdot \left(\frac{L_s}{L_{LL}} - 0,1\right)$$

without being taken lower than 0,1 and grater than 1.

L_s : Longitudinal distance, in m, from the aft end of L_{LL} to the towing point

C_2 : Angle of heel correction for C_1, taken equal to:

$$C_2 = \left(\frac{\theta}{3 \cdot \theta_d} + 0,5\right)$$

without being taken lower than 1.

θ_d : Angle to deck edge, in degree, taken equal to:

$$\theta_d = \operatorname{atan}\left(\frac{2 \cdot f}{B}\right)$$

ϕ : Freeboard amidships, in m

γ : Specific water density, in t/m^3, to be taken equal to 1,025

V : Lateral velocity, in m/s, to be taken equal to 2,57 (5 Knots)

A_p : Lateral projected area, in m^2, of the underwater hull

C_3 : Distance from the centre of A_p to the waterline as a fraction of the draught related to the heeling angle, taken equal to:

$$C_3 = \left(\frac{\theta}{\theta_d}\right) \cdot 0,26 + 0,3$$

without being taken lower than 0,5 and greater than 0,83.

T : Loading condition draught, in m

h : Vertical distance, in m, from the waterline to the towing point

3.2.7 Exemption *(1/1/2025)*

Tugs of any length with the navigation notation **sheltered area** may be exempted from complying with the requirement specified in [3.2.5] and [3.2.6], provided that the initial metacentric height GM, in m, corrected according to Pt B, Ch 3, Sec 2, [4.7], in the most severe condition is not less than the value obtained from the following formula:

$$GM = \frac{66 \cdot T_{BP} \cdot H \cdot B}{f \cdot \Delta}$$

where:

B : Ship's maximum breadth, in m

f : Ship's freeboard, in mm, to be assumed not greater than 650 mm

H : Vertical distance, in m, between the towing hook, or equivalent fitting, and half draught at midship corresponding to Δ

Δ : Loading condition displacement, in t

T_{BP} : Defined in [2.1.1].

3.3 Structure design principles

3.3.1 Bollards

For tugs equipped for side towing, the relevant bollards are to be effectively fixed on the deck in way of side transverses and deck beams or bulkheads.

3.3.2 Fenders

A strong fender for the protection of the tug's sides is to be fitted at deck level.

Alternatively, loose side fenders may be fitted, provided that they are supported by vertical ordinary stiffeners extending from the lightship waterline to the fenders themselves.

3.3.3 Floors

Floors are to be arranged with a welded face plate in the machinery space; elsewhere, floor flanging may be accepted as an alternative to the fitting of welded face plates.

3.3.4 Shaft tunnels

For tugs having small depth, the shaft tunnel may be omitted. In this case, access to the shaft line is to be given through the floor of the space above.

3.4 Hull scantlings

3.4.1 General

The net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with Part B, Chapter 7 or Part B, Chapter 8, as applicable, where the hull girder loads and the local loads are defined in Part B, Chapter 5 or Pt B, Ch 8, Sec 1, as applicable, to be calculated for T not less than 0,85 D.

3.4.2 Side plating thickness for tugs with L < 65 m

For tugs with L < 65 m, the net thickness of the side plating is to be increased by 1 mm with respect to that calculated according to Part B, Chapter 8, without being greater than that of the adjacent bottom plating calculated for the same panel dimensions.

3.5 Other structures

3.5.1 Machinery casings

Exposed machinery casings are to be not less than 900 mm in height, measured from the upper surface of the deck, and provided with weathertight means of closure.

In general, the longitudinal sides of the machinery casings are to be extended downwards by a deck girder to which the deck beams are to be connected.

Side ordinary stiffeners are to be connected to the deck. Their spacing is to be not greater than 0,75 m.

3.5.2 Emergency exits from machinery space

Emergency exits from the machinery space to the upper deck are to be located as high as possible above the waterline and in way of the ship's centreline, so that they may be used even at extreme angles of heel.

Escape hatch coaming heights are to be not less than 600 mm above the upper surface of the deck.

Escape hatch covers are to have hinges arranged athwartship and are to be capable of being opened and closed watertight from either side.

3.5.3 Height of hatchway coamings

The height of the hatchway coamings is to be not less than 300 mm. Hatch covers are to be fitted with efficient securing devices.

3.6 Rudder and bulwarks

3.6.1 Rudder

For tugs, the rudder stock diameter is to be increased by 5% with respect to that calculated according to Pt B, Ch 10, Sec 1, [4].

3.6.2 Bulwarks

The bulwarks are to be sloped inboard to avoid distortions likely to occur during contact. Their height may be reduced where required by operational necessities.

3.7 Equipment

3.7.1 Equipment number for tugs with the navigation notation "unrestricted navigation" *(1/7/2024)*

For tugs with the navigation notation **unrestricted navigation**, the equipment number EN is to be obtained from Pt B, Ch 10, Sec 4, [2.1.2] the following may be substituted for the term 2hB:

$$2 \cdot (a \cdot B + \sum h_n \cdot b_n)$$

where a, B and h_n are defined in Pt B, Ch 10, Sec 4, [2.1.2] and b_n is the breadth, in m, of the widest superstructure or deckhouse of each tier n having a breadth greater than B/4.

For tugs where the vertical extent of the superstructure is much greater than usual, the Society may require an increased equipment number EN.

3.7.2 Equipment number for tugs with the navigation notation coastal area or sheltered area

For tugs with the navigation notation **coastal area** or **sheltered area**, the equipment number EN is to be obtained from the following formula:

$EN = 2{,}51\ (L\ B\ D)^{2/3}$

For tugs where the vertical extent of the superstructure is much greater than usual, the Society may require an increased equipment number EN.

For tugs with total block coefficient C_B less than 0,60, at a draught T equal to 0,85 D, the equipment number EN is to be obtained from the following formulae:

$EN = 1{,}76\ (L\ B\ D)^{2/3}$

For tugs where the vertical extent of the superstructure is much greater than usual, the Society may require an increased equipment number EN.

3.7.3 Anchors, chain cables and ropes *(1/1/2017)*

Tugs with notation **unrestricted navigation** or **summer navigation** with equipment number EN calculated according [3.7.1], are to be provided with equipment in anchors, chain cables and ropes obtained from Pt B, Ch 10, Sec 4.

Tugs with notation **unrestricted navigation** or **summer navigation** with equipment number EN calculated according g [3.7.1] equal to or less than 205, may reduce the number of anchor to one, and the mass of that anchor can be reduced to half of the mass indicated in Pt B, Ch 10, Sec 4, Tab 1. In the case only one anchor is adopted, the total lenght of anchor chain cable may be reduced to half of that indicated in Pt B, Ch 10, Sec 4, Tab 1. No reduction is forseen for chain cable diameter.

Tugs with the navigation notation **coastal area** or **sheltered area** with equipment number EN calculated according [3.7.2], are to be provided with equipment in anchors, chain cables and ropes obtained from Tab 1 and Tab 2.

3.7.4 Additional equipment

Tugs are to be fitted with the additional equipment specified in Tab 3.

3.7.5 Tugs under 45 m in length intended for towing service only *(1/7/2024)*

For tugs under 45 m in length intended for towing service only, one anchor may be used onboard provided that the second anchor and its relevant chain cable holds readily available to be installed. In case of loss of anchor, the tug is to remain in port until replace anchor equipment is installed onboard.

Table 1 : Equipment for tugs with the navigation notation coastal area or sheltered area *(1/7/2013)*

Equipment number EN A< EN ≤ B		Stockless anchors		Stud link chain cables for anchors		
A	B	N **(1)**	Mass per anchor, in kg	Total length, in m **(2)**	Diameter, in mm	
					mild steel	high strength steel
0	55	1	70	110,0	14,0 **(3)**	-
55	64	1	74	110,0	14,0 **(3)**	-
64	74	1	83	110,0	14,0 **(3)**	-
74	84	1	90	110,0	14,0 **(3)**	-
84	94	1	99	110,0	14,0	12,5
94	104	1	105	110,0	14,0	12,5
104	114	1	110	110,0	14,0	12,5
114	124	1	115	110,0	14,0	12,5
124	139	1	122	110,0	14,0	12,5
139	159	1	130	137,5	14,0	12,5
159	179	1	140	137,5	14,0	12,5
179	199	1	157	165,0	14,0	12,5
199	205	2	173	165,0	14,0	12,5
205	219	2	346	165,0	26,0	22,0
219	244	2	384	192,5	26,0	22,0
244	264	2	420	192,5	28,0	24,0
264	289	2	466	220,0	30,0	26,0
289	314	2	500	247,5	30,0	26,0
314	334	3	540	275,0	32,0	28,0
334	364	3	575	302,5	34,0	30,0
364	389	3	690	302,5	34,0	30,0
389	414	3	770	330,0	36,0	32,0
414	444	3	885	330,0	36,0	32,0
444	474	3	1000	357,5	38,0	34,0
474	504	3	1130	357,5	38,0	34,0
504	534	3	1270	385,0	40,0	34,0
534	569	3	1420	385,0	40,0	34,0
569	600		1540	440,0	42,0	36,0

(1) The third anchor is intended as a spare and is not required for the purpose of classification.

(2) Where the total length required for chain cables is less than 220 m, one only of the two anchors may be linked with the chain cable and arranged in a hawse pipe. In this case, the second anchor is to be stowed such that it can be easily joined to the chain cable and dropped overboard in the event of loss of the first anchor.

(3) These diameters are applicable to studless chain cables.

Table 2 : Mooring lines for tugs with the navigation notation coastal area or sheltered area *(1/1/2022)*

Equipment number EN A< EN ≤ B		Mooring lines				
A	B	N	Breaking load, in kN	N	Ship Design Minimum Breaking Load, in kN	Length of each line, in m
0	55	1	24,5	1	59,8	110
55	64	1	24,5	1	66,7	110
65	74	1	24,5	1	73,5	110
75	84	1	24,5	1	80,4	110
85	94	1	30,4	1	86,3	110
95	104	1	34,3	1	91,2	110
105	114	1	38,2	1	95,1	110
115	124	1	43,2	1	99,0	110
125	139	1	49,0	1	104	110
140	159	1	58,8	1	111	120
160	179	1	68,6	1	119	120
180	199	1	78,4	1	127	120
200	219	1	88,2	1	136	120
220	244	1	98,0	1	145	120
245	264	1	108	1	154	120
265	289	1	108	1	163	120
290	314	1	108	1	172	130
315	334	1	108	1	174	130
335	364	1	108	2	174	130
365	389	1	108	2	174	130
390	414	1	108	2	174	140
415	444	1	108	2	174	140
445	474	1	108	2	174	140
475	504	1	108	2	174	140
505	534	1	108	2	174	150
535	569	1	108	2	174	150
570	600	1	108	2	174	160

Table 3 : Additional equipment for tugs *(1/1/2025)*

Arrangement or equipment	Navigation notation		
	Unrestricted navigation	**Coastal area**	**Sheltered area**
Fender	Requested	Requested	Requested
Towing hook or winch	Requested	Requested	Requested
Towing guide bar **(1)**	Requested	Requested	Not requested
No. of towlines of suitable diameter **(2)**	2	2	1
Length, in m, of towlines of suitable diameter **(2)**	200	150	100
No. of line throwing appliances (with 4 charges)	1	Not requested	Not requested
Crew accommodation spaces	Requested	Requested	Not requested

(1) The Society may not require the towing guide bar depending on the characteristics of the ship under consideration and where any obstructions on the deck area aft do not interfere with the towline during towing operations.

(2) The suitability of the towline diameter is left to the judgement of the interested parties.

3.8 Towing equipment

3.8.1 General *(1/1/2026)*

In general, towing hooks and winches are to be arranged in way of the ship's centreline, in such a position as to minimise heeling moments in normal working conditions.

In general, towing winches are to be chosen in such a way that their brake holding capacity is to be equal to or greater than 1.25·CL, where CL is to be calculated in compliance with Tab 6 or Tab 7, as the case may be.

The provisions in [3.8] are applicable to towing hooks and towing winches made up of metal materials having a well defined yielding/proof(0.2%) stress and a well defined ultimate stress.

The towing hook and the towing winch materials are to comply with the applicable requirements of Part D.

The towing hook and the towing winch are to be tested after construction in compliance with the requirements given in [3.9].

Towing winches intended for anchor handling service are to comply also with the requirements of Ch 15, Sec 2, [8.3].

3.8.2 Documents to be submitted *(1/1/2025)*

The documents to be submitted for the review and the approval of the towing hook design are listed in Tab 4.

Table 4 : Documents to be submitted (Towing hook) *(1/1/2025)*

No.	A/I **(1)**	Document
1	I	General Assembly: main views of the hook with the captioning of the various components, with the extreme angles of working rotations and with the safe working load specification.
2	A	Structural Drawings: representation of each hook component showing the scantlings, the weld features, the bolt features and the construction material specification.
(1) A: to be submitted for approval I: to be submitted for information		

The documents to be submitted for the review and the approval of the towing winch design are listed in Tab 5.

Table 5 : Documents to be submitted (Towing winch) *(1/1/2025)*

No.	A/I **(1)**	Document
1	I	General Assembly: main views of the winch with the captioning of the various components.
2	I	Data Sheet: sheet with the specification of the following values: • active pull at each layer • winding speed at each layer • power and torque of the prime mover • reduction ratio • max brake torque • rope construction material • rope diameter • rope length.
3	A	Structural drawings: representations showing the scantlings, the weld features, the bolt features, and the construction material specification of the following components: • Frame • Drum • Shaft • Brake • Accessories (if any).
(1) A: to be submitted for approval I: to be submitted for information		

3.8.3 Towline breaking strength *(1/1/2026)*

The towline breaking strength, in kN, is to be not less than 2,2 times the value of the design bollard pull T_{BP}, as defined in [2.1.1].

3.8.4 Towing Winch - configuration *(1/1/2025)*

The winch brake is normally to act directly on the drum and is to be operable in case of failure of the primary power supply system (either manually or otherwise arranged).

Winches may be equipped with a device for automatic adjustment of the tow.

Towing winches are to be provided with an emergency release system as described in [3.8.5].

Means are to be provided to prevent the fleet angle as shown on Fig 1 from becoming great enough to inhibit operation of the emergency release system.

The dimensioning of the winch drum is to take into account the rope bending specifications provided by the towline manufacturer.

Due consideration is to be given to the proper spooling of the towline on the winch drum, as well as preventing the towline to slip over the flanges of the drum.

The in-board end of the towline is to be attached to the winch drum with a weak link or similar arrangement that is designed to release the towline at low load.

In no case less than three turns are to remain on the drum in under normal operation.

3.8.5 Winch emergency release system requirements *(1/7/2021)*

a) Performance requirements

1) The emergency release system is to operate across the full range of towline load, fleet angle and ship heel angle under all normal and reasonably foreseeable abnormal conditions (these may include, but are not limited to, the following: vessel electrical failure, variable towline load (for example due to heavy weather), etc.).

2) The emergency release system shall be capable of operating with towline loads up to at least 100 per cent of the maximum design load.

3) The emergency release system is to function as quickly as is reasonably practicable and within a maximum of three seconds after activation.

4) The emergency release system is to allow the winch drum to rotate and the towline to pay out in a controlled manner such that, when the emergency release system is activated, there is sufficient resistance to rotation to avoid uncontrolled unwinding of the towline from the drum. Spinning (free, uncontrolled rotation) of the winch drum is to be avoided, as this could cause the towline to get stuck and disable the release function of the winch.

5) Once the emergency release is activated, the towline load required to rotate the winch drum is to be no greater than:

- the lesser of five tonnes or five per cent of the maximum design load when two layers of towline are on the drum, or
- 15 per cent of the maximum design load where it is demonstrated that this resistance to rotation does not exceed 25 per cent of the force that will result in listing sufficient for the immersion of the lowest unprotected opening.

6) Emergency release of the towline is to be possible in the event of a blackout. For this purpose, where additional sources of energy are required, such sources are to comply with [3.8.5] a) 7).

7) The sources of energy required by [3.8.5] a) 6) are to be sufficient to achieve the most onerous of the following conditions (as applicable):

- sufficient for at least three attempts to release the towline (i.e. three activations of the emergency release system). Where the system provides energy for more than one winch it is to be sufficient for three activations of the most demanding winch connected to it.
- Where the winch design is such that the drum release mechanism requires continuous application of power (e.g. where the brake is applied by spring tension and released using hydraulic or pneumatic power), sufficient power is to be provided to operate the emergency release system (e.g. hold the brake open and allow release of the towline) in the event of a blackout for a minimum of five minutes. This may be reduced to the time required for the full length of the towline to feed off the winch drum at the load specified in [3.8.5] a) 5) if this is less than five minutes.

b) Operational requirements

1) Emergency release operation must be possible from the bridge and from the winch control station on deck. The winch control station on deck is to be in a safe location. A position in close proximity to the winch is not regarded as “safe location”, unless it is documented that the position is at least protected against towline break or winch failure.

2) The emergency release control is to be located close to an emergency stop button for winch operation, if provided, and shall be clearly identifiable, clearly visible, easily accessible and positioned to allow safe operability.

3) The emergency release function is to take priority over any emergency stop function. Activation of the winch emergency stop from any location is not to inhibit operation of the emergency release system from any location.

4) Emergency release system control buttons are to require positive action to cancel, the positive action may be made at a different control position from the one where the emergency release was activated. It must always be possible to cancel the emergency release from the bridge regardless of the activation location and without manual intervention on the working deck.

5) Controls for emergency use are to be protected against accidental use.

6) Indications are to be provided on the bridge for all power supply and/or pressure levels related to the normal operation of the emergency release system. Alarms are to activate automatically if any level falls outside of the limits within which the emergency release system is fully operational.

7) Wherever practicable, control of the emergency release system is to be provided by a hard-wired system, fully independent of programmable electronic systems.

8) Computer based systems that operate or may affect the control of emergency release systems are to meet the requirements for Category III systems as given in Pt C, Ch 2, Sec 3.

9) Components critical for the safe operation of the emergency release system are to be identified by the manufacturer.

3.8.6 Towing Winch - Strength *(1/1/2025)*

The strength of the winch components is to be verified with respect to the following loads to be considered as exerted by the towing rope on the drum:

a) Calculation Load (CL): the values of CL, conceived as a basical load amplified by the DAF factor, are reported on Tab 6 for winches of conventional tugs and on Tab 7 for winches of escort tugs:

b) Brake Load (BL): force equal to the max retaining capacity of the brake before slippage with the towing rope at the first layer.

c) Haul in Load (HIL): force equal to the max active pulling capacity of the drum on the rope at the first layer.

Table 6 : Calculation Load *(1/1/2025)*

Tug and Salvage Tug			
“sheltered area” Navigation		Other Navigations	
T_{BP} [KN]	CL [kN]	T_{BP} [KN]	CL [kN]
$T_{BP} < 400$	$1,6 \cdot T_{BP}$	$T_{BP} < 400$	$2,0 \cdot T_{BP}$
$400 \leq T_{BP} \leq 1200$	$(T_{BP} / 1,25) + 320$	$400 \leq T_{BP} \leq 1200$	$T_{BP} + 400$
$T_{BP} > 1200$	$1,06 \cdot T_{BP}$	$T_{BP} > 1200$	$1,33 \cdot T_{BP}$

Table 7 : Calculation Load *(1/1/2025)*

Escort Tug			
“sheltered area” Navigation		Other Navigations	
$T_{H, MAX}$ [KN]	CL [kN]	$T_{H, MAX}$ [KN]	CL [kN]
$T_{H, MAX} < 400$	$1,92 \cdot T_{H, MAX}$	$T < 400$	$2,4 \cdot T_{H, MAX}$
$400 \leq T_{H, MAX} \leq 1200$	$(2,28 - (T_{H, MAX} / 1111)) \cdot T_{H, MAX}$	$400 \leq T \leq 1200$	$(2,85 - (T_{H, MAX} / 889)) \cdot T_{H, MAX}$
$T_{H, MAX} > 1200$	$1,2 \cdot T_{H, MAX}$	$T > 1200$	$1,5 \cdot T_{H, MAX}$

The stresses acting on each component of the winch calculated with the above loads are not to exceed the allowable stresses reported on Tab 8; it is to be noted that the stresses can be obtained by an engineering analysis or by a FEM calculation but they have always to be combined in Von Mises stresses before comparison with the allowable stresses.

Table 8 : Allowable stresses *(1/1/2025)*

Load	Allowable Stress
CL	$R_{eh}/1,56$
BL	$R_{eh}/1,25$
HIL	$R_{eh}/2,5$

When the stresses acting in the winch components are calculated by means of FEM calculations taking accurately into account the stress concentrations, the allowable stresses envisaged in Tab 8 may be multiplied by 1,1.

Specific buckling and/or fatigue analysis aimed to show the compliance of the winch components with the requirements of any recognized national or international standard may be requested by the Society on a case by case basis.

In all cases, it is to be checked that the thickness of the drum is not lower than that calculated according to the following formula:

$$t = \sqrt{t_f^2 + t_f \cdot t_c + t_c^2}$$

with:

$$t_f = \frac{1250 \cdot M}{d_m^2 \cdot \sigma_{allcb}}$$

$$t_c = \frac{500 \cdot F}{p \cdot \sigma_{allcc}}$$

where:

M [N·m] is the bending moment induced by the maximum load F, in kN, on the drum considered as a beam; the load F is to be taken as equal to the HIL, as above defined

d_m is the mean diameter of the drum (d_e - t), in millimeters

d_e is the nominal diameter of the drum and it corresponds to the external diameter in case of not grooved drums and to the diameter at the roots of the grooves in case of grooved drums

σ_{allcb} and σ_{allcc} are the combined allowable stresses for bending and compression, respectively.

The stresses σ_{allcb} and σ_{allcc} are to be taken as the lower value between fatigue allowable stress and general allowable stress, both to be evaluated as stated below.

For an actual number of cycles and for the type of material used, the fatigue basic stresses, in MPa, are to be taken as specified in Tab 9. The actual number of cycles is to be evaluated on the basis of the rotation speed of the drum (one cycle for each revolution), from the usage frequency and of the duration of life assigned to the winch.

Table 9 : Fatigue basic stresses *(1/1/2025)*

Type of Material	$2 \cdot 10^6$ Cycles	$5 \cdot 10^6$ Cycles	$1 \cdot 10^8$ Cycles
	σ_{b1} [MPa]	σ_{b2} [MPa]	σ_{b3} [MPa]
Malleable Cast Iron Spheroidal Cast Iron Carbon Steel (general)	125	92	50
Rolled Carbon Steel (basic ndt on weld seams)	125	92	50
Rolled Carbon Steel (100% ndt on weld seams)	150	110	60

The equivalent number of cycles N_e is obtained by multiplying the actual number of cycles by the spectrum factor Km that is to be calculated in compliance with § 2.1.3.3 of the FEM 1.001 (Sec 1, Booklet 2, 1998 Edition) or, conservatively, it can be taken equal to 1. According to the equivalent number of cycles N_e, the fatigue allowable stress can be obtained by means of the following expressions:

- if N_e is less than $5 \cdot 10^6$ cycles:

  $\sigma_{allf} = \sigma_{b1} \cdot (1 \cdot 10^6 / N_e)^{1/3}$
- if N_e is between $5 \cdot 10^6$ and $1 \cdot 10^8$ cycles:

  $\sigma_{allf} = \sigma_{b2} \cdot (5 \cdot 10^6 / N_e)^{1/5}$
- if N_e is equal to or greater than $1 \cdot 10^8$ cycles:

  σ_{b3}

The general allowable stress for bending σ_{allgb} is to be calculated as specified below:

- Malleable cast iron and spheroidal cast iron castings:
  $\sigma_{allgb} = 0,2 \cdot R_m$ if elongation A < 12 %
  $\sigma_{allgb} = 0,67 \cdot R_m$ if elongation A ≥ 12 %
- Grey cast iron castings:
  $\sigma_{allgb} = 0,185 \cdot R_m$
- Steel castings and rolled steel:
  $\sigma_{allgb} = 0,67 \cdot R_{eh}$

where R_m and R_{eh} are the ultimate tensile stress and the yield stress of the material, respectively.

The general allowable stress for compression σ_{allgc} is to be calculated as specified below:

- Malleable cast iron and spheroidal cast iron castings:
  $\sigma_{allgc} = 0,5 \cdot R_{eh}$ if elongation A ≥ 12 %
- Grey cast iron castings:
  $\sigma_{allgc} = 0,67 \cdot R_m$ if elongation A < 12 %
- Steel castings and rolled steel:
  $\sigma_{allgc} = 0,67 \cdot R_{eh}$

where R_m and R_{eh} are the ultimate tensile stress and the yield stress of the material, respectively.

When a manufacturer applies for the certification of a towing winch as an isolated machine not linked to any specific vessel, then its strength is to be checked in compliance with the above requirements together with a set of anticipated design assumptions on the following features:

a) service notation of the vessel (**tug**, **salvage tug** or **escort tug**)

b) navigation notation of the vessel (**sheltered area** or not)

c) value of T_{BP} or of $T_{H, MAX}$, as the case may be, depending on the choice about the service notation.

The above set of anticipated design assumptions is to be reported on the test certificate of the winch.

3.8.7 Towing Hook - Quick Release Device *(1/1/2025)*

The quick-release device is to be capable of being operated from a remote control device on the bridge, or as near as practicable, while the hook is under load. It is required that, in the case of a critical situation, the towline can be immediately released regardless of the angle of heel and the direction of the towline.

3.8.8 Towing Hook - Strenght *(1/1/2025)*

The strength of the towing hook (together with the attachment pieces/swivels) is to be such that, under a towline pull equal to DAF·SWL, the equivalent Von Mises stress does not exceed $R_{eh}/1,25$.

The value of the DAF can be obtained from Tab 10 or from Tab 11, as applicable.

Table 10 : DAF values *(1/1/2025)*

Tug and Salvage Tug			
“sheltered area” Navigation		Other Navigations	
SWL [KN]	DAF [-]	SWL [KN]	DAF [kN]
SWL < 400	1,6	SWL < 400	2,0
400 ≤ SWL ≤ 1000	((SWL / 1,25) + 320)/SWL	400 ≤ SWL ≤ 1200	((SWL / 1,25) + 400)/SWL
SWL > 1000	1,06	SWL > 1200	1,33

Table 11 : DAF values *(1/1/2025)*

Escort Tug			
“sheltered area” Navigation		Other Navigations	
SWL [KN]	DAF [kN]	SWL [KN]	DAF [kN]
SWL < 400	1,92	SWL < 400	2,4
400 ≤ SWL ≤ 1200	(2,28 - ($T_{H, MAX}$ / 1111))	400 ≤ SWL ≤ 1200	(2,85 - ($T_{H, MAX}$ / 889))
SWL > 1200	1,2	SWL > 1200	1,5

Specific fatigue analysis aimed to show the compliance of the hook components with the requirements of any recognized national or international standard may be requested by the Society on a case by case basis.

3.8.9 Towing Fittings *(1/1/2025)*

The strength of the fittings intended for guiding the towline to the towed vessel is to be such that:

a) if subject to the loads of a hook towage, the equivalent Von Mises stress in each component does not exceed $R_{eh}/1,25$ with respect to a towline pull equal to CL (see [3.8.~~5~~6] and Tab 6)

b) if subject to the loads of a winch towage, the equivalent Von Mises stress in each component does not exceed $R_{eh}/1,25$ with respect to a towline pull equal to BL (see [3.8.6] and Tab 7).

Examples of typical fittings intended for guiding the towline to the towed vessel are fairleads, staples, gob-eyes and towing pins.

When a manufacturer applies for the certification of a towing fitting designed for a specific Safe Working Load (SWL), then the strength of the fitting is to be such that, under a towline pull equal to DAF·SWL, the equivalent Von Mises stress does not exceed the following value:

$\sigma_{VM} \leq R_{eh}/1,25$

The value of the DAF can be obtained from Tab 10 or from Tab 11, as applicable.

When the stresses acting in the fitting components are calculated by means of a fine mesh FE model (where fine mesh model means a FE model whose elements have a size less than 4 times the relevant thickness), the above allowable stress is to be multiplied by 1,1.

Specific buckling and/or fatigue analysis aimed to show the compliance of the fittings components with the requirements of any recognized national or international standard may be requested by the Society on a case by case basis.

3.8.10 Supporting hull structures *(1/1/2025)*

The scantlings of supporting hull structures are to be such that:

a) if subject to the loads of a hook towage, they are in compliance with Pt B, Ch 7 or Pt B, Ch 8, with respect to a towline pull equal to CL

b) if subject to the loads of a winch towage, they are in compliance with Pt B, Ch 7 or Pt B, Ch 8, with respect to a towline pull equal to BL.

3.9 Equipment testing

3.9.1 General *(1/1/2025)*

a) All testing defined in [3.9] is to be witnessed by a Society surveyor

b) The towing hook is to be subjected to a static tensile test, where the testing force TF is to be equal to DAF·SWL, where the DAF is defined in Tab 10 or in Tab 11, as applicable

c) The quick-release device a towing hook is to be tested both at the hook SWL and hook testing force TF, defined above. The force necessary to open the hook under load is to be not greater than 150 N.

After installation on board, an unhooking trial under load is to be carried out by means of the above remote control device. This trial may be performed with a test load less than the hook SWL.

d) The towing winch is to be subjected to a static tensile test, where the testing force TF is to be equal to CL, where CL is defined in Tab 6 or in Tab 7, as applicable.

e) For each emergency release system or type thereof, the performance requirements in [3.8.5] a) are to be verified either at the manufacturer's works or as part of the commissioning of the towing winch when it is installed on board. Where verification solely through testing is impracticable (e.g. due to health and safety), testing may be combined with inspection, analysis or demonstration in agreement with the Society.

f) The performance capabilities, as well as instructions for operation, instructions of the emergency release system are to be documented by the manufacturer and made available on board the ship on which the winch has been installed.

g) Instructions for surveys of the emergency release system are to be documented by the manufacturer, agreed by the Society and made available on board the ship on which the winch has been installed.

h) Where necessary for conducting the annual and special surveys of the winch, adequately sized strong points are to be provided on deck.

3.9.2 Installation trials *(1/1/2025)*

a) The full functionality of the emergency release system is to be tested as part of the shipboard commissioning trials to the satisfaction of the surveyor. Testing may be conducted either during a bollard pull test or by applying the towline load against a strong point on the deck of the tug that is certified to the appropriate load.

b) Where the performance of the winch in accordance with [3.8.5] a) has previously been verified, the load applied for the installation trials is to be at least the lesser of 30% of the maximum design load (see [2.3.7]) or 80% of vessel bollard pull.

3.10 Tug testing

3.10.1 **Bollard pull test** *(1/7/2012)*

At the request of the interested parties, tugs may be subjected to a bollard pull test. The value of the bollard pull is indicated in a statement to be kept on board together with the ship documents.

The bollard pull test is to be carried out in the presence of a Surveyor of the Society according to the Rules for the certification of the bollard pull of tugs.

In the case of sister ships, the Society may assign the bollard pull on the basis of the results obtained from the tests carried out on the prototype ship.

3.11 Additional arrangements and equipment for tugs with additional service feature "rescue"

3.11.1 *(1/7/2004)*

Tugs with additional service feature "rescue" are to be provided with at least the arrangements and equipment indicated in [3.11.2].

3.11.2 *(1/1/2017)*

a) a "RESCUE ZONE" area on each side of the ship's main deck where the relevant bulwark is lower than in the other part of the ship or provided with a gate in order to facilitate the embarkation of the shipwrecked persons. This zone is to be clearly identified by such wording written in at least 500 mm high/200 mm wide letters and side strips made in high intensity photo luminescent material

b) nets or other equipment to facilitate the recovery of shipwrecked persons from the sea

c) blankets (at least one for each person forming the maximum capacity of shipwrecked persons for which the ship is designed)

d) cabins and beds in addition to those provided on board for the normal complement of crew (beds for at least 30% of the maximum capacity of shipwrecked persons for which the ship is designed)

e) bathrooms and showers in addition to those provided on board for the normal complement of crew (bathrooms and showers for at least 1/6 of the maximum capacity of shipwrecked persons for which the ship is designed)

f) sitting places (chairs, sofas and armchairs) in addition to those provided on board for the normal complement of crew (for 70% of the maximum capacity of shipwrecked persons for which the ship is designed)

g) facilities and provisions for shipwrecked persons in addition to those necessary for the normal complement of crew (food rations for at least 300% of the maximum capacity of shipwrecked persons for which the ship is designed)

h) first aid kits and medicines (for at least 100% of the maximum capacity of shipwrecked persons for which the ship is designed)

i) a sick bay.

3.11.3 *(1/7/2010)*

Relaxation from the requirements of [3.11.2] may be granted by the Society case-by-case on the basis of the ship operational area.

3.11.4 *(1/7/2010)*

The maximum number of shipwrecked persons for which the ship is designed as well as the ship operational area, where [3.11.3] applies, are recorded in the Certificate of Classification of the ship.

The relevant arrangements and equipment are recorded in the ship's status.

3.11.5 *(1/1/2021)*

An addendum to the trim and stability booklet is to be issued and submitted to the Society for approval. Such an addendum shall include:

a) loading conditions pertaining to the maximum capacity of shipwrecked persons; and

b) for each of the above loading conditions, checking of the criteria in Pt B, Ch 3, Sec 2, [2] and [3] (i.e. including weather criterion) and Ch 11, Sec 3, [1.1.3] and [1.1.4]. Such criteria are to be applied for any ship operational area.

3.12 Additional arrangements and equipment for tugs with additional service feature "standby vessel"

3.12.1 *(1/7/2016)*

Tugs with additional service feature "**standby vessel**" are to be provided with at least the arrangements and equipment indicated in [3.12.2].

3.12.2 *(1/7/2016)*

a) Rescue area

Ships with additional service feature **standby vessel** are to be provided, on each side, with a clearly marked rescue area having length not less than 8 m.

The rescue area is to comply with the following requirements:

- The ship's side in way of the rescue zone is to be free of any obstacle
- The ship's deck in way of the rescue area is to be so arranged as to protect personnel against injury
- The area is to be adequately fitted far from propellers and any ship side discharges up to 2 m below the waterline
- Each rescue area is to be provided with a scrambling net made of corrosion resistant and non-slip material

b) Rescue area lighting

Satisfactory lighting is to be provided along the rescue area.

A searchlight, able to provide an illumination level of 50 lux at a distance of 250 m, is to be available on each side and operated from the navigation bridge.

4 Additional requirements for salvage tugs

4.1 General

4.1.1 Application

The requirements of this Article apply to ships with the service notation **salvage tug** and specify the criteria these ships are to satisfy in addition to those in [3].

4.2 Equipment

4.2.1 Additional equipment

Ships with the service notation **salvage tug** are to be fitted with the additional equipment specified in Tab 12 in addition to that specified in Tab 3.

5 Additional requirements for escort tugs

5.1 General

5.1.1 Application

The requirements of this Article apply to ships with the service notation **escort tug** and specify the criteria these tugs are to satisfy in addition to those in [3].

Table 12 : Additional equipment for salvage tugs

Arrangement or equipment	Number of items
Fixed or movable drainage pumps having approximately the same capacity **(1) (2) (3)**	2 or more pumps of total capacity ≥ 400 m^3/h
Fire pumps each capable of throwing two simultaneous jets of water having a horizontal reach not less than 30 m **(4)**	2 pumps, each having a capacity ≥ 60 m^3/h
Breathing apparatuses for divers	2
Gas masks with filter	2
Cargo boom	1, with service load ≥ 1 t
Power operated winch capable of producing an adequate pull	1
Water stops to stop leaks of approximately 1 x 2 m	4
Complete set of equipment for flame cutting with at least 25 metres of flexible piping	1
Drain hoses	at least 20 m per pump
Fire hoses	10
Connections for fire main	at least 3
Power operated diver's compressor, with associated equipment **(5)**	1
Additional towline equipment, at least equal to that required for tugs in Tab 3	1
Lamps for underwater operation	2
Floodlight of power ≥ 500 W	1
Working lamps	2
Winding drums with wire ropes	see **(6)**
Electrical cables, each not less than 100 metres long and capable of supplying at least 50 kW	3
Tackles with lifting capacity of 1 t	2
Tackles with lifting capacity of 3 t	2
Radar with a range not less than 24 nautical miles	1
Echo-sounding device with a range of 100 m	1
Hydraulic jackets with lifting capacity of 10 t	2
Hydraulic jackets with lifting capacity of 20 t	2
Portable electrical drill with a set of twist bits having diameters up to 20 mm	1

(1) For each pump fitted on board, a suction strainer and, in the case of non self-priming pumps, a foot valve, are also to be provided.

(2) Where portable pumps are used, they are to be capable of effectively operating even with transverse and longitudinal inclinations up to 20°.

(3) These pumps are additional to the drain pumps intended for the drainage service of the ship.

(4) These pumps may be the same required for drainage purposes provided they have an adequate head.

(5) As an alternative, a compressor for recharging the oxygen tanks of divers may be provided together with two complete sets of equipment for divers.

(6) Winding drums fitted on board are to be capable of housing wire ropes of suitable size and length not normally less than 350 m.

5.1.2 Documents to be submitted *(1/1/2025)*

In addition to the documents defined in Pt B, Ch 1, Sec 3, the following plans are to be submitted to the Society for information:

- towing arrangement plan, including the components making up the towline with the relevant minimum breaking loads
- the list of the rated steady towline forces $T_{H,R}$ and the rated steering forces $T_{Y,R}$ (see [2.3.3])
- preliminary stability calculation.

5.1.3 Propulsion forces *(1/7/2005)*

The hydrodynamic forces acting on the tug, the towline pull and the tug propulsion force are to be so designed that these forces are in equilibrium.

However, the engine is to ensure a sufficient thrust for manoeuvring the tug quickly for any angular position β, where β is defined in Fig 2.

5.1.4 Loss of propulsion

In the case of propulsion loss, the heeling moment due to the remaining forces is to lead to a safe equilibrium position of the tug with reduced heel.

5.2 Stability

5.2.1 Intact stability *(1/7/2005)*

A stability analysis of the tug is to be carried out taking into account the heeling moment caused by the forces acting on the tug, as shown in Fig 4.

The stability analysis is to consider:

- all potential attitudes of the escort tug relative to the direction of line pull,
- the maximum line pull,
- the resultant combination of heel and trim on the escort tug.

The stability analysis is to include the effects of fenders, skegs, and other appendages on both the reserve buoyancy and the lateral resistance of the escort tug:

The two following intact stability criteria are to be complied with:

$A \geq 1{,}25\ B$

$C \geq 1{,}4\ D$

where:

A : Righting lever curve area, in m·rad, measured from the heeling angle θ_C to a heeling angle of 20° (see Fig 5)

B : Heeling arm curve area, in m·rad, measured from the heeling angle θ_C to a heeling angle of 20° (see Fig 5)

C : Righting lever curve area, in m·rad, measured from the angle 0° heel to the heeling angle θ_D (see Fig 6)

D : Heeling arm curve area, in m·rad, measured from the angle 0° heel to the heeling angle θ_D (see Fig 6)

θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms, to be obtained when the maximum steering force $T_{Y,MAX}$, defined in [2.3.4], is applied from the tug

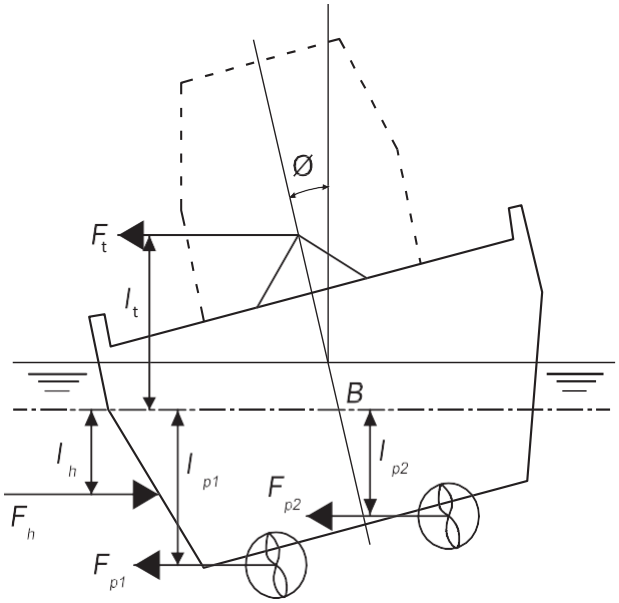
θ_D : Heeling angle, to be taken as the lesser of:

- the angle of downflooding
- 40°.

The heeling arm curve is to be obtained from the full scale tests (see [5.5]), for the maximum steering force T_Y.

Moreover, the heeling arm is to be assumed constant from the angle of equilibrium θ_C to an angle equal to 20°.

Figure 4 : Dynamic stability components *(1/7/2005)*



F_t = Towline pull force, in t

F_{p1}, F_{p2} = Propulsion thrust forces, in t

F_h = Hull and appendage force, in t

l_t = Towline pull force arm, in m

l_{p1}, l_{p2} = Propulsion thrust forces arms, in m

l_h = Hull and appendage force arm, in m

Figure 5 : Definition of the areas A and B

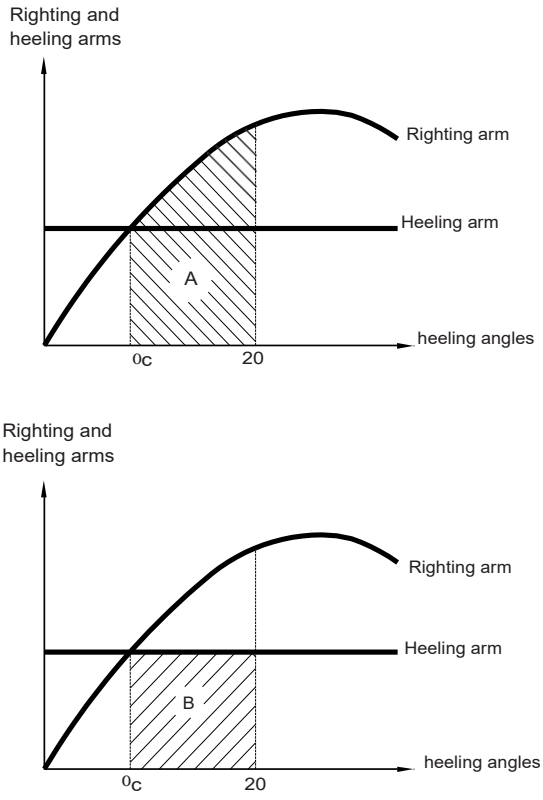
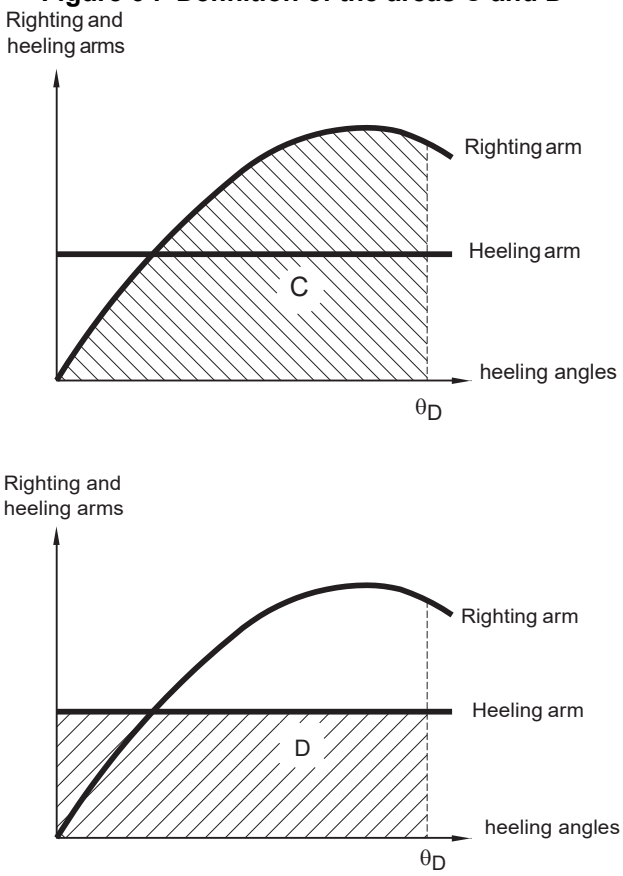


Figure 6 : Definition of the areas C and D



5.3 Structural design principles

5.3.1 Hull shape

The hull shape is to be such as to provide adequate hydrodynamic lift and drag forces and to avoid excessive trim angles for large heeling angles.

5.3.2 Bulwark

A bulwark is to be fitted all around the weather deck.

5.4 Towing Equipment

5.4.1 Towline breaking stength *(1/1/2026)*

The towline breaking strength, in KN, is to be not less than 2,2 times the value of the design maximum steady towline force $T_{H,MAX}$, as defined in [2.3.4].

5.4.2 Towing winches *(1/1/2025)*

The escort winch is to be fitted with a system suitable to reduce the load in order to avoid overload due to dynamic oscillations of the towline. It is to be able to release the towline when the pull is greater than 50% of the towline breaking load.

Escort operations in conditions where dynamic oscillations of the towline are likely to occur may not be based on use of the brakes of the winch drum.

Escort operations performed by escort tugs in calm water conditions, such as in ports and sheltered (confined) waters, may be based on the use of the brakes of the winch drum.

The escort winch is to be fitted with equipment to continuously measure the tension in the towline. The measured data are to be displayed in the wheelhouse next to the control desk or another appropriate location.

As a minimum, the winch brake holding load is to be equal to or greater than 1,25·CL, where CL is to be calculated in compliance with Tab 7.

5.5 Full-scale or model-scale tests

5.5.1 Testing *(1/1/2025)*

The following requirements apply to full scale or model scale tests to be carried out in order to obtain the values of the main characteristics of the tug defined in [2.3].

5.5.2 Documentation to be submitted prior to testing *(1/1/2025)*

The following documentation is to be submitted to the Society for approval prior to testing:

- test speed of the tug; the speed is to be intended as relative speed with respect to the sea motions, therefore the effects of any possible current are to be taken into account
- main propulsion characteristics (power, maximum orientation angle of the rudder)
- preliminary calculation of the rated steady towline force $T_{H,\ R}$ and the rated steering force $T_{Y,R}$ at the test speed
- calculation of the route deviation of the escorted ship (for the tests, the escorted ship is to be selected so that the route deviation induced by the tug is not too large)
- preliminary stability calculation in the above conditions
- towing arrangement plan, including the load cell and the specification of the breaking loads of the towline components
- documentation relevant to the bollard pull test (see [3.10.1]).

5.5.3 Data to be collected during tests *(1/1/2025)*

During the tests, all data needed to define the characteristics of the tug are to be collected, e.g. the relative position ship-tug, their heading and speed, the towline length, the towline angle α (see Fig 2), the maximum steady towline force $T_{H,\ MAX}$, the ship rudder position, the heeling angle of the tug and any other parameter used in the preliminary calculation.

5.6 Alternative to full-scale tests or to model scale tests

5.6.1 *(1/1/2025)*

The steady towline force T_H and the steering force T_Y that the tug applies on the assisted ship is to be evaluated by a computer model programme that considers a quasi-steady solution, in which the horizontal forces and moments are balanced. The programme is also to consider the hydrodynamic forces on the escort tug's hull and underwater appendages, the forces acting on the rudder and the thrusts of the propellers.

5.7 Inclinometer

5.7.1 *(1/1/2021)*

Escort tugs are to be equipped with a calibrated heeling angle measurement system (inclinometer). The measured heeling angle is to be displayed in the wheelhouse next to the control desk or another appropriate location.

SECTION 3 INTEGRATED TUG/BARGE COMBINATION

Symbols

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

R_{eH} : Yield stress, in N/mm^2, of the steel used, and not exceeding the lower of 0,7 R_m and 450 N/mm^2

R_m : Minimum ultimate tensile stress, in N/mm^2, of the steel used.

1 General

1.1 Application

1.1.1 General

The requirements of this Section apply to the integrated tug/barge combinations constituted by:

- a tug, to which the additional service feature **barge combined** is assigned
- a barge, to which the additional service feature **tug combined** is assigned

and specify the criteria these combinations are to satisfy in addition to those in:

- Sec 2, [3], for the tug
- Ch 19, Sec 2, for the barge.

1.1.2 When a series of barges may be operated in combination with a specific tug, the identification numbers of such barges are to be indicated in the tug class certificate.

1.1.3 When a series of tugs may be operated in combination with a specific barge, the identification numbers of such tugs are to be indicated in the barge Certificate of Classification.

1.2 Permanent connections

1.2.1 An integrated tug/barge combination is connected with permanent connection if the tug and the barge cannot be disconnected in open sea. The connection is such that no relative motion between the tug and the barge is permitted.

1.3 Removable connections

1.3.1 General

An integrated tug/barge combination is connected with removable connection if the tug and the barge can be disconnected in open sea. The disconnecting procedure is to be performed safely by one man and is to take less than 5 min. After disconnection in open sea, the tug is to be arranged to tow the barge by hawser.

The procedure for disconnecting and reconnecting at sea the integrated tug/barge combination is to be made available for guidance to the Master.

1.3.2 Types of removable connections

The removable connection is classed in the two following types:

- rigid connection, if no relative motion between the tug and the barge is permitted
- flexible connection, if relative motion between the tug and the barge is permitted (e.g. the tug is free to pitch with respect to the barge).

1.3.3 Tug

The tug is to have the capability of separating from the barge and shifting to tow it by hawser.

2 General arrangement design

2.1 Bulkhead arrangement

2.1.1 Number and disposition of tug transverse watertight bulkheads

The tug is to be fitted with transverse watertight bulkheads according to Pt B, Ch 2, Sec 1.

2.1.2 Number and disposition of barge transverse watertight bulkheads

In applying the criteria in Pt B, Ch 2, Sec 1, [3], the barge is to be fitted at least with an aftermost transverse watertight bulkhead located forward of the connection area and extended from side to side.

The cargo spaces are to be separated from the other spaces not used for cargo by watertight bulkheads.

2.1.3 Barge collision bulkhead

The collision bulkhead of the barge is to be located at a distance, in m, from the fore end of L of not less than 0,05 L_{LLC} or 10 m, whichever is the lesser, and not more than 0,08 L_{LLB}, where:

L_{LLC} : Ship's length, in m, measured between the aft and fore ends of L of the integrated tug/barge combination, taken at the fore and aft ends of the freeboard length

L_{LLB} : Ship's length, in m, measured between the aft and fore ends of L of the barge considered as an individual ship, taken at the fore and aft ends of the freeboard length.

3 Integrated tug/barge combinations with permanent connection: stability, freeboard, design loads, hull scantlings and equipment

3.1 Stability calculations

3.1.1 The integrated tug/barge combination is to comply with the applicable intact and damage stability requirements in Part B, Chapter 3 considering the integrated tug/barge combination as a ship of the size of the combination.

3.2 Freeboard calculation

3.2.1 The freeboard is to be taken as the greatest of:

- the freeboard of the tug, considered as an individual ship
- the freeboard of the barge, considered as an individual ship
- the freeboard of the integrated tug/barge combination, considered as a ship of the size of the combination. For the freeboard calculation the barge is to be considered as being manned.

3.3 Still water hull girder loads

3.3.1 The still water hull girder loads and the forces transmitted through the connection are to be calculated for each loading condition considering the integrated tug/barge combination as a ship of the size of the combination.

3.4 Wave hull girder loads

3.4.1 The wave hull girder loads and the forces transmitted through the connection are to be calculated according to Pt B, Ch 5, Sec 2 considering the integrated tug/barge combination as a ship of the size of the combination.

3.4.2 Direct calculation

When deemed necessary by the Society, the wave hull girder loads and the forces transmitted through the connection are to be obtained from a complete analysis of the integrated tug/barge combination motion and acceleration in irregular waves, unless such data are available from similar ships.

These loads are to be obtained as the most probable the integrated tug/barge combination, considered as a ship of the size of the combination, may experience during its operating life for a probability level of 10^{-8}. For this calculation, the wave statistics relevant to the area of navigation and/or worst weather condition expressed by the navigation notation assigned to the integrated tug/barge combination are to be taken into account. For unrestricted navigation, the wave statistics relevant to the North Atlantic are to be taken into account.

When the difference between the tug and the barge depths is not considered negligible by the Society, its effects are to be considered in evaluating the buoyancy force distributions and the corresponding hull girder loads on the tug structures immediately aft of the connection section, for the different wave encountering conditions.

3.5 Still water local loads

3.5.1 The still water local loads are to be calculated according to Pt B, Ch 5, Sec 5 for each loading condition and draught of the integrated tug/barge combination. The draught of the integrated tug/barge combination is to be taken not less than 0,85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

3.6 Wave local loads

3.6.1 The wave local loads are to be calculated according to Pt B, Ch 5, Sec 5, [2] considering the integrated tug/barge combination as a ship of the size of the combination. The draught of the integrated tug/barge combination is to be taken not less than 0,85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

3.7 Hull girder strength

3.7.1 Strength check

The longitudinal strength is to comply with Part B, Chapter 6, where the hull girder loads are those defined in [3.3] and [3.4].

3.7.2 Loading manual

The loading manual is to include the (cargo and ballast) loading conditions of the integrated tug/barge combination at sea and in port conditions on the basis of which the approval of its hull structural scantlings is based.

The manual is to indicate the still water bending moment and shear force along the length of the integrated tug/barge combination as well as the permissible values at each hull section.

Information on loading and unloading sequences is to be provided for guidance to the Master.

3.8 Scantlings of plating, ordinary stiffeners and primary supporting members

3.8.1 The net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with Part B, Chapter 7 or Part B, Chapter 8, where the hull girder and local loads are those defined in [3.3] to [3.6].

In any case, the net scantlings of plating, ordinary stiffeners and primary supporting members of the tug and the barge are to be not less than those obtained according to Sec 2 and Ch 19, Sec 2 for the tug alone and the barge alone, respectively.

3.9 Equipment

3.9.1 The equipment is to be in accordance with the requirements in both

- Sec 2, for the tug, and
- Ch 19, Sec 2, for the barge, considering the barge as a ship of the size of the integrated tug/barge combination.

4 Integrated tug/barge combination with removable connection: stability, freeboard, design loads, hull scantlings and equipment

4.1 Stability calculations

4.1.1 The integrated tug/barge combination is to comply with the applicable intact stability requirement in Part B, Chapter 3, considering the integrated tug/barge combination as a ship of the size of the combination.

4.2 Freeboard calculation

4.2.1 The freeboard is to be calculated for the tug and the barge considered as individual ships.

4.3 Still water hull girder loads

4.3.1 General

The still water hull girder loads and the forces transmitted through the connection are to be calculated for each loading condition considering the integrated tug/barge combination as a ship of the size of the combination.

4.3.2 Integrated tug/barge combination with removable flexible connection

For integrated tug/barge combinations with removable flexible connection, the effect of the degrees of freedom of the connection on the still water hull girder loads in the combination may be taken into account (e.g. free pitch of the tug with respect to the barge implies vertical bending moment equal to zero in the connection).

4.4 Wave hull girder loads

4.4.1 The wave hull girder loads and the forces transmitted through the connection are to be calculated according to [3.4].

4.4.2 Integrated tug/barge combination with removable flexible connection

For integrated tug/barge combinations with removable flexible connection, the effect of the degrees of freedom of the connection on the wave hull girder loads in the combination may be taken into account (e.g. free pitch of the tug with respect to the barge implies vertical bending moment equal to zero in the connection).

4.5 Still water local loads

4.5.1 The still water local loads are to be calculated according to Pt B, Ch 5, Sec 5 for each loading condition and draught of the integrated tug/barge combination. The draught of the integrated tug/barge combination is to be taken not less than 0,85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

4.6 Wave local loads

4.6.1 The wave local loads are to be calculated according to Pt B, Ch 5, Sec 5, [2] considering the integrated tug/barge combination as a ship of the size of the combination. The draught of the integrated tug/barge combination is to be taken not less than 0,85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

4.7 Hull girder strength

4.7.1 The longitudinal strength is to comply with Part B, Chapter 6, where the hull girder loads are those defined in [4.3] and [4.4].

4.7.2 Loading manual

The loading manual is to include the items specified in [3.7.2].

4.8 Scantlings of plating, ordinary stiffeners and primary supporting members

4.8.1 Integrated tug/barge combinations with removable rigid connection

For integrated tug/barge combinations with removable rigid connection, the net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with Part B, Chapter 7 or Part B, Chapter 8, where the hull girder and local loads are those defined in [4.3] to [4.6].

In any case, the net scantlings of plating, ordinary stiffeners and primary supporting members of the tug and the barge are to be not less than those obtained according to Sec 2 and Ch 19, Sec 2 for the tug alone and the barge alone, respectively.

4.8.2 Integrated tug/barge combinations with removable flexible connection

For integrated tug/barge combinations with removable flexible connection, the net scantlings of plating, ordinary stiffeners and primary supporting members of the tug and the barge are to be not less than those obtained according to Sec 2 and Ch 19, Sec 2 for the tug alone and the barge alone, respectively.

4.9 Equipment

4.9.1 The equipment is to be in accordance with [3.9.1].

5 Connection

5.1 General

5.1.1 The components of the connecting/disconnecting system are to be fitted on the tug.

Where the connecting system is located on a tug superstructure, this is to be checked according to Pt B, Ch 9, Sec 4. The efficiency of the structural connection between this superstructure and the underlying hull structures is to be ensured.

5.1.2 The connecting system is to comply with the following requirements:

- it is to be permanently locked in position, at sea, with remote indication and control on the bridge
- it is to remain locked in the event of damage to the control system. A local control is to be provided for enabling the disconnection from the coupler machinery room.

5.2 Scantlings

5.2.1 General

The bow of the tug and the stern of the barge are to be reinforced in order to withstand the connection forces.

The structure reinforcements are to be continued in aft and fore directions of the integrated tug/barge combination in order to transmit the connection forces to the hull structure of the tug and the barge.

5.2.2 Calculation of stresses in the connection

The stresses in the connection are to be obtained by means of direct calculations, where the connection forces are to be obtained according to [3.3] and [3.4] or [4.3] and [4.4], as applicable, and the partial safety factors specified in Tab 1 are to be applied.

When calculating the stresses in the connection, pre-loading from locking devices, if any, is to be taken into account.

For notch type connections, the analysis of the barge wing walls is to take into account the effects of bending moment, shear force and torque.

Table 1 : Partial safety factors

Partial safety factors covering uncertainties regarding	Symbol	Partial safety factor value
Still water hull girder loads	γ_{S1}	1,00
Wave hull girder loads	γ_{W1}	1,15
Still water pressure	γ_{S2}	1,00
Wave pressure	γ_{W2}	1,20
Material	γ_m	1,02
Resistance	γ_R	1,02

5.2.3 Shear check of the structural elements of the connection

The shear stresses in the structural elements of the connection are to comply with the following formulae:

$$\tau_E \leq \tau_{ALL}$$

$$\tau \leq 0,5 \frac{R_Y}{\gamma_R \gamma_m}$$

where:

τ : Shear stress, in N/mm^2, to be obtained as a result of direct calculations

τ_{ALL} : Allowable shear stress, in N/mm^2, to be taken equal to:

- $\tau_{ALL} = 0,5 \frac{R_Y}{\gamma_R \gamma_m}$ for structural steel plates
- $\tau_{ALL} = \frac{75}{\gamma_R \gamma_m k_1}$ for castings and forgings

γ_R : Resistance partial safety factor, defined in Tab 1

γ_m : Material partial safety factor, defined in Tab 1

k_1 : Material factor for castings and forgings, to be taken equal to:

$$k_1 = \left(\frac{235}{R_{eH}}\right)^{0,75}$$

5.2.4 Yielding check of the structural elements of the connection

The Von Mises equivalent stresses in the structural elements of the connection are to comply with the following formula:

$\sigma_E \leq \sigma_{ALL}$

where:

σ_E : Von Mises equivalent stress, in N/mm^2, to be obtained as a result of direct calculations

σ_{ALL} : Allowable stress, in N/mm^2, to be taken equal to:

- $\sigma_{ALL} = \frac{R_Y}{\gamma_R \gamma_m}$ for structural steel plates
- $\sigma_{ALL} = \frac{150}{\gamma_R \gamma_m k_1}$ for castings and forgings

γ_R : Resistance partial safety factor, defined in Tab 1

γ_m : Material partial safety factor, defined in Tab 1

k_1 : Material factor for castings and forgings, defined in [5.2.3].

5.2.5 Deflections

Deflections of the structural elements in the connection are to be obtained from direct calculations, to be carried out in accordance with [5.2.2] and submitted to the Society for review.

Deflection and pre-loading of the connection, if any, are to be considered in order to avoid hammering in the connection area.

6 Other structures

6.1 Tug fore part

6.1.1 General

For integrated tug/barge combinations with permanent connection or removable rigid connection, the tug fore structure is to be aligned with the barge aft structure in way of the notch or the dock bottom.

6.1.2 Scantlings

The net scantlings of the fore part of the tug are to be in accordance with Part B, Chapter 7, considering the hull girder loads, the local loads and the connection forces defined in [3.3] to [3.6] for integrated tug/barge combinations with permanent connection or [4.3] to [4.6] for integrated tug/barge combinations with removable connection.

6.2 Tug aft part

6.2.1 Scantlings for integrated tug/barge combinations with permanent or removable rigid connections

The net scantlings of the aft part of the tug are to be in accordance with Pt B, Ch 9, Sec 2 considering this part as belonging to a ship of the size of the integrated tug/barge combination.

6.2.2 Scantlings for integrated tug/barge combinations with removable flexible connections

The net scantlings of the aft part of the tug are to be in accordance with Pt B, Ch 9, Sec 2 considering the tug as an individual ship.

6.3 Barge fore part

6.3.1 Scantlings for integrated tug/barge combinations with permanent or removable rigid connections

The net scantlings of the fore part of the barge are to be in accordance with Pt B, Ch 9, Sec 1 considering this part as belonging to a ship of the size of the integrated tug/barge combination.

6.3.2 Scantlings for integrated tug/barge combinations with removable flexible connections

The net scantlings of the fore part of the barge are to be in accordance with Pt B, Ch 9, Sec 1 considering the barge as an individual ship.

6.4 Barge aft part

6.4.1 General

For integrated tug/barge combinations with permanent connection or removable rigid connection, the barge aft structure is to be aligned with the tug fore structure in way of the notch or the dock bottom.

6.4.2 Scantlings

The net scantlings of the aft part of the barge are to be in accordance with Part B, Chapter 7, considering the hull girder loads, the local loads and the connection forces defined in [3.3] to [3.6] for integrated tug/barge combinations with permanent connection or [4.3] to [4.6] for integrated tug/barge combinations with removable connection.

7 Hull outfitting

7.1 Rudder and steering gear

7.1.1 The tug rudder and steering gear are to be in accordance with Pt B, Ch 10, Sec 1 and Pt C, Ch 1, Sec 11, respectively, considering the maximum service speed (in ahead and astern condition) of the tug as an individual ship and the maximum service speed (in ahead and astern condition) of the integrated tug/barge combination.

The characteristics and performance of the rudder and the steering gear are to ensure the manoeuvrability of the integrated tug/barge combination.

8 Construction and testing

8.1 Test of the disconnection procedure of removable connection

8.1.1 Tests are to be carried out in order to demonstrate the capability of the tug to be safely disconnected from the barge within 5 min by one man.

These tests may be performed in harbour. However, additional information is to be submitted to the Society in order to demonstrate the capability of the tug and the barge of being safely disconnected and reconnected at sea. The operating procedure, indicating the maximum or pre-fixed sea states, is to be made available for guidance to the Master, as indicated in [1.3.1].

Chapter 15
SUPPLY VESSELS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **supply vessel**, as defined in Pt A, Ch 1, Sec 2, [4.8.3].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to supply vessels.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to supply vessels.

Table 1 *(1/1/2007)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and cargo system	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for supply vessels are given in this Chapter.	

SECTION 2 HULL AND STABILITY

Symbols

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3],

s : Length, in m, of the shorter side of the plate panel.

α : Working fleet angle, in degrees, between the anchor handling wire rope in way of the last connection with the ship and a vertical axis, measured on the vertical plane π on which the anchor handling line lies (see Fig 1),

β : Working fleet angle, in degrees, measured horizontally between the vertical plane π on which the anchor handling line lies and the longitudinal vertical plane in way of the last connection with the ship (see Fig 1),

F_{AH} : Maximum allowed tension, in kN, in the steel wire rope used for anchor handling operation.

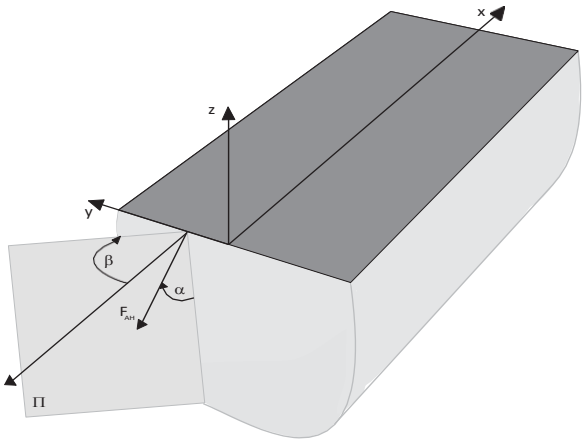
1 General

1.1 Definitions

1.1.1 Supply vessels

Supply vessels are, in general, single deck ships arranged with superstructures forward and a broad open deck aft intended for cargo.

Figure 1 *(1/7/2011)*



1.1.2 Additional service feature “oil product”

The additional service notation of supply vessels designed to carry oil products having any flashpoint in dedicated tanks is to be completed by the additional service feature **oil product**.

1.1.3 Additional service feature “chemical product”

The additional service notation of supply vessels designed to carry noxious products is to be completed by the additional service feature **chemical product**.

The products which may be carried are:

- hazardous and noxious liquids listed in Tab 1 and those other products which may be assigned to this list
- flammable liquid.

1.1.4 Additional service feature standby vessel *(1/7/2003)*

The additional service notation of supply vessels designed to provide rescue and standby services to offshore installations is to be completed by the additional service feature **standby vessel**.

1.1.5 Additional service feature "rescue" *(1/7/2004)*

The additional service notation of supply vessels is completed by the additional service feature **rescue** when they are specially equipped for the rescue of shipwrecked persons and for their accommodation.

1.1.6 Additional service feature "anchor handling" *(1/1/2026)*

The additional service notation of supply vessels is completed by the additional service feature **anchor handling** when they have visibility from the bridge and equipment specially designed for anchor handling operation which comply with the requirements in [8.3].

For the purposes of the anchor handling equipment verifications, the following definitions apply:

a) Anchor handling winch: any winch for the purpose of deploying, recovering and repositioning anchors and mooring lines in subsea operations.

b) Guide pin: deck supports, generally retractable, used to keep the anchoring line within a limited region of the working deck.

c) Stopper: device used for securing and holding a section of line, thereby relieving the load on the winch drum.

d) Roller: rollers, fairleads or other equipment used at the line exit from the vessel to support the line during lifting or lowering in order to avoid chafing and excessive bending and arranged to ease also the launch and recovery of rig anchors.

e) Haul in Load (HIL): force equal to the max active pulling capacity of the drum on the rope at the first layer.

f) Brake Load (BL): force equal to the max retaining capacity of the brake before slippage with the rope at the first layer.

g) Rendering Load (RL): force equal to the rope tension when drum starts to rotate in the opposite direction of the applied driving torque.

h) Safe working load (SWL): max static force which a shipboard fitting has been designed for. The SWL shall be declared the fitting manufacturer, and it is to be clearly marked on the fitting itself.

1.1.7 Additional service feature "anchor handling stab" *(1/1/2026)*

The additional service notation of supply vessels is completed by the additional service feature **anchor handling stab** when they comply with the requirements for the assignment of the additional service feature anchor handling and, in addition, fulfil specific stability requirements related to this service.

1.1.8 Additional service feature "heavycargo (X kN/m^2)" *(1/7/2022)*

The additional service notation of supply vessels is completed by the additional service feature **heavycargo (X kN/m^2)** when the weather deck intended to support heavy cargoes fulfills the appropriate structural rule requirements. The value X indicates the maximum allowable local pressure in kN/m^2, which is to be greater than 10 kN/m^2. The requirements for the assignment of this additional service feature are given in Pt B, Ch 5, Sec 6, [4.1.1] and Part B, Chapter 7 or Part B, Chapter 8, as applicable.

1.1.9 Additional service feature "heavyliquid (X t/m^3)" *(1/7/2022)*

The additional service notation of supply vessels is completed by the additional service feature **heavyliquid (X t/m^3)** when the ship is designed with specified cargo tanks strengthened to carry heavy liquids (i.e liquids having density greater than the one of the sea water) that fulfill the appropriate structural rule requirements. The value X indicates the maximum density in t/m^3 of the liquids that can be carried in the specified tanks 98% full. The requirements for the assignment of this additional service feature are given in Part B, Chapter 5 and Part B, Chapter 7 or Part B, Chapter 8, as applicable.

1.1.10 Additional service feature "Crew Transfer Vessel - CTV" *(1/7/2022)*

The additional service notation of supply vessels is completed by the additional service feature **Crew Transfer Vessel - CTV** when they are specially intended to transport technician and other personnel out to sites.

1.1.11 Additional service feature "Dive Support Vessel - DSV" *(1/7/2022)*

The additional service notation of supply vessels is completed by the additional service feature **Dive Support Vessel - DSV** when they are specially intended to support the offshore diving operation.

1.1.12 Additional service feature "Patrol and Guard Vessel" *(1/7/2022)*

The additional service notation of supply vessels is completed by the additional service feature **Patrol and Guard Vessel** when they are specially intended to patrol a coastal area or site for security, observation and defense.

1.1.13 Additional service feature "Seismic and Geotechnical Survey Vessel - SGSV" *(1/7/2022)*

The additional service notation of supply vessels is completed by the additional service feature **Seismic and Geotechnical Survey Vessel - SGSV** when they are specially intended for the purpose of research, seismic survey and mapping at seas.

1.1.14 Additional service feature "Windfarm Service Vessel - WSV" *(1/7/2022)*

The additional service notation of supply vessels is completed by the additional service feature **Windfarm Service Vessel - WSV** when they are specially intended to transport technician and other personnel to offshore wind farm and to support operations of wind farm maintenance and survey.

1.1.15 Integral tank

Integral tank means a cargo containment envelope which forms part of the ship's hull and which may be stressed in the same manner and by the same loads which stress the contiguous hull structure and which is normally essential to the structural completeness of the ship's hull.

1.1.16 Gas-dangerous spaces

Gas-dangerous spaces include:

- cargo tanks and cargo storage vessels
- cofferdams adjacent to cargo tanks and cargo storage vessels
- spaces where cargo handling pumps are located
- double bottoms or duct keels located under cargo tanks
- enclosed or partially enclosed spaces located directly above cargo tanks
- enclosed or partially enclosed spaces, located directly above pump rooms and cofferdams adjacent to cargo tanks and cargo storage vessels and which are not separated from such spaces by a gas-tight deck or effectively ventilated
- closed or partially closed spaces where piping, valves or other equipment for cargo handling are located
- zones on the weather deck located within a range of less than 10 m measured horizontally from the outlets of gas vents in cargo tanks and cargo storage vessels
- zones on the weather deck located above cargo tanks and cargo storage vessels within a height of 2,4 m above the deck or top of cargo storage vessels. Such zones are to be extended 3 m beyond the fore, aft and side ends of cargo tanks
- zones and partially enclosed spaces on the weather deck located within 3 metres of: hatches, any other openings in cargo tanks and cargo storage vessels, any cargo handling pumps which are not located in a space set aside for that purpose and the ends of cargo loading and unloading arrangements
- spaces for the storage of cargo hoses, if any.

2 General arrangement design

2.1 Compartment arrangement for all ships

2.1.1 Location of cargo tanks and cargo storage vessels

All cargo tanks and cargo storage vessels are to be located aft of the collision bulkhead and forward of the aft peak.

2.1.2 Independent portable tanks

Independent portable tanks, to be fitted on the weather deck, may be used as cargo storage vessels subject to the following conditions:

- the portable tanks are to be securely fastened to the hull structure
- in the zone on the weather deck where the portable tanks are arranged, a suitable possibly removable containment coaming is to be fitted such as to prevent any spillage and/or leakages from flowing to gas-safe areas
- a space is to be left between tanks and ship sides sufficient to allow easy passage of ship personnel and transfer of fire-fighting arrangements
- the cargo handling system serving portable tanks is to be such that liquid heads higher than those allowable for cargo tanks, if any, served by the same system cannot occur.

Provisions are to be made such that any portable tank is easily identifiable by means of markings or suitable plates.

2.2 Compartment arrangement for ships with additional service feature “oil pro-duct”

2.2.1 Length of cargo tanks

The length of each cargo tank may not exceed 10 metres or one of the values of Tab 3, as applicable, whichever is the greater.

2.2.2 Simultaneous carriage of dry cargoes and oil products

In general, the simultaneous carriage of dry cargoes and oil products with any flashpoint is not permitted.

Nevertheless, dry cargoes and oil products with a flashpoint of at least 43°C (closed cup test) may be simultaneously carried without special limitations provided that the room temperature in the spaces adjacent to cargo tanks, or where cargo storage vessels are installed, is at least 10°C below the flashpoint of the same oil products.

Where the above products are carried in storage vessels installed on the weather deck, adequate protection against accidental impact of the dry cargoes carried in the same area is to be provided.

Table 1 : Hazardous and noxious permitted products *(1/1/2009)*

Name	Category **(1) (2)**	Flammability
Drilling Brines, including Sodium Chloride Solution	Z	No
Drilling Brines, including Calcium Bromide Solution	Z	No
Drilling Brines, including Calcium Chloride Solution	Z	No
Calcium nitrate/Magnesium nitrate/Potassium chloride solution	Z	No
Calcium Nitrate Solution (50% or less)	Z	No
Drilling brines (containing zinc salts)	X	No
Potassium Formate Solution	Z	No
Potassium Chloride Solution	Z	No
Ethyl Alcohol	Z	Yes
Ethylene Glycol	Y	No
Ethylene Glycol monoalkyl ether	Y	Yes
Methyl Alcohol	Y	Yes
Acetic acid	Z	Yes
Formic acid	Y	Yes
Hydrochloric Acid	Z	No
Sulphuric Acid	Y	No
Toluene	Y	Yes
Xylene	Y	Yes
Liquid carbon dioxide	N/A	No
Liquid nitrogen	N/A	No
Noxious liquid, NF, (7) n.o.s. (trade name ..., contains ...) ST3, Cat. Y	Y	No
Noxious liquid, F, (8) n.o.s. (trade name …., contains …) ST3, Cat. Y	Y	Yes
Noxious liquid, NF, (9) n.o.s. (trade name …, contains …) ST3, Cat. Z	Z	No
Noxious liquid, F, (10) n.o.s. (trade name …, contains …) ST3, Cat. Z	Z	Yes
Noxious liquid, (11) n.o.s. (trade name …, contains …) Cat. Z	Z	No
Non-noxious liquid, (12) n.o.s. (trade name …, contains …) Cat. OS	N/A	No

(1) Product categories are defined in Tab 2

(2) N.A. means "not applicable"

Table 2 : Hazardous and noxious product category *(1/1/2009)*

Category	Definition
X	Noxious liquid substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health and, therefore, justify the prohibition of the discharge into the marine environment.

Category	Definition
Y	Noxious liquid substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of the discharge into the marine environment.
Z	Noxious liquid substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a minor hazard to either marine resources or human health and therefore justify less stringent restrictions on the quality and quantity of the discharge into the marine environment.

Table 3 : Length of cargo tanks

Longitudinal Bulkhead	Type of Cargo Tank	b_i/B **(1)**	Centreline Bulkhead	Length (m)
No bulkhead	-	-	-	(0,5. b_i/B + 0,1) L **(2)**
Centreline bulkhead	-	-	-	(0,25. b_i/B + 0,15) L
Two or more bulkheads	Wing cargo tank	-	-	0,2 L
	Centre cargo tank	if b_i/B > 1/5	-	0,2 L
		if b_i/B < 1/5	NO	(0,5. b_i/B + 0,1) L
			YES	(0,25. b_i/B + 0,15) L

(1) Where b_i is the minimum distance from the ship side to the outer longitudinal bulkhead of the tank in question measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.

(2) Not to exceed 0,2 L.

2.3 Compartment arrangement for ships with additional service feature “chemical product”

2.3.1 Location of cargo tanks and cargo storage vessels

Cargo tanks containing products as listed in [1.1.3] are to be located at least 760 mm measured inboard from the side of the vessel perpendicular to the centreline at the level of the summer load waterline.

2.3.2 Location of accommodation or service spaces and control stations

Accommodation or service spaces, or control stations may not be located within the cargo area.

2.3.3 Cargo tank extension

Cargo tanks may extend to the deck plating, provided dry cargo is not handled in that area. Where dry cargo is handled on the deck area above a cargo tank, the cargo tank may not extend to the deck plating unless a continuous, permanent deck sheathing of wood or other suitable material of appropriate thickness and construction is fitted to the satisfaction of the Society.

Cargoes may not be carried in either the fore or aft peak tanks.

2.3.4 Cargo segregation with fuel oils or other cargoes

Cargoes which react in a hazardous manner with other cargoes or fuel oils are to:

- *be segregated from such other cargoes or fuel oils by means of a cofferdam, void space, cargo pump room, pump room, empty tank, or tank containing a mutually compatible cargo;*
- *have separate pumping and piping systems which may not pass through other cargo tanks containing such cargoes, unless encased in a tunnel; and*
- *have separate tank venting systems.*

2.3.5 Cargo segregation with other spaces

Tanks containing cargo or residues of cargo listed in [1.1.3] are to be segregated from machinery spaces, shaft tunnels, if fitted, dry cargo spaces, accommodation and service spaces and from drinking water and stores for human consumption, by means of a cofferdam, void space, cargo pump room, empty tank, fuel oil tank, or other similar space. On-deck stowage of independent tanks or installation of independent tanks in otherwise empty hold spaces is to be considered as satisfactory.

2.3.6 Substances with a flashpoint exceeding 60°C

For pollution hazard only substances having a flashpoint exceeding 60°C (closed cup test), the Society may waive the arrangements referred to in [2.3.5] and [2.3.9] provided that the segregation requirements for accommodation spaces, drinking water and stores for human consumption are observed. Additionally, [2.3.10] and [2.7.1] need not be applied.

2.3.7 Tank openings and connections

Except for the tank connections to cargo pump rooms, all tank openings and connections to the tank are to terminate above the weather deck and are to be located in the tops of the tanks. Where cofferdams are provided over integral tanks, small trunks may be used to penetrate the cofferdam.

2.3.8 Openings to accommodation, service and machinery spaces and control stations

a) *Unless they are spaced at least 7 m away from the cargo area containing flammable products, entrances, air inlets and openings to accommodation, service and machinery spaces and control stations may not face the cargo area. Doors to spaces not having access to accommodation, service and machinery spaces and control stations, such as cargo control stations and storerooms, may be permitted by the Society within the 7 m zone specified above, provided the boundaries of the spaces are insulated to A-60 standard. When arranged within the 7 m zone specified above, windows and sidescuttles facing the cargo area are to be of a fixed type. Such sidescuttles in the first tier on the main deck are to be fitted with inside covers of steel or equivalent material.*

b) *In order to guard against the danger of hazardous vapours, due consideration is to be given to the location of air intakes and openings into accommodation, service and machinery spaces and control stations in relation to cargo piping and cargo vent systems.*

c) *For pollution hazard only substances having a flashpoint exceeding 60°C, the arrangements referred to in a) and b) may be waived.*

2.3.9 Openings for pipes

Cargo piping may not pass through any accommodation, service or machinery space other than cargo pump rooms or pump rooms.

2.3.10 Cofferdams

Where not bounded by bottom shell plating, fuel oil tanks, a cargo pump room or a pump room, the cargo tanks are to be surrounded by cofferdams. Tanks for other purposes (except fresh water and lubricating oils) may be accepted as cofferdams for these tanks.

2.3.11 Machinery space ventilators

Due regard is to be given to the position of machinery space ventilators. Preferably they are to be fitted in a position above the superstructure deck, or above an equivalent level if no superstructure deck is fitted.

2.4 Compartment arrangement for ships with additional service feature “standby vessel “

2.4.1 Survivor spaces *(1/7/2003)*

For ships with additional service feature **standby vessel**, a suitable closed accommodation space is to be provided for survivors.

The space is to be fitted with lighting, ventilation and adequate sanitary facilities, to be available exclusively for the survivors.

2.5 Access arrangement for all ships

2.5.1 Access to spaces below the freeboard deck

Access to the areas below the freeboard deck is, in general, to be provided from a position above the deck of a first tier superstructure.

As an alternative, indirect access may be provided from a space fitted with an outer door having a sill not less than 600 mm high and a self-closing, gas-tight inner door having a sill not less than 380 mm high.

2.5.2 Access to cargo pump rooms

Access to cargo pump rooms is only to be provided from an open position on the weather deck.

2.6 Access arrangement for ships with additional service feature “oil product”

2.6.1 Access to spaces within the cargo area

The access to spaces within the cargo area is to meet the requirements of Ch 7, Sec 2, [6.3].

2.6.2 Access to the gas-safe spaces

Gas-safe spaces such as accommodation, service, machinery and other similar spaces may not have any direct communication with gas-dangerous spaces defined in [1.1.16].

Nevertheless, access openings to gas-safe spaces below the weather deck, which are located less than 10 metres but not less than 3 metres from the outlets of gas vents in cargo tanks and cargo storage vessels, may be permitted where they are intended as emergency means of escape from normally attended spaces or as access to normally unattended spaces, provided that the relevant doors are kept permanently closed when the ship is not gas-freed.

Suitable warning plates are to be fixed in the proximity of such openings.

2.7 Access arrangement for ships with additional service feature “chemical pro-duct”

2.7.1 Access to spaces

For access to all spaces, the minimum spacing between cargo tank boundaries and adjacent ship's structures is to be 600 mm.

2.7.2 Access to the cargo deck

Hatches, doors, etc. which give access to the cargo deck are to be kept closed during navigation and are to comply with Pt B, Ch 2, Sec 1, [6.2.4].

2.7.3 Access to the machinery space

Access to the machinery space is, as far as practicable, to be arranged within the forecastle. Any access to the machinery space from the exposed cargo deck is to be provided with two weathertight closures. Access to spaces below the exposed cargo deck is preferably to be from a position within or above the superstructure deck.

2.8 Access arrangement for ships with additional service feature “standby vessel”

2.8.1 Rescue area *(1/7/2003)*

Ships with additional service feature **standby vessel** are to be provided, on each side, with a clearly marked rescue area having length not less than 8 m.

The rescue area is to comply with the following requirements:

- The ship's side in way of the rescue zone is to be free of any obstacle
- The ship's deck in way of the rescue area is to be so arranged as to protect personnel against injury
- The area is to be adequately fitted far from propellers and any ship side discharges up to 2 m below the waterline.
- Each rescue area is to be provided with a scrambling net made of corrosion resistant and non-slip material.

2.8.2 Rescue area lighting *(1/7/2003)*

Satisfactory lighting is to be provided along the rescue area.

A searchlight, able to provide an illumination level of 50 lux at a distance of 250 m, is to be available on each side and operated from the navigation bridge.

2.9 Additional arrangements and equipment for supply vessels with additional service feature "rescue"

2.9.1 *(1/7/2004)*

Supply vessels with additional service feature "rescue" are to be provided with at least the following arrangements and equipment indicated in [2.9.2].

2.9.2 *(1/10/2021)*

a) a "RESCUE ZONE" area on each side of the ship's main deck where the relevant bulwark is lower than in the other part of the ship or provided with a gate in order to facilitate the embarkation of the shipwrecked persons. This zone is to be clearly identified by such wording written in at least 500 mm high/200 mm wide letters and side strips made in high intensity photo luminescent material

b) nets or other equipment to facilitate the recovery of shipwrecked people from the sea

c) blankets (at least one for each person forming the maximum capacity of shipwrecked people for which the ship is designed)

d) cabins and beds in addition to those provided on board for the normal complement of crew (beds for at least 30% of the maximum capacity of shipwrecked people for which the ship is designed)

e) bathrooms and showers in addition to those provided on board for the normal complement of crew (one bathroom and shower for every 50 persons or fraction of the maximum capacity of shipwrecked people for which the ship is designed)

f) sitting places (chairs, sofas and armchairs) in addition to those provided on board for the normal complement of crew (for 100% of the maximum capacity of shipwrecked people for which the ship is designed)

g) facilities and provisions for shipwrecked persons in addition to those necessary for the normal complement of crew (food rations for at least 300% of the maximum capacity of shipwrecked people for which the ship is designed)

h) first aid kits and medicines (for at least 100% of the maximum capacity of shipwrecked people for which the ship is designed)

i) a sick bay.

2.9.3 *(1/10/2021)*

Relaxation from the requirements of [2.9.2] may be granted by the Society case-by-case on the basis of the ship operational area, e.g. for ships operating in tropical and subequatorial climate areas, the requirement in [2.9.2] d) may be relaxed to beds for at least 10% of the maximum capacity of shipwrecked people for which the ship is designed and, for the remaining capacity of shipwrecked people, suitable thermal suites for the protection against cold and suitable sheltered areas by means of fixed or mobile shelter equipment (e.g. canopies).

2.9.4 *(1/7/2013)*

The maximum number of shipwrecked persons for which the ship is designed as well as the ship operational area, where [2.9.3] applies, are recorded in the Certificate of Classification of the ship.

The relevant arrangements and equipment are recorded in the ship's status.

2.9.5 *(1/1/2021)*

An addendum to the trim and stability booklet is to be issued and submitted to the Society for approval. Such an addendum shall include:

a) loading conditions pertaining to the maximum capacity of shipwrecked persons; and

b) for each of the above loading conditions, checking of the criteria in Pt B, Ch 3, Sec 2, [2] and [3] (i.e. including weather criterion) and Ch 11, Sec 3, [1.1.3] and [1.1.4]. Such criteria are to be applied for any ship operational area.

2.10 Additional requirements for supply vessels with additional service feature "anchor handling" and "anchor handling stab"

2.10.1 Visibility from the bridge deck *(1/7/2011)*

The visibility from the bridge deck is to be in compliance with the following requirements:

- the view of the sea surface from the working position at the workstation is to be not less than 600 m from the ship's stern (see Fig 2)
- the horizontal field of vision from the working position at the workstation shall extend over an arc of not less than the ship's stern breadth (see Fig 3)
- the anchor handling steel wire stoppers are to be visible from the working position at the workstation
- the spooling of the steel wire rope and the steel wire rope's guides/rollers are to be visible from the bridge
- for ships with the additional service feature anchor handling stab, the marking requested on the working bridge in [2.10.2] is to be visible from the bridge.

Figure 2 *(1/7/2011)*

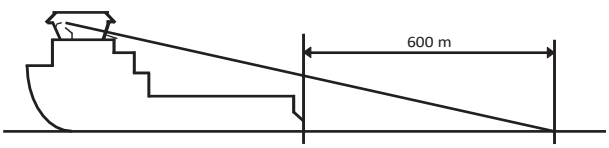
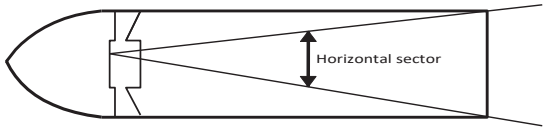


Figure 3 *(1/7/2011)*



2.10.2 **Marking on the aft end of working bridge (only supply vessels with additional service feature "anchor handling stab")** *(1/7/2011)*

For ships with the additional service feature anchor handling stab, adequate marking, which enables the Master to evaluate the angle β, is to be fitted on the aft end of the working bridge.

3 Stability

3.1 General

3.1.1 **Application** *(1/7/2002)*

Every decked offshore supply vessel of 24 metres and over but not more than 100 metres in length is to comply with the provisions of [3.2] The intact stability of a vessel of more than 100 metres in length is specified on a case-by-case basis.

3.1.2 **Relaxation** *(1/7/2002)*

Relaxation in the requirements of [3.2] may be permitted by the Society for vessels engaged in near-coastal voyages provided the operating conditions are such as to render compliance with [3.2] unreasonable or unnecessary.

3.2 Intact stability for all ships

3.2.1 General stability criteria

The stability of the ship, for the loading conditions defined in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.12] with the assumptions in [3.2.5], is to be in compliance with the requirements of Pt B, Ch 3, Sec 2, [2.1] or as an alternative with the requirements of [3.2.2]. The additional criteria of [3.2.3] are also to be complied with.

3.2.2 Alternative stability criteria

The following equivalent criteria are recommended where a vessel's characteristics render compliance with Pt B, Ch 3, Sec 2, [2.1] impracticable:

- *The area, in m.rad, under the curve of righting levers (GZ curve) may not be less than 0,070 up to an angle of 15° when the maximum righting lever (GZ) occurs at 15° and 0,055 up to an angle of 30° when the maximum righting lever (GZ) occurs at 30° or above. Where the maximum righting lever (GZ) occurs at angles of between 15° and 30°, the corresponding area "A", in m.rad, under the righting lever curve is to be:*

  $A = 0{,}055 + 0{,}001 \cdot (30° - \theta_{max})$

  where θ_{max} is the angle of heel, in degrees, at which the righting lever curve reaches its maximum.
- *The area, in m.rad, under the righting lever curve (GZ curve) between the angles of heel of 30° and 40°, or between 30° and θ_f if this angle is less than 40°, may not be less than 0,03,* where θ_f is defined in Pt B, Ch 3, Sec 2, [2.1.2].
- *The righting lever (GZ), in m, is to be at least 0,20 at an angle of heel equal to or greater than 30°.*
- *The maximum righting lever (GZ) is to occur at an angle of heel not less than 15°.*
- *The initial transverse metacentric height (GM), in m, may not be less than 0,15.*

3.2.3 Additional criteria

A minimum freeboard at the stern of at least 0,005 L is to be maintained in all operating conditions.

3.2.4 Factors of influence

The stability criteria mentioned in [3.2.1] and [3.2.2] are minimum values; no maximum values are recommended. It is advisable to avoid excessive values, since these might lead to acceleration forces which could be prejudicial to the vessel, its complement, its equipment and the safe carriage of cargo.

Where anti-rolling devices are installed, the stability criteria indicated in [3.2.1] and [3.2.2] are to be maintained when the devices are in operation.

3.2.5 Assumptions for calculating loading conditions

If a vessel is fitted with cargo tanks, the fully loaded conditions of Pt B, Ch 3, App 2, [1.2.12] are to be modified, assuming first the cargo tanks full and then the cargo tanks empty.

If in any loading condition water ballast is necessary, additional diagrams are to be calculated, taking into account the water ballast, the quantity and disposition of which are to be stated in the stability information.

In all cases when deck cargo is carried, a realistic stowage weight is to be assumed and stated in the stability information, including the height of the cargo and its centre of gravity.

Where pipes are carried on deck, a quantity of trapped water equal to a certain percentage of the net volume of the pipe deck cargoes is to be assumed in and around the pipes. The net volume is to be taken as the internal volume of the pipes, plus the volume between the pipes. This percentage is 30 if the freeboard amidships is equal to or less than 0,015 L and 10 if the freeboard amidships is equal to or greater than 0,03 L. For intermediate values of the freeboard amidships, the percentage may be obtained by linear interpolation. In assessing the quantity of trapped water, the Society may take into account positive or negative sheer aft, actual trim and area of operation.

A vessel, when engaged in towing operations, may not carry deck cargo, except that a limited amount, properly secured, which would neither endanger the safe working of the crew nor impede the proper functioning of the towing equipment, may be accepted.

3.3 Intact stability for ships with additional service feature “oil product”

3.3.1 Liquid transfer operations

Ships with particular internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling, the design of oil tankers of 5000 t deadweight and above is to be such that the following criteria are complied with*:*

a) *The intact stability criteria reported in b) are to be complied with for* the worst possible condition of loading and ballasting as defined in c)*, consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.*

b) *The initial metacentric height GM_0, in m, corrected for free surface measured at 0° heel, is to be not less than 0,15. For the purpose of calculating GM_0, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.*

c) *The vessel is to be loaded with:*

- *all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank,*
- *cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value,*
- *full departure consumable,*
- *1% of the total water ballast capacity.The maximum free surface moment is to be assumed in all ballast tanks.*

3.3.2 Alternative requirements for liquid transfer operation

As an alternative to the requirements in [3.3.1], simple supplementary operational procedures are to be followed when the ship is carrying oil cargoes or during liquid transfer operations*.*

Simple supplementary operational procedures for liquid transfer operations means written procedures made available to the Master which:

- *are approved by the Society,*
- *indicate those cargo and ballast tanks which may, under any specific condition of liquid transfer and possible range of cargo densities, be slack and still allow the stability criteria to be met. The slack tanks may vary during the liquid transfer operations and be of any combination provided they satisfy the criteria,*
- *are to be readily understandable to the officer-in-charge of liquid transfer operations,*
- *provide for planned sequences of cargo/ballast transfer operations,*
- *allow comparisons of attained and required stability using stability performance criteria in graphical or tabular form,*
- *require no extensive mathematical calculations by the officer-in-charge,*
- *provide for corrective actions to be taken by the officer-in-charge in the event of departure from the recommended values and in case of emergency situations, and,*
- *are prominently displayed in the approved trim and stability booklet and at the cargo/ballast transfer control station and in any computer software by which stability calculations are performed.*

3.4 Intact stability for ships with additional service feature "anchor handling stab"

3.4.1 Effects to be considered due to anchor handling steel wire rope tension *(1/7/2011)*

The additional trimming and heeling moment due to the maximum allowed tension in steel wire rope F_{AH} is to be taken into account in the ship stability calculations. In particular, the following criteria are to be fulfilled:

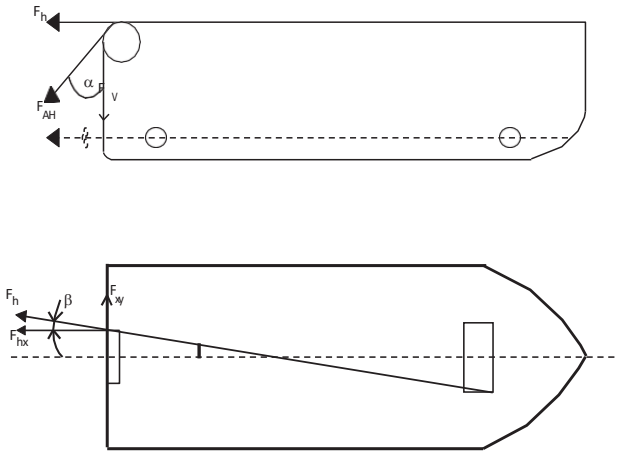
- the vertical component F_v of the force F_{AH} is to be applied at the upper edge of the stern roller (see Fig 4)
- the horizontal component F_h of the force F_{AH} is to be applied at the highest point between the upper edge of the stern roller and the edge of the winch where the steel wire rope is deployed
- for the purpose of calculating the heeling moments, the vertical and horizontal components F_v and F_h are to be applied at the outer edge of the stern roller (see Fig 4)
- the effect of the propeller is to be taken into account
- an adequate range of working fleet angles α and β are to be considered in order to cover all possible operative conditions.

3.4.2 Stability criteria to be fulfilled during anchor handling operations *(1/7/2011)*

The maximum allowable KG curves are to be obtained taking into account that the static heeling angle calculated considering the effect of the anchor handling steel wire rope is to be less than the minimum of the following angles:

- heeling angle equivalent to a GZ value equal to 50% of GZ_{max}
- the angle which results in water on the working deck when the deck is calculated as flat
- 15 degrees.

Figure 4 *(1/7/2011)*



3.4.3 Information to be provided to the Master *(1/7/2011)*

A "stability operational manual for anchor handling operation" is to be provided on board for guidance to the Master, containing at least the following minimum information:

- curves indicating the maximum allowable KG for anchor handling operations as a function of the draft amidships, trim, maximum allowed tension F_{AH} in the steel wire rope used for anchor handling and the working fleet angles α and β. The maximum KG curves are to be calculated applying the steel wire rope load as indicated in [3.4.2] and satisfying the criteria provided in [3.4.3]
- general arrangement drawing with description of the ship, propulsion and thruster configuration
- calculation example showing the use of KG curves
- compliance with the requirements listed in [3.4.3] for some typical operating loading conditions, considered by the Designer as being the most unfavourable combinations of tension in steel wire rope and working fleet angles α and β
- in general, the maximum allowable KG curves are to take into account also other stability criteria that the ship is required to satisfy. Where the maximum allowable KG curves indicated in the anchor handling operational manual take into account only the criteria provided in [3.4.3], a warning is to be given in the manual specifying that compliance of the actual loading conditions with applicable requirements other than those in [3.4.3] is to be verified by the Master according to the information provided in the ship's loading manual
- maximum brake holding capacity of the winch

- maximum pull of the winch
- instructions for control of the maximum tension in the anchor handling steel wire rope.

4 Structure design principles

4.1 General

4.1.1 For ships greater than 24 m in length, it is recommended that a double skin is provided to reinforce the protection of the main compartments in the event of contact with pontoons or platform piles.

4.2 Side structure exposed to bumping

4.2.1 Longitudinally framed side

In the whole area where the side of the ship is exposed to bumping, distribution frames are to be provided at mid-span, consisting of an intercostal web of the same height as the ordinary stiffeners with a continuous face plate.

Within reinforced areas, scallop welding for all side ordinary stiffeners is forbidden.

4.2.2 Transversely framed side

In the whole area where the side of the ship is exposed to bumping, a distribution stringer is to be fitted at mid-span, consisting of an intercostal web of the same height as the ordinary stiffeners with a continuous face plate.

Side frames are to be fitted with brackets at ends.

Within reinforced areas, scallop welding for all side ordinary stiffeners is forbidden.

4.2.3 Fenders

Efficient fenders, adequately supported by structural members, are to be fitted on the side, including the forecastle, on the full length of the areas exposed to contact.

4.3 Deck structure

4.3.1 Local reinforcements are to be fitted in way of specific areas which are subject to concentrated loads.

4.3.2 Exposed decks carrying heavy cargoes or pipes are to provide protection and means of fastening for the cargo, e.g. inside bulwarks, guide members, lashing points, etc.

4.4 Structure of cement tanks and mud compartments

4.4.1 Cargo tanks and hoppers intended to carry mud or cement are to be supported by structures which distribute the acting forces as evenly as possible on several primary supporting members.

5 Design loads

5.1 Dry uniform cargoes

5.1.1 Still water and inertial pressures

The still water and inertial pressures transmitted to the structure of the upper deck intended to carry loads are to be obtained, in kN/m^2, as specified in Pt B, Ch 5, Sec 6, [4], where the value of p_S is to be taken not less than 24 kN/m^2.

6 Hull scantlings

6.1 Plating

6.1.1 Minimum net thicknesses

The net thickness of the side and upper deck plating is to be not less than the values given in Tab 4.

Table 4 : Minimum net thickness of the side and upper deck plating

Plating	Minimum net thickness, in mm
Side below freeboard deck	The greater of: • $2,1 + 0,031\ L\ k^{0,5} + 4,5\,s$ • $8\ k^{0,5}$
Side between freeboard deck and strength deck	The greater of: • $2,1 + 0,013\ L\ k^{0,5} + 4,5\,s$ • $8\ k^{0,5}$
Upper deck	7,0

6.1.2 Strength deck plating

Within the cargo area, the net thickness of strength deck plating is to be increased by 1,5 mm with respect to that determined according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable.

6.2 Ordinary stiffeners

6.2.1 Longitudinally framed side exposed to bumping

In the whole area where the side of the ship is exposed to bumping, the net section modulus of ordinary stiffeners is to be increased by 15% with respect to that determined according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as applicable.

6.2.2 Transversely framed side exposed to bumping

In the whole area where the side of the ship is exposed to bumping, the net section modulus of ordinary stiffeners, i.e. side, ‘tweendeck and superstructure frames, is to be increased by 25% with respect to that determined according to Pt B, Ch 7, Sec 2 or Pt B, Ch 8, Sec 4, as applicable.

6.3 Primary supporting members

6.3.1 Distribution stringers

The net section modulus of the distribution stringer required in [4.2.2] is to be at least twice that calculated in [6.2.2] for ordinary stiffeners.

6.3.2 Cement tanks and mud compartments

The net scantlings of the primary supporting members of cement tanks and mud compartments are to be calculated taking into account high stresses resulting from vertical and horizontal accelerations due to rolling and pitching.

Secondary moments due to the tendency of materials to tip over are to be considered by the Society on a case-by-case basis.

7 Other structure

7.1 Aft part

7.1.1 Rollers

At the transom, local reinforcements are to be fitted in way of rollers and other special equipment intended for cargo handling.

7.1.2 Structures in way of rollers

The structures in way of the stern rollers and those of the adjacent deck are considered by the Society on a case-by-case basis, taking into account the relevant loads which are to be specified by the Designer.

7.1.3 Propeller protection

It is recommended that devices should be fitted to protect the propellers from submerged cables.

7.2 Superstructures and deckhouses

7.2.1 Forecastle

The forecastle length may not exceed 0,3 to 0,4 times the length L.

7.2.2 Deckhouses

Due to their location at the forward end of the ship, deckhouses are to be reduced to essentials and special care is to be taken so that their scantlings and connections are sufficient to support wave loads.

7.2.3 Minimum net thicknesses

The net thickness of forecastle aft end plating and of plating of deckhouses located on the forecastle deck is to be not less than the values given, in mm, in Tab 5.

Table 5 : Minimum net thickness of forecastle aft end plating and plating of deckhouses located on the forecastle deck

Plating	Minimum net thickness, in mm
Forecastle aft end	1,04 (5 + 0,01 L)
Front of deckhouses located on the forecastle deck	1,44 (4 + 0,01 L)
Sides of deckhouses located on the forecastle deck	1,31 (4 + 0,01 L)
Aft end of deckhouses located on the forecastle deck	1,22 (4 + 0,01 L)

7.2.4 Ordinary stiffeners

The net section modulus of ordinary stiffeners of the forecastle aft end and of deckhouses located on the forecastle deck is to be not less than the value obtained from Tab 6.

Ordinary stiffeners of the front of deckhouses located on the forecastle deck are to be fitted with brackets at their ends. Those of side and aft end bulkheads of deckhouses located on the forecastle deck are to be welded to decks at their ends.

Table 6 : Ordinary stiffeners of the forecastle aft end and of deckhouses located on the forecastle deck

Ordinary stiffeners	Net section modulus, in cm^3
Forecastle aft end and front of deckhouses located on the forecastle deck	3 times the value calculated according to Pt B, Ch 9, Sec 4, [4].
Sides and aft end of deckhouses located on the forecastle deck	0,75 times that of the forecastle ‘tweendeck frames.

7.3 Arrangement for hull and superstructure openings

7.3.1 Sidescuttles and windows *(1/7/2025)*

Typical arrangements of sidescuttles and windows complying with the requirements given below and Pt B, Ch 9, Sec 9 are shown in Fig 5 and Fig 6.

Side scuttles are normally not to be accepted in the ship sides below third tier forward of 0,1 L_{LL} from forward perpendicular, however they may be accepted if their strength and position is found suitable, i.e. strength is consistently higher than the one strictly required and/or position is adequately protected, to the satisfaction of the Society.

In the after end bulkhead of deckhouses and superstructures, in sides of deckhouses and of superstructures that are not part of the shell plating, windows will be accepted in second tier and higher, above the freeboard deck. In front bulkheads of deckhouses and superstructures, windows will be accepted in third tier and higher, above the freeboard deck. In the first tier of the front bulkhead above the weather deck (forecastle deck) only side scuttles will be accepted.

The minimum thickness t, in mm, of glasses for sidescuttles and windows is to be obtained from the formula:

$$t = \frac{b}{S}\sqrt{p\beta}$$

where:

b : smaller dimension of the glass, in mm

S : safety factor obtained from Tab 7

β : adimensional factor

p : design sea pressure as given in Pt B, Ch 9, Sec 4, [2.2] to be assumed in any case not less than 6,5 KN/m^2

$\beta = 0,54\ A_r - 0,078A_r^2 - 0,17$ for $A_r < 3$

$\beta = 0,75$ for $A_r \geq 3$

A_r = a/b

a = length of the longer window side, in mm

Furthermore, the thickness of windows is not to be taken less than 10 mm. When laminated glass panes are used, to obtain the total thickness of the laminated panes a calculation for equivalent thickness according to a recognized international standard may be used by the designer.

Table 7 : Safety factor S *(1/7/2020)*

Window and sidescuttle location	2nd tier	3rd tier	4th tier and above
Front or side	100	100	150
Aft	100	150	200

7.3.2 Deadlights *(1/7/2025)*

Hinged deadlights are to be fitted to:

- side scuttles in the vessel's hull, i.e. shell plating
- windows and side scuttles in the sides of deckhouses and superstructures up to and including the third tier above the freeboard deck
- all windows and side scuttles in front bulkheads of superstructures and deckhouses
- windows and side scuttles in the after end of bulkheads of superstructures and deckhouses, casings and companionways in the first and second tier above the freeboard deck
- windows and side scuttles in all bulkheads of the first tier on the weather deck.

Deadlights fitted in the side of third tier may be portable if they are stored adjacent to the windows for quick mounting.

For tier four and above, unless it is the first tier above the forward weather deck, the deadlights may be portable if they are stored adjacent to the windows for quick mounting. In the second tier above the freeboard deck and higher, deadlights on windows may be arranged externally, provided there is easy and safe access for closing. Other deadlights are to be internally hinged.

Deadlights are to be available for each type of window sited on the front of a wheelhouse that is located on the forward part of the vessel, unless the wheelhouse is located on fifth tier (or above) and is at least two decks above the forward weather deck. For externally fitted deadlights, an arrangement for easy and safe access are to be provided (e.g. gangway with railing). The deadlights of portable type are to be stowed adjacent to the window for quick mounting. For the wheelhouse front windows, at least two deadlights are to have means for providing a clear view.

The strength of side scuttles with internally hinged deadlights and toughened glass panes is to comply with ISO 1751 as follows:

- Type A (heavy): in the hull, in the sides of superstructures and in the front of superstructures and deckhouses (weather deck tier).
- Type B (medium): in the after end of superstructures and in the sides and ends of deckhouses (except front in weather deck tier).

Figure 5 : Side scuttles and windows in supply vessel with complete superstructure and uppermost forecastle *(1/7/2025)*

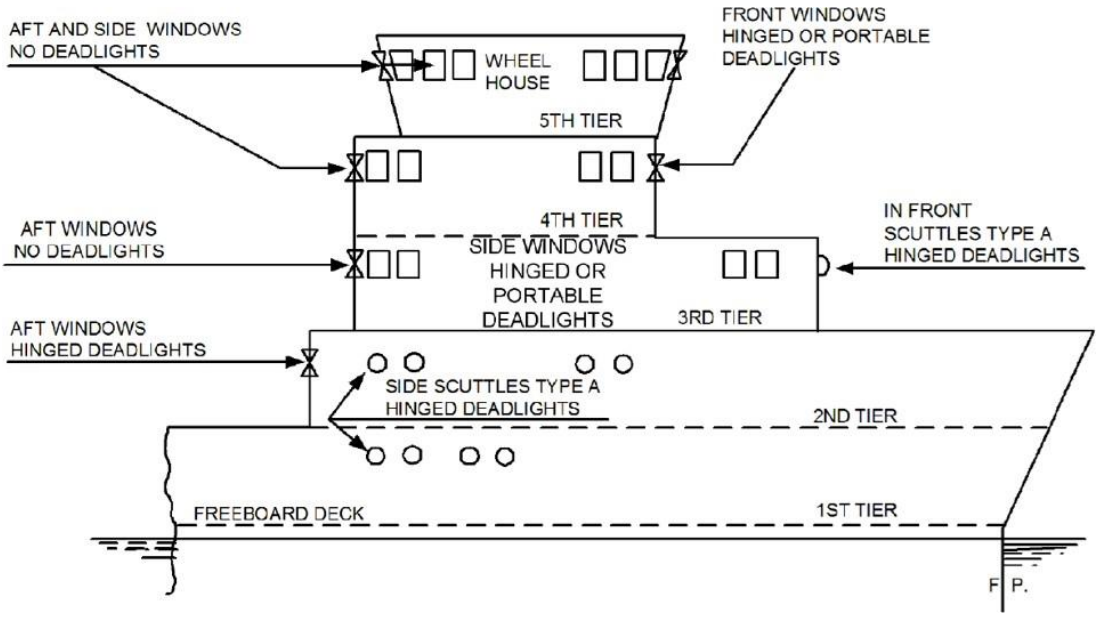
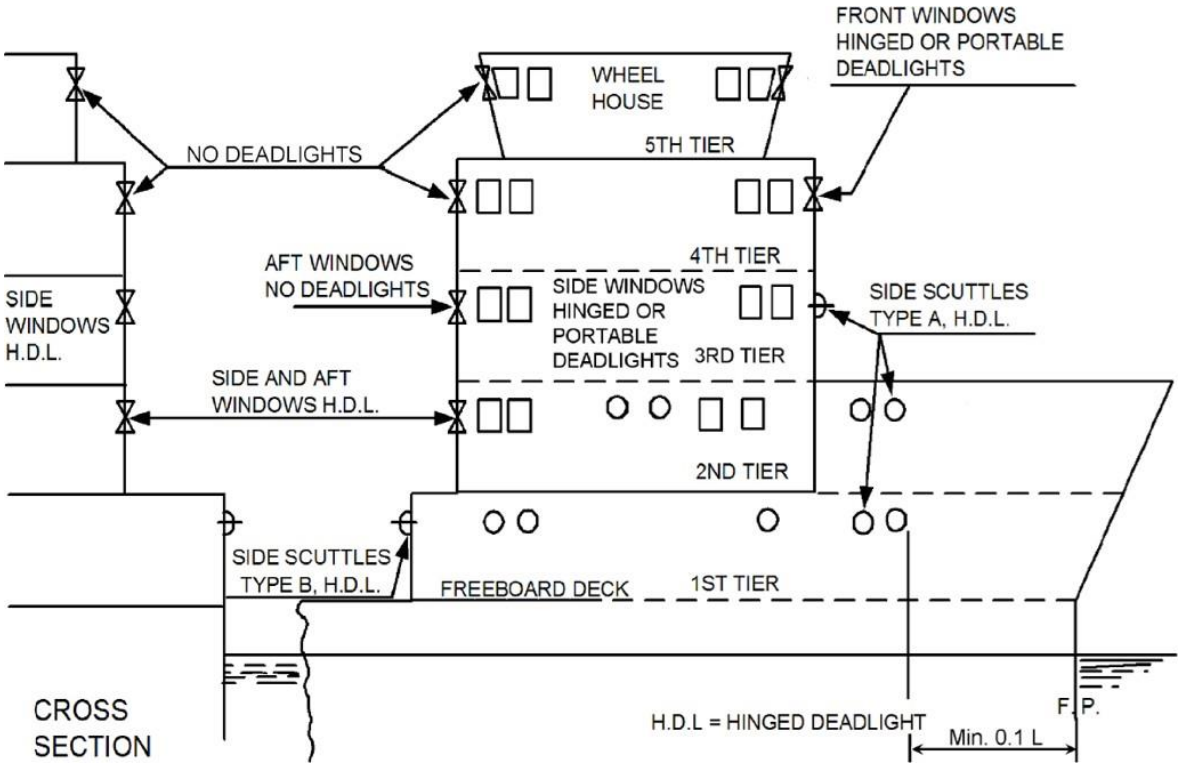


Figure 6 : Side scuttles and windows in supply vessel with forecastle only *(1/7/2025)*



7.3.3 Sidescuttles of gas-safe spaces facing gas-dangerous spaces

Sidescuttles of gas-safe spaces facing gas-dangerous spaces, excluding those of non-opening type, are to be capable of ensuring an efficient gas-tight closure.

Warning plates are to be fitted on access doors to accommodation and service spaces facing the cargo area indicating that the doors and sidescuttles mentioned above are to be kept closed during cargo handling operations.

7.3.4 Freeing ports

The area of freeing ports is to be increased by 50% with respect to that determined according to Pt B, Ch 9, Sec 9, [5].

Shutters may not be fitted.

7.3.5 Freeing ports through box-bulwarks

Where box-bulwarks the upper level of which extends to the forecastle deck are fitted in way of the loading area, the freeing ports are to pass through these box-bulwarks, and their area is to be increased to take account of the height of the bulwarks.

7.3.6 Miscellaneous

Air pipes, ventilators, small hatchways, fans and control valves are to be located outside the loading area and protected from possible shifting of the deck cargo.

8 Hull outfitting

8.1 Rudders

8.1.1 Rudder stock scantlings

The rudder stock diameter is to be increased by 5% with respect to that determined according to Pt B, Ch 10, Sec 1, [4].

8.2 Bulwarks

8.2.1 Plating

In the case of a high bulwark, fitted with a face plate of large cross-sectional area, which contributes to the longitudinal strength, the net thickness of the plating contributing to the longitudinal strength is to be not less than the value obtained according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable.

8.2.2 Stays

The bulwark stays are to be strongly built with an attachment to the deck reinforced to take account of accidental shifting of deck cargo (e.g. pipes).

8.2.3 Bulwark arrangement for ships with additional service feature standby vessel *(1/7/2003)*

For ships with additional service feature **standby vessel**, bulwarks or railings in way of the rescue zone are to be easy to open or remove, so as to enable direct access to deck.

8.3 Requirements for anchor handling equipment for ships with additional service feature "anchor handling" and "anchor handling stab"

8.3.1 General *(1/1/2026)*

The provisions in [8.3] are applicable to anchor handling equipment made up of steel. The steel of the anchor handling equipment is to comply with the applicable requirements of Part D.

8.3.2 Documents to be submitted *(1/1/2026)*

The documents to be submitted for the review and the approval of the guide pins and of the stoppers design are listed in Tab 8:

Table 8 : Documents to be submitted (guide pins and stoppers) *(1/1/2026)*

No.	A/I **(1)**	Document
1	I	General Assembly: main views of the device with the captions of the various components, with the extreme angles of working rotations and with the safe working load specification.
2	A	Structural Drawings: representation of each device component showing the scantlings, the weld features, the bolt features and the construction material specification.
(1) A: to be submitted for approval I: to be submitted for information		

The documents to be submitted for the review and the approval of the anchor handling winches design are listed in Tab 9.

Table 9 : Documents to be submitted (Anchor handling winch) *(1/1/2026)*

No.	A/I **(1)**	Document
1	I	General Assembly: main views of the winch with the captioning of the various components.
2	I	Data Sheet: sheet with the specification of the following values: • active pull at each layer; • winding speed at each layer; • power and torque of the prime mover; • reduction ratio; • max brake torque; • rope construction material; • rope diameter; • rope length.
3	A	Structural drawings: representations showing the scantlings, the weld features, the bolt features, and the construction material specification of the following components: • Frame; • Drum; • Shaft; • Brake; • Accessories (if any).
(1) A: to be submitted for approval I: to be submitted for information		

8.3.3 Anchor handling winch - Configuration *(1/1/2026)*

The anchor handling winch brake is normally to act directly on the drum and is to be operable in case of failure of the primary power supply system (either manually or otherwise arranged).

Anchor handling winches are to be provided with an emergency release system as described in [8.3.5].

The dimensioning of the winch drum is to take into account the rope bending specifications provided by the rope manufacturer.

The in-board end of the rope is to be attached to the winch drum with a weak link or similar arrangement that is designed to release the towline at low load. In no case less than three turns are to remain on the drum in under normal operation.

Any dual service winch to be used both for towing operation and for anchor handling operation is to be compliant with the requirements of [8.3] and with those of Ch 14, Sec 2, [3.8].

8.3.4 Anchor handling winch - Strength *(1/1/2026)*

The strength of the anchor handling winch is to be checked with respect to the following loads:

a) Haul in Load (HIL): force equal to the max active pulling capacity of the drum on the rope at the first layer.

b) Brake Load (BL): force equal to the max retaining capacity of the brake before slippage with the rope at the first layer.

c) Rendering Load (RL): force equal to the rope tension when drum starts to rotate in the opposite direction of the applied driving torque.

The stresses acting on each component of the winch calculated with the above loads are not to exceed the allowable stresses reported on Tab 10; it is to be noted that the stresses can be obtained by an engineering analysis or by a FEM calculation but they have always to be combined in Von Mises stresses before comparison with the allowable stresses.

Table 10 : Allowable stresses *(1/1/2026)*

Load	Allowable Stress
HIL	Reh / 2,5
BL	Reh / 1,25
RL	Reh / 1,20
Note 1: Reh (yield stress) is not to be taken more than 80% of Rm (ultimate tensile stress).	

When the stresses acting in the winch components are calculated by means of FEM calculations taking accurately into account the stress concentrations, the allowable stresses envisaged in Tab 8 may be multiplied by 1,1.

Specific buckling and/or fatigue analysis aimed to show the compliance of the winch components with the requirements of any recognized national or international standard may be requested by the Society on a case-by-case basis.

In all cases, the thickness of the drum is to be checked in compliance with the provisions of Ch 14, Sec 2, [3.8.5].

8.3.5 Anchor handling winch - Brake *(1/1/2026)*

The retaining capacity of the brake is not to be less than 1,25 times the max dynamic force on the winch line during the anchoring handling operation. In no case, however, the retaining capacity of the brake is not to be less than 2,0 times the haul in load of the winch.

8.3.6 Anchor handling winch - Emergency release system *(1/1/2026)*

The anchor handling winch is to be provided with a system for releasing the rope in a quick, safe and controlled manner under all critical circumstances like overloading, loss of power or loss of the ordinary controls.

The controls of the emergency release system shall be fitted mainly in the winch control station. However, a second control shall be fitted also in another location having ease of access and good visibility on the operational field.

The controls of the emergency release system shall be easily detectable by any operator and be protected against unintentional activation. Instructions for the proper usage of the emergency release system controls shall be clearly displayed close to the controls themself.

8.3.7 Guide pins - Strength *(1/1/2026)*

The strength of the pins is to be checked with respect to the greatest of the following loads:

a) 2·Safe Working Load (SWL): 2 times the max design rope tension applied to the pin structures in static conditions.

b) Brake Load (BL): force equal to the max retaining capacity of the ah winch brake before slippage with the wire rope at the first layer.

c) 2·Haul In Load (HIL): 2 times the max active pulling capacity of the ah winch drum on the rope at the first layer.

The stresses acting on each component of the pins calculated with the above loads are not to exceed the allowable stress reported on Tab 11; it is to be noted that the stresses can be obtained by an engineering analysis or by a FEM calculation, but they have always to be combined in Von Mises stresses before comparison with the allowable stresses.

Table 11 : Allowable stresses *(1/1/2026)*

Load	Allowable Stress
max (2·SWL;BL;2·HIL)	Reh / 1,2

When the stresses acting in the pin components are calculated by means of FEM calculations taking accurately into account the stress concentrations, the allowable stresses envisaged in Tab 8 may be multiplied by 1,1.

Specific buckling and/or fatigue analysis by the Society on a case-by-case basis.

8.3.8 Stoppers - Strength *(1/1/2026)*

The strength of the wire stoppers is to be checked with respect to 2 times the max design rope tension applied to the stopper structures in static conditions (2·Safe Working Load (SWL)).

The stresses acting on each component of the stoppers calculated with the above load are not to exceed the allowable stress reported on Tab 12; it is to be noted that the stresses can be obtained by an engineering analysis or by a FEM calculation, but they have always to be combined in Von Mises stresses before comparison with the allowable stresses.

Table 12 : Allowable stresses *(1/1/2026)*

Load	Allowable Stress
2·SWL	Reh / 1,2

When the stresses acting in the stopper components are calculated by means of FEM calculations taking accurately into account the stress concentrations, the allowable stresses envisaged in Tab 8 may be multiplied by 1,1.

Specific buckling and/or fatigue analysis may be requested by the Society on a case-by-case basis.

8.3.9 Stoppers - Emergency release system *(1/1/2026)*

The stoppers is to be provided with a system for releasing the rope in a quick, safe and controlled manner under all critical circumstances like overloading, loss of power or loss of ordinary controls.

The controls of the emergency release system are to be fitted mainly in the winch control station. However, a second control is to be fitted also in another location having ease of access and good visibility on the operational field.

The controls of the emergency release system are to be easily detectable by any operator and be protected against unintentional activation. Instructions for the proper usage of the emergency release system controls are to be clearly displayed close to the controls themself.

8.3.10 Roller - Strength *(1/1/2026)*

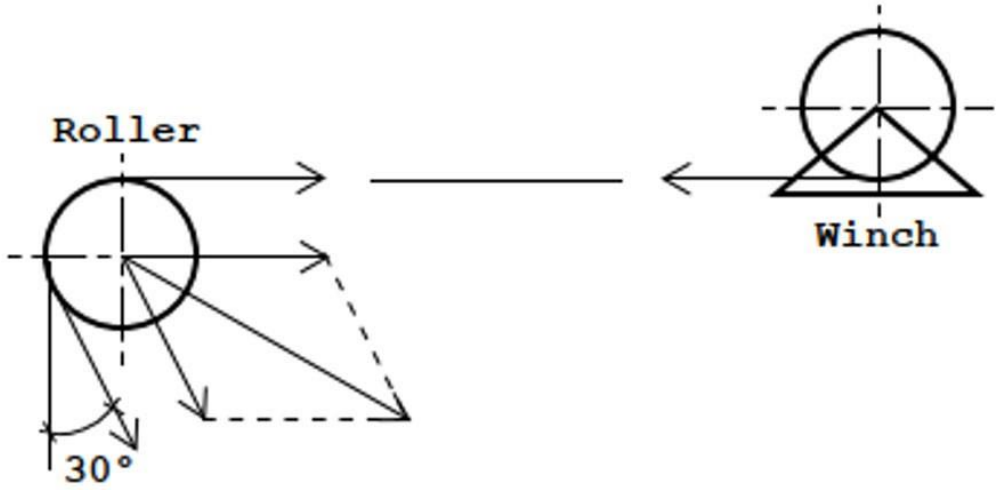
The strength of the roller is to be checked with respect to the greatest of the following loads:

a) Brake Load (BL): force equal to the max retaining capacity of the ah winch brake before slippage with the wire rope at the first layer.

b) 2·Haul In Load (HIL): 2 times the max active pulling capacity of the ah winch drum on the rope at the first layer.

The combined force on the roller is to be obtained considering that the max angle between a vertical line and the inclined line of the anchor cable below the hull is equal to 30° towards the winch (see Fig 7).

Figure 7 : Roller wrap angle *(1/1/2026)*



The stresses acting on each component of the pins calculated with the above loads are not to exceed the allowable stress reported on Tab 13; it is to be noted that the stresses can be obtained by an engineering analysis or by a FEM calculation, but they have always to be combined in Von Mises stresses before comparison with the allowable stresses.

Table 13 : Allowable stresses *(1/1/2026)*

Load	Allowable Stress
max (BL;2·HIL)	Reh / 1,2

When the stresses acting in the pin components are calculated by means of FEM calculations taking accurately into account the stress concentrations, the allowable stresses envisaged in Tab 8 may be multiplied by 1,1.

Specific buckling and/or fatigue analysis by the Society on a case-by-case basis.

8.3.11 Supporting hull structures *(1/1/2026)*

The scantlings of supporting hull structures are to be in compliance with Part B, Chapter 7 or Part B, Chapter 8, with respect to the following loads:

a) max (2·HIL;BL;RL) for the structures supporting the anchor handling winch;

b) max (2·SWL;BL;2·HIL) for the structures supporting the guide pins;

c) max (2·SWL) for the structures supporting the wire stoppers;

d) max (BL;2·HIL) for the structures supporting the roller.

8.3.12 Winch monitoring systems *(1/1/2026)*

The ship with additional service feature **anchor handling stab** is to be fitted with a monitoring system on the bridge deck showing the following information:

a) winch operation data (tension of steel wire rope, wirerope length, wire speed);

b) winch control system status.

8.3.13 Anchor handling winch - Line *(1/1/2026)*

The breaking load of the anchor handling line is not to be less than the max between BL and 2·HIL for both steel and synthetic ropes.

8.3.14 Anchor handling loose gear *(1/1/2026)*

The anchor handling loose gear is to be designed and tested according to the provisions for the offshore loose gear in Chapter 12 of TASNEEF Rules for loading and unloading arrangements and for other lifting appliances on board ships. The PSI factor to be considered in the design verifications and in the testing is to be equal to 1,8.

8.3.15 Anchor handling winch - Testing *(1/1/2026)*

The anchor handling winch is to be load tested with respect to the 95% of the BL and with respect to the HIL after installation on board. The rope of the winch is to be fixed to an onshore strong point or to an anchor on the seabed.

Functional tests are to be carried out after installation on board aimed at verifying the following aspects:

a) proper working within the specified limitations;

b) proper working under the normal operation modes;

c) proper working under the emergency operation modes, including the emergency release and the dead ship operations.

8.4 Equipment

8.4.1 Chain cables for anchors *(15/3/2009)*

With the exception of ships with the additional class notation **DYNAPOS**, the required total length and the diameter of chain cables for bow anchors are to be those obtained from Pt B, Ch 10, Sec 4, Tab 1, for the EN range in the table, two rows below the one calculated according to Pt B, Ch 10, Sec 4, [2.1.2] or Pt B, Ch 10, Sec 4, [2.1.3], as applicable, for the ship under consideration.

8.4.2 Mooring lines

The length of mooring lines is to be calculated according to Pt B, Ch 10, Sec 4, [3.5].

However, in the case of ships provided with devices enabling ample manoeuvring characteristics (e.g. ships provided with two or more propellers, athwartship thrust propellers, etc.), the length of mooring lines, in m, may be reduced to (L+20).

8.4.3 Chain locker

Chain lockers are to be arranged as gas-safe spaces. Hull penetrations for chain cables and mooring lines are to be arranged outside the gas-dangerous spaces specified in [1.1.16].

8.4.4 Towline breaking load for ships with additional service feature standby vessel *(1/7/2003)*

For ships with additional service feature **standby vessel**, the towline breaking load is to be not less than 0,04 P, in t, where P is the total power of the propulsion engines, in kW.

SECTION 3 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Application

1.1.1 *(1/1/2022)*

This Section provides, for ships having the service notation **supply vessel**, requirements for:

- machinery systems
- cargo tanks and piping systems, in particular where the service features **oil product** or **chemical product** are assigned
- the calculation of the continuous duty pull of windlasses.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted for approval.

2 Machinery systems

2.1 Bilge system

2.1.1 General

In supply vessels having the service feature **oil product** or **chemical product**, cargo pump rooms, duct keels below cargo tanks, hold spaces in which independent cargo tanks are installed and all gas-dangerous, dry cofferdams are to be served by an independent bilge pumping system entirely situated within the cargo area and fitted with pumps or ejectors. No connection is permitted with the bilge system serving gas-safe spaces of the ship.

2.1.2 Drainage of cargo pump rooms

Pumps and ejectors used for the drainage of cargo pump rooms are also to be capable of leading their delivery to a cargo tank, through a non-return valve and a connection at the tank top. Such provisions are intended to enable the drainage of such spaces in the event of cargo leakages without the risk of sea pollution.

2.1.3 Specific requirement for acids

Spaces for acid storage tanks and acid pumping and piping are to be provided with drainage arrangements of corrosion-resistant materials.

2.2 Other piping systems not intended for cargo

2.2.1 Piping systems serving ballast tanks

Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks are to be independent of similar equipment serving cargo tanks.

2.2.2 Piping systems serving spaces adjacent to cargo tanks

Where intended for ballast water, fuel oil, foam-forming liquids or dispersants, spaces adjacent to cargo tanks may be drained by pumps located in the machinery space, provided that the piping is directly connected to the associated pump and does not run through cargo tanks or cargo storage vessels.

Table 1 : Documents to be submitted

No.	A/I **(1)**	Document **(2)**
1	A	Plan of cargo handling systems intended for: • powdery products such as cement, baryte, bentonite, etc. • liquid muds • oil products **(3)** • chemical products **(4)**
2	A	Plan of gas vents in cargo tanks and cargo storage vessels **(3) (4)**
3	A	Plan of level gauging systems in cargo tanks and cargo storage vessels **(3) (4)**
4	A	Plan of the draining systems serving bilges in the cargo pump room and other gas-dangerous spaces **(3) (4)**
5	A	Plan of the pumping systems serving non-dry spaces adjacent to cargo tanks and cargo storage vessels **(3) (4)**
6	A	Constructional plan of the automatic shut-off devices fitted to cargo hose couplings **(3)**
7	A	Plan of the cargo heating system

(1) A: To be submitted for approval in four copies
I: To be submitted for information in duplicate

(2) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

(3) for ships having the service feature **oil product**.

(4) for ships having the service feature **chemical product**.

2.2.3 Air pipes and sounding pipes of gas-dangerous cofferdams

a) Gas-dangerous cofferdams are to be provided with air pipes led to the open and, where not accessible, also with sounding pipes.

b) Outlets to the open of air pipes are to be fitted with easily removable metallic flameproof wire gauze.

2.3 Cargo heating systems

2.3.1 General

Heating media for cargo heating are to be compatible with the cargo itself and their temperature is not to exceed 220°C.

2.3.2 Use of steam

Where steam is used as a heating medium, the condensate from the cargo heating system is to be led to an observation tank located in an accessible, well-ventilated and well-lit position in the machinery space, well clear of boilers and other heat sources.

2.3.3 Use of cooling water

Cooling water from machinery in the engine room is not to be used for cargo heating. When it is intended to use the heat from such water, a secondary system outside the engine room is to be provided.

2.4 Exhaust pipes

2.4.1 In supply vessels having the service feature **oil product** or **chemical product**, the exhaust outlets from engines are to be fitted as high as practicable above the upper deck and are to be provided with spark arresters.

2.5 Steering gear

2.5.1 The steering gear is to be capable of putting the rudder from 35° on either side to 30° on the other side in not more than 20 seconds with the ship at its deepest seagoing draught and running ahead at maximum service speed.

3 Cargo systems - Requirements applicable to oil and chemical products

3.1 Cargo segregation

3.1.1 For cargo handling, a pumping and piping system entirely separate from other pumping and piping systems on board is to be provided. Such systems are not to pass through any accommodation, service or machinery space other than cargo pump rooms.

3.2 Materials

3.2.1 Materials for construction of tanks, piping, fittings and pumps are to be in accordance with Ch 7, Sec 4, [3.3.2], Chapter 6 of the IBC Code, or Chapter 6 of the IGC Code, as applicable.

3.3 Installation of independent portable tanks

3.3.1 Independent portable tanks are to be fitted on the weather deck and are subject to the following conditions:

- the portable tanks are to be securely fastened to the hull structure to the satisfaction of the Society
- in the zone of the weather deck where the portable tanks are arranged, a suitable possibly removable containment coaming is to be fitted such as to prevent any spillages and flowing to gas-safe areas
- a space is to be left between tanks and ship sides sufficient to allow easy passage of ship personnel and transfer of fire-fighting arrangements.

4 Cargo systems of ships having the service feature “oil product”

4.1 Cargo pumping system, piping system and pump rooms

4.1.1 General *(1/1/2017)*

a) Where cargo handling pumps are installed in a space set aside for that purpose, such space is to comply with the applicable requirements for oil tankers. Refer to Ch 7, Sec 4 or Ch 7, Sec 5 for FP>60°C.

b) For the construction, installation and operation of cargo pumps, the applicable requirements for oil tankers are to be complied with. Refer to Ch 7, Sec 4 or Ch 7, Sec 5 for FP>60°C.

4.1.2 Piping system *(1/1/2025)*

a) The cargo piping system is to be installed, except as stipulated in [4.1.3], within the cargo tank and cargo storage vessel area and is not to run through tanks, fuel oil tanks and other compartments not belonging to the cargo system.

b) Where necessary, cargo piping is to be provided with joints or expansion bends (see Note 1).

c) Pipe lengths serving tanks are to be provided with shut-off valves operable from the weather deck.

d) In order to prevent any generation of static electricity, the outlets of filling lines are to be led as low as possible in the tanks.

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

4.1.3 Loading and unloading connections

a) Pipe ends, valves and other fittings to which hoses for cargo loading and unloading are connected are to be of steel or other ductile material and are to be of solid construction and effectively secured.

b) Connecting couplings for cargo hoses are to be fitted with devices which automatically shut off the cargo piping when the hose is disconnected and with means for quick-release of the hose, to be provided by the installation either of a coupling hydraulically controlled from outside the cargo area or of a weak link assembly which will break when subjected to a pre-determined pull.

c) Where a pipe end to which hoses for cargo loading and unloading are connected is arranged outside the cargo tank area, the connection piping to such end is to be provided, in way of its connection to the manifold in the cargo tank area, with a blank spectacle flange or a spool piece, irrespective of the number and type of valves fitted in way of such connection. The space within a range of 3 metres from the above pipe end is to be considered gas-dangerous as far as electrical installations or other sources of ignition are concerned.

4.2 Cargo tanks and cargo storage vessels

4.2.1 Design and construction of portable tanks

a) The cargo handling system serving portable tanks is to be such that liquid heads higher than those allowable for cargo tanks, if any, served by the same system cannot occur.

b) Scantling of portable tanks is to be in compliance with the provisions of Pt C, Ch 1, App 4, except that the minimum thickness is not to be less than 5 mm.

c) Provisions are to be made such that any portable tank is easily identifiable by means of markings or suitable plates.

d) Portable tanks are to be provided with appropriate access hatches allowing the use of portable gas-freeing equipment.

4.2.2 Level gauging systems

a) Each cargo tank or cargo storage vessel is to be fitted with at least one level gauging device of the closed type. Refer to Ch 7, Sec 4, [4.4.2].

b) Sounding pipes may be accepted provided that they are so constructed and installed as to minimise the quantity of gas released during sounding operations. Such sounding pipes are not to be arranged within enclosed spaces.

4.2.3 Venting systems *(1/1/2017)*

Cargo tanks and cargo storage vessels are to be provided with gas venting systems entirely separate from any vent pipes serving other compartments. Such systems are to comply with the requirements for gas venting systems of cargo tanks of oil tankers. Refer to Ch 7, Sec 4, [4.2] or Ch 7, Sec 5, [4.2] for FP>60°C.

4.3 Prevention of pollution

4.3.1 *(1/1/2017)*

Residues of cargo oil, tank washing, other mixtures or ballast water containing cargo oil may be discharged into the sea provided that the discharge is in accordance with the relevant conditions as required under MARPOL 73/78, Annex I. Refer to Ch 7, Sec 4, [5] or Ch 7, Sec 5, [5] for FP>60°C.

5 Cargo systems of ships having the service feature “chemical product”

5.1 General

5.1.1 Unless otherwise stated, the special requirements for the cargo as referred to in Chapter 17 of the IBC Code or Chapter 19 of the IGC Code are applicable.

5.2 Cargo pumping and piping systems

5.2.1 Segregation

Cargoes which react in a hazardous manner with other cargoes or fuel oils are to have separate pumping and piping systems not passing through other cargo tanks containing such cargoes, unless encased in a tunnel.

5.2.2 Cargo transfer system

a) The cargo transfer system is to comply with the requirements of Chapter 5 of the IBC Code.

b) The remote shutdown devices for all cargo pumps and similar equipment, required by 5.6.1.3 of the IBC Code, are to be capable of being activated from a dedicated cargo control location which is manned at the time of cargo transfer and from at least one other location outside the cargo area and at a safe distance from it.

c) In the case of transfer operations involving pressure in excess of 5 MPa gauge, arrangements for emergency depressurising and disconnection of the transfer hose are to be provided. The controls for activating emergency depressurisation and disconnection of the transfer hose are to meet the provisions of b) above.

5.2.3 Special requirements for acids

Piping systems intended for acids are to comply with the following provisions:

a) Flanges and other detachable connections are to be covered by spray shields.

b) Portable shield covers protecting the connecting flanges of the loading manifold are to be provided. Drip trays of corrosion-resistant material are to be provided under loading manifolds for acids.

5.3 Cargo tanks

5.3.1 General

a) Cargo tanks are to be of the type required by the IBC Code or IGC Code, as applicable.

b) Portable tanks meeting the requirements of Section 13 of the General Introduction to the International Maritime Dangerous Goods Code for the cargo concerned or other portable tanks specifically approved by the Society may be used, provided that they are properly located and secured to the vessel.

5.3.2 Design, construction and testing of the tanks

a) The design of the tanks is to comply with standards acceptable to the Society taking into account the carriage temperature and relative density of cargo. Due consideration is also to be given to dynamic forces and any vacuum pressure to which the tanks may be subjected.

b) Integral and independent gravity tanks are to be constructed and tested according to recognised standards taking into account the carriage temperature and relative density of cargo.

c) The greatest of the following design pressures (gauge) is to be used for determining scantlings of independent pressure tanks:

- 0,07 MPa,
- the vapour pressure of the cargo at 45°C,
- the vapour pressure of the cargo at 15°C above the temperature at which it is normally carried, or
- the pressure which occurs in the tank during the loading or unloading.

d) Except for the tank connections to cargo pump rooms, all tank openings and connections to the tank are to terminate above the weather deck and are to be located in the tops of the tanks. Where cofferdams are provided over integral tanks, small trunks may be used to penetrate the cofferdam.

Note 1: This clause need not be applied for pollution hazard only substances having a flashpoint exceeding 60°C.

5.3.3 Level gauging systems and level alarms

a) Each cargo tank is to have a level gauging system and, where required by Chapter 17 of the IBC Code, a level alarm. Such devices are to comply with the relevant requirements of the IBC Code.

Note 1: Requirement 15.19.6 of the IBC Code for a visual and audible high-level alarm may be waived by the Society taking into account the cargo carriage arrangements and cargo loading procedures.

b) Level gauging systems for process tanks on board well-stimulation vessels are to be to the satisfaction of the Society.

5.3.4 Venting systems

a) Cargoes which react in a hazardous manner with other cargoes or fuel oils are to have separate tank venting systems.

b) Independent pressure tanks are to be fitted with pressure relief devices which are so designed as to direct the discharge away from personnel and have a set pressure and capacity which is in accordance with standards acceptable to the Society taking into account the design pressure referred to in [5.3.2].

c) Cargo tank vent systems of integral or independent gravity tanks are to meet the requirements of the IBC Code, except that the height specified in IBC 8.2.2 may be reduced to 2 m.

d) The location of cargo tank vent outlets for independent pressure tanks and for cargo tanks used to carry pollution hazard only substances with a flashpoint exceeding 60°C (closed cup test) is to be to the satisfaction of the Society.

e) Cargo tank vent systems of portable tanks allowed under [5.3.1] are to be to the satisfaction of the Society, taking into account the provisions of [5.3.4].

5.4 Prevention of pollution

5.4.1 Category X and Y substances *(1/1/2007)*

Discharge into the sea of category X and Y noxious liquid substances or ballast water, tank washing, or other residues or mixtures containing such substances is prohibited. Any discharges of residues containing noxious liquid substances are to be to reception facilities in port. As a consequence of this prohibition, the Society may waive the requirements for efficient stripping and underwater discharge arrangements in MARPOL 73/78, Annex II.

5.4.2 Category Z substances *(1/1/2007)*

Residues of category Z substances, tank washings, other mixtures or ballast water containing such substances may be discharged into the sea provided that the discharge is in accordance with the relevant conditions as required under MARPOL 73/78, Annex II.

5.5 Personnel protection

5.5.1 Decontamination showers and eyewashes

Except in the case of pollution hazard only substances, a suitably marked decontamination shower and eyewash are to be available on deck in a convenient location. The shower and eyewash are to be operable in all ambient conditions.

5.5.2 Protective and safety equipment

Protective and safety equipment is to be kept on board in suitable locations as required in Chapter 14 of the IBC Code or the IGC Code for products to be carried.

6 Requirements for windlass

6.1 Assumptions for the calculation of the continuous duty pull

6.1.1 *(1/1/2022)*

The calculation of the continuous duty pull P_C that the windlass unit prime mover is to be able to supply is based on the following assumptions:

- ordinary stockless anchors
- wind force equal to 6 on Beaufort Scale
- water current velocity 3 knots
- anchorage depth 100 m
- P_C includes the influences of buoyancy and hawse pipe efficiency; the latter is assumed equal to 70%
- the anchor masses assumed are those defined in Pt D, Ch 4, Sec 1, excluding tolerances
- only one anchor is assumed to be raised at a time.

Owing to the buoyancy, the chain masses assumed are smaller than those defined in Pt D, Ch 4, Sec 1, and are obtained, per unit length of the chain cable, in kg/m, from the following formula:

$m_L = 0,0218\ d^2$

where d is the chain cable diameter, in mm.

6.2 Calculation of the continuous duty pull

6.2.1 *(1/1/2022)*

The calculation of the continuous duty pull P_C is to be in accordance to Pt C, Ch 1, Sec 15.

Chapter 16
FIRE FIGHTING VESSELS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **fire-fighting ship**, as defined in Pt A, Ch 1, Sec 2, [4.8.4].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to fire-fighting ships.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to fire-fighting ships.

Table 1

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection and extinction	Sec 4
(1) No specific requirements for fire fighting ships are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 Stability

1.1 Intact stability

1.1.1 General

The stability of the ship for the loading conditions defined in Pt B, Ch 3, App 2, [1.2.11] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

1.1.2 Additional criteria

All the loading conditions reported in the trim and stability booklet, with the exception of lightship, are also to be checked in order to investigate the ship's capability to support the effect of the reaction force of the water jet in the beam direction due to the monitors fitted on board.

A fire-fighting ship may be considered as having sufficient stability, according to the effect of the reaction force of the water jet in the beam direction due to the monitors fitted on board, if the heeling angle of static equilibrium θ_0, corresponding to the first intersection between heeling and righting arms (see Fig 1), is less than 5°.

The heeling arm may be calculated as follows:

$$b_h = \frac{\Sigma \cdot R_i \cdot h_i + S \cdot (T/2 - e)}{9{,}81 \cdot \Delta} \cos\theta$$

where:

b_h : Heeling arm, in m, relevant to the reaction force of the water jet of the monitors fitted on board, and to the effect of transversal manoeuvring thrusters. The monitors are assumed to be oriented in beam direction parallel to the sea surface, so as to consider the most severe situation.

R_i : Reaction force, in kN, of the water jet of each monitor fitted on board (see Fig 2)

h_i : Vertical distance, in m, between the location of each monitor and half draught (see Fig 2)

S : Thrust, in kN, relevant to manoeuvring thruster(s), if applicable (see Fig 2)

e : Vertical distance, in m, between the manoeuvring thruster axis and keel (see Fig 2)

Δ : Displacement, in t, relevant to the loading condition under consideration

T : Draught, in m, corresponding to Δ (see Fig 2).

Figure 1 : Heeling and righting arm curves

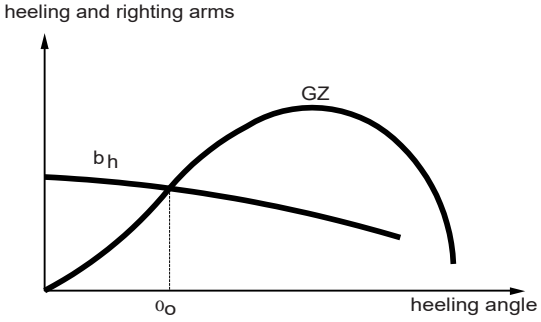
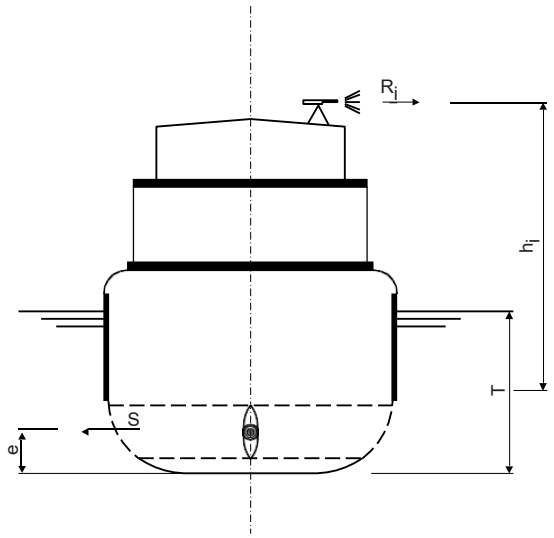


Figure 2 : Reaction force of water jet in the beam direction due to monitors



2 Structure design principles

2.1 Hull structure

2.1.1 The strengthening of the structure of the ships, where necessary to withstand the forces imposed by the fire-extinguishing systems when operating at their maximum capacity in all possible directions of use, are to be considered by the Society on a case-by-case basis.

2.2 Water and foam monitors

2.2.1 The monitors are to be of robust construction and are to be of a type approved by the Society.

The seatings of the monitors are to be of adequate strength for all modes of operation.

3 Other structures

3.1 Arrangement for hull and superstructure openings

3.1.1 On ships which are not fitted with a water-spraying system complying with Sec 4, [3], all windows and port lights are to be fitted with efficient deadlights or external steel shutters, except for the wheelhouse.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Application

1.1.1

a) This Section provides, for ships having the service notations **fire-fighting ship E**, **fire-fighting ship 1**, **fire-fighting ship 2**, and **fire-fighting ship 3**, specific requirements for:

- machinery systems
- fire-fighting systems installed on board the ship and intended for fighting of external fires.

b) The requirements related to the self-protection water-spraying systems fitted to fire-fighting ships having the additional service feature **water spray** are given in Sec 4.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted.

2 Design of machinery systems

2.1 Manoeuvrability

2.1.1 General

a) The ratios between the main ship dimensions and the power of propulsion engines and of engines driving side thrusters are to be adequate and such as to ensure an effective manoeuvrability during fire-fighting operations.

b) The side thrusters and the main propulsion system are to be capable of maintaining the ship in position in still water and of withstanding the reaction forces of the water monitors even in the most unfavourable combination of operating conditions of such monitors, without requiring more than 80% of the above propulsive power, to prevent engine overload.

Table 1 : Documents to be submitted

No.	A/I **(1)**	Document **(2)**
1	I	General arrangement showing the disposition of all fire-fighting equipment
2	A	Details of all fire-fighting equipment such as pumps and monitors, including their capacity, range and trajectory of delivery
3	A	Schematic diagram of the water fire-fighting system
4	A	Plan of the water monitor seating arrangements
5	A	Diagram of local control and remote control system for water monitors
6	A	Schematic diagram of the fixed foam fire-extinguishing system
7	A	Plan of the foam monitor seating arrangements **(3)**
8	A	Diagram of local control and remote control system for foam monitors **(3)**
9	A	Specification and plan showing the location of firemen’s outfits
10	A	Particulars of the means of keeping the ship in position during fire-fighting operations
11	I	Calculation of the required fuel oil capacity according to [2.2.1] **(4)**

No.	A/I **(1)**	Document **(2)**
12	I	Operating manual

(1) A: To be submitted for approval in four copies
I: To be submitted for information in duplicate

(2) Diagrams are also to include, where applicable:
- the (local and remote) control and monitoring systems and automation systems
- the instructions for the operation and maintenance of the piping system concerned (for information).

(3) for ships having the service notation **fire-fighting ship 3**.

(4) for ships having one of the following service notations: **fire-fighting ship 1**, **fire-fighting ship 2**, **fire-fighting ship 3**.

2.1.2 Power control system

An operating control system of the power supplied by the engines is to be provided, including:

- an alarm device operating at 80% of the maximum propulsive power available in free navigation, and
- an automatic reduction of power on reaching 100% of the above propulsive power,

to prevent engine overload.

Note 1: Such operating control system may not be required, at the discretion of the Society, in cases where the installed power is redundant.

2.2 Fuel oil capacity

2.2.1 All ships are to have fuel oil tanks whose capacity is to be sufficient for continuous fighting of fires whilst all the water monitors are operating for a period of time not less than:

- 24 hours in the case of ships having the service notation **fire-fighting ship 1**
- 96 hours in the case of ships having the service notation **fire-fighting ship 2** or **fire-fighting ship 3**.

This capacity is to be additional to that provided for the normal operation of the ship (propulsion, etc.).

Note 1: The determination of such required capacity is the responsibility of the Designer.

2.3 Scuppers

2.3.1 When the ship is protected by a water-spraying system, suitable scuppers or freeing ports are to be provided to ensure efficient drainage of water accumulating on deck surfaces when such system is in operation.

3 General requirements for fire-fighting systems

3.1 General

3.1.1 This Article applies to both water fire-extinguishing systems and fixed foam fire-extinguishing systems.

3.2 Independence of pumping and piping systems

3.2.1 The piping system serving the water and foam monitors are not to be used for other services except for the water-spraying system referred to in Sec 4.

3.2.2 Where the water monitor pumps are also used for the water-spraying system referred to in Sec 4, it is to be possible to segregate the two systems by means of a valve.

3.2.3 The piping system from the pumps to the water monitors is to be separate from the piping system to the hose connections required for the portable fire-fighting equipment referred to in [6.2].

3.3 Design and construction of piping systems

3.3.1 General

a) Fire-fighting piping systems are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) The maximum design water velocity is not normally to exceed 2 m/s in the suction line.

3.3.2 Sea suctions

a) Sea suctions for fire-fighting pumps are not to be used for other purposes.

b) Sea suctions and associated sea chests are to be so arranged as to ensure a continuous and sufficient water supply to the fire-fighting pumps, not adversely affected by the ship motion or by water flow to or from bow thrusters, side thrusters, azimuth thrusters or main propellers.

c) Sea suctions are to be located as low as practicable to avoid:
   - clogging due to debris or ice
   - oil intake from the surface of the sea.

d) Sea water inlets are to be fitted with gratings having a free passage area of at least twice that of the sea suction valve. Efficient means are to be provided for clearing the gratings.

3.3.3 Pumps

a) Means are to be provided to avoid overheating of the fire-fighting pumps when they operate at low delivery rates.

b) The starting of fire-fighting pumps when sea water inlet valves are closed is either to be prevented by an interlock system or to trigger an audible and visual alarm.

3.3.4 Valves

a) A sea water suction valve and water delivery valve with a nominal diameter exceeding 450 mm are to be provided with a power actuation system as well as a manual operation device.

b) The sea water suction valve and water delivery valve and pump prime movers are to be operable from the same position.

3.3.5 Protection against corrosion

Means are to be provided to ensure adequate protection against:

- internal corrosion, for all piping from sea water inlets to water monitors
- external corrosion, for the lengths of piping exposed to the weather.

3.3.6 Piping arrangement

Suction lines are to be as short and straight as practicable.

3.4 Monitors

3.4.1 Design of monitors

a) Monitors are to be of a type approved by the Society.

b) Monitors are to be of robust construction and capable of withstanding the reaction forces of the water jet.

3.4.2 Support of the monitors

The seatings of the monitors are to be of adequate strength for all mode of operations.

3.5 Monitor control

3.5.1 General

Water monitors and foam monitors are to be operated and controlled with a remote control system located in a common control station having adequate overall visibility.

3.5.2 Manual control

In addition to the remote control system, a local manual control is to be arranged for each monitor. It is to be possible to:

- disconnect the local manual control from the control station
- disconnect the remote control system, from a position close to each monitor, to allow the operation with the local manual control.

3.5.3 Valve control

The valve control is to be designed so as to prevent pressure hammering.

3.5.4 Control system

a) The control system is to comply with the relevant provisions of Pt C, Ch 3, Sec 1 and Pt C, Ch 3, Sec 2.

b) The control system is to be designed with a redundancy level such that lost function can be restored within 10 minutes.

c) In the case of a hydraulic or pneumatic control system, the control power units are to be duplicated.

3.5.5 Marking

All control and shut-off devices are to be clearly marked, both locally and in the control station.

4 Water fire-fighting system

4.1 Characteristics

4.1.1

a) For ships having the service notation **fire-fighting ship 1**, **fire-fighting ship 2** or **fire-fighting ship 3**, the number of pumps and monitors and their characteristics are to be in accordance with the requirements given in Tab 2.

b) For ships having the service notation **fire-fighting ship E**, the characteristics of the water fire-fighting system will be given special consideration by the Society.

4.2 Monitors

4.2.1 Monitors are to be so arranged as to allow an easy horizontal movement of at least 90° equally divided about the centreline of the ship. The allowed vertical angular movement is to be such that the height of throw required in Tab 2 can be achieved.

4.2.2 The monitors are to be located such that the water jet is free from obstacles, including ship's structure and equipment.

4.2.3 The monitors are to be capable of throwing a continuous full water jet without significant pulsations and compacted in such a way as to be concentrated on a limited surface.

4.2.4 At least two monitors are to be equipped with a device to make the dispersion of the water jet (spray jet) possible.

Table 2 : Number of pumps and monitors and their characteristics *(1/7/2004)*

Required characteristics	Service notations				
	fire-fighting ship 1	**fire-fighting ship 2**			**fire-fighting ship 3**
minimum number of water monitors	2	2	3	4	4
minimum discharge rate per monitor (m^3/h)	1200	3600	2400	1800	2400
minimum number of fire-fighting pumps	1	2			2
minimum total pump capacity (m^3/h) **(1)**	2400	7200			9600
length of throw of each monitor (m) **(2) (4)**	120	150			150
height of throw of each monitor (m) **(3) (4)**	45	70			70

(1) Where the water monitor pumps are also used for the self-protection water-spraying system, their capacity is to be sufficient to ensure the simultaneous operation of both systems at the required performances.

(2) Measured horizontally from the monitor outlet to the mean impact area.

(3) Measured vertically from the sea level, the mean impact area being at a distance of at least 70 m from the nearest part of the ship.

(4) The length and height of throw are to be capable of being achieved with the required number of monitors operating simultaneously in the same direction.

4.3 Piping

4.3.1 The maximum design water velocity is not normally to exceed 4 m/s in the piping between pumps and water monitors.

5 Fixed foam fire-extinguishing system

5.1 General

5.1.1 *(1/1/2007)*

a) Ships having the service notation **fire-fighting ship 3** are to be equipped with a fixed low expansion foam monitor system complying with the provisions of this Article.

b) Where a fixed low expansion foam monitor system is fitted on a ship having the service notation **fire-fighting ship 1** or **fire-fighting ship 2**, the arrangement and characteristics of the system will be considered by the Society on a case-by-case basis.

c) For ships having the service notation **fire-fighting ship E**, some relaxation in the provisions of this Section may be accepted by the Society.

5.2 Characteristics

5.2.1 Foam expansion ratio

The foam expansion ratio is not to exceed 12.

5.2.2 Foam monitors

a) The ship is to be fitted with two foam monitors, each having a foam solution capacity not less than 300 m^3/h.

b) The height of throw is to be at least 50 m above the sea level, when both monitors are in operation at the maximum foam production rate.

5.2.3 Foam concentrate capacity

Sufficient foam concentrate is to be available for at least 30 min of simultaneous operation of both monitors at maximum capacity.

Note 1: When determining the necessary quantity of foam concentrate, the concentration rate is assumed to be 5%.

5.3 Arrangement

5.3.1 Foam generating system

The foam generating system is to be of a fixed type with separate foam concentrate tank, foam-mixing units and piping to the monitors.

5.3.2 Pumps

The pumps of the water monitor system may be used for supplying water to the foam monitor system. In such case, it may be necessary to reduce the pump water delivery pressure to ensure correct water pressure for maximum foam generation.

6 Portable fire-fighting equipment

6.1 Portable high expansion foam generator

6.1.1 Ships having the service notation **fire-fighting ship 2** or **fire-fighting ship 3** are to be equipped with a portable high expansion foam generator having a foam capacity not less than 100 m^3/min for fighting of external fires.

6.1.2 The total capacity of foam concentrate is to be sufficient for 30 min of continuous foam production. The foam concentrate is to be stored in portable tanks of about 20 litres capacity.

6.2 Hydrants and fire hoses

6.2.1 Hydrants

a) Hydrants are to be provided in accordance with Tab 3.

b) At least half of the required hydrants are to be arranged on the main weather deck.

c) Where hydrants are fed by the pumps serving the monitor supply lines, provision is to be made to reduce the water pressure at the hydrants to a value permitting safe handling of the hose and the nozzle by one man.

6.2.2 Fire hose boxes

a) At least one box containing fire hoses is to be provided for every two hydrants.

b) Each box is to contain two fire hoses complete with dual-purpose (spray/jet) nozzles.

6.2.3 Fire hoses

a) Fire hoses and associated nozzles are to be of a type approved by the Society.

b) Fire hoses are to be of 45 to 70 mm in diameter and generally are to be 20 m in length.

Table 3 : Number of hydrants

fire-fighting ship E	fire-fighting ship 1	fire-fighting ship 2	fire-fighting ship 3
4 at each side	4 at each side	8 at each side	8 at each side **(1)**
(1) May be increased to 10 hydrants at each side, depending on the ship's length.			

7 Firemen's outfits

7.1 Number and characteristics

7.1.1 *(1/1/2007)*
The total number of firemen's outfits to be fitted on board is to be in accordance with Tab 4.

Table 4 : Number of firemen's outfits

fire-fighting ship E	fire-fighting ship 1	fire-fighting ship 2	fire-fighting ship 3
4	4	8	8

7.1.2 The air breathing apparatuses, protective clothing and electric safety lamps constituting parts of firemen's outfits are to be of a type approved by the Society.

7.1.3 Breathing apparatuses are to be of the self-contained type. They are to have a capacity of at least 1200 litres of free air.
At least one spare air bottle is to be provided for each apparatus.

7.1.4 The firemen's outfits are to be stored in a safe position readily accessible from the open deck.

7.2 Compressed air system for breathing apparatuses

7.2.1 General
All ships are to be equipped with a high pressure air compressor complete with all fittings necessary for refilling the bottles of air breathing apparatuses. The compressor is to be located in a suitable sheltered location.

7.2.2 Capacity
The capacity of the compressor is to be sufficient to allow the refilling of the bottles of air breathing apparatuses in no more than 30 min. This capacity is not to be less than 75 l/min.

7.2.3 Accessories
a) The compressor is to be fitted on the air suction with a suitable filter.
b) The compressor is to be fitted on the delivery with oil separators and filters capable of preventing passage of oil droplets or vapours to the air bottles.

8 Testing

8.1 General

8.1.1 The provisions of this Article are related to the workshop and on board tests to be carried out for:
- machinery systems
- fire-fighting systems.

They supplement those required in Part C, Chapter 1 for machinery systems.

8.2 Workshop tests

8.2.1 Tests for material
a) Materials used for the housing of fire-fighting pumps are to be subjected to a tensile test at ambient temperature according to the relevant provisions of Part D.
b) Materials used for pipes, valves and other accessories are to be tested in accordance with the provisions of Pt C, Ch 1, Sec 10, [21.3].

8.2.2 Hydrostatic testing

After completion of manufacture and before installation on board, pipes, valves, accessories and pump housings are to be submitted to a hydrostatic test in accordance with the provisions of Pt C, Ch 1, Sec 10, [21.4].

8.3 On board tests

8.3.1 Fixed fire-fighting systems

a) After assembly on board, the water fire-fighting system and the fixed foam fire-extinguishing system are to be checked for leakage at normal operating pressure.

b) The water fire-fighting system and fixed foam fire-extinguishing system are to undergo an operational test on board the ship, to check their characteristics and performances.

8.3.2 Propulsion and manoeuvring systems

a) A test is to be performed to check the manoeuvring capability of the ship.

b) The capability of the side thrusters and of the main propulsion system to maintain the ship in position with all water monitors in service without requiring more than 80% of the propulsive power is to be demonstrated.

SECTION 4 FIRE PROTECTION AND EXTINCTION

1 General

1.1 Application

1.1.1 *(1/1/2007)*

This Section provides, for ships having the service notations **fire-fighting ship 1**, **fire-fighting ship 2** and **fire-fighting ship 3**, specific requirements for:

- fire protection
- self-protection water-spraying system.

1.1.2 For ships having the service notation **fire-fighting ship E**, fire protection arrangements will be given special consideration by the Society.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted for approval.

2 Fire protection of exposed surfaces

2.1 Structural fire protection

2.1.1 *(1/7/2003)*

a) On ships having the service notation **fire-fighting ship 1**, all exterior boundaries above the lightest operating waterline, including superstructures and exposed decks, are to be of steel and are to be internally insulated so as to form A-60 class divisions unless they are self-protected with a water-spraying system having a capacity of not less than 10 l/min for each square metre (see also [3.2.1]).

b) On ships having the service notation **fire-fighting ship 2** or **fire-fighting ship 3**, all exterior boundaries are to be of steel but they need not be insulated.

c) On all ships, other boundaries may be constructed of materials other than steel, subject to special consideration by the Society.

2.2 Deadlights and shutters

2.2.1 On ships for which the additional service feature **water spray** is not assigned, steel deadlights or external steel shutters are to be provided on all windows, sidescuttles and navigation lights, except for the windows of the navigating bridge.

3 Self-protection water-spraying system

3.1 General

3.1.1 *(1/1/2007)*

The provisions of this Article apply to the self-protection water-spraying systems fitted to ships having the additional service feature **water spray**.

3.2 Capacity

3.2.1 The capacity of the self-protection water-spraying system is to be not less than 10 l/min for each square metre of protected area. In the case of surfaces which are internally insulated, such as to constitute A-60 class divisions, a lower capacity may be accepted, provided it is not less than 5 l/min for each square metre of protected area.

3.3 Arrangement

3.3.1 Areas to be protected

The fixed self-protection water-spraying system is to provide protection for all vertical areas of the hull and superstructures as well as monitor foundations and other fire-fighting arrangements, and is to be fitted in such a way as not to impair the necessary visibility from the wheelhouse and from the station for remote control of water monitors, also during operation of spray nozzles.

3.3.2 Sections

The fixed self-protection water-spraying system may be divided into sections so that it is possible to isolate sections covering surfaces which are not exposed to radiant heat.

3.3.3 Spray nozzles

The number and location of spray nozzles are to be suitable to spread the sprayed water uniformly on areas to be protected.

Table 1 : Documents to be submitted

No.	A/I **(1)**	Document
1	A	Plan showing the structural fire division, including doors and other closing devices of openings in A and B class divisions
2	I	Fire test reports for insulating materials
3	A	Schematic diagram of the fixed self-protection water-spraying system
(1) A: To be submitted for approval in four copies I: To be submitted for information in duplicate		

3.4 Pumps

3.4.1 Use of pumps serving other systems *(1/1/2007)*

The following pumps may be used for the self-protection water-spraying system:

- fire pumps supplying the fire main system
- water monitor system pumps referred to in Sec 3, [4].

In this case, a shut-off valve is to be provided to segregate the systems concerned.

3.4.2 Capacity of the pumps

a) The pumps of the self-protection water-spraying system are to have a capacity sufficient to spray water at the required pressure from all spray nozzles of the system.

b) Where the pumps serving the self-protection water-spraying systems are also used for another service, their capacity is to be sufficient to ensure the simultaneous operation of both systems at the required performances.

3.5 Piping system and spray nozzles

3.5.1 General

Pipes are to be designed and manufactured according to the requirements of Pt C, Ch 1, Sec 10.

3.5.2 Protection against corrosion

Steel pipes are to be protected against corrosion, both internally and externally, by means of galvanising or equivalent method.

3.5.3 Drainage cocks

Suitable drainage cocks are to be arranged and precautions are to be taken in order to prevent clogging of spray nozzles by impurities contained in pipes, nozzles, valves and pumps.

Chapter 17
OIL RECOVERY SHIPS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2012)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **oil recovery ship**, as defined in Pt A, Ch 1, Sec 2, [4.8.5].

If the ship collects only oil with flashpoint exceeding 60°C, this restriction will be reported on the ship operation manual and the service feature flash point > 60°C is assigned.

In the case of ships provided with tanks dedicated to the containment of oil both with flashpoint ≤ 60°C and with flashpoint > 60°C, in the ship operation manual (see Sec 3, Tab 1) and in the ship documents it is to be clearly indicated for each tank which is the allowed flashpoint of the oil contained therein.

1.1.2 *(1/7/2011)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to oil recovery ships.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to oil recovery ships.

Table 1 *(1/1/2007)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	Sec 4
Automation	**(1)**
Fire protection, detection and extinction	Sec 5
(1) No specific requirements for oil recovery ships are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 General

1.1 Oil removal

1.1.1 Oil removal is to be performed by conveying with suitable apparatuses the top layers of polluted water collected by the ship moving ahead into separation tanks and/or by skimming mobile belts or rotating disks acting on the oil film and/or by means of floating suction pumps operating on the sea surface.

Alternative methods, equivalent to those mentioned, are to be considered by the Society on a case-by-case basis.

1.2 Definitions

1.2.1 Accumulation tank

An accumulation tank is a tank intended for the retention of oil removed and separated from sea water.

1.2.2 Settling tank

A settling tank is a tank intended for the retention of polluted water and its subsequent separation from oil.

2 General arrangement design

2.1 Segregation of spaces intended for retention of oil

2.1.1 Tanks *(1/7/2011)*

Accumulation tanks are to be separated from the engine room and service and accommodation spaces,by means of a cofferdam or equivalent space.

Fuel tanks, settling tanks, tanks for ballast water, foam-forming liquid or anti-pollution liquid, storerooms for oil removal equipment and pump rooms are considered equivalent to a cofferdam.

This cofferdam may be omitted, however, between the above-mentioned spaces and

- settling tanks
- accumulation tanks that are dedicated to the retention of oil with flashpoint > 60°C only.

In the case of tanks containing foam-forming liquid having a bulkhead adjacent to accumulation tanks, fuel oil tanks or dispersing liquid tanks, the scantlings of such bulkhead and associated welds are to be adequately increased.

2.1.2 Openings in accumulation tank ceilings

All openings in accumulation tank ceilings are to lead to the open.

2.1.3 Location of the accumulation tanks

Accumulation tanks are to be located abaft the collision bulkhead.

2.1.4 Movable tanks

In the case of oil collected in movable tanks fitted on the weather deck, the location of such tanks is to be such as to comply with the requirements in Sec 3, [4.2] relevant to gas vents.

2.2 Dangerous spaces

2.2.1 *(1/7/2002)*

Dangerous spaces are those indicated in Sec 4, [3] and Sec 4, Tab 1.

2.3 Access to safe spaces

2.3.1 *(1/7/2002)*

See Sec 4, [3.1.3].

3 Stability

3.1 Intact stability

3.1.1 General

The stability of the ship for the loading conditions reported in the trim and stability booklet is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

4 Design loads

4.1 Oil removal and spraying

4.1.1 The still water and inertial loads transmitted by the operation of apparatuses and/or equipment for oil removal and spraying of any dispersant to the hull structure are to be taken into account.

5 Hull scantlings

5.1 Accumulation tanks

5.1.1 The net scantlings of any accumulation tanks consisting of movable tanks are considered by the Society on a case-by-case basis.

6 Other structures

6.1 Hull and superstructure openings

6.1.1 Windows in safe spaces located in front of dangerous spaces, where not of the fixed type, are to be such as to ensure an efficient gas-tight closure.

7 Construction and testing

7.1 Testing

7.1.1 Oil removal equipment

On completion of construction, a test is to be carried out on all equipment for oil removal in order to check:

- safeguards against fire and explosions during operations involving removal, retention on board, carriage and unloading of oil spilled on the sea surface
- structural strength in relation to stresses caused by equipment used during oil removal operations.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Application

1.1.1 *(1/7/2012)*

This Section provides, for ships having the service notation **oil recovery ship**, specific requirements for:

- machinery systems
- recovered oil pumping and piping systems
- tanks.

The requirements of this Section apply, in addition to those contained in Pt C, Ch 1, Sec 10, to oil recovery ships for collection of oil having flash point not exceeding 60°C, except what specified in items [1], [2.4.1] a), [3.1.1] b) and c), [3.1.2] and [3.2.1] b) which also apply to oil recovery ships for collection of oil having flash point exceeding 60°C.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted.

1.3 Definitions

1.3.1 Gas-dangerous areas

Gas-dangerous areas and zones are defined in Sec 2, [2.2.1].

1.3.2 Accumulation and settling tanks

Accumulation and settling tanks are defined in Sec 2, [1.2].

2 Machinery installations and piping systems not intended for recovered oil

2.1 Bilge system

2.1.1 Arrangements are to be provided to drain the recovered oil pump room by means of power pumps or a bilge ejector.

Note 1: On **oil recovery ships** of less than 500 tons gross tonnage, the pump room may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

2.2 Sea water cooling system

2.2.1 One of the suctions serving the sea water cooling system (see Pt C, Ch 1, Sec 10, [10.7.1]) is to be located in the lower part of the hull.

2.3 Water fire-extinguishing system

2.3.1 Sea suctions serving the fire water pumps are to be located as low as possible.

2.4 Exhaust gas systems

2.4.1

a) Exhaust lines from engines, gas turbines, boilers and incinerators are to be led to a gas-safe position as high as practicable above the deck and are to be fitted with a spark arrester.

b) Where the distance between the exhaust lines of engines and the dangerous zones is less than 3 m, the ducts are to be fitted in a position:
   - near the waterline if cooled by water injection, or
   - below the waterline in other cases.

2.5 Additional requirements for machinery installations in gas-dangerous areas

2.5.1 Attention is drawn to the risk of ignition in gas-dangerous spaces from sparking due to:

- formation of static electricity, or
- friction between moving parts.

2.5.2 No part having a surface temperature exceeding 220°C is permitted within the gas-dangerous areas.

2.5.3 Where precautions are taken against the risk of ignition, the installation of internal combustion engines may be permitted in zone 2 open gas-dangerous areas, subject to special consideration by the Society.

3 Pumping system, piping system and pump rooms intended for recovered oil

3.1 Design of pumping and piping systems

3.1.1 General

a) The relevant provisions of Ch 7, Sec 4, [3] and Pt C, Ch 1, Sec 10 are to be complied with.

b) Except where otherwise permitted by the Society, pumping and piping systems intended for recovered oil are to be independent from other pumping and piping systems of the ship.

c) Piping is to be permanently installed. However, the use of portable pumps may be permitted, subject to special consideration by the Society.

3.1.2 Systems for oil recovery

Oil recovery is to be performed:

- by conveying with suitable systems the top layers of polluted water collected by the ship moving ahead into separation tanks, and/or
- by skimming mobile belts or rotating disks acting on the oil film, and/or
- by means of floating suction pumps operating on the sea surface.

Alternative methods will be specially considered by the Society.

3.1.3 System for unloading oil residues

Ships fitted with structural accumulation tanks are to be equipped with a system enabling the unloading of oil residues contained in accumulation tanks to shore facilities or to a supply vessel, simultaneously with oil recovery.

3.2 Arrangement of piping systems and pump rooms

3.2.1 Piping systems *(1/7/2010)*

a) Piping systems for handling of oil recovered are not to pass through accommodation spaces.

Piping handling oil with flashpoint £ 60°C is allowed to pass through the following spaces provided that piping joints are of welded type:

- machinery spaces,
- service spaces,
- other enclosed gas-safe spaces.

b) Where the transfer of recovered oil into accumulation tanks is carried out by means of flexible hoses or movable piping, only suitable connections are to be used. Small hatches are not permitted.

3.2.2 Pump rooms *(1/1/2007)*

a) Pump rooms containing the pumps for handling the recovered oil are to comply with the provisions given in Chapter 7 for pump rooms of ship having the service notation **oil tanker**.

b) For draining of pump rooms, see [2.1.1].

3.2.3 *(1/7/2006)*

The separated oil is to be transferred from the settling tanks to the accumulation tanks.

In this way a pipe branch connection is to be provided between the settling tanks and the accumulation tanks.

The branch connection is to be provided with a suction pipe fitted at an adequate height inside the settling tanks where it is possible to collect the separated oil.

A dedicated system is to be provided to collect and discharge the water separated from the oil inside the settling tanks.

The instructions to the crew relevant to the removal of the separated oil from the settling tanks to the accumulation tanks are to be duly indicated in the operation manual.

4 Settling and accumulation tanks

4.1 General

4.1.1 The arrangement of settling and accumulation tanks is to comply with the provisions of Sec 2, [2.1.1].

4.2 Vent pipes

4.2.1 Settling tanks

Vent pipes of settling tanks are to be fitted with:

- adequate flameproof wire gauze, and
- closing appliances complying with the provisions of Pt C, Ch 1, Sec 10, [9.1].

4.2.2 Accumulation tanks

a) Vent pipes of accumulation tanks are to lead to the open at least 2 m above the weather deck and are to be located at least 5 m from ignition sources, openings in accomodation spaces and other safe spaces, and air intakes of ventilation systems for accomodation spaces, engine rooms and other safe spaces in which ignition sources may be present.

b) Openings of vent pipes to the open are to be so arranged as to allow a direct flow upwards and fitted with:

- flameproof wire gauze made of corrosion resistant material easily removable for cleaning, and
- closing appliances complying with the provisions of Pt C, Ch 1, Sec 10, [9.1].

4.3 Level gauging and overfilling control

4.3.1 Level gauging

a) Accumulation tanks are to be fitted with sounding pipes or other level gauging devices of a type approved by the Society.

b) Sounding pipes in accumulation tanks are to terminate in the open air.

4.3.2 Overfilling control

a) Accumulation tanks are to be fitted with a high level alarm, an overflow control system or equivalent means to prevent the liquid from rising in the vent pipes.

b) The high level alarm is to be of a type approved by the Society and is to give an audible and visual alarm at the control station.

4.4 Heating systems

4.4.1 Heating systems fitted to accumulation tanks are to comply with the provisions of Ch 7, Sec 4, [2.6].

Table 1 : Documents to be submitted *(1/7/2002)*

No.	A/I **(1)**	Document **(2)**
1	I	General plan of the system for oil recovery and specification of all relevant apparatuses
2	A	Schematic arrangement of recovered oil piping and pumping systems
3	A	Tank venting arrangement
4	I	Procedure and limiting conditions for recovering oil, cargo transfer, tank cleaning, gas freeing and ballasting (operation manual)

(1) A: To be submitted for approval in four copies
I: To be submitted for information in duplicate

(2) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

SECTION 4 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/1/2007)*

The requirements in this Section apply, in addition to those contained in Part C, Chapter 2, to oil recovery ships for collection of oil having flashpoint not exceeding 60°C.

1.2 Documentation to be submitted

1.2.1 *(1/1/2007)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, [2.1.1], the following is to be submitted for approval:

a) plan of dangerous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

2 Design requirements

2.1 System of supply

2.1.1 *(1/1/2007)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

2.1.2 In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

2.2 Earth detection

2.2.1 *(1/1/2007)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [2.1.1].

3 Hazardous locations and types of equipment

3.1 Electrical equipment permitted in hazardous areas

3.1.1 *(1/1/2007)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5], and Pt C, Ch 2, Sec 3, [10.1.6].

In addition, in Zone 1 and Zone 2, the installation of the following is permitted: hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of an impressed current cathodic protection system, or transducers

such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

3.1.2 The explosion group and temperature class of electrical equipment of a certified safe type are to be at least IIA and T3.

3.1.3 There are normally not to be access doors or other openings between a safe space, such as accommodation or service spaces, engine rooms and similar spaces, and a hazardous area.

Access doors may, however, be accepted between such spaces and hazardous areas, provided that:

a) safe spaces are fitted with forced ventilation in order to maintain an overpressure therein

b) access doors are:

1) of a self-closing type and arranged to swing into the safer space, so that they are kept closed by the overpressure, with the self-closing device capable of shutting the doors against an inclination of 3,5° opposing closure, without hold-back hooks keeping them in an open position, or

2) gas-tight, kept closed during oil recovery operation until gas freeing is carried out, and provided with a warning plate (suitable instructions are given in the oil recovery manual).

3.2 Hazardous area classification

3.2.1 *(1/1/2007)*

For hazardous area classification see Tab 1.

Table 1 : Classification of hazardous areas for oil recovery ships for collection of oil having flashpoint not exceeding 60°C *(1/1/2007)*

Spaces		Hazardous area
No.	Description	
1	Accumulation tanks, pipes and equipment containing the recovered oil.	Zone 0
2	Cofferdams and enclosed or semi-enclosed spaces adjacent to or immediately above accumulation tanks, unless fitted with forced ventilation capable of giving at least 20 air changes per hour and having characteristics such as to maintain the effectiveness of such ventilation.	Zone 1
3	Spaces containing pumps for the handling of recovered oil.	Zone 1
4	Double bottoms or duct keels located under accumulation tanks.	Zone 1
5	Enclosed or semi-enclosed spaces immediately above pump rooms for the hauling of recovered oil or above vertical cofferdams adjacent to accumulation tanks unless separated by a gas-tight deck and fitted with forced ventilation capable of giving at least 20 air changes per hour having characteristics such as to maintain the effectiveness of such ventilation.	Zone 1
6	Enclosed or semi-enclosed spaces containing pipes, valves or other equipment for the handling of recovered oil unless fitted with forced ventilation capable of giving at least 20 air changes per hour and having characteristics such as to maintain the effectiveness of such ventilation.	Zone 1
7	Areas on open deck, or semi-enclosed spaces on open deck within 3 m from equipment for oil recovery, hatches or any other openings in accumulation tanks and any pump for the handling of recovered oil not fitted in a pump room.	Zone 1
8	Areas on open deck over all accumulation tanks up to a height of 2,4 m above the deck.	Zone 1
9	Enclosed or semi-enclosed spaces for floating pumps and associated hoses and other equipment which may similarly contain residues of recovered oil.	Zone 1
10	Areas indicated in Sec 3, [4.2.2] a).	Zone 1

SECTION 5 FIRE PROTECTION, DETECTION AND EXTINCTION

1 General

1.1 Application

1.1.1 *(1/7/2009)*

For ships having the service notation **oil recovery ship**, this Section provides specific requirements addressing safety against fire and explosion during handling, storage and transportation of oil recovered from the sea.

For oil recovery ships intended to collect only oil having a flashpoint exceeding 60°C, the requirements of [2] and [3.3] do not apply.

The application of the requirements of this Section to ships of less than 500 gross tonnage and classed for restricted navigation will be specially considered by the Society in each case.

1.2 Documents to be submitted

1.2.1 *(1/7/2008)*

The documents listed in Tab 1 are to be submitted for approval.

1.3 Definitions

1.3.1 *(1/7/2008)*

a) Gas-dangerous areas and zones are defined in Sec 2, [2.2.1].

b) Accumulation tanks are defined in Sec 2, [2.1.1].

2 Ventilation systems

2.1 General

2.1.1 *(1/7/2008)*

Gas-dangerous spaces are to have a ventilation system independent from that serving gas-safe spaces.

2.1.2 *(1/7/2008)*

Ventilation systems are to be so arranged as to avoid the formation of gas pockets.

2.1.3 *(1/7/2008)*

Attention is drawn to the specific ventilation arrangements imposed on certain spaces in order to consider them safe spaces. Refer to Sec 2, [2.2.1].

2.2 Ventilation of recovered oil pump rooms

2.2.1 *(1/7/2008)*

Recovered oil pump rooms are to be provided with a mechanical ventilation system of the extraction type capable of giving at least 8 air changes per hour.

Note 1: Where the pump room is not normally entered during oil handling, the mechanical ventilation may be omitted.

2.2.2 *(1/7/2008)*

Ventilation intakes are to be so arranged as to minimise the possibility of recycling hazardous vapours from ventilation discharge openings.

2.2.3 *(1/7/2008)*

Exhaust and inlet ventilation ducts are to be led upwards to a gas-safe area on the weather deck in locations at least 3 m and 1,5 m, respectively, from any ventilation intake and opening to gas-safe spaces.

2.2.4 *(1/7/2008)*

Protection screens of not more than 13 mm square mesh are to be fitted on ventilation duct intakes and outlets.

2.2.5 *(1/7/2008)*

Ventilation fans are to be of non-sparking construction as per Pt C, Ch 4, Sec 1, [5.3].

2.2.6 *(1/7/2008)*

The ventilation system is to be capable of being controlled from outside the pump room.

2.3 Ventilation of enclosed normally entered dangerous spaces other than cargo pump rooms

2.3.1 *(1/7/2008)*

Enclosed normally entered dangerous spaces are to be provided with a mechanical ventilation system of the extraction type capable of giving at least 8 air changes per hour.

Table 1 : Documents to be submitted *(1/7/2008)*

No.	**(1)**	Documents **(2)**
1	A	Diagram of the ventilation systems serving: • dangerous spaces including pump room • machinery spaces • accommodation spaces
2	A	Specification of flammable gas detectors
3	A	Drawing and specification of the fixed/movable fire-fighting systems and structural fire protection required by this Section

(1) A: To be submitted for approval in four copies

(2) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

2.3.2 *(1/7/2008)*

Ventilation intakes are to be located at a distance of not less than 3 m from the ventilation outlets of pump rooms.

2.4 Ventilation of enclosed safe spaces adjacent to dangerous areas

2.4.1 *(1/7/2008)*

Safe spaces adjacent to dangerous areas are to be provided with a mechanical ventilation system capable of maintaining the space with a positive pressure.

2.4.2 *(1/7/2008)*

Ventilation intakes are to be located in a gas-safe area on the weather deck as far as practicable from the ventilation outlets of gas-dangerous spaces.

3 Fire protection and fire fighting

3.1 General

3.1.1 *(1/7/2008)*

Ships having the service notation **oil recovery ship** are to comply with the provisions for fire protection and fire fighting stipulated for cargo ships in Part C, Chapter 4.

3.2 Oil flashpoint and gas measurement systems

3.2.1 General *(1/7/2017)*

Where, due to fire or explosion hazards, the ship is required to operate at a safe distance from the source of oil spill, suitable equipment is to be provided to measure the concentration of flammable gases.

For ships intended to collect only oil having a flashpoint exceeding 60°C, suitable equipment is to be provided to measure the oil flashpoint.

3.2.2 Gas measurement system *(1/7/2009)*

a) A fixed flammable gas detecting system is to be provided in order to check the hydrocarbon gas concentration in the following locations:

- engine room
- open deck (one forward, one astern).

The system is to be capable of giving an alarm in the wheelhouse (or other suitable location) and on the open deck when the vapour concentration of hydrocarbons and similar products in the atmosphere exceeds 30 % of the lower explosive limit of the mixture of such vapours and air.

b) In addition to the fixed system, at least one portable gas detection instrument is to be provided on board.

c) For ships of 200 gross tonnage or less and for ships intended to collect oil having a flashpoint exceeding 60°C, as an alternative to the requirements stated in items a) and b), two portable gas detectors may be accepted.

In addition, for ships of 200 gross tonnage or less but exceeding 18 metres in length and, the following requirements are to be met:

- simultaneous samples are to be obtained for analysis at least every 15 minutes in two different locations (one forward, another astern), and
- the results of these analyses are to be recorded in a register kept for the purpose.

Information regarding these operations is to be clearly recorded in the Operation Manual cited in Sec 3, Tab 1.

3.2.3 Oil flashpoint measurement *(1/7/2008)*

The equipment for oil flashpoint measurement may be portable.

3.3 Structural fire protection

3.3.1 *(1/7/2008)*

Where cargo tanks are arranged forward of the superstructure or aft of the superstructure within 10 m of the nearest gas-dangerous zone, exterior boundaries of superstructures and deckhouses enclosing accommodation and including any overhanging decks which support such accommodation are to be insulated to A-60 standard for the whole of the portions which face the gas-dangerous areas and for a distance of 3 m aft or forward of such areas. This requirement is also applicable to access doors in such boundaries. Alternatively, insulation to A-0 standard with a permanently installed water-spraying system in compliance with [3.3.3] may be accepted. Aluminium bulkheads will not be accepted in these boundaries.

3.3.2 *(1/7/2008)*

Portholes or windows in the area specified in [3.3.1] are to have the same fire rating as the bulkhead in which they are fitted. This requirement does not apply to wheelhouse windows. Portholes or windows which have a lower fire rating than that required, or which are to be protected by a water-spraying system in accordance with [3.3.3], are to be fitted with permanently installed inside deadlights of steel having a thickness equal to the steel in the bulkhead in which they are fitted.

3.3.3 *(1/7/2008)*

If it is impractical to fit deadlights, windows in the area specified in [3.3.1] are to be protected by a sprinkler system having a capacity of at least 10 litres/minute/m^2. The system is to be fully activated by opening of one valve on the bridge.

3.4 Fire fighting

3.4.1 *(1/7/2009)*

For the protection of the deck area in way of accumulation tanks, the following fire-fighting equipment is to be provided:

a) two dry powder fire extinguishers, each with a capacity of at least 50 kg

b) at least one fire extinguisher having a capacity of at least 45 l.

3.4.2 *(1/7/2009)*

The foam fire extinguisher is to be capable of producing a foam blanket over the accumulation tanks in order to efficiently reduce the emission of flammable gases.

3.4.3 *(1/7/2009)*
For ships intended to collect only oil having a flashpoint exceeding 60°C, in lieu of the equipment required in [3.4.1] b), one portable foam applicator with one spare tank is to be provided. The capacity of the portable foam applicator is to be suitable for the deck area to be protected to the Society's satisfaction.

3.4.4 *(1/7/2009)*
For ships of 200 gross tonnage or less, in lieu of the equipment required in [3.4.1], the portable foam applicator required in [3.4.3] is to be provided.

Chapter 18
CABLE-LAYING UNITS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*
Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **cable laying unit**, as defined in Pt A, Ch 1, Sec 2, [4.8.7].

1.1.2 *(1/1/2022)*
Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to cable laying units.

1.2 Summary table

1.2.1 *(1/1/2022)*
Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to cable laying units.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for cable laying units are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 The requirements of this Section apply to ships fitted, in general, with one or more continuous decks, suitable holds for the carriage of cables and superstructures extending for most of the ship's length.

The main characteristics of the ship may vary according to the service primarily performed which may be as follows:

- laying (and possibly burying) submarine cables on the sea bed
- hauling and repairing submarine cables.

2 Stability

2.1 Intact stability

2.1.1 General

The stability, the freeboard and the metacentric radius or roll period are to be such as to ensure:

- satisfactory seakeeping performance in working conditions
- a steady working platform in order to facilitate the performance of cable laying and/or repair operations.

Anti-roll tanks or bilge keels of adequate size may be fitted to meet the above requirements.

2.1.2 Tanks intended for liquid consumable

Special attention is to be paid to the arrangement of tanks intended to contain liquid consumables in order to prevent weight variations during service resulting in excessive changes in the ship's trim.

At the same time the arrangement of ballast water tanks is to be such as to ensure the best ship's trim, in any loading condition, for the performance of all work for which the ship is intended.

2.1.3 Intact stability criteria

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.1] and for the (departure and arrival) loading conditions corresponding to the maximum draught is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

3 Hull scantlings

3.1 Cable tanks

3.1.1 The net scantlings of cable tanks are to be obtained through direct calculations to be carried out according to Pt B, Ch 7, App 1, where the still water and wave loads are to be calculated for the most severe condition of use.

3.2 Connection of the machinery and equipment with the hull structure

3.2.1 The net scantlings of the structures in way of the connection between the hull structure and the machinery and equipment, constituting the laying or hauling line for submarine cables, are to be obtained through direct calculation to be carried out according to Pt B, Ch 7, App 1, based on the service loads of such machinery and equipment, as specified by the Designer.

In calculating these above service loads, the Designer is to take into account the inertial loads induced by ship motions in the most severe condition of use.

4 Other structures

4.1 Fore part

4.1.1 In general, a high freeboard is needed in the forward area, where most repair work is carried out, in order to provide adequate safety and protection against sea waves.

5 Hull outfitting

5.1 Equipment

5.1.1 Hawse pipes

Hawse pipes are to be integrated into the hull structure in such a way that anchors do not interfere with the cable laying.

5.1.2 Sheaves

Where there is a risk that, in rough sea conditions, sheaves are subjected to wave impact loads, special solutions such as the provision of retractable type sheaves may be adopted.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Propulsion and manoeuvrability

1.1.1 The main propulsion systems of cable laying and/or repair ships are to be capable of:

a) maintaining an adequate speed during the transit condition

b) ensuring a satisfactory manoeuvrability at the speed assumed by the Designer for the performance of cable laying and/or repair operations.

1.2 Documents to be submitted

1.2.1 Tab 1 lists the documents which are to be submitted.

Table 1

No.	A/I **(1)**	Document
1	I	General arrangement of the cable laying equipment
2	I	Design loads on all components of the cable laying equipment
3	A	Structural plans of all components of the cable laying equipment, including gears, pressure vessels, hydraulic systems, etc., as applicable
4	A	Materials and welding details
5	A	Foundations and fastening of the equipment to the ship structures

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

2 Arrangements for cable laying, hauling and repair

2.1 Typical machinery and equipment of cable laying units

2.1.1 *(1/1/2022)*

Cable laying units, in relation to the special service to be performed, are generally to be provided with the following machinery and equipment:

a) a main windlass for cable hauling or laying, which generally consists of a drum with a horizontal axis (the surface of which is formed by a series of timed conveyors which fleet the cable axially across the face of the drum) housing the repeaters fitted throughout the cable length without damaging them (see Fig 1 (a))

b) a linear tensioner working in conjunction with the main windlass and fitted between it and the cable tank, which maintains the due tension of the cable in relation to the cable type so as to allow effective cable hauling or laying. In order to permit the passage of repeaters, the tensioner may be of the type having either a series of double opposed rubber tyres (see Fig 1 (b)) or pressure-compensated opposed tracks (see Fig 1 (c)).

c) a dynamometer, normally fitted between the main windlass and the bow and stern sheaves, which continuously measures the force required to displace the cable under tension

d) one or more cable transporters, used to move the cable from the tank(s) and the tensioner.

All the above machinery and equipment form the "cable laying or hauling line". More than one line may be fitted on board in the case of special service requirements.

2.2 Design of cable handling machinery and equipment

2.2.1 In general, the scantlings of components of machinery and equipment listed in [2.1] and, more generally, of any other machinery and/or equipment to be used for the laying, hauling or repair of submarine cables are not the subject of

specific requirements for class. However, such machiney and equipment are to be designed taking into account the necessary mechanical structural strength with selection of materials appropriate for the intended use based on loads supplied by the Manufacturer.

2.3 Safety

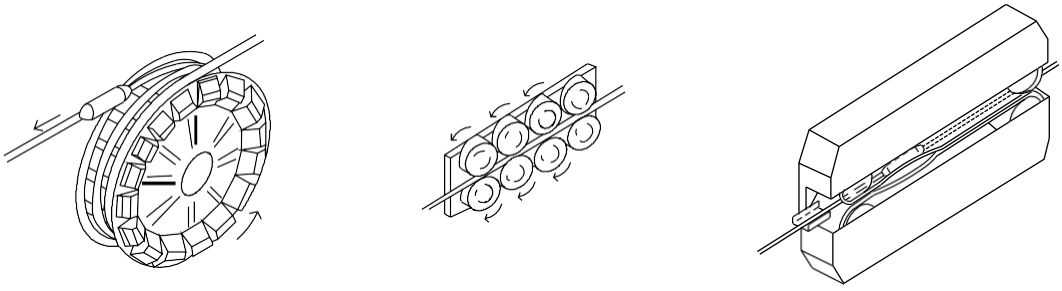
2.3.1 The requirements of this Chapter are based on the assumption that during cable handling all necessary safety measures are taken, due consideration being given to risks connected with the use of machinery and equipment dealt with in [2.1], and that such machinery and equipment are properly used by skilled personnel.

2.4 Testing of cable handling machinery and equipment

2.4.1 General

Machinery covered by [2.1] is to be tested in compliance with the following requirements, with the exception of prime movers and "hydraulic accumulator" type pressure vessels, which are to be tested in compliance with the applicable requirements of the various Sections of the Rules.

Figure 1 : Cable handling machinery



(a) Fleeting cable drum

(b) Rubber tyre tensioner

(c) Track linear tensioner

2.4.2 Testing of materials and components of the machinery

a) In general, testing is required for materials intended for shafts, gearing, pressure parts of pumps and hydraulic motors, and plates of foundations of welded construction.

b) As far as mechanical tests of materials are concerned, internal shop testing certificates submitted by the Manufacturer may be accepted by the Society at its discretion; in such cases, testing operations witnessed by the Surveyor may be limited to visual external inspection associated, where necessary, with non-destructive examinations and hardness tests.

2.4.3 Hydrostatic tests

Pressure parts are to be subjected to hydrostatic tests in accordance with the applicable requirements.

2.4.4 Tests on electrical components

The tests required in Part C, Chapter 2 are to be carried out as applicable.

2.4.5 Running tests

a) Running tests of each individual piece of equipment are to be carried out whenever possible at the Manufacturer’s works; as an alternative, the above tests may be performed on board during the trials required after installation of machinery.

b) During the running tests, the suitability of all the arrangements concerned is to be checked in relation to the various expected service conditions.

c) On completion and subject to the result of the above tests, the inspection of components may be required, with dismantling where deemed necessary by the Surveyor in charge of the testing.

3 On board trials

3.1 Ship trials

3.1.1

a) Upon completion of construction, in addition to conventional sea trials, specific tests may be required at the Society's discretion in relation to the particular service for which the ship is intended or the particular characteristics of machinery and equipment fitted on board.

b) In particular, as far as propulsion and steering systems are concerned, tests may be required to check the manoeuvring capability and the speed of the ship whilst operating with only directional propellers or active rudders or a combination thereof.

c) In the case of ships mainly intended for repair of submarine cables, a check of manoeuvring capability whilst running astern or a complete overturning trial may be required to be carried out using the rudder, active rudders or side thrusters only.

d) In the case of ships provided with a dynamic positioning system, tests to check the capability of holding the desired position or heading are requested.

3.2 Equipment trials

3.2.1

a) As far as arrangements for the cable laying, hauling and/or repair lines are concerned, tests are to be carried out to verify the proper operation of all relevant machinery and equipment, by means of the actual hauling and laying of submarine cables, plain or with repeaters, at different ship speeds and, if necessary, in different sea and weather conditions.

b) Special attention is to be paid during such tests so as to prevent cables being forced to reach their minimum allowed bending radius, both inside and outside the ship.

Chapter 19
NON-PROPELLED UNITS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/9/2022)*

Ships complying with the requirements of this Chapter are eligible for the assignment of one of the following service notations applicable to non-propelled units, as defined in Pt A, Ch 1, Sec 2, [4.9]:

- **barge** with the additional service features:
  - **general cargo**
  - **oil**
  - **liquefied gas**
  - **LNG bunker**
  - **chemical**
  - **tug combined**
  - **accommodation**
  - **equipped for carriage of containers**
- **pontoon** with the additional service features:
  - **crane**
  - **equipped for carriage of containers**

The service notation **barge-oil** may be completed by the additional service feature **flash point > 60°C**, where the unit carries only oil with flash point exceeding 60°C.

1.1.2 *(1/5/2013)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable taking into account the exemptions given in the different Sections of this Chapter, and with the requirements of this Chapter, which are specific to non-propelled units.

1.1.3 *(1/6/2021)*

Barge-general cargo are to comply with the requirements in this Chapter for barge that are not specific to barge with other additional service features.

1.1.4 *(1/6/2021)*

Barge-liquefied gas and **barge-LNG bunker** are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), as amended, as specified in Ch 9, [1.1.1] and [1.1.2].

1.1.5 *(1/6/2021)*

Barge-chemical are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), as amended, as specified in Ch 8 [1.1.1] to [1.1.3].

The requirements in this chapter applicable to barge-chemical apply to units intended to carry products listed in the table in Chapter 17 of the IBC Code. For the carriage of products listed in the table in Chapter 18 of the IBC Code and products not at present listed in either of the tables in Chapter 17 or Chapter 18 of the IBC Code, the Society reserves the right to establish specific requirements.

1.1.6 *(1/9/2022)*

Barge-equipped for carriage of containers and **pontoon-equipped for carriage of containers** are to have fixed arrangements in compliance with the applicable requirements in Part E, Chapter 2.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to non-propelled units.

Table 1 *(1/6/2021)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and Stability	Sec 2
Machinery Systems	Sec 3
Additional Requirements for Machinery and Cargo Systems of Barge-Oil	Sec 4
Additional Requirements for Machinery and Cargo Systems of Barge-Liquefied Gas	Sec 5
Additional Requirements for Machinery and Cargo Systems of Barge-LNG Bunker	Sec 6
Additional Requirements for Machinery and Cargo Systems of Barge-Chemical	Sec 7
Electrical Installations	Sec 8
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for non-propelled units are given in this Chapter.	

SECTION 2 HULL AND STABILITY

Symbols

L_G : Ship's length, in m, measured at the maximum load waterline

s : Spacing, in m, of ordinary stiffeners.

1 General

1.1 Application

1.1.1 General *(1/6/2021)*

Unless otherwise specified, the requirements of this Section apply to ships with one of the service notations **barge**, **pontoon** and **pontoon - crane**.

Specific requirements which apply only to ships with the service notation **barge** or ships with the service notation **pontoon** or **pontoon - crane** are indicated.

Barges with the additional service feature **tug combined** are also to comply with the applicable additional requirements in Ch 14, Sec 3.

Intact stability additional requirements for units with service notations **barge-oil**, **barge-accommodation, barge-liquified gas**, **barge-LNG bulker** and **barge-chemical**, are indicated in [2.3] to [2.6] respectively.

1.1.2 Main characteristics of non-propelled units

The requirements of this Section are based on the following assumptions, relevant to the main characteristics of non-propelled units:

- the structural configuration and proportions of non-propelled units are similar to those of propelled ships
- the cargo is homogeneously distributed.

The scantlings of non-propelled units with unusual shapes and dimensional proportions or carrying cargoes which are not homogeneously distributed, such as containers or heavy loads concentrated in limited areas, are to be considered by the Society on a case-by-case basis, taking into account the results of direct calculations, to be carried out according to Pt B, Ch 7, App 1.

2 Stability

2.1 Intact stability for ships with service notation "barge", "pontoon" or "pontoon-crane"

2.1.1 Application *(1/7/2012)*

The requirements of this item [2.1] apply to seagoing ships with one of the service notations **barge**, **pontoon** and **pontoon-crane** with the following characteristics:

a) unmanned

b) having a block coefficient not less than 0,9

c) having a breadth/depth ratio greater than 3,0

d) having no hatchways in the deck except small manholes closed with gasketed covers.

The requirements of item [2.1] also apply to barges that do not comply with d).

The intact stability of ships not having any one of the above characteristics is to comply with Pt B, Ch 3, Sec 2, unless otherwise decided by the Society, on a case by case basis, taking into account the ship's characteristics. In this case, an appropriate entry is made in the classification files of the ship.

Items [2.1.2] and [2.1.3] do not apply to barges.

2.1.2 Trim and stability booklet

In addition to the information to be included in the trim and stability booklet specified in *Pt B, Ch 3, App 2, [1.1],* simplified stability guidance, such as a loading diagram, is to be submitted to the Society for approval, so that pontoons may be loaded in compliance with the stability criteria.

2.1.3 Stability calculations

Stability calculations may be carried out according to the following criteria:

- no account is to be taken of the buoyancy of deck cargo (except buoyancy credit for adequately secured timber)
- consideration is to be given to such factors as water absorption (e.g. timber), trapped water in cargo (e.g. pipes) and ice accretion
- in carrying out wind heel calculations:
  - the wind pressure is to be constant and for general operations considered to act on a solid mass extending over the length of the deck and to an assumed height above the deck
  - the centre of gravity of the cargo is to be assumed at a point mid-height of the cargo
  - the wind lever arm is to be taken from the centre of the deck cargo to a point at one half the draught
- calculations are to be carried out covering the full range of operating draughts
- the downflooding angle is to be taken as the angle at which an opening through which progressive flooding may take place is immersed. This would not be an opening closed by a watertight manhole cover or a vent fitted with an automatic closure.

2.1.4 Intact stability criteria

The following intact stability criteria are to be complied with, for the loading conditions specified in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.2]:

- the area under the righting lever curve up to the angle of maximum righting lever is to be not less than 0,08 m·rad
- the static angle of heel due to a uniformly distributed wind load of 0,54 kPa (wind speed 30 m/s) may not exceed a heeling angle corresponding to half the freeboard for the relevant loading condition, where the lever of wind heeling moment is measured from the centroid of the windage area to half the draught
- The minimum range of stability is to be:
  - 20° for L < 100 m
  - 20° - 0,1° (L - 100) for 100 $\leq$ L $\leq$ 150 m
  - 15° for L > 150 m.

2.2 Additional intact stability criteria for ships with service notation “pontoon - crane”

2.2.1 Application

The requirements of this item apply to ships with the service notation **pontoon - crane** and specify the criteria these ships are to satisfy during cargo lifting in addition to those in [2.1].

2.2.2 Intact stability criteria during cargo lifting *(1/7/2003)*

The following intact stability criteria are to be complied with:

- $\theta_C \leq 15°$
- $GZ_C \leq 0,6\ GZ_{MAX}$
- $A_1 \geq 0,4\ A_{TOT}$

where:

θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms (see Fig 1)

GZ_C, GZ_{MAX}: Defined in Fig 1

A_1 : Area, in m·rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_C to the heeling angle equal to the lesser of:

- heeling angle θ_R of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 1)
- heeling angle θ_F, corresponding to flooding of unprotected openings as defined in Pt F, Ch 13, Sec 11, [2.1.4] (see Fig 1)

A_{TOT} : Total area, in m·rad, below the righting lever curve.

In the above formula, the heeling arm, corresponding to the cargo lifting, is to be obtained, in m, from the following formula:

$$b = \frac{Pd - Zz}{\Delta}$$

where:

P : Cargo lifting mass, in t

d : Transversal distance, in m, of lifting cargo to the longitudinal plane (see Fig 1)

Z : Mass, in t, of ballast used for righting the pontoon, if applicable (see Fig 1)

z : Transversal distance, in m, of the centre of gravity of Z to the longitudinal plane (see Fig 1)

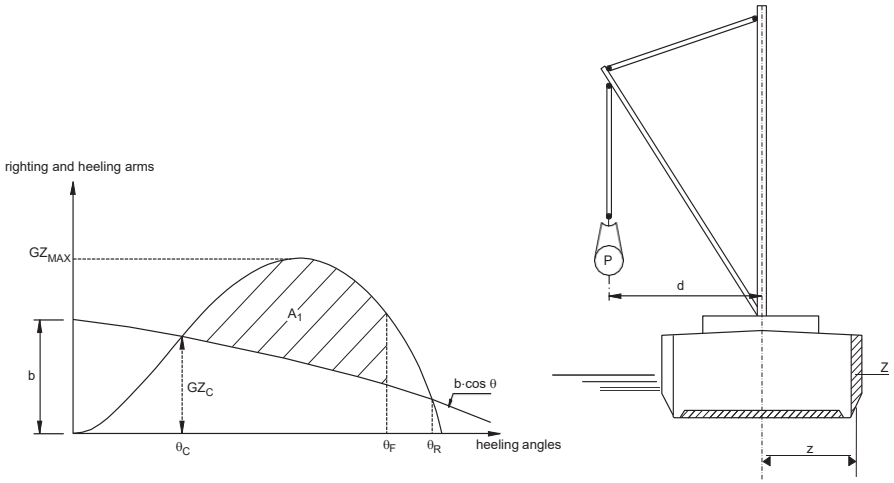
Δ : Displacement, in t, at the loading condition considered.

The above check is to be carried out considering the most unfavourable situations of cargo lifting combined with the lesser initial metacentric height GM, corrected according to the requirements in Pt B, Ch 3, Sec 2, [4].

The residual freeboard of the unit during lifting operations in the most unfavourable stability condition is to be not less than 0,30 m. However, the heeling of the unit is not to produce in the lifting devices higher loads than those envisaged by the Manufacturer, generally expected to be 5° in the boom plane and 2° transversally in the case of a crane.

The vertical position of the centre of gravity of cargo lifting is to be assumed in correspondence of the suspension point.

Figure 1 : Cargo lifting



2.2.3 Intact stability criteria in the event of sudden loss of cargo during lifting *(1/7/2003)*

This additional requirement is compulsory when counterweights or ballasting of the ship are necessary or when deemed necessary by the Society taking into account the ship dimensions and the weights lifted.

The case of a hypothetical loss of cargo during lifting due to a break of the lifting cable is to be considered.

In this case, the following intact stability criteria are to be complied with:

- $\frac{A_2}{A_1} \geq 1$
- $\theta_2 - \theta_3 \geq 20°$

where:

A_1 : Area, in m·rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_1 to the heeling angle θ_C (see Fig 3),

A_2 : Area, in m·rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_C to the heeling angle θ_2 (see Fig 3)

A_3 : Area, in m.rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_C to the heeling angle θ_3 (see Fig 3)

θ_1 : Heeling angle of equilibrium during lifting (see Fig 3)

θ_2 : Heeling angle corresponding to the lesser of θ_R and θ_F

θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms (see Fig 3)

θ_3 : Maximum heeling angle due to roll, at which $A_3 = A_1$, to be taken not greater than 30° (angle in correspondence of which the loaded cargo on deck is assumed to shift (see Fig 3)

θ_R : Heeling angle of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 3).

θ_F : Heeling angle at which progressive flooding may occur (see Fig 3)

In the above formulae, the heeling arm, induced on the ship by the cargo loss, is to be obtained, in m, from the following formula:

$$b = \frac{Zz}{\Delta}\cos\theta$$

where Z, z and Δ are defined in [2.2.2].

2.3 Additional intact stability criteria for ships with service notation "barge-oil"

2.3.1 General *(1/5/2013)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.6] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2. In addition, the requirements in [2.3.2] are to be complied with.

2.3.2 Liquid transfer operations *(1/5/2013)*

Ships with certain internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling, the design of barges of 5000 t deadweight and above is to be such that the following criteria are complied with:

a) The intact stability criteria reported in b) is to be complied with for the worst possible condition of loading and ballasting as defined in c), consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.

b) The initial metacentric height GMo, in m, corrected for free surface measured at 0° heel, is to be not less than 0,15. For the purpose of calculating GMo, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.

c) The vessel is to be loaded with:
   - all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank
   - cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value
   - full departure consumable
   - 1% of the total water ballast capacity.The maximum free surface moment is to be assumed in all ballast tanks.

2.4 Additional intact stability criteria for units with service notation "barge - accommodation"

2.4.1 Application *(1/7/2014)*

In addition to the requirements of [2.1], the requirements of this item [2.4] apply to ship units with the service notation **barge - accommodation**.

2.4.2 Righting moment and heeling moment curves *(1/7/2014)*

a) Curves of righting moments and of wind heeling moments similar to Fig 3 with supporting calculations are to be prepared covering the full range of operating draughts.

   The righting moment curves and wind heeling moment curves are to be related to the most critical axes.

   Account is to be taken of the free surface of liquid in tanks.

   Where equipment is of such a nature that it can be lowered and stowed, additional wind heeling moment curves may be required and such data are to clearly indicate the position of such equipment.

b) The curves of wind heeling moments are to be drawn for wind forces calculated by the following formula:

   $F = 0,5\ C_s \cdot C_H \cdot r \cdot V^2 \cdot A$

   where:

   F : the wind force, in N

   C_s : the shape coefficient depending on the shape of the structural member exposed to the wind (see Tab 1);

   C_H : the height coefficient depending on the height above sea level of the structural member exposed to the wind (see Tab 2);

   r : the air mass density (1,222 kg/m^3)

   V : the wind velocity, in m/s;

   A : the projected area of all exposed surfaces in either the upright or the heeled condition, in m^2.

   Shapes or combinations of shapes which do not readily fall into the specified categories will be subject to special consideration by the Society.

Realistic operating conditions are to be evaluated as follows:

1) The unit is to be capable of remaining in the operating mode with a sustained wind velocity of not less than 36 m/s (70 knots).
2) The capability of remaining in safe condition during a severe storm condition, with a sustained wind velocity of not less than 51,5 m/s (100 knots), in a reasonable period of time for the particular unit.
3) In all cases, the limiting wind velocities are to be specified and instructions are to be included in the Stability booklet for changing the mode of operation by redistribution of the variable load and equipment, by changing draughts, or both.
4) Consideration may be given to a reduced sustained wind velocity of not less than 25,8 m/s (50 knots). Particulars of the applicable service restrictions are to be recorded in the stability booklet. For the purpose of calculation, it is to be assumed that the unit is floating free of mooring restraints.

In calculating the projected areas to the vertical plane, the area of surfaces exposed to wind due to heel or trim, such as under-deck surfaces, etc., is to be included using the appropriate shape factor.

An appropriate shape coefficient is to be taken from Tab 1.

In calculating the wind forces, the following procedures are recommended:

- in the case of units with columns, the projected areas of all columns are to be included; i.e. no shielding allowance is to be taken;
- the block projected area of a clustering of deckhouses may be used in lieu of the calculation of each individual area. The shape coefficient may be assumed to be 1,1;
- isolated houses, structural shapes, cranes, etc. are to be calculated individually, using the appropriate shape coefficient.

c) In calculating the wind heeling moments, the lever of the wind overturning force is to be taken vertically from the centre of pressure of all surfaces exposed to the wind to the centre of lateral resistance or, if available, the centre of hydrodynamic pressure, of the underwater body of the unit.

The unit is to be assumed floating free of mooring restraints.

However, the possible detrimental effects of mooring restraints are to be considered.

d) The wind heeling moment curve is to be calculated for a sufficient number of heel angles to define the curve. For unit shaped hulls, the curve may be assumed to vary as the cosine function of unit heel.

Table 1 : Values of the shape coefficient C_s *(1/7/2014)*

Shape	C_s
Spherical	0,4
Cylindrical	0,5
Large flat surfaces (hull, deckhouse, smooth under-deck areas)	1,0
Drilling derrick	1,25
Wires	1,2
Exposed beams and girders under deck	1,3
Small parts	1,4
Isolated shapes (crane, beam, etc.)	1,5
Clustered deckhouses or similar structures	1,1

Table 2 : Values of the height coefficient C_H *(1/7/2014)*

Height above sea level (m)	C_H
0 - 15,3	1,00
15,3 - 30,5	1,10
30,5 - 46,0	1,20
46,0 - 61,0	1,30
61,0 - 76,0	1,37

Height above sea level (m)	C_H
76,0 - 91,5	1,43
91,5 - 106,5	1,48
106,5 - 122,0	1,52
122,0 - 137,0	1,56
137,0 - 152,5	1,60
152,5 - 167,5	1,63
167,5 - 183,0	1,67
183,0 - 198,0	1,70
198,0 - 213,5	1,72
213,5 - 228,5	1,75
228,5 - 244,0	1,77
244,0 - 256,0	1,79
above 256	1,80

2.4.3 Intact stability *(1/7/2014)*

a) The stability of a unit is to meet the following criteria (see also Fig 2).

1) For all units, the area under the righting moment curve to the second intercept or downflooding angle, whichever is less, is to be not less than 40% in excess of the area under the wind heeling moment curve to the same limiting angle.

2) The righting moment curve is to be positive over the entire range of angles from upright to the second intercept.

3) A check is to be carried out to ensure that the lesser of the downflooding angle and the second intercept angle is not greater than the following angles:

- the angle for which the stresses of whichever primary structural element become excessive;
- the limit angle for which lashes of loads on the decks are calculated.

b) Each unit is to be capable of attaining a severe storm condition in a period of time consistent with the meteorological conditions. The procedures recommended and the approximate length of time required, are to be contained in the stability booklet.

It is to be possible to achieve the severe storm condition without the removal or relocation of solid consumables or other variable load. However, the Society may permit relaxations in a geographic location where weather conditions annually or seasonally do not become sufficiently severe to require a unit to go to severe storm condition.

The geographic locations, weather conditions and loading conditions in which this is permitted are to be identified in the stability booklet.

c) Alternative stability criteria may be considered by the Society provided an equivalent level of safety is maintained and if they are demonstrated to afford adequate positive initial stability. In determining the acceptability of such criteria, the Society may consider at least the following and take into account as appropriate:

1) environmental conditions representing realistic winds (including gusts) and waves appropriate for worldwide service in various modes of operation;

2) dynamic response of a unit. Analysis is to include the results of wind tunnel tests, wave tank model tests and non-linear simulation, where appropriate. Any wind and wave spectra used is to cover sufficient frequency ranges to ensure that critical motion responses are obtained;

3) potential for flooding taking into account dynamic responses and wave profile in a seaway;

4) susceptibility to capsizing considering the unit's restoration energy and the static inclination due to the mean wind speed and the maximum dynamic response;

5) an adequate safety margin to account for uncertainties.

2.4.4 Intact stability for units to be moored in sheltered waters *(1/7/2014)*

The initial metacentric height GM_0, duly corrected for free surfaces effects of liquids, see Pt B, Ch 3, Sec 2, [4], is to result not less than 0,35 m in any expected operating condition.

2.5 Additional intact stability criteria for units with service notation "barge - liquified gas" and "barge - LNG bunker"

2.5.1 General *(1/6/2021)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.8] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

2.6 Additional intact stability criteria for units with service notation "barge - chemical"

2.6.1 General *(1/6/2021)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.7] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

3 Structure design principles

3.1 Hull structure

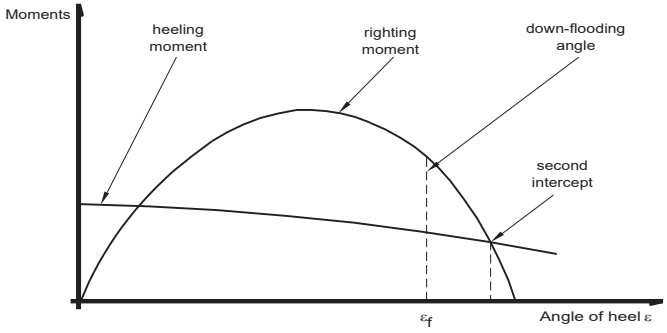
3.1.1 Framing of ships with one of the service notations “pontoon” and “pontoon - crane”

In general, ships with one of the service notations **pontoon** and **pontoon - crane** are to be longitudinally framed.

3.1.2 Supports for docked non-propelled units

Adequate supports are to be fitted on the longitudinal centreline in order to carry loads acting on the structure when the non-propelled units are in dry dock.

Figure 2 : Righting moment and heeling moment curves *(1/7/2014)*



3.1.3 Truss arrangement supporting deck loads

Where truss arrangements are used as supports of the deck loads, including top and bottom girders in association with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with the horizontal of about 45° and cross-sectional area of about 50% that of the adjacent pillars.

3.2 Lifting appliances

3.2.1 Crane or derrick position during navigation

For ships with the service notation **pontoon - crane**, the crane boom or the derrick structure is to be lowered and efficiently secured to the pontoon during the voyage.

4 Hull girder strength

4.1 Yielding check

4.1.1 Small non-propelled units lifted by crane

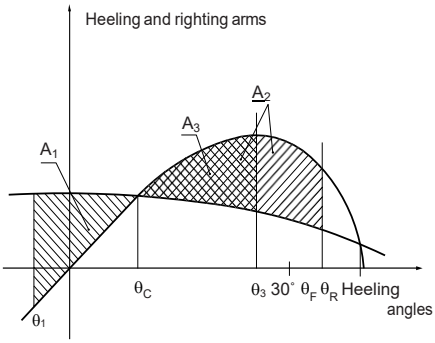
For small non-propelled units intended to be lifted on board ship by crane, the hull girder strength is to be checked, in the condition of fully-loaded barge lifted by crane, through criteria to be agreed with the Society on a case-by-case basis.

In any case, in general, the normal stress σ and the shear stress τ induced in the hull girder when lifted by crane are to comply with the following formulae:

$\sigma \leq 150/k$ N/mm^2

$\tau \leq 100/k$ N/mm^2.

Figure 3 : Cargo loss *(1/7/2002)*



A_1: Area between θ_1 and θ_C
A_2 : Area between θ_C and θ_2 (in the figure $\theta_2 = \theta_F$)
A_3: Area between θ_C and θ_3
$A_3 = A_1$

4.1.2 Ships with service notation “pontoon” carrying special cargoes

For ships with the service notation **pontoon** intended for the carriage of special cargoes, such as parts of offshore units, the hull girder strength is to be checked through criteria to be agreed with the Society on a case-by-case basis.

Moreover, where these ships are fitted with arrangements for launching the above structures, additional calculations are to be carried out in order to evaluate the stresses during the various stages of launching. The Society may accept stresses higher than those in [4.1.1], to be considered on a case-by-case basis, taking into account favourable sea and weather conditions during launching.

4.1.3 Ships with service notation “pontoon - crane”

For ships with the service notation **pontoon - crane** having length greater than 65 m, the hull girder strength is to be checked when the lifting appliance, such as a crane or derrick, is operated, taking into account the various loading conditions considered, through criteria to be agreed with the Society on a case-by-case basis.

5 Hull scantlings

5.1 General

5.1.1 Minimum net thicknesses of ships with service notation “barge” carrying liquids

For ships with the service notation **barge** carrying liquid cargo inside tanks, the net thicknesses of cargo tank platings are to be not less than the values given in Tab 3.

For other structures or transverse bulkheads not forming boundaries of cargo tanks, the above minimum thicknesses may be reduced by 1 mm.

In pump rooms, the net thicknesses of plating of exposed decks, longitudinal bulkheads and associated ordinary stiffeners and primary supporting members are to be not less than the values given in Tab 3.

5.1.2 Minimum net thicknesses of decks forming tank top

Where the decks of non-propelled units form a tank top, the minimum net thicknesses of plating are to be not less than those obtained from Tab 3.

5.1.3 Scantlings of plating, ordinary stiffeners and primary supporting members

Where no rudder is fitted, in applying the formulae in Part B, Chapter 7 or Part B, Chapter 8, as applicable, L need not exceed 0,97 L_G.

5.1.4 Net thickness of strength deck plating

Within the cargo area, the net thickness of strength deck plating is to be increased by 1,5 mm with respect to that calculated according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable.

Table 3 : Minimum net thickness of plating

Plating	Minimum net thickness, in mm
Decks, sides, bottom, inner bottom, bulkheads, primary supporting members in the cargo area	• For L ≤ 45m, the greater of: - $(4,1 + 0,060\ L)k^{0,5}$ - $2,8 + 0,060\ L$ • For 45m < L ≤ 200m, the greater of: - $(5,9 + 0,023\ L)k^{0,5}$ - $4,5 + 0,023\ L$ • For L > 200m, the greater of: - $(8,6 + 0,009\ L)k^{0,5}$ - $7,2 + 0,009\ L$
Weather deck, within cargo area outside 0,4 amidships	• For L ≤ 200m, the greater of: - $11,3\ s\ k^{0,5}$ - $11,3\ s - 1,4$ • For 200m < L < 250m, the greater of: - $(11,3\ s + 0,026\ (L - 200))k^{0,5}$ - $11,3\ s + 0,026\ s\ (L - 200) - 1,4$ • For L ≥ 250m, the greater of: - $12,6\ s\ k^{0,5}$ - $12,6\ s - 1,4$
Plating of ordinary stiffeners and other structures of cargo tanks	• For L ≤ 45m, the greater of: - $(4,1 + 0,060\ L)k^{0,5}$ - $2,8 + 0,060\ L$ • For 45m < L ≤ 200m, the greater of: - $(5,9 + 0,023\ L)k^{0,5}$ - $4,5 + 0,023\ L$ • For L > 200m, the greater of: - $10,0\ k^{0,5}$ - $8,6$
Note 1: k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3].	

5.2 Hull scantlings of non-propelled units with the service notation “pontoon” fitted with arrangements and systems for launching operations

5.2.1 Additional information *(1/1/2015)*

In addition to the documentation specified in Pt B, Ch 1, Sec 3, the following information is to be submitted to the Society for approval:

- maximum draught of the ship during the different stages of the launching operations
- maximum still water and inertial operating loads and their distribution in load out, towing and launching conditions
- launching cradle or grillage location.

The scantlings of the launching cradle or grillage and, if fitted, of the skid beams are to be submitted to the Society for information, in order to check that their loads are correctly transmitted to the deck structure.

5.2.2 Scantlings of plating, ordinary stiffeners and primary supporting members

In applying the formulae in Part B, Chapter 7 or Part B, Chapter 8, as applicable, T is to be taken equal to the maximum draught during the different stages of launching and taking into account, where appropriate, the differential static pressure.

5.2.3 Deck scantlings *(1/1/2015)*

The net scantlings of decks are to be in accordance with Part B, Chapter 7 or Part B, Chapter 8, considering the maximum loads acting on the launching cradle or grillage.

The net thickness of deck plating in way of launch ground ways is to be suitably increased if the cradle or grillage may be placed in different positions.

The scantlings of decks in way of pivoting and end areas of the cradle or grillage are to be obtained through direct calculations, to be carried out according to the criteria in Pt B, Ch 7, App 1.

5.2.4 Launching cradles or grillage *(1/1/2015)*

The launching cradles or grillage are to be adequately connected to deck structures and arranged, as far as possible, in way of longitudinal bulkheads or at least of girders.

5.3 Hull scantlings of non-propelled units with service notation "pontoon - crane"

5.3.1 Loads transmitted by the lifting appliances

The forces and moments transmitted by the lifting appliances to the ship's structures, during both lifting service and navigation, are to be obtained by means of criteria to be considered by the Society on a case-by-case basis.

5.3.2 Ship's structures

The ship's structures, subjected to the forces transmitted by the lifting appliances, are to be reinforced to the Society's satisfaction.

5.3.3 Lifting appliances

The check of the behaviour of the lifting appliances at sea is outside the scope of the classification and is under the responsibility of the Designer. However, where the requirements in [3.2.1] may not be complied with (i.e. sailing with boom or derrick up) or where, exceptionally, trips with suspended load are envisaged, the Designer is to submit the check of the lifting appliances during navigation to the Society for information.

The Society may check these calculations following a specific request, while also reserving the right to do so, when deemed necessary, without any such request.

6 Other structures

6.1 Reinforcement of the flat bottom forward area of ships with one of the service notations "pontoon" and "pontoon - crane"

6.1.1 Application *(1/7/2024)*

The requirements in this Article are applicable to barges, pontoons and barge-shaped assisted propelled units with a navigation notation other than sheltered area.

For barges, pontoons and barge-shaped assisted propelled units of less than 100 m in length, when a reduction of the speed is provided in relation with the sea state to avoid bottom impact pressure for flat bottom area, the requirements related to the bottom impact pressure are not applicable.

6.1.2 Area to be reinforced

The structures of the flat bottom forward area are to be able to sustain the dynamic pressure due to the bottom impact.

The flat bottom forward area is:

- longitudinally, over the bottom located from the fore end to 0,15 L aft of the fore end
- transversely, over the whole flat bottom, and the adjacent zones up to a height, from the base line, not less than 2L, in mm. In any case, this height need not be greater than 300 mm.

6.1.3 Bottom impact

The bottom dynamic impact pressure is to be considered if:

$T_F < 0,04\ L$,

where T_F is the minimum forward draught, in m, among those foreseen in operation in ballast conditions or conditions of partial loading.

If T_F is less than 0,025 L, strengthening of the flat bottom forward is to be considered by the Society on a case-by-case basis.

6.1.4 Partial safety factors

The partial safety factors to be considered for checking the reinforcements of the flat bottom forward area are specified in Tab 4.

Table 4 : Reinforcements of the flat bottom forward area - Partial safety factors

Partial safety factors covering uncertainties regarding:	Partial safety factors		
	Symbol	Plating	Ordinary stiffeners
Still water pressure	γ_{S2}	1,00	1,00
Wave pressure	γ_{W2}	1,10	1,10
Material	γ_m	1,02	1,02
Resistance	γ_R	1,30	1,15

6.1.5 Scantlings of plating and ordinary stiffeners

Where T_F is less than 0,03 L, the net scantlings of plating and ordinary stiffeners of the flat bottom forward area, as defined in [6.1.2], are to be not less than those obtained according to Pt B, Ch 9, Sec 1, [2] and those obtained from Tab 5.

Where T_F is between 0,03 L and 0,04 L, the net scantlings of plating and ordinary stiffeners are to be obtained by linear interpolation between those obtained according to Pt B, Ch 9, Sec 1, [2] and those obtained from Tab 5.

6.1.6 Tapering

Outside the flat bottom forward area, scantlings are to be gradually tapered so as to reach the values required for the areas considered.

6.1.7 Floor spacing

In the area to be reinforced, defined in [6.1.2], the floor spacing is to be not greater than 0,68 $L^{1/4}$.

7 Hull outfitting

7.1 Equipment

7.1.1 Manned non-propelled units

The equipment of anchors, chain cables and ropes to be fitted on board manned non-propelled units is to comply with Pt B, Ch 10, Sec 4, unless otherwise required by the Society.

Chain cables for anchors may be replaced by steel ropes having the same breaking load. The ropes are to be connected to the anchors by approximately 10 m of chain cable complying with Pt B, Ch 10, Sec 4.

Non-propelled units continuously assisted by a tug may have only one anchor, complying with Pt B, Ch 10, Sec 4, and a chain rope having length neither less than 75% of the length obtained according to Pt B, Ch 10, Sec 4, nor less than 220 m.

7.1.2 Manned non-propelled units with navigation notation “sheltered area”

For non-propelled units with the navigation notation **sheltered area**, the equipment is not required for classification purposes.

However, in this case, the equipment to be fitted may be obtained from Pt B, Ch 10, Sec 4, based on the value of equipment number EN equal to 50% of that obtained from the applicable formulae in Pt B, Ch 10, Sec 4, [2].

7.1.3 Unmanned non-propelled units

For unmanned non-propelled units, the equipment is not required for classification purposes. The scantlings of anchors, chain cables and ropes to be fitted on board are the responsibility of the Designer.

7.1.4 Towing arrangements

Non-propelled units are to be fitted with suitable arrangements for towing, with scantlings under the responsibility of the Designer.

The Society may, at the specific request of the interested parties, check the above arrangements and the associated hull strengthening; to this end, the maximum pull for which the arrangements are to be checked is to be specified on the plans.

Table 5 : Reinforcements of plating and ordinary stiffeners of the flat bottom forward area

Element	Formula	Minimum value
Plating	Net thickness, in mm: $t = 13{,}9 c_a c_r s \sqrt{\gamma_R \gamma_m \frac{\gamma_{W2} p_{BI}}{R_y}}$	Net minimum thickness, to be taken, in mm, not less than: $t = 0{,}03L + 5{,}5 - c_E$ nor than the lesser of: $t = 16$ $t = 6{,}3\,(s - 0{,}228\,L^{1/4}) + 0{,}063\,L + 3{,}5$ where s is to be taken not less than $0{,}182\,L^{1/4}$
Ordinary stiffeners	Net section modulus, in cm^3, to be taken as the lesser of: $w = \gamma_R \gamma_m \beta_b \frac{\gamma_{W2} p_{BI}}{16 c_P R_y} \left(1 - \frac{s}{2\ell}\right) s \ell^2 10^3$ $w = \gamma_R \gamma_m \beta_b \frac{\gamma_{S2} T}{6 R_y} s \ell^2 10^4$	Web net minimum thickness, in mm, to be not less than the lesser of: • $t = 1{,}5 L^{1/3}_2$ • the thickness of the attached plating.
	Net shear sectional area, in cm^2: $A_{Sh} = 10 \gamma_R \gamma_m \beta_s \frac{\gamma_{W2} p_{BI}}{R_y} \left(1 - \frac{s}{2\ell}\right) s \ell$	

Note 1:

c_E : coefficient, to be taken equal to:

$c_E = 1$ for $L \leq 65$ m

$c_E = 3 - L / 32{,}5$ for $65 \text{ m} < L < 90$ m

$c_E = 0$ for $L \geq 90$ m

c_P : Ratio of the plastic section modulus to the elastic section modulus of the ordinary stiffeners with an attached shell plating, to be taken equal to 1,16 in the absence of more precise evaluation

γ_R, γ_m, γ_{S2}, γ_{W2}: Partial safety factors, defined in Tab 4

p_{BI} : Bottom dynamic impact pressure, defined in Pt B, Ch 9, Sec 1, [3.2].

8 Additional arrangement requirements for ships with service notation "Barge-oil"

8.1 Application

8.1.1 *(1/5/2013)*

The requirements of this item apply to ships with the service notation "**barge-oil**".

8.2 Cargo segregation

8.2.1 *(1/5/2013)*

Unless expressly provided otherwise, in ships enabled to carry cargoes having a flashpoint below 60°C, tanks containing cargo or cargo residues are to be placed forward of and segregated from accommodation, service and machinery spaces, drinking water and stores for human consumption by means of a cofferdam, a cargo pump room, a fuel oil tank, a ballast tank or any other similar compartment and arranged in such a way that a single failure of a deck or bulkhead will not permit the entry of gas or vapour from the cargo tank into control stations, accommodation and service spaces (see Fig 3 and Fig 4).

8.3 Size and arrangement of cargo tanks and slop tanks

8.3.1 Cargo tanks *(1/5/2013)*

Barge-oil of 600 t deadweight and above are not allowed to carry oil in any compartment extending forward of a collision bulkhead located in accordance with Pt B, Ch 2, Sec 1, [2].

Figure 4 *(1/5/2013)*

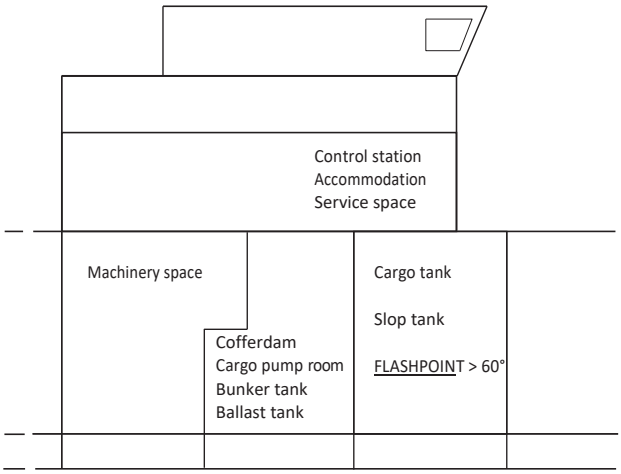
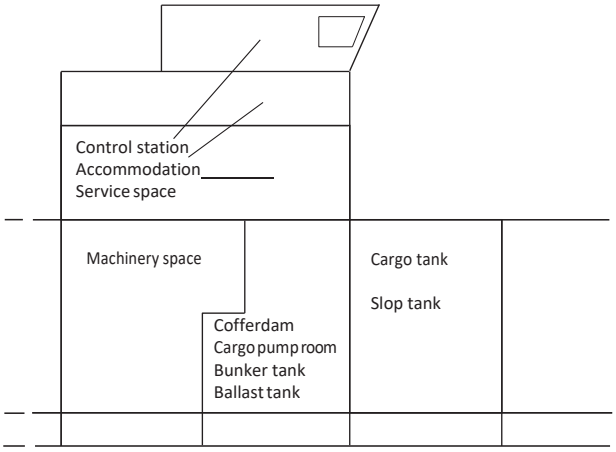


Figure 5 *(1/5/2013)*



8.3.2 Size and arrangement of cargo tanks *(1/5/2013)*

The length of each cargo tank is not to exceed 10 metres or one of the values of Tab 6, as applicable, whichever is the greater.

Table 6 : Length of cargo tanks *(1/5/2013)*

Longitudinal bulkhead arrangement	Cargo tank	Condition	Centreline bulkhead arrangement	Length of cargo tanks, in m
No bulkhead	-	-	-	$(0,5\ b_i / B + 0,1)\ L$
Centreline bulkhead	-	-	-	$(0,25\ b_i / B + 0,15)\ L$
Two or more bulkheads	Wing cargo tank	-	-	0,2 L
	Centre cargo tank	$b_i / B \geq 1/5$	-	0,2 L
		$b_i / B < 1/5$	No	$(0,5\ b_i / B + 0,1)\ L$
			Yes	$(0,25\ b_i / B + 0,15)\ L$

(1) b_i is the minimum distance from the ship side to the outer longitudinal bulkhead of the i-th tank, measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.

(2) Not to exceed 0,2 L

8.3.3 Slop tanks *(1/5/2013)*

The arrangements of the slop tank or combination of slop tanks are to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is to be not less than 3 per cent of the oil carrying capacity of the ships, except that the Society may accept:

- 2% for such barge -oil where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system
- 2% where segregated ballast tanks are provided in accordance with [5]. This capacity may be further reduced to 1,5% for such barge -oil where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system.
- The society may accept slop tanks of any size, including absence of dedicated slop tanks, for units which:
  - are dedicated to the same type of cargo for many consecutive voyages, and
  - are arranged with segregated ballast tanks, and
  - do not carry out tank washing on a regular basis, and
  - retain on board (in cargo tanks) the total quantity of washing media, and discharge it ashore.

8.4 Access arrangement

8.4.1 *(1/5/2013)*

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo tanks and ballast compartments.

8.4.2 *(1/5/2013)*

Means of access to side and centre tanks may not be provided in the same transverse section.

8.4.3 *(1/5/2013)*

The pipe tunnel in the double bottom is to comply with the following requirements:

- it may not communicate with the engine room
- provision is to be made for at least two exits to the open deck arranged at a maximum distance from each other. One of these exits fitted with a watertight closure may lead to the cargo pump room.

8.4.4 **Access to compartments in the cargo area** *(1/5/2013)*

Access to cofferdams, ballast tanks, cargo tanks and other compartments in the cargo area is to be direct from the open deck and such as to ensure their complete inspection. Access to double bottom compartments may be through a cargo pump room, pump room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

8.4.5 **Access to the fore peak tank** *(1/1/2026)*

The requirements for access to the fore peak tank in Ch 7, Sec 2, [7.2] and [7.3] apply.

Indirect access from the open deck to the fore peak tank through an enclosed space may be accepted if the unit is only enabled to carry products having a flashpoint exceeding 60°C.

8.4.6 **Access through horizontal openings** *(1/5/2013)*

For access through horizontal openings the dimensions are to be sufficient to allow a person wearing a self-contained, air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the compartment. The minimum clear opening is to be not less than 600 mm by 600 mm..

8.4.7 **Access through vertical openings** *(1/5/2013)*

For access through vertical openings the minimum clear opening is to be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

8.4.8 **Barge-oil less than 5000 t deadweight** *(1/5/2013)*

For barge-oil of less than 5000 t deadweight smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

9 Mooring systems for units with the service notation "barge - accommodation"

9.1 Application

9.1.1 *(1/7/2014)*

For units with the service notation barge - accommodation, the mooring system is to be in accordance with with the requirements in Pt F, Ch 13, Sec 21 for the assignment of the additional class notation **MOORING**.

10 Additional requirements for ships with service notation "Barge-liquefied gas"

10.1 Accommodation, service and machinery spaces and control stations

10.1.1 **Precautions against hazardous vapours** *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.2.2

Compliance with the relevant requirements of the IGC Code, in particular with 3.2.4, 3.8, 8.2.10 and 12.1.6, as applicable, also ensures compliance with the requirements in IGC Code 3.2.2, relevant to precautions against hazardous vapours.

10.1.2 **Air outlets** *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.2.4

The requirements in IGC Code 3.2.4, relevant to air intakes, are also intended to be applicable to air outlets. This interpretation also applies to the requirements in IGC Code 3.8.4.

10.1.3 **Doors facing cargo area** *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.2.4

Doors facing the cargo area or located in prohibited zones in the sides are to be restricted to stores for cargo-related and safety equipment, cargo control stations as well as decontamination showers and eye wash.

Where such doors are permitted, the space may not give access to other spaces covered in IGC Code 3.2.4 and the common boundaries with these spaces are to be insulated with A60 class bulkheads.

10.1.4 **Exemptions, ventilation openings and type of closures** *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.2.6

The requirement for fitting air intakes and openings with closing devices operable from inside the space in ships intended to carry toxic products is to apply to spaces which are used for the ship's radio and main navigating equipment, cabins, mess rooms, toilets, hospitals, galleys, etc., but does not apply to spaces not normally manned such as engine room casings, steering gear compartments.

The closing devices are to give a reasonable degree of gas-tightness. Ordinary steel fire-flaps without gaskets/seals are normally not considered satisfactory.

10.1.5 **Openings for removal of machinery** *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.2.6

Bolted plates of A60 class for removal of machinery may be accepted on bulkheads facing cargo areas, provided signboards are fitted to warn that these plates may only be opened when the ship is in gas-free condition.

10.2 Access arrangement

10.2.1 **Access to compartments in the cargo area** *(1/6/2021)*

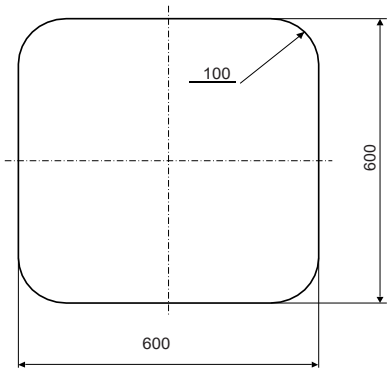
a) Passage through hatches and manholes

IGC CODE REFERENCE : Ch 3, 3.5

For the purpose of the requirements in IGC Code 3.5.3, the following applies:

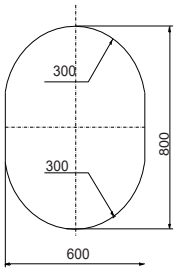
1) The term “minimum clear opening of not less than 600 x 600 mm” means that such openings may have corner radii up to a maximum of 100 mm (see Fig 6).

Figure 6 : Minimum horizontal hatch size *(1/6/2021)*



2) The term “minimum clear opening of not less than 600 x 800 mm” also includes an opening of the size specified in Fig 7:

Figure 7 : Minimum size of manholes *(1/6/2021)*



b) Cofferdams

IGC CODE REFERENCE : Ch 3, 3.5

Where fitted, cofferdams are to have sufficient size for easy access to all their parts. The width of the cofferdams may not be less than 600 mm.

c) Pipe tunnels

IGC CODE REFERENCE : Ch 3, 3.5

Pipe tunnels are to have enough space to permit inspection of pipes. The pipes in pipe tunnels are to be installed as high as possible from the ship’s bottom.

d) Access to pipe tunnels

IGC CODE REFERENCE : Ch 3, 3.5

Access to pipe tunnels through manholes in the engine space is not permitted.

10.2.2 Access to the bow *(1/6/2021)*

a) This item [10.2.2] applies to ships subject to the International Load Line Convention 1966, as amended.

b) Liquefied gas carriers are to be provided either with a gangway between the superstructure or deckhouse aft and the forecastle, or with equivalent arrangements in accordance with the International Load Line Convention 1966, as amended.

c) Liquefied gas carriers are to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means are to be accepted by the Society.

Note 1: The Society considers means in compliance with the Guidelines adopted by the Maritime Safety Committee of IMO with Resolution MSC.62(67) on 5/12/1996 as being acceptable.

10.3 Cargo containment

10.3.1 *(1/6/2021)*

The requirements of Ch 9, Sec 4 apply.

10.4 Materials for construction

10.4.1 *(1/6/2021)*
The requirements of Ch 9, Sec 6 apply.

11 Additional requirements for ships with service notation "Barge-LNG bunker"

11.1 Mooring and fendering

11.1.1 *(1/6/2021)*
Steel to steel contact between LNG bunker ship and receiving ship e.g. via mooring lines, ladders, gangways, chains for fender support etc. shall be avoided through the use of insulation. Bunker hoses/pipes shall be supported and isolated to prevent electrical contact with the receiving ship.

11.1.2 *(1/6/2021)*
The rubber fenders used for keeping the distance between the LNG bunkering ship and receiving ship shall be built according to an international recognized standard such as ISO 17357-2 or equivalent. The dimensions and arrangement of fenders shall be verified during risk assessment as required in [11.1.1] taking into consideration the interferences of the hazardous areas of both ships and the minimum bend radius of the bunkering hose.

11.2 Access arrangement

11.2.1 *(1/6/2021)*
The requirements of [10.2] apply.

11.3 Cargo containment

11.3.1 *(1/6/2021)*
The requirements of Ch 9, Sec 4 apply.

11.4 Materials for construction

11.4.1 *(1/6/2021)*
The requirements of Ch 9, Sec 6 apply.

12 Additional requirements for ships with service notation "Barge-chemical"

12.1 Accommodation, service and machinery spaces and control stations

12.1.1 **Air intakes and other openings to accommodation spaces** *(1/6/2021)*
IBC CODE REFERENCE : Ch 3, 3.2.2

The requirements relevant to air intakes in IBC Code 3.2.2 are also intended to be applicable to air outlets. This interpretation also applies to the requirements in IBC Code 3.2.3, 3.7.4, 8.3, 15.12.1.3 and 19.3.8.

12.1.2 **Windows, sidescuttles and doors** *(1/6/2021)*
IBC CODE REFERENCE : Ch 3, 3.2.3

a) Access facing the cargo area or other prohibited zones is to be restricted to stores for cargo-related and safety equipment, cargo control stations and emergency shower spaces.

b) Entrances and openings to service spaces located forward of the cargo area may not face such area. However, for small ships alternative arrangements may be specially considered by the Society.

c) The bolt spacing for bolted plates mentioned in the paragraph in the reference is to be such as to guarantee a suitable gas-tightness.

12.1.3 **Ships fitted with deckhouses originating from main deck** *(1/6/2021)*
IBC CODE REFERENCE : Ch 3, 3.2.3

On all chemical tankers, regardless of the type of products to be carried, where a deckhouse is substituted for a superstructure and liquid products could flow along the sides of the house, the house front is to be continued to the sides of the ship in the form of a sill, or a permanent spillage barrier is to be arranged as described in Regulation II-2/56.6 of SOLAS 74(83).

12.2 Cargo tank arrangement

12.2.1 Location of cargo tanks *(1/6/2021)*

IBC CODE REFERENCE: Ch 2, 2.6

The requirements in IBC Code 2.6 apply to cargo tanks.

12.3 Access arrangement

12.3.1 Access to compartments in the cargo area *(1/6/2021)*

a) Access to fuel oil tanks

IBC CODE REFERENCE : Ch 3, 3.4.1

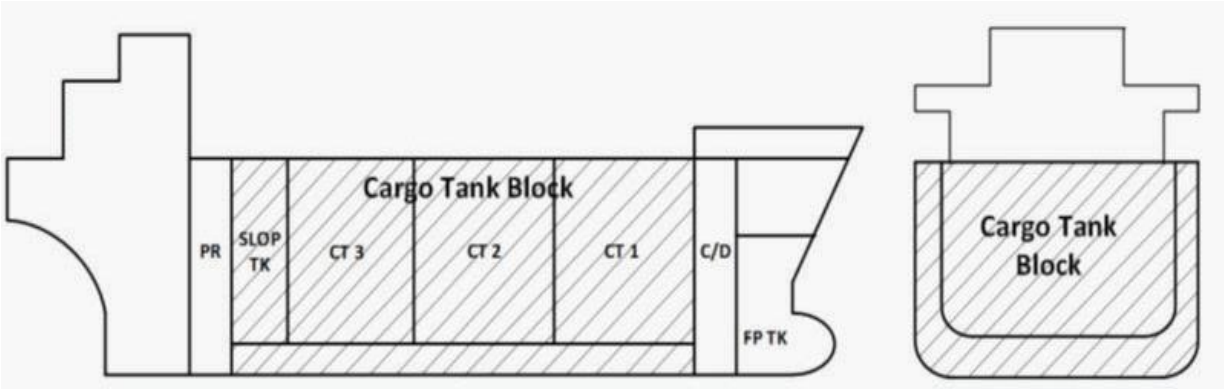
The requirements in IBC Code 3.4.1 apply to fuel oil tanks adjacent to cargo tanks even if such fuel oil tanks are not included in the “cargo area” as defined in IBC Code 1.3.5.

b) Accesses and escapes from double bottom tanks and similar spaces

IBC CODE REFERENCE : Ch 3, 3.4.1

To cater for restrictions in the movement of personnel and to limit the time needed for a possible emergency escape, two separate means of access are generally to be fitted in double bottom tanks and similar spaces where obstructions impede movement. The two accesses are to be as widely separated as practicable. Only one access may be approved in special circumstances if, it being understood that the escapes have the required dimensions, the ability to readily traverse the space and to remove an injured person can be proved to the satisfaction of the Society.

Figure 8 *(1/6/2021)*

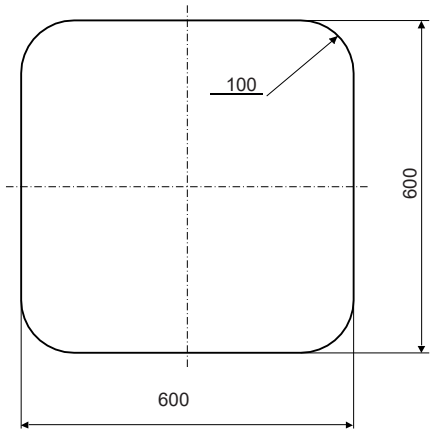


c) Access through horizontal openings

IBC CODE REFERENCE : Ch 3, 3.4.2

The shape of the minimum acceptable clear opening of 600 mm by 600 mm is indicated in Fig 9.

Figure 9 : Shape of minimum acceptable clear opening of 600 mm by 600 mm *(1/6/2021)*

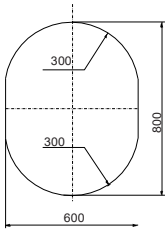


d) Access through vertical openings

IBC CODE REFERENCE : Ch 3, 3.4.3

For pressure cargo tanks only, access openings may be circular openings having a diameter not less than 600 mm. The minimum size of vertical oval openings is defined in Fig 10.

Figure 10 : Minimum size of vertical oval openings *(1/6/2021)*



12.3.2 Access to the bow *(1/6/2021)*

a) This item [12.3.2] applies to ships subject to the International Load Line Convention 1966, as amended.

b) Chemical tankers are to be provided either with a gangway between the superstructure or deckhouse aft and the forecastle, or with equivalent arrangements in accordance with the International Load Line Convention 1966, as amended.

c) Chemical tankers are to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means are to be accepted by the Society.

Note 1: The Society considers means in compliance with the Guidelines adopted by the Maritime Safety Committee of IMO with Resolution MSC.62(67) on 5/12/1996 as being acceptable.

12.3.3 Access to pump rooms *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.3.1

In general, a cargo pump room is to be provided with one set of access/escape ladders. Where it is envisaged that personnel are normally employed in a pump room or the pump room is unusually large, an additional means of escape may be required.

12.3.4 Segregation of pump rooms *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.3.1

Cargo pump rooms and pump rooms may not give direct access to other ship spaces and are to be separated from adjacent spaces by means of gas-tight bulkheads and/or decks.

12.4 Coamings

12.4.1 *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.7.7

In general, the height of the coaming is to be not less than 150 mm. In any case, it is to be not less than 50 mm above the upper edge of the sheerstrake.

12.5 Cargo containment

12.5.1 *(1/6/2021)*
The requirements of Ch 8, Sec 4 apply.

12.6 Materials for construction

12.6.1 *(1/6/2021)*
The requirements of Ch 8, Sec 6 apply.

12.7 Minimum distance of cargo tanks from shell

12.7.1 Exception *(1/6/2021)*
Any cargo tank, irrespective of its location, may be used for collecting contaminated cargo pump room bilge water or tank washings, as an exception to the requirements in IBC Code 2.6.1.1.

12.7.2 Suction wells *(1/6/2021)*
In general, the area of suction wells is not to be greater than that required to accommodate cargo pumps, suction pipes, valves, heating coils etc., and to ensure efficient flow and the necessary access for cleaning and maintenance.

SECTION 3 MACHINERY SYSTEMS

1 General

1.1 Application

1.1.1 *(1/6/2021)*

This Section applies to non-propelled units.

Item [3] provides additional requirements that only apply to barges having the service notation barge-accommodation.

Sections 4 to 7 provide additional requirements that only apply to barges having the service notations **barge-oil**, **barge-liquified gas**, **barge-LNG bunker** and **barge-chemical**, respectively.

1.2 Documents to be submitted

1.2.1 *(1/6/2021)*

The documents listed in Tab 1 are to be submitted for approval for all barges.

1.3 Exemptions

1.3.1 *(1/5/2013)*

The requirements in Pt C, Ch 1, Sec 10, [11.4.1] b) do not apply to service tanks.

The requirements in Pt C, Ch 1, Sec 10, [11.4.6] a) do not apply.

2 Bilge system

2.1 Bilge system in ships having no source of electrical power

2.1.1 General *(1/7/2011)*

Where there is no source of electrical power on board, hand pumps are to be provided, in sufficient number and so positioned as to permit an adequate drainage of all the compartments of the ship.

The requirement to provide a bilge system and associated hand pumps may be waived in the case of vessels without persons on board.

***2.1.2* Arrangement of the bilge system** *(1/7/2010)*

The bilge system is to comply with one of the following arrangements:

a) at least one pump is to be provided for each compartment

b) at least two pumps connected to a bilge main are to be provided. The main is to have branch pipes allowing the draining of each compartment through at least one suction.

The spaces served only by hand pumps may be not provided with air pipes according to Pt C, Ch 1, Sec 10, [9.1]. In any event they are anyway to be provided with sounding means according to Pt C, Ch 1, Sec 10, [9.2].

2.1.3 Hand pumps

a) Hand pumps are to be capable of being operated from positions above the load waterline and are to be readily accessible at any time.

b) Hand pumps are to have a maximum suction height not exceeding 7,30 m.

2.1.4 Size of bilge pipes

a) The internal diameter, in mm, of suction pipes is not to be less than the diameter given by the following formula:

$$d_1 = \frac{T}{100} + 50$$

where:

T : Underdeck tonnage, in tons.

b) When the ship is subdivided into small watertight compartments, the diameter of these suctions need not exceed 50 mm.

2.2 Bilge system in ships having a source of electrical power

2.2.1 General

On board ships having no propelling machinery but having a source of electrical power, mechanical pumps are to be provided for draining the various compartments of the ship.

Cargo pumps may be used for this purpose.

2.2.2 Arrangement of the bilge system

The bilge system is to comply with the provisions of Pt C, Ch 1, Sec 10, [6.3] to Pt C, Ch 1, Sec 10, [6.6] applicable to the spaces concerned, except that direct suctions need not be provided.

2.2.3 Bilge pumps

The number and capacity of the bilge pumps are to comply with the relevant requirements of Pt C, Ch 1, Sec 10, [6.7].

2.2.4 Size of bilge pipes

The size of bilge pipes is to comply with the relevant requirements of Pt C, Ch 1, Sec 10, [6.8].

2.2.5 Unmanned barges and occasionally manned barges *(1/1/2017)*

The requirement to provide pumps and a bilge system suitable to drain water from each compartment may be waived in the case of vessels without persons on board, and in case of vessels intended to have persons on board only during specific operations at fixed location, with the presence of an assisting propelled ship in close proximity.

Even in these latest units, when the source of power is made of engines located within compartments having the bottom plating in any place extending below the deepest waterline, these compartments are to be fitted with suctions from suitably located pumps operated by power.

The waiver to occasionally manned units may be granted only to such units showing satisfactory stability in the worse combination of loading and flooding of two adjacent compartments.

Table 1 : Documents to be submitted for all barges

No.	A/I **(1)**	Document **(2)**
1	A	Diagram of the bilge system
2	A	Diagram of the central priming system intended for the bilge pumps, where provided
3	A	Capacity, prime mover and location of the bilge pumps

(1) A: To be submitted for approval in four copies
I: To be submitted for information in duplicate

(2) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

3 Additional requirements for units with service notation "barge-accommodation"

3.1 Bilge system

3.1.1 General *(1/6/2021)*

a) The bilge pumping system required in Pt C, Ch 1, Sec 10, [6] is to be capable of operation under all practicable conditions after a casualty, whether the unit is upright or listed. For this purpose, wing suctions is generally to be fitted except in narrow compartments at the end of the unit where one suction may be sufficient. In compartments of unusual form, additional suctions may be required.

b) Arrangements are to be made whereby water in the compartment may find its way to the suction pipes.

c) Where, for particular compartments, the Society is satisfied that the provisions of drainage may be undesirable, it may allow such provision to be dispensed with if damage stability calculations show that the survival capability of the unit will not be impaired.

3.1.2 Bilge pumps *(1/7/2014)*

a) Number and capacity of bilge pumps

Any unit is to be provided with at least two power bilge pumps connected to the bilge main. For units with the service notation **barge-accommodation**, where the bilge pump numeral is 30 or more, one additional independent power pump is to be provided.

The bilge pump numeral is to be calculated as follows:

- where P_1 is greater than P:

$$\text{bilge pump numeral} = 72 \cdot \left[\frac{M + 2P_1}{V + P_1 - P} \right]$$

- in other cases:

$$\text{bilge pump numeral} = 72 \cdot \left[\frac{M + 2}{V} \right]$$

where:

L : the length of the unit (m), as defined in the International Convention on Load Lines in force

M : the volume of the machinery space (m^3), that is below the bulkhead deck; with the addition thereto of the volume of any permanent oil fuel bunkers which may be situated above the inner bottom and forward of, or abaft, the machinery space. For the purpose of this item, machinery spaces are spaces between the watertight boundaries of a space containing the auxiliary machinery, including boilers and generators. In the case of unusual arrangements, the Administration may define the limits of the machinery spaces;

P : the whole volume of the passenger and crew spaces below the bulkhead deck (m^3), which are provided for the accommodation and use of passengers and crew, excluding baggage, store, provision and mail rooms;

V : the whole volume of the unit below the bulkhead deck (m^3);

P_1 : NK where:

N : the number of passengers for which the ship is to be certified; and

K : 0,056 L

Each of the above pumps is to have a capacity not less than that required in Pt C, Ch 1, Sec 10, [6.7.4].

For use of ejectors in lieu of bilge pumps, see Pt C, Ch 1, Sec 10, [6.7.2].

b) Location of bilge pumps

Where practicable, the power bilge pumps are to be placed in separate watertight compartments and so arranged or situated that these compartments will not be flooded by the same damage. If the auxiliary machinery and boilers are in two or more watertight compartments, the pumps available for bilge service are to be distributed as far as is possible throughout these compartments.

c) Availability of pumps

On a unit of 91,5 m in length and upwards or having a bilge pump numeral of 30 or more, as stated in [3.1.2] a), the arrangements are to be such that at least one power bilge pump will be available for use in all flooding conditions which the unit is required to withstand, as follows:

1) one of the required bilge pumps is to be an emergency pump of a reliable submersible type having a source of power situated above the bulkhead deck, or

2) the bilge pumps and their sources of power are to be so distributed throughout the length of the unit that at least one pump in an undamaged compartment will be available.

d) Draining capability

With the exception of additional pumps which may be provided for peak compartments only, each required bilge pump is to be so arranged as to draw water from any space required to be drained.

3.1.3 Direct bilge suction *(1/7/2014)*

a) In units subject to subdivision regulations, independent power bilge pumps situated in machinery and/or boiler spaces are to have direct suctions from these spaces, except that not more than two such suctions are to be required in any one space.

b) Where two or more such suctions are provided in one compartment, there is to be at least one on each side of the unit.

c) The Society may require independent power bilge pumps situated in other spaces to have separate direct suctions.

3.1.4 Control location *(1/7/2014)*

a) The spindles of the sea inlet and direct suction valves are to extend well above the engine room platform.

b) Where the pumps are driven by electric motors, their starting equipment are to be located at, or above, the level of the motors.

3.1.5 Provision against bilge system damage *(1/7/2014)*

a) Damage to the bilge system

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 unit than one fifth of the breadth of the unit (measured at right angles to the centreline at the level of the deepest subdivision load line), or is in a duct keel, a non-return valve is to be fitted to the pipe in the compartment containing the open end.

b) Operation in the case of flooding

1) Distribution boxes, cocks and valves in connection with the bilge pumping system is to be so arranged that, in the event of flooding, one of the bilge pumps may be operative on any compartment; in addition, damage to a pump or its pipe connecting to the bilge main outboard of a line drawn at one fifth of the breadth of the unit is to not put the bilge system out of action.

2) If there is only one system of pipes common to all the pumps, the necessary valves for controlling the bilge suctions must be capable of being operated from above the bulkhead deck.

3) 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 condition; in that case, only the valves necessary for the operation of the emergency system need be capable of being operated from above the bulkhead deck.

c) Valve controls

All cocks and valves referred in [3.1.5] b) which can be operated from above the bulkhead deck are to have their controls at their place of operation clearly marked and are to be provided with means to indicate whether they are open or closed.

3.1.6 Bilge system for small units *(1/7/2014)*

For units not subject to subdivision regulations, less than 25 tons gross tonnage, the bilge system will be specially considered by the Society in each single case.

3.2 Ballast system

3.2.1 *(1/7/2014)*

Water ballast should not in general be carried in tanks intended for fuel oil. In units in which it is not practicable to avoid putting water in fuel oil tanks, oily-water separating equipment to the satisfaction of the Society is to be fitted, or other alternative means, such as discharge to shore facilities are to be provided for disposing of the oily-water ballast.

3.3 Special requirements for starting arrangement of emergency generating sets

3.3.1 *(1/7/2014)*

The arrangements are to be such that the energy for the first charge of the sources of stored energy for starting the emergency generator can be produced on board under emergency condition, without external aid.

3.3.2 *(1/7/2014)*

The arrangements are to be such that the emergency generating set is automatically started periodically and kept running for a predetermined warm-up time. The interval between the starting and warm-up periods is not to exceed one month, and an alarm is to be given in case of failure of the starting attempts.

SECTION 4 ADDITIONAL REQUIREMENTS FOR MACHINERY AND CARGO SYSTEMS OF BARGE-OIL

1 General

1.1 Application

1.1.1 *(1/6/2021)*

These units are to comply with the requirements of Sec 3.

The requirements in this Section are additional to the ones in Sec 3.

Item [2] provides additional requirements that only apply to barges having the service notation barge-oil intended to carry oil having any flashpoint (i.e. including oils having flash point < 60°C).

Item [3] provides additional requirements that only apply to barges having the service notation barge-oil intended to carry only oil having flashpoint > 60°C.

Oil means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products (other than those petrochemicals listed in IBC Code Chapter 17).

1.2 Documents to be submitted

1.2.1 *(1/6/2021)*

The documents listed in Tab 1 are to be submitted for approval for barge oil intended to carry oil having any flashpoint.

The documents listed in Tab 1 are to be submitted for approval, for barge-oil intended to carry only oil having flashpoint > 60°Cexcept for items 8 and 9.

1.3 Exemptions

1.3.1 *(1/6/2021)*

The requirements in Pt C, Ch 1, Sec 10, [11.4.1] b) do not apply to service tanks.

The requirements in Pt C, Ch 1, Sec 10, [11.4.6] a) do not apply.

2 Additional requirements for ships with service notation "barge-oil"

2.1 Piping systems other than cargo piping system

2.1.1 Materials *(1/6/2021)*

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

***2.1.2* Independence of piping systems** *(1/6/2021)*

a) Bilge, ballast and scupper systems serving spaces located within the cargo area:
   - are to be independent from any piping system serving spaces located outside the cargo area
   - are not to lead outside the cargo area.

b) Fuel oil systems are to:
   - be independent from the cargo piping system
   - have no connections with pipelines serving cargo or slop tanks
   - bilge pumps serving spaces located within the cargo area are to be located in the cargo pump room or in another suitable space within the cargo area.

***2.1.3* Passage through cargo tanks and slop tanks** *(1/1/2025)*

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted, ballast pipes passing through cargo tanks are to fulfil the following provisions:

- they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
- they are to be of extra-reinforced wall thickness as per Pt C, Ch 1, Sec 10, Tab5
- they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

2.1.4 Draining of pump rooms *(1/6/2021)*

Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:

- a screw-down non-return valve is fitted on the bilge suctions, and
- a valve is fitted between the pump suction and the bilge distribution box.

Table 1 : Additional documents to be submitted for barge-oil *(1/6/2021)*

No.	Document **(1)**
1	General layout of cargo pump room with details of: • bulkhead penetrations • gas detection system • other alarms and safety arrangements
2	Diagram of cargo piping system
3	Diagram of the cargo tank venting system with: • indication of the outlet position • details of the pressure/vacuum valves and flame arrestors • details of the draining arrangements, if any
4	Diagram of the cargo tank level gauging system with overfill safety arrangements
5	Diagram of the cargo tank cleaning system
6	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
7	Diagram of the cargo heating systems
8	Diagram of inert gas system with details of the inert gas plant
9	Diagram of gas measurement system for double hull and double bottom spaces
(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.	

2.1.5 Ballast system *(1/1/2026)*

Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo oil and fuel oil systems.

In barges of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

Ballast pumps are to be located in the cargo pump room, or a similar space within the cargo area not containing any source of ignition.

Where installed in the cargo pump room, ballast pumps are to comply with the applicable provisions of [2.2.3] and [2.2.4].

Ballast systems serving segregated ballast in the cargo area are to be entirely located within the cargo area and are not to be connected to other piping systems.

Where they are intended to be filled with water ballast, the cofferdams located at the fore and aft ends of the cargo spaces may be emptied by a ballast pump located inside the machinery compartment or the forward space provided that:

- the suction is directly connected to the pump and not to a piping system serving machinery spaces
- the delivery is directly connected to the ship side.

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

Provisions may be made for filling cargo tanks with sea water, where permitted. Such ballast water is to be dealt with as per [2.4].

The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges. See also [2.4.10].

Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

In barges of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with [2.1.3] b).

Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

The fore peak tank can be ballasted with the system serving ballast tanks within the cargo area, provided the requirements in Ch 7, Sec 2, [7.2.1] are complied with.

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

2.1.6 Integrated cargo and ballast system *(1/6/2021)*

The requirements for integrated cargo and ballast systems are given in Ch 7, Sec 4, [3.5].

2.1.7 Air and sounding pipes of spaces other than cargo tanks *(1/6/2021)*

The air and sounding pipes fitted to the following spaces:

- cofferdams located at the fore and aft ends of the cargo spaces
- tanks and cofferdams located within the cargo area and not intended for cargo

are to be led to the open.

The air pipes referred to above are to be arranged as per Pt C, Ch 1, Sec 10, [9] and are to be fitted with easily removable flame screens at their outlets.

In barges of 600 tonnes deadweight and above, the air and sounding pipes referred above are not to pass through cargo tanks except in the following cases:

- short lengths of piping serving ballast tanks
- lines serving double bottom tanks located within the cargo area, except in the case of barges of 5000 tonnes deadweight and above where the provisions of [2.1.3], item b) are complied with.

2.1.8 Scupper pipes *(1/6/2021)*

Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt C, Ch 1, Sec 10, Tab 22, column 1.

2.1.9 Heating systems intended for cargo *(1/6/2021)*

a) Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 10.

b) The steam and heating media temperature within the cargo area is not to exceed 220° C.

c) Blind flanges or similar devices are to be provided on the heating circuits fitted to tanks carrying cargoes which are not to be heated.

d) Heating systems are to be so designed that the pressure maintained in the heating circuits is higher than that exerted by the cargo oil. This need not be applied to heating circuits which are not in service provided they are drained and blanked-off.

e) Isolating valves are to be provided at the inlet and outlet connections of the tank heating circuits. Arrangements are to be made to allow manual adjustment of the flow.

f) Heating pipes and coils inside tanks are to be built of a material suitable for the heated fluid. They are to have welded connections only.

g) To reduce the risk of liquid or gaseous cargo returns inside the engine or boiler rooms, steam heating systems of cargo tanks are to satisfy either of the following provisions:
   - they are to be independent of other ship services, except cargo heating or cooling systems, and are not to enter machinery spaces, or
   - they are to be provided with an observation tank on the water return system located within the cargo area. However, this tank may be placed inside the engine room in a well-ventilated position remote from boilers and other sources of ignition. Its air pipe is to be led to the open and fitted with a flame arrester.

h) Hot water systems serving cargo tanks are to be independent of other systems. They are not to enter machinery spaces unless the expansion tank is fitted with:
   - means for detection of flammable vapours
   - a vent pipe led to the open and provided with a flame arrester.

i) Thermal oil heating systems serving cargo tanks are to be arranged by means of a separate secondary system, located completely within the cargo area. However, a single circuit system may be accepted provided that:
   - the system is so arranged as to ensure a positive pressure in the coil of at least 3 m water column above the static head of the cargo when the circulating pump is not in operation
   - means are provided in the expansion tank for detection of flammable cargo vapours. Portable equipment may be accepted
   - valves for the individual heating coils are provided with a locking arrangement to ensure that the coils are under static pressure at all times.

2.2 Cargo pumping system

2.2.1 Number and location of cargo pumps *(1/6/2021)*

Arrangements are to be adopted to make discharge by pumps in the oil terminal possible, taking into account the NPSHD at the pumps, or a fixed mean of discharging and stripping is to be fitted.

Cargo pumps are to be located:

- in a dedicated pump room, or
- on deck, or
- when designed for this purpose, within the cargo tanks.

2.2.2 Use of cargo pumps *(1/6/2021)*

Except where expressly permitted in [2.1.5] and Sec 3, [2.2.1], cargo pumps are to be used exclusively for handling the liquid cargo and are not to have any connections to compartments other than cargo tanks.

Subject to their performance, cargo pumps may be used for tank stripping.

Cargo pumps may be used, where necessary, for the washing of cargo tanks

2.2.3 Cargo pumps drive *(1/6/2021)*

a) Prime movers of cargo pumps are not to be located in the cargo area, except in the following cases:
   - steam driven machine supplied with steam having a temperature not exceeding 220 °C
   - hydraulic motors
   - electric motors of certified explosion proof type.

b) Pumps with a submerged electric motor are not permitted in cargo tanks.

   Where cargo pumps are driven by a machine which is located outside the cargo pump room, the following arrangements are to be made:

   1) drive shafts are to be fitted with flexible couplings or other means suitable to compensate for any misalignment

2) the shaft bulkhead or deck penetration is to be fitted with a gas-tight gland of a type approved by the Society. The gland is to be efficiently lubricated from outside the pump room and so designed as to prevent overheating. The seal parts of the gland are to be of material that cannot initiate sparks.

3) temperature sensing devices are to be fitted for bulkhead shaft gland bearings.

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

2.2.4 Design of cargo pumps *(1/6/2021)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

c) Pump casings are to be fitted with temperature sensing devices; see [2.2.5].

2.2.5 Monitoring of cargo pumps *(1/6/2021)*

Cargo pumps are to be monitored as required in Tab 2.

2.2.6 Control of cargo pumps *(1/6/2021)*

Cargo pumps are to be capable of being stopped from:

- a position outside the pump room, and
- a position next to the pumps.

2.2.7 Cargo piping design *(1/6/2021)*

Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 10 applicable to piping systems of class III.

- For tests, refer to Sec 4, [4].
- Cargo piping is, in general, to be made of steel or cast iron.
- Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.
- Spheroidal graphite cast iron may be used for cargo oil piping.
- Grey cast iron may be accepted for cargo oil lines:
  - within cargo tanks, and
  - on the weather deck for pressure up to 1,6 Mpa.

  It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.
- Plastic pipes may be used in the conditions specified in Pt C, Ch 1, App 3. Arrangements are to be made to avoid the generation of static electricity.

Cargo pipe lengths may be connected either by means of welded joints or, unless otherwise specified, by means of flange connections.

Where necessary, cargo piping is to be fitted with expansion joints or bends.

Expansion joints including bellows are to be of a type approved by the Society.

Expansion joints made of non-metallic material may be accepted only inside tanks and provided they are:

- of an approved type
- designed to withstand the maximum internal and external pressure
- electrically conductive

Sliding type couplings are not to be used for expansion purposes where lines for cargo oil pass through tanks for segregated ballast.

Valves with remote control are to comply with Pt C, Ch 1, Sec 10, [2.7.3].

Submerged valves are to be remote controlled. In the case of a hydraulic remote control system, control boxes are to be provided outside the tank, in order to permit the emergency control of valves.

Valve actuators located inside cargo tanks are not to be operated by means of compressed air.

Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 4 times the maximum pressure under cargo transfer conditions.

The ohmic electrical resistance of cargo hoses is not to exceed $10^6\ \Omega$.

Table 2 : Monitoring of cargo pumps *(1/6/2021)*

Equipment, parameter	Alarm **(1)**	Indication **(2)**	Comments
pump, discharge pressure	-	L	• on the pump **(3)**, or • next to the unloading control station
pump casing, temperature	H		visual and audible, in cargo control room or pump control station
bulkhead shaft gland bearing, temperature	H		visual and audible, in cargo control room or pump control station

(1) H = high
(2) L = low
(3) and next to the driving machine if located in a separate compartment

2.2.8 Cargo piping arrangement and installation *(1/6/2021)*

Cargo piping is not to pass through tanks or compartments located outside the cargo area.

Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [2.1.3] b).

Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [2.1.3] b) are complied with.

Piping through cargo tanks, see also Ch 7, Sec 2, [3.1.4].

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

Stop valves are to be provided to isolate each tank.

A stop valve is to be fitted at each end of the cargo manifold.

When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

Main cargo oil valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

To avoid the hazard of an incendive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the following requirements are to be complied with:

- the loading pipes are to be led as low as practicable in the tank
- the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than $10^6\ \Omega$.

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

- clearly visible so that any shortcoming can be clearly detected
- designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint
- easy to install and replace.

Where the ship is arranged for loading and unloading outside the cargo area, the following provisions are to be complied with:

- the piping outside the cargo area is to be fitted with a shut-off valve at its connection with the piping system within the cargo area and separating means such as blank flanges or removable spool pieces or equivalent (see Note 1) are to be provided when the piping within the cargo area is not in use
- the shore connection is to be fitted with a shut-off valve and a blank flange

Note 1: Those indicated in the IMO MSC/Circ. 474 are acceptable as equivalent

d) pipe connections outside the cargo area are to be of welded type only

e) arrangements are made to allow the piping outside the cargo area to be efficiently drained and purged.

2.3 Cargo tanks and fittings

2.3.1 *(1/6/2021)*

The provisions of this paragraph apply to cargo tanks and slop tanks.

2.3.2 **Cargo tank venting** *(1/6/2021)*

Cargo tanks are to be provided with venting systems entirely distinct from the air pipes of the other compartments of the ship. The arrangements and position of openings in the cargo tank deck from which emission of flammable vapours can occur are to be such as to minimise the possibility of flammable vapours being admitted to enclosed spaces containing a source of ignition, or collecting in the vicinity of deck machinery and equipment which may constitute an ignition hazard.

2.3.3 **Design of venting arrangements** *(1/6/2021)*

The venting arrangements are to be so designed and operated as to ensure that neither pressure nor vacuum in cargo tanks exceeds design parameters and be such as to provide for:

a) the flow of the small volumes of vapour, air or inert gas mixtures caused by thermal variations in a cargo tank in all cases through pressure/vacuum valves, and

b) the passage of large volumes of vapour, air or inert gas mixtures during cargo loading and ballasting, or during discharging,

c) a secondary means of allowing full flow relief of vapour, air or inert gas mixtures to prevent overpressure or underpressure in the event of failure of the arrangements in b). Alternatively, pressure sensors may be fitted in each tank protected by the arrangement required in b), with a monitoring system in the ship's cargo control room or the position from which cargo operations are normally carried out. Such monitoring equipment is also to provide an alarm facility which is activated by detection of overpressure or underpressure conditions within a tank.

2.3.4 **Combination of venting arrangements** *(1/6/2021)*

a) the venting arrangements in each cargo tank may be independent or combined with other cargo tanks and may be incorporated into the inert gas piping.

b) where the arrangements are combined with other cargo tanks, either stop valves or other acceptable means are to be provided to isolate each cargo tank. Where stop valves are fitted, they are to be provided with locking arrangements which are to be under the control of the responsible ship's officer. There is to be a clear visual indication of the operational status of the valves or other acceptable means. Where tanks have been isolated, it is to be ensured that relevant isolating valves are opened before cargo loading or ballasting or discharging of those tanks is commenced. Any isolation must continue to permit the flow caused by thermal variations in a cargo tank in accordance with [2.3.3] a).

c) if cargo loading or ballasting or discharging of a cargo tank or cargo tank group is intended, which is isolated from a common venting system, that cargo tank or cargo tank group is to be fitted with a means for overpressure or underpressure protection as required in [2.3.3] c).

2.3.5 **Arrangement of vent lines** *(1/6/2021)*

The venting arrangements are to be connected to the top of each cargo tank and are to be self-draining to the cargo tanks under all normal conditions of trim and list of the ship. Where it may not be possible to provide self-draining lines, permanent arrangements are to be provided to drain the vent lines to a cargo tank.

Plugs or equivalent means are to be provided on the lines after the safety relief valves.

2.3.6 **Openings for pressure release** *(1/6/2021)*

Openings for pressure release required by [2.3.3] a) are to:

a) have as great a height as is practicable above the cargo tank deck to obtain maximum dispersal of flammable vapours but in no case less than 2 m above the cargo tank deck,

b) be arranged at the furthest distance practicable but not less than 5 m from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery and equipment which may constitute an ignition hazard. Anchor windlass and chain locker openings constitute an ignition hazard.

2.3.7 **Pressure/vacuum valves** *(1/6/2021)*

a) One or more pressure/vacuum-breaking devices are to be provided to prevent the cargo tanks from being subject to:

   1) a positive pressure, in excess of the test pressure of the cargo tank, if the cargo were to be loaded at the maximum rated capacity and all other outlets were left shut; and

2) a negative pressure in excess of 700 mm water gauge if cargo were to be discharged at the maximum rated capacity of the cargo pumps and the inert gas blowers were to fail.

Such devices are to be installed on the inert gas main unless they are installed in the venting system required by this item [2.3] or on individual cargo tanks.

b) Pressure/vacuum valves are to be set at a positive pressure not exceeding 0,021 MPa and at a negative pressure not exceeding 0,007 MPa. Higher setting values not exceeding 0,07 MPa may be accepted in positive pressure if the scantlings of the tanks are appropriate.

c) Pressure/vacuum valves required by [2.3.3] a) may be provided with a bypass when they are located in a vent main or masthead riser. Where such an arrangement is provided, there are to be suitable indicators to show whether the bypass is open or closed

d) Pressure/vacuum valves are to be of a type approved by the Society in accordance with Ch 7, App 1.

e) Pressure/vacuum valves are to be readily accessible.

f) Pressure/vacuum valves are to be provided with a manual opening device so that valves can be locked on open position. Locking means on closed position are not permitted.

2.3.8 Vent oulets *(1/6/2021)*

Vent outlets for cargo loading, discharging and ballasting required by [2.3.3] b) are to:

a) permit:

1) the free flow of vapour mixtures, or

2) the throttling of the discharge of the vapour mixtures to achieve a velocity of not less than 30 m/s,

b) be so arranged that the vapour mixture is discharged vertically upwards

c) where the method is by free flow of vapour mixtures, be such that the outlet is not less than 6 m above the cargo tank deck or fore and aft gangway if situated within 4 m of the gangway and located not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard,

d) where the method is by high velocity discharge, be located at a height not less than 2 m above the cargo tank deck and not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard. These outlets are to be provided with high velocity devices of a type approved by the Society,

e) be designed on the basis of the maximum designed loading rate multiplied by a factor of at least 1,25 to take account of gas evolution, in order to prevent the pressure in any cargo tank from exceeding the design pressure. The Master is to be provided with information regarding the maximum permissible loading rate for each cargo tank and in the case of combined venting systems, for each group of cargo tanks.

The arrangements for the venting of vapours displaced from the cargo tanks during loading and ballasting are to comply with this item [2.3] and are to consist of either one or more mast risers, or a number of high-velocity vents. The inert gas supply main may be used for such venting.

2.3.9 High velocity valves *(1/6/2021)*

a) High velocity valves are to be readily accessible

b) High velocity valves not required to be fitted with flame arresters (see [2.3.10]) are not to be capable of being locked on open position.

2.3.10 Prevention of the passage of flame into the tanks *(1/6/2021)*

a) The venting system is to be provided with devices to prevent the passage of flame into the cargo tanks. The design, testing and locating of these devices are to comply with Ch 7, App 1.

Ullage openings are not to be used for pressure equalisation. They are to be provided with self-closing and tightly sealing covers. Flame arresters and screens are not permitted in these openings.

b) A flame arresting device integral to the venting system may be accepted.

c) Flame screens and flame arresters are to be designed for easy overhauling and cleaning.

2.3.11 Prevention of liquid rising in the venting system *(1/6/2021)*

a) Provisions are to be made to prevent liquid rising in the venting system; refer to [2.3.16].

b) Cargo tanks gas venting systems are not to be used for overflow purposes.

c) Spill valves are not considered equivalent to an overflow system.

2.3.12 Cargo tank purging and/or gas-freeing *(1/6/2021)*

a) Arrangements are to be made for purging and/or gas-freeing of cargo tanks. The arrangements are to be such as to minimise the hazards due to the dispersal of flammable vapours in the atmosphere and to flammable mixtures in a cargo tank. Accordingly, the provisions of [2.3.13] and [2.3.14], as applicable, are to be complied with.

b) In the case of fans installed in safe spaces, two non-return devices are to be fitted to avoid return of cargo vapours to safe spaces when the ventilation system is shut down. These non-return devices are to operate in all normal conditions of ship trim and list.

c) Discharge outlets are to be located at least 10 m measured horizontally from the nearest air intake and openings to enclosed spaces with a source of ignition and from deck machinery equipment which may constitute an ignition hazard.

2.3.13 Ships provided with an inert gas system *(1/6/2021)*

When the ship is provided with an inert gas system, the cargo tanks are first to be purged in accordance with the provisions of Part C, Chapter 4 until the concentration of hydrocarbon vapours in the cargo tanks has been reduced to less than 2% by volume. Thereafter, gas-freeing may take place at the cargo tank deck level.

2.3.14 Ships not provided with an inert gas system *(1/6/2021)*

When the ship is not provided with an inert gas system, the operation is to be such that the flammable vapour is discharged initially:

a) through the vent outlets as specified in [2.3.8], or

b) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 30 m/s maintained during the gas-freeing operation, or

c) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 20 m/s and which are protected by suitable devices to prevent the passage of flame.

The above outlets are to be located not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery, which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard.

When the flammable vapour concentration at the outlet has been reduced to 30% of the lower flammable limit, gas-freeing may thereafter be continued at cargo tank deck level.

2.3.15 Cargo tank level gauging systems *(1/6/2021)*

a) Each cargo or slop tank is to be fitted with a level gauging system indicating the liquid level along the entire height of the tank. Unless otherwise specified, the gauge may be portable or fixed with local reading.

b) Gauging devices and their remote reading systems are to be type approved.

c) Ullage openings and other gauging devices likely to release cargo vapour to the atmosphere are not to be arranged in enclosed spaces.

   1) a “restricted gauging device” means a device which penetrates the tank and which, when in use, permits a small quantity of vapour or liquid to be exposed to the atmosphere. When not in use, the device is completely closed. Examples are sounding pipes.

   2) a “closed gauging device” means a device which is separated from the tank atmosphere and keeps tank contents from being released. It may:

      - penetrate the tank, such as float-type systems, electric probe, magnetic probe or protected sight glass,
      - not penetrate the tank, such as ultrasonic or radar devices.

   3) an “indirect gauging device” means a device which determines the level of liquid, for instance by means of weighing or pipe flow meter.

In barges fitted with an inert gas system, the gauging devices are to be of the closed type; use of indirect gauging devices will be given special consideration.

In barges not fitted with an inert gas system:

- the gauging devices are to be of the closed or restricted types. Ullage openings may be used only as a reserve sounding means and are to be fitted with a watertight closing appliance.
- Where restricted gauging devices are used, provisions are to be made to avoid dangerous escape of liquid or vapour under pressure when using the device relieve the pressure in the tank before the device is operated.
- Where used, sounding pipes are to be fitted with a a self-closing blanking device.

2.3.16 Protection against tank overload *(1/6/2021)*

Provisions are to be made to guard against liquid rising in the venting system of cargo or slop tanks to a height which would exceed the design head of the tanks. This is to be accomplished by high level alarms or overflow control systems or other equivalent means, together with gauging devices and cargo tank filling procedures.

Sufficient ullage is to be left at the end of tank filling to permit free expansion of liquid during carriage.

High level alarms, overflow control systems and other means referred to above are to be independent of the gauging systems referred to in [2.3.15].

High level alarms are to be type approved.

High level alarms are to give an audible and visual signal at the control station, where provided.

Where the tank level gauging systems, cargo and ballast pump control systems and valve control systems are centralised in a single location, the provisions above may be complied with by the fitting of a level gauge for the indication of the end of loading, in addition to that required for each tank under [2.3.15]. The readings of both gauges for each tank are to be as near as possible to each other and so arranged that any discrepancy between them can be easily detected.

2.3.17 Tank washing systems *(1/6/2021)*

Adequate means are to be provided for cleaning the cargo tanks, except on units which:

- are dedicated to the same type of cargo for many consecutive voyages, and
- are arranged with segregated ballast tanks according to Sec 2, [5], and
- do not carry out tank washing on a regular basis, and
- use shore services for tank washing and disposal of washing media and residues, when needed.

Crude oil washing systems, when fitted, are to comply with the provisions of Ch 7, App 2 related to safety.

Tank washing machines are to be of a type approved by the Society.

Washing machines are to be made of steel or other electricity conducting materials with a limited propensity to produce sparks on contact.

Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 10, depending on the kind of washing fluid, water or crude oil.

Crude oil washing pipes are also to satisfy the requirements of [2.2.7].

Crude oil washing machines may be connected to water washing pipes, provided that isolating arrangements, such as a valve and a detachable pipe section, are fitted to isolate water pipes.

Tank cleaning openings are not to be arranged in enclosed spaces.

The complete installation is to be permanently earthed to the hull.

2.4 Prevention of pollution by cargo oil

2.4.1 Application *(1/6/2021)*

Unless otherwise specified, the provisions of [2.4.4], [2.4.5] and [2.4.6] apply only to barges of 150 gross tonnage and above.

2.4.2 Provisions for barges of less than 150 gross tonnage *(1/6/2021)*

The control of discharge for **barges** of less than 150 gross tonnage is to be effected by the retention of oil on board with subsequent discharge of all contaminated washings to reception facilities unless adequate arrangements are made to ensure that the discharge of any effluent into the sea, where allowed, is effectively monitored to ensure that the total quantity of oil discharged into the sea does not exceed 1/30 000 of the total quantity of the particular cargo of which the residue formed a part.

2.4.3 Exemptions *(1/6/2021)*

The provisions of [2.4.4] and [2.4.5] may be waived in the following cases:

- barges engaged exclusively on voyages within 50 miles from the nearest land and of 72 hours or less in duration and limited to trades between ports or terminals agreed by the Society, provided that oily mixtures are retained on board for subsequent discharge to reception facilities
- carrying products which through their physical properties inhibit effective product/water separation and monitoring, for which the control of discharge is to be effected by the retention of residues on board with discharge of all contaminated washings to reception facilities.

2.4.4 **Retention of oil on board** *(1/6/2021)*

Adequate means are to be provided for transferring the dirty ballast residue and tank washings from the cargo tanks into a slop tank approved by the Society.

2.4.5 **Capacity of slop tanks** *(1/6/2021)*

The arrangement of the slop tank or combination of slop tanks is to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is not to be less than 3% of the oil carrying capacity of the ship, except that the Society may accept:

a) 2% for barges where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without the introduction of additional water into the system

b) 2% where segregated ballast tanks are provided, or where a cargo tank cleaning system using crude oil washing is fitted in accordance with [2.3.17]. This capacity may be further reduced to 1,5% for barges where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without introduction of additional water into the system

c) slop tanks of any size, including absence of dedicated slop tanks, for units which:
   - are dedicated to the same type of cargo for many consecutive voyages, and
   - are arranged with segregated ballast tanks, and
   - do not carry out tank washing on a regular basis.

Barges of 70 000 tonnes deadweight and above are to be fitted with at least two slop tanks.

2.4.6 **Design of slop tanks** *(1/6/2021)*

Slop tanks are to be so designed particularly in respect of the position of inlets, outlets, baffles or weirs where fitted, as to avoid excessive turbulence and entrainment of oil or emulsion with the water.

2.4.7 **Pumping, piping and discharge arrangements** *(1/6/2021)*

In every barge, a discharge manifold for connection to reception facilities for the discharge of dirty ballast water or oil contaminated water is to be located on the open deck on both sides of the ship.

2.4.8 **Discharge pipelines** *(1/6/2021)*

In every barge, pipelines for the discharge of ballast water or oil contaminated water from cargo tank areas to the sea, where permitted, are to be led to the open deck or to the ship side above the waterline in the deepest ballast condition, except that:

a) segregated ballast and clean ballast may be discharged below the waterline:
   - in ports or at offshore terminals, or
   - at sea by gravity,

   provided that the surface of the ballast water has been examined immediately before the discharge to ensure that no contamination with oil has taken place.

b) on every barge at sea, dirty ballast water or oil contaminated water from tanks in the cargo area, other than slop tanks, may be discharged by gravity below the waterline, provided that sufficient time has elapsed in order to allow oil/water separation to have taken place and the water ballast has been examined immediately before the discharge with an oil/water interface detector, in order to ensure that the height of the interface is such that the discharge does not involve any increased risk of harm to the marine environment.

2.4.9 **Discharge stopping** *(1/6/2021)*

Means are to be provided for stopping the discharge into the sea of ballast water or oil contaminated water from cargo tank areas, other than those discharges below the waterline permitted under [2.4.8], from a position on the upper deck or above located so that the manifold in use referred to [2.4.7] in and the discharge to the sea from the pipelines referred to [2.4.8] may be visually observed. Means for stopping the discharge need not be provided at the observation position if a positive communication system such as a telephone or radio system is provided between the observation position and the discharge control position.

2.4.10 **Cargo piping connections to sea chests** *(1/6/2021)*

On every barge where a sea chest is permanently connected to the cargo pipeline system, it is to be equipped with both a sea chest valve and an inboard isolation valve. In addition to these valves, the sea chest is to be capable of isolation from the cargo piping system whilst the barge is loading, transporting or discharging cargo by use of a positive means that is to the satisfaction of the Society. Such a positive means is a facility that is installed in the pipeline system in order

to prevent the section of pipeline between the sea chest valve and the inboard valve being filled with cargo under all circumstances.

Examples of positive means may take the form of blanks, spectacle blanks, pipeline blinds, evacuation or vacuum systems, or air or water pressure systems. In the event that evacuation or vacuum systems, or air or water pressure systems are used, then they are to be equipped with both a pressure gauge and alarm system to enable the continuous monitoring of the status of the pipeline section, and thereby the valve integrity, between the sea chest and inboard valves.

3 Additional requirements for barge-oil intended to carry products having flashpoint >60°C

3.1 Piping systems other than cargo piping system

3.1.1 *(1/6/2021)*

The requirements in [2.1] are applicable with the following exceptions.

3.1.2 Independence of piping systems *(1/6/2021)*

Requirements in [2.1.2] are applicable except for item a) and third bullet of item b).

3.1.3 Draining of pump rooms *(1/6/2021)*

Requirements in [2.1.4] are applicable except for second bullet.

3.1.4 Ballast system *(1/1/2025)*

In lieu of the requirements in [2.1.5] the following applies.

Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo oil and fuel oil systems.

In barges of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

The mean intended to pump from segregated ballast tanks is to be a pump or an eductor used exclusively for dealing with ballast. The ballast system serving the spaces located outside the cargo area may be used for this purpose.

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

Provisions may made for filling cargo tanks with sea water, where permitted. Such ballast water is to be dealt with as per Ch 7, Sec 5, [5].

The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges. See also [2.4.10].

Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

In oil barges of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with[2.1.3] b).

Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

3.1.5 Heating systems intended for cargo *(1/6/2021)*

The requirements in [2.1.9] are not applicable.

3.2 Cargo pumping system

3.2.1 Number and location of cargo pumps *(1/5/2013)*

Each cargo tank is to be served by at least one fixed mean of discharging and stripping. As an alternative, arrangements are to be adopted to make discharge by pumps in the oil terminal possible, taking into account the NPSHD at the pumps.

3.2.2 Use of cargo pumps *(1/5/2013)*

a) Except where expressly permitted in [3.1.4] and Sec 3, [2.2.1] cargo pumps are to be used exclusively for handling the liquid cargo and are not to have any connections to compartments other than cargo tanks.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

3.2.3 Cargo pump drive *(1/5/2013)*

Pumps with a submerged electric motor are not permitted in cargo tanks.

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

3.2.4 Design of cargo pumps *(1/5/2013)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

3.2.5 Monitoring of cargo pumps *(1/5/2013)*

Cargo pumps are to be monitored as required in Tab 3.

3.2.6 Control of cargo pumps *(1/5/2013)*

Cargo pumps are to be capable of being stopped from:

- a position outside the pump room, and
- a position next to the pumps.

Table 3 : Monitoring of cargo pumps *(1/5/2013)*

Equipment, parameter	Alarm	Indication **(1)**	Comments
pump, discharge pressure		L	• on the pump **(2)**, or • next to the unloading control station
(1) L = low **(2)** and next to the driving machine if located in a separate compartment			

3.3 Cargo piping

3.3.1 Cargo piping design *(1/6/2021)*

The requirements in [2.2.7] are applicable.

3.3.2 Cargo pipes passing through tanks or compartments *(1/5/2013)*

a) Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [2.1.3], item b) are complied with.

3.3.3 Cargo piping passing through bulkheads *(1/5/2013)*

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

3.3.4 Valves *(1/5/2013)*

a) Stop valves are to be provided to isolate each tank.

b) A stop valve is to be fitted at each end of the cargo manifold.

c) When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

d) Main cargo oil valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

3.4 Cargo tanks and fittings

3.4.1 Application *(1/6/2021)*

The provisions of [3.4] apply to cargo tanks and slop tanks.

3.4.2 Cargo tank venting *(1/5/2013)*

The relevant provisions of Pt C, Ch 1, Sec 10, [9] and Pt C, Ch 1, Sec 10, [11] are to be complied with.

Tank venting systems are to open to the atmosphere at a height of at least 760 mm above the weather deck. If the cargo is carried at a temperature exceeding the flashpoint by more than 15°C, this height is to be increased to 2,4 m.

Tanks may be fitted with venting systems of the open type provided with a flame screen. For ships carrying bulk cargoes with flashpoint > 100°C, the flame screen may be omitted.

3.4.3 Protection against tank overload *(1/6/2021)*

The requirements in [2.3.16] are applicable.

3.4.4 Tank washing systems *(1/6/2021)*

The requirements in [2.3.17] are applicable

3.5 Prevention of pollution by cargo oil

3.5.1 *(1/6/2021)*

The requirements in [2.4] are applicable with the following additional exemption:

3.5.2 *(1/5/2013)*

Where, in the view of the Society, the equipment referred to in [2.4.7] and [2.4.8] is not obtainable for the monitoring of discharge of oil refined products (white oils), compliance with such requirements may be waived provided that discharge is performed only in accordance with the applicable procedures.

4 Certification, inspection and testing

4.1 Application based on flashpoint

4.1.1 *(1/6/2021)*

The provisions of Ch 7, Sec 4, [6] are applicable to barge-oil intended to carry oil having any flashpoint (i.e. including oils having flash point < 60°C).

The provisions of Ch 7, Sec 5, [6] are applicable to barge-oil intended to carry only oil having flashpoint > 60°C.

SECTION 5 ADDITIONAL REQUIREMENTS FOR MACHINERY AND CARGO SYSTEMS OF BARGE-LIQUEFIED GAS

1 General

1.1 Application

1.1.1 *(1/6/2021)*

These units are to comply with the requirements of Sec 3.

The requirements in this Section are additional to the ones in Sec 3.

These units are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), as amended, as specified in Ch 9, [1.1.1] and [1.1.2].

The requirements of this Section supplement those of the IGC Code.

All the requirements of this Section are cross referenced to the applicable Chapters, Sections or paragraphs of the IGC Code, as appropriate.

1.2 Documents to be submitted

1.2.1 *(1/6/2021)*

The documents listed in Tab 1 are to be submitted for approval.

1.3 Exemptions

1.3.1 *(1/6/2021)*

The requirements in Pt C, Ch 1, Sec 10, [11.4.1] b) do not apply to service tanks.

The requirements in Pt C, Ch 1, Sec 10, [11.4.6] a) do not apply.

Table 1 : Documents to be submitted *(1/6/2021)*

No	A/I	Documents
1	I	List of products to be carried, including maximum vapour pressure, maximum liquid temperature and other important design conditions
2	I	P&A manual, when applicable
3	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
4	A	Plans, arrangement and calculations of safety relief valves
5	A	Details of cargo handling and vapour system, including arrangements and details of piping and fitting
6	A	Details of cargo pumps and cargo compressors
7	A	Details of process pressure vessels and relative valving arrangement
8	A	Piping stress analysis when T<-110°C
9	A	Cargo operating manual
10	A	Bilge and ballast system in cargo area
11	A	Gas freeing system in cargo tanks including inert gas system
12	A	Interbarrier space drainage, inerting and pressurisation systems
13	A	Ventilation system in cargo area
14	A	Refrigeration and reliquefaction plant system diagram, if any
Note 1: A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

No	A/I	Documents
15	A	Gas detection system
16	A	Loading and unloading operation description, including cargo tank filling limits
17	A	Cargo tank testing and inspection procedures
Note 1: A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

2 Cargo pump rooms and cargo compressor rooms

2.1 Equipment in cargo pump rooms and cargo compressor rooms

2.1.1 *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.3

Cargo pump rooms and/or cargo compressor rooms of ships carrying flammable gases may not contain electrical equipment, except as provided for in Chapter 10 of the IGC Code, or other ignition sources such as internal combustion engines or steam engines with operating temperature which could cause ignition or explosion of mixtures of such gases, if any, with air.

3 Bilge, ballast and fuel oil arrangements

3.1 Drainage arrangement

3.1.1 Drainage of dry spaces in the cargo area *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.7

Dry spaces within the cargo area are to be fitted with a bilge or drain arrangement not connected to the machinery space.

Spaces not accessible at all times are to be fitted with sounding arrangements.

Spaces without a permanent ventilation system are to be fit- ted with a pressure/vacuum relief system or with air pipes.

3.2 Additional requirements relative to the bilge system

3.2.1 Operation of the bilge system in cargo and interbarrier spaces *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.7

Bilge arrangements for holds containing cargo tanks and for interbarrier spaces are to be operable from the weather deck.

3.2.2 Means for leakage detection *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 3.7

With reference to the means to ascertain leakages in holds and/or in interbarrier spaces, the following requirements apply:

- the above-mentioned means is to be suitable to ascertain the presence of water:
  - in holds containing type C independent tanks
  - in holds and interbarrier spaces outside the second- ary barrier
- the above-mentioned means is to be suitable to ascertain the presence of liquid cargo in the spaces adjacent to cargo tanks which are not type C independent tanks.

Where the aforesaid spaces may be affected by water leakages from the adjacent ship structures, the means is also to be suitable to ascertain the presence of water.

Where the above-mentioned means is constituted by electrical level switches, the relevant circuits are to be of the intrinsically safe type and signals are to be transduced the wheelhouse and to the cargo control station, if fitted.

4 Bow or stern loading and unloading arrangements

4.1 Locations of stopping devices for cargo pumps and compressors

4.1.1 *(1/6/2021)*

IGC CODE REFERENCE : Ch 3, 8.7

Devices to stop cargo pumps and cargo compressors and to close cargo valves are to be fitted in a position from which it is possible to keep under control the loading/unloading manifolds.

5 Process pressure vessels and liquid, vapour and pressure piping systems

5.1 General

5.1.1 **Process pressure vessels** *(1/6/2021)*

IGC CODE REFERENCE : Ch 5, 5.1.2

Process pressure vessels handling cargo are to be considered at least as class 2 pressure vessels, in accordance with Pt C, Ch 1, Sec 3, [1.4.1].

5.1.2 **Temperature of steam and heating media within the cargo area** *(1/6/2021)*

IGC CODE REFERENCE : Ch 5, 5.1

The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

5.2 Cargo and process piping

5.2.1 **General** *(1/6/2021)*

a) Provisions for protection of piping against thermal stress

IGC CODE REFERENCE : Ch 5, 5.7.1, 5.11.6.4

Expansion joints are to be protected from extensions and compressions greater than the limits fixed for them and the connected piping is to be suitably supported and anchored. Bellow expansion joints are to be protected from mechanical damage.

The design and installation of expansion bellows is to be in accordance with recognized standards acceptable to the Society.

b) Segregation of high temperature piping

IGC CODE REFERENCE : Ch 5, 5.7.2

High temperature pipes are to be thermally isolated from the adjacent structures. In particular, the temperature of pipelines is not to exceed 220 °C in gas-dangerous zones.

c) Pressure relief valve setting

IGC CODE REFERENCE : Ch 5, 5.5.6 and 5.5.7

Pressure relief valves are to be set to discharge at a pressure not greater than the design pressure such that the overpressure during discharge does not exceed 110% of the design pressure.

d) Protection against leakage

IGC CODE REFERENCE : Ch 5, 5.2

Where the piping system is intended for liquids having a boiling point lower than - 30 °C, permanent means to avoid possibility of contact between leaks and hull structures are to be provided in all those locations where leakage might be expected, such as shore connections, pump seals, flanges subject to frequent dismantling, etc.

e) Means for detecting the presence of liquid cargo

IGC CODE REFERENCE : Ch 5, 5.2

The means to detect the presence of liquid cargo may be constituted by electrical level switches whose circuit is intrinsically safe. The alarm signals given by the level switches are to be transmitted to the wheelhouse and to the cargo control station, if provided.

f) Connections of relief valve discharges to cargo tanks

IGC CODE REFERENCE : Ch 5, 5.2

The connections, if any, to the cargo tanks of relief valve discharges fitted on the liquid phase cargo piping are not to be fitted with shut-off valves, but are to be provided with non-return valves in the proximity of the tanks.

g) Centrifugal pumps

IGC CODE REFERENCE : Ch 5, 5.2

Overpressure relief valves on cargo pumps may be omitted in the case of centrifugal pumps having a maximum delivery head, the delivery valve being completely closed, not greater than that permitted for the piping.

5.2.2 Scantlings based on internal pressure *(1/6/2021)*

a) Piping scantlings

IGC CODE REFERENCE : Ch 5, 5.11.2.2, 5.11.2.4 and 5.11.4

Piping systems are to be designed in accordance with recognized standards acceptable to the Society.

The minimum thickness is to be in accordance with recognized standards acceptable to the Society.

b) Piping subject to green seas

IGC CODE REFERENCE : Ch 5, 5.11.2.2

In particular for piping subject to green seas, the design pressure P, in bar, in the formula in 5.11.2.2 of the IGC CODE is to be replaced by an equivalent pressure P' given by the following formula:

$$P' = \frac{1}{2}\left(P + \sqrt{P^2 + 0{,}006R'K\frac{D_C}{D}}\right)$$

where:

D_C : External diameter of the pipe taking into account the insulation (in mm), whose thickness is to be taken at least equal to:

40 mm if $D \leq 50$ mm

80 mm if $D \geq 150$ mm

Intermediate values are to be determined by interpolation.

R' : Drag corresponding to the effect of green seas, in da N/m^2, such as given in Tab 2 as a function of the location of the pipes and of their height H (in m) above the deepest loadline; intermediate values are to be determined by interpolation.

K : permissible stress, in N/mm^2

Table 2 *(1/6/2021)*

External diameter of pipe **(1)**	Aft of the quarter of the ship's length			Forward of the quarter of the ship's length		
	H ≤ 8	H = 13	H ≥ 18	H ≤ 8	H = 13	H ≥18
≤ 25	1500	250	150	2200	350	150
50	1400	250	150	2000	350	150
75	1100	250	150	1600	350	150
100	700	250	150	700	350	150
≥150	500	250	150	700	350	150
(1) D_C if the pipe is insulated, D otherwise.						

5.2.3 Desigmn pressure *(1/6/2021)*

a) Design pressure definition

IGC CODE REFERENCE : Ch 5, 5.4.1

For each piping section, the maximum pressure value among those applicable in paragraph 5.11.2.2 of the IGC Code is to be considered.

Higher and lower values of the saturated and superheated vapour pressure at 45°C may be used if agreed upon by the Society.

5.2.4 Permissible stress *(1/6/2021)*

a) Flanges not complying with standards

IGC CODE REFERENCE : Ch 5, 5.11.6.1, 5.11.6.2

For flanges not complying with a standard, the dimensions and type of gaskets are to be to the satisfaction of the Society.

Flanges are to be selected as to type, made and tested in accordance with the Pt C, Ch 1, Sec 10.

5.2.5 Stress analysis *(1/6/2021)*

a) Calculations in accordance with recognised standards

IGC CODE REFERENCE : Ch 5, 5.11.5

When such an analysis is required, it is to be carried out in accordance with the requirements listed below. Subject to this condition, calculations in accordance with recognised standards are admitted by the Society.

b) Calculation cases

IGC CODE REFERENCE : Ch 5, 5.11.5

The calculations are to be made for every possible case of operation, but only those leading to the most unfavourable results are required to be submitted.

c) Loads to be taken for calculation

IGC CODE REFERENCE : Ch 5, 5.11.5

The calculations are to be carried out taking into account the following loads:

1) piping not subject to green seas:
   - pressure
   - weight of the piping with insulation and internal medium
   - contraction
2) piping subject to green seas that is liable to be in operation at sea and in port:
   - pressure
   - weight of the piping and internal medium
   - green seas
   - contraction
   - ship motion accelerations
3) piping subject to green seas that is in operation only in port; the more severe of the following two combinations of loads:
   - pressure
   - weight of the piping of the internal fluid
   - contraction

   and
   - weight of the piping
   - green seas
   - expansion, assuming that the thermal stresses are fully relaxed.

d) Green sea directions

IGC CODE REFERENCE : Ch 5, 5.11.5

When green seas are considered, their effects are to be studied, unless otherwise justified, in the following three directions:

- axis of the ship
- vertical
- horizontal, perpendicular to the axis of the ship. The load on the pipes is the load R’ defined in [5.2.2] b).

e) Stress intensity

IGC CODE REFERENCE : Ch 5, 5.11.5

The stress intensity is to be determined as specified in the formulae in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures:

1) for primary stresses resulting from:
   - pressure
   - weight
   - green seas
2) for primary stresses and secondary stresses resulting from contraction.

f) Stress intensity limits

IGC CODE REFERENCE : Ch 5, 5.11.5

1) For the first case, the stress intensity is to be limited to the lower of:

0,8 R_e and 0,4 R_m

2) For the second case, the stress intensity is to be limited to the lower of:

1,6 R_e and 0,8 R_m.

g) Piping with expansion devices

IGC CODE REFERENCE : Ch 5, 5.11.5

For piping fitted with expansion devices, their characteristics are to be submitted to the Society. Where these characteristics are such that the forces and moments at the ends of the devices are negligible for the contraction they must absorb, the calculation of the loads due to contraction in the corresponding piping is not required. It is, however, to be checked that the stress intensity corresponding to the primary stresses does not exceed the limits given in Ch 9, Sec 5, [2.5.6] f).

h) Flexibility coefficient

IGC CODE REFERENCE : Ch 5, 5.11.5

The flexibility coefficient of elbows is to be determined from the formulae given in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures.

i) Local stresses

IGC CODE REFERENCE : Ch 5, 5.11.5

Particular attention is to be paid to the calculation of local stresses in the assemblies subjected to axial forces and bending moments. The Society reserves the right to request additional justifications or local strengthening where considered necessary.

j) Materials

IGC CODE REFERENCE : Ch 5, 5.12

Aluminised pipes may be fitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

For an outer pipe or duct equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour, the effects of both pressure and possible low temperature in the event of a high pressure line failure shall be taking into account.

k) Piping fabrication and joining details

IGC CODE REFERENCE : Ch 5, 5.8

The Society may accept relaxations, based on recognized standards, from the requirements in IGC Code, 5.8 for piping inside cargo tanks and open ended piping.

Acceptance of types of piping connections other than those mentioned in IGC Code, 5.8 may be considered by the Society case by case.

l) Welding, post-weld heat treatment and non-destructive testing

IGC CODE REFERENCE : Ch 5, 5.9

For post-weld heat treatments, the Society may waive the requirement for thermal stress relieving for pipes having a wall thickness less than 10 mm in relation to the design temperature and pressure of the concerned piping system.

For butt-welded joints of pipes not covered by IGC Code 5.9.3.2 spot radiographic controls or other non-destructive controls are to be carried out at the discretion of the Society depending upon service, position and materials.

5.3 Tests of piping components and pumps prior to installation on board

5.3.1 Valves *(1/6/2021)*

a) Prototype Testing

IGC CODE REFERENCE : Ch 5, 5.13

For safey valves that are subject to IGC Code para. 8.2.5, the flow or capacity are to certified by the Society; for other types of valves, the manufacturer is to certify the flow properties of the valves based on tests carried out according to recognized standards.

For emergency shutdown valves, with materials having melting temperatures lower than 925°C, the type testing shall include a fire test to a standard acceptable to the Society.

b) Unit Production Testing

IGC CODE REFERENCE: Ch 5, 5.13

All valves are to be tested at the Manufacturer's plant in the presence of the Society's Surveyor.

Testing is to include a hydrostatic test of the valve body at a pressure equal to 1,5 times the design pressure for all valves, seat and stem leakage test at a pressure equal to 1,1 times the design pressure for valves other than safety valves. In addition, cryogenic testing consisting of valve operation and leakage verification for a minimum of 10% of each type and size of valve for valves other than safety valves intended to be used at a working temperature below -55°C. The set pressure of safety valves is to be tested at ambient temperature.

For valves used for isolation of instrumentation in piping not greater than 25 mm, unit production testing need not be witnessed by the surveyor. Records of testing are to be available for review.

As an alternative to the above, if so requested by the relevant Manufacturer, certification of a valve may be issued subject to the following:

- the valve has been approved as required in a) for valves intended to be used at a working temperature below -55°C, and
- the Manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodical audits, and
- the quality control plan contains a provision to subject each valve to a hydrostatic test of the valve body at a pressure equal to 1,5 times the design pressure for all valves and seat and stem leakage test at a pressure equal to 1,1 times the design pressure for valves other than safety valves. The set pressure of safety valves is to be tested at ambient temperature. The Manufacturer is to maintain records of such tests, and
- cryogenic testing is performed, in the presence of the Society's representative, consisting of valve operation and leakage verification for a minimum of 10% of each type and size of valve for valves other than safety valves intended to be used at a working temperature below -55°C.

5.3.2 Cargo Pumps *(1/6/2021)*

a) Prototype Testing

Each size and type of pump is to be approved through design assessment and prototype testing. Prototype testing is to be witnessed in the presence of the Society's Surveyor. In lieu of prototype testing, satisfactory in-service experience of an existing pump design approved by a QSCS Classification Society submitted by the Manufacturer may be considered.

Prototype testing is to include a hydrostatic test of the pump body equal to 1,5 times the design pressure and a capacity test. For submerged electric motor driven pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature. For shaft driven deep well pumps, the capacity test may be carried out with water. In addition, for shaft driven deep well pumps, a spin test to demonstrate satisfactory operation of bearing clearances, wear rings and sealing arrangements is to be carried out at the minimum design temperature. The full length of shafting is not required for the spin test, but must be of sufficient length to include at least one bearing and sealing arrangements. After completion of tests, the pump is to be opened out for examination.

b) Unit Production Testing

All pumps are to be tested at the Manufacturer's plant in the presence of the Society's Surveyor. Testing is to include a hydrostatic test of the pump body equal to 1,5 times the design pressure and a capacity test. For submerged electric motor driven pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature. For shaft driven deep well pumps, the capacity test may be carried out with water.

As an alternative to the above, if so requested by the relevant Manufacturer, the certification of a pump may be issued subject to the following:

- the pump has been approved as required in a) and
- the Manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodical audits, and
- the quality control plan contains a provision to subject each pump to a hydrostatic test of the pump body equal to 1,5 times the design pressure and a capacity test. The Manufacturer is to maintain records of such tests.

5.4 Cargo system valving requirements

5.4.1 Cargo tank connections for gauging *(1/6/2021)*

a) Exemption

IGC CODE REFERENCE : Ch 5, 5.5.5

The requirements in paragraph 5.5.5 of the IGC Code relevant to cargo tank connections for pressure gauges and measuring devices do not apply to tanks with an MARVS not exceeding 0,07 MPa.

5.4.2 Emergency shutdown *(1/6/2021)*

a) Clarification on location of fusible elements

IGC CODE REFERENCE : Ch 18, 18.10

The cargo stations in way of which the fusible elements mentioned in paragraph 18.10.3.2 of the IGC Code are to be fitted are to be intended as the loading and unloading manifolds.

5.5 Cargo transfer methods

5.5.1 Discharge into common header *(1/6/2021)*

IGC CODE REFERENCE : Ch 5, 5.6

When two or more pumps located in different cargo tanks are operating at the same time discharging into a common header, the stopping of the pumps is to activate an alarm at the centralised cargo control location.

5.6 Bonding

5.6.1 Static electricity *(1/6/2021)*

a) Acceptable resistance

IGC CODE REFERENCE : Ch 5, 5.7.4

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than $10^6\ \Omega$.

b) Bonding straps

IGC CODE REFERENCE : Ch 5, 5.7.4

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

1) independent cargo tanks
2) cargo tank piping systems which are electrically separated from the hull of the ship
3) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

1) clearly visible so that any shortcoming can be clearly detected
2) designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint
3) easy to install and replace.

5.7 Integrated cargo and ballast system

5.7.1 General *(1/6/2021)*

The requirements for integrated cargo and ballast systems are given in Ch 7, Sec 4, [3.5].

6 Cargo tank venting system

6.1 Pressure relief systems

6.1.1 Cargo tank *(1/6/2021)*

a) Size of pressure relief devices

IGC CODE REFERENCE : Ch 8, 8.4.1.2 and Figure 8.1

For application of the formula in paragraph 8.4.1.2 of the IGC Code, the following is to be applied for prismatic tanks:

- L_{min}, for non-tapered tanks, is the smaller of the horizontal dimensions of the flat bottom of the tank. For tapered tanks, as would be used for the forward tank, L_{min} is the smaller of the length and the average width.
- For prismatic tanks whose distance between the flat bottom of the tank and bottom of the hold space is equal to or less than $L_{min}/10$:

  A = external surface area minus flat bottom surface area.
- For prismatic tanks whose distance between the flat bottom of the tank and bottom of the hold space is greater than $L_{min}/10$:

A = external surface area.

6.1.2 Interbarrier spaces *(1/6/2021)*

a) Protection of interbarrier spaces

IGC CODE REFERENCE : Ch 8, 8.2.2

1) The formula for determining the relieving capacity given in b) is developed for interbarrier spaces surrounding independent type A cargo tanks, where the thermal insulation is fitted to the cargo tanks.
2) The relieving capacity of pressure relief devices of interbarrier spaces surrounding independent type B cargo tanks may be determined on the basis of the method given in b); however, the leakage rate is to be determined in accordance with 4.7.2 of the IGC Code.
3) The relieving capacity of pressure relief devices for interbarrier spaces of membrane and semi-membrane tanks is to be evaluated on the basis of specific membrane/semi-membrane tank design.
4) The relieving capacity of pressure relief devices for interbarrier spaces adjacent to integral type cargo tanks may, if applicable, be determined as for type A independent cargo tanks.

b) Size of pressure relief devices

IGC CODE REFERENCE : Ch 8, 8.4

The combined relieving capacity (in m^3/s) of the pressure relief devices for interbarrier spaces surrounding type A independent cargo tanks where the insulation is fitted to the cargo tanks may be determined by the following formula:

$$Q_{sa} = 3{,}4 \cdot A_C \cdot \frac{\rho}{\rho_V} \sqrt{h}$$

where:

Q_{sa} : Minimum required discharge rate of air in standard conditions of 273 K and 1.013 bar

A_C : Design crack opening area in (m^2)

$$A_C = \frac{\pi}{4} \cdot \delta \cdot l$$

with:

δ : Max. crack opening width in (m)

$$\delta = 0{,}2 \cdot t$$

t : Thickness of tank bottom plating in (m)

l : Design crack length in (m) equal to the diagonal of the largest plate panel of the tank bottom (see Fig 1)

h : Max. liquid height above tank bottom plus 10 × MARVS in (m)

ρ : Density of product liquid phase in kg/m^3 at the set pressure of the interbarrier space relief device

ρ_V : Density of product vapour phase in kg/m^3 at the set pressure of the interbarrier space relief device and a temperature of 273 K.

MARVS: max allowable relief valve setting of the cargo tank (bar)

6.1.3 Vents *(1/6/2021)*

IGC CODE REFERENCE : Ch 8, 8.2.10

The height of vent exits as indicated in paragraph 8.2.10 of the IGC Code is also to be measured above storage tanks and cargo liquid lines, where applicable.

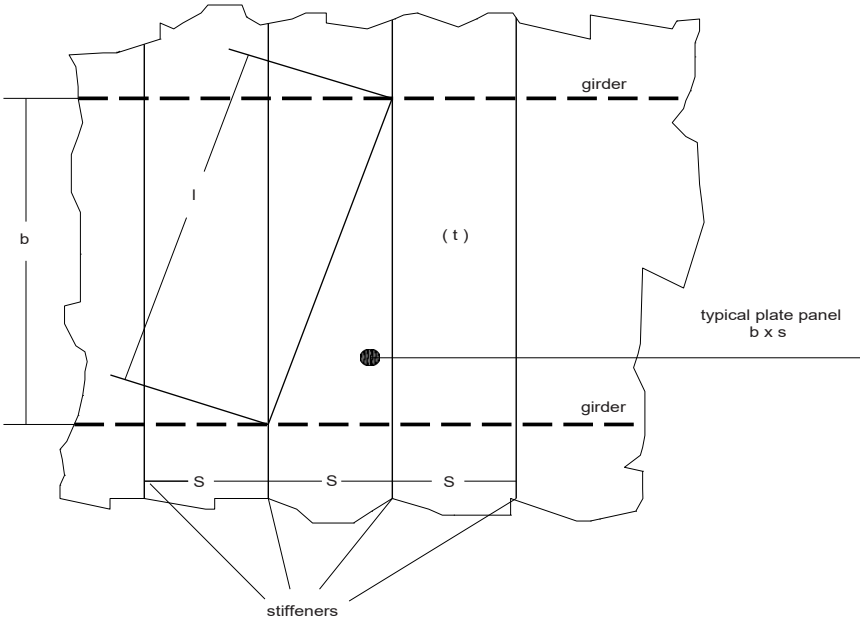
6.1.4 Segregation of vents *(1/6/2021)*

a) Additional requirements on vent location

IGC CODE REFERENCE : Ch 8, 8.2.11.1 and 8.2.11.2

1) The distances of the vent exits are to be measured horizontally.
2) In the case of carriage of flammable and/or toxic products, the vent exits are to be arranged at a distance of at least 5 m from exhaust ducts and at least 10 m from intake ducts serving cargo pump rooms and/or cargo compressor rooms.
3) The distances are also intended to refer to outlets of ventilation ducts of safe spaces.

Figure 1 : Determination of l *(1/6/2021)*



6.2 Additional pressure relieving system for liquid level control

6.2.1 Tank filling limits *(1/6/2021)*

IGC CODE REFERENCE : Ch 13, 13.3.2

The words 'to prevent the tank from becoming liquid full' in paragraph 13.3.2 of the IGC Code have the following meaning:

At no time during the loading, transport or unloading of the cargo including fire conditions will the tank be more than 98% liquid full, except as permitted by 15.4.1 of the IGC Code. These requirements, together with those of 8.2.17 of the IGC Code, are intended to ensure that the pressure relief valves remain in the vapour phase.

7 Environmental control

7.1 Inerting

7.1.1 General *(1/6/2021)*

a) Dew point

IGC CODE REFERENCE : Ch 9, 9.4.1

As far as the IGC Code requirements relevant to the dew point are concerned, the following additional provisions apply:

1) where cargo tank insulation is not protected from water vapour penetration by means of an effective vapour barrier, accepted by the Society, the maximum value of the dew point is to be less than the design temperature

2) where cargo tank insulation is protected by an effective vapour barrier, accepted by the Society, the maximum value of the dew point is to be less than the minimum temperature which may be found on any surface within the spaces filled with dry inert gas or dry air

3) the temperature of the hull structures adjacent to cargo tanks is not to become lower than the minimum permissible working temperature, specified in Ch 9, Sec 6, for the steel grade employed for such hull structures.

b) Precautions against fire

IGC CODE REFERENCE : Ch 9, 9.4.1

Precautions are to be taken to minimise the risk that static electricity generated by the inert gas system may become a source of ignition.

7.2 Inert gas production on board

7.2.1 Exemptions *(1/6/2021)*

IGC CODE REFERENCE : Ch 9, 9.5

a) Inert gas generating systems are to be considered as essential services and are to comply with the applicable Sections of the Rules, as far as applicable.

b) Where, in addition to inert gas produced on board, it is possible to introduce dry air into the above-mentioned spaces, where this is acceptable depending on the type of cargo tank adopted, or to introduce inert gas from a supply existing on board, it is not necessary that standby or spare components for the inert gas system are kept on board.

8 Mechanical ventilation in the cargo area

8.1 Spaces required to be entered during normal cargo handling operations

8.1.1 Ventilation duct arrangement *(1/6/2021)*

IGC CODE REFERENCE : Ch 12, 12.1.5

a) Ventilation ducts to gas-dangerous spaces are to be fitted with metallic shut-off dampers provided with "open" and "closed" signs. These dampers are to be arranged in the open, in a readily accessible position.

b) Gas-dangerous spaces for the purpose of a) are those mentioned in paragraph 12.1.1 of the IGC Code. For other spaces which are gas-dangerous only due to their position, some relaxation may be granted.

8.1.2 Recirculation prevention *(1/6/2021)*

IGC CODE REFERENCE : Ch 12, 12.1.5

a) Exhaust ducts from gas-dangerous spaces are to be arranged at a distance in the horizontal direction of at least 10 m from ventilation outlets of gas-safe spaces. Shorter distances may be accepted for ventilation outlets from safe spaces protected by air-locks.

b) Intakes of gas-dangerous spaces are to be arranged at a distance in the horizontal direction of at least 3 m from ventilation intakes and outlets and openings of accommodation spaces, control stations and other gas-safe spaces.

c) Exhaust and intake ducts for the same gas-dangerous space, or for the same space rendered safe by an air-lock, are to be arranged at a distance from each other in the horizontal direction of not less than 3 m.

8.1.3 Additional requirements for non-sparking fans *(1/6/2021)*

a) Non-sparking fans

IGC CODE REFERENCE : Ch 12, 12.1.7

1) A fan is considered as non-sparking if in both normal or abnormal conditions it is unlikely to produce sparks.

2) The air gap between the impeller and the casing is to be not less than 0,1 of the shaft diameter in way of the impeller bearing and not less than 2 mm. It need not be more than 13 mm.

b) Materials for non-sparking fans

IGC CODE REFERENCE : Ch 12, 12.1.7

1) The impeller and the housing in way of the impeller are to be made of materials as per list in the Code, with a production certificate.

2) Electrostatic charges both in the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation on board of the ventilation units is to be such as to ensure their safe bonding to the hull.

3) The following impellers and housings are considered as sparking and are not permitted:

- impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance
- housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
- any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

c) Type test for non-sparking fans

IGC CODE REFERENCE : Ch 12, 12.1.7

Type tests on the finished product are to be carried out in accordance with the requirements of the Society or an equivalent national or international standard.

d) Motor shafting

IGC CODE REFERENCE : 12, 12.1.7

The shafting penetration of motors driving fans through bulkheads and decks of dangerous spaces or through ventilation ducts is to be fitted with a gas-tight sealing device, of the oil-seal type or equivalent, deemed suitable by the Society.

8.2 Spaces not normally entered

8.2.1 General requirements *(1/6/2021)*

a) Minimum number of air changes

IGC CODE REFERENCE : 12, 12.2

Both fixed and portable systems are to guarantee the efficient ventilation of such spaces in relation to the relative density, in respect of the air, and to the toxicity of the gases transported. The type of portable fans and their connection to the spaces served are to be approved by the Society. In no case are portable electrical fans acceptable.

9 Instrumentation (Gauging, Gas detection)

9.1 General

9.1.1 Cargo tank instrumentation *(1/6/2021)*

The instrumentation is to be of a type approved by the Society.

9.1.2 Detection of leak through secondary barrier *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.7.1

Upon special approval, appropriate temperature indicating devices may be accepted by the Society instead of gas detecting devices when the cargo temperature is not lower than - 55 °C.

9.1.3 Indicator location *(1/6/2021)*

Monitoring list

IGC CODE REFERENCE : Ch. 13, 13.1.2

The following information and alarms are to be concentrated in the positions specified in this requirement.

a) The following is to be transduced to the "cargo control room" and the "control position" as defined in 3.4.1 of the IGC Code:
   1) the indication signalling the presence of water and/or liquid cargo in holds or interbarrier spaces
   2) the cargo heater low temperature alarm
   3) the alarm signalling the presence of liquid cargo in the vent main as per 5.2.2.4 of the IGC Code
   4) the indication of the hull temperature and the hull structure low temperature alarm required in 13.7.2.2 of the IGC Code
   5) the alarm signalling the automatic shutdown of electrically driven submerged pumps required in 10.2.9 of the IGC Code
   6) the indication of the cargo level and the cargo tank high level alarm required in 13.3.1 of the IGC Code
   7) the indication of the vapour space pressure and the vapour space pressure gauges of each cargo tank and associated high and low pressure alarms required in 13.4.1 of the IGC Code
   8) the gas detection equipment alarm required in 13.6.13 of the IGC Code
   9) the cargo compressor high temperature alarm required in 17.4.2.2 of the IGC Code
   10) the alarm for automatic shutdown of the cargo compressor for high pressure or high temperature, as required in 17.16.4.4 of the IGC Code.

   When the cargo system is not remote controlled and therefore the aforesaid "control positions" are not required, the above-mentioned controls, information and alarms are to be located in a suitable, easily accessible location.

   If this position is an enclosed space, it is to comply with the requirements of 3.4 of the IGC Code. This position should preferably be located in the wheelhouse.

b) Independently of the above, the following is to be transduced to the wheelhouse:
   1) the alarm signalling the presence of water and/or liquid cargo in holds or interbarrier spaces
   2) the cargo heater low temperature alarm

3) the alarm signalling the presence of liquid cargo in the vent main as per 5.2.2.4 of the IGC Code
4) the indication of the pressure value in the vapour space of each cargo tank mentioned in 13.4.1 of the IGC Code; such indication is to give the setting pressure value of the relief valve and the minimum allowable pressure value in the cargo tank concerned
5) the high pressure and low pressure alarms, when required, for cargo tanks as per 13.4.2 of the IGC Code
6) the hull structure low temperature alarm required in 13.7.2.2 of the IGC Code
7) the gas detection equipment alarm required in 13.6.13 of the IGC Code
8) the cargo compressor high temperature alarm required in 17.4.2.2 of the IGC Code
9) the alarm for automatic shutdown of the cargo compressor for high pressure or high temperature, as required in 17.16.4.4 of the IGC Code.

c) Where the cargo control room is located within the accommodation spaces and is readily accessible, the alarms in b) may be grouped in a single audible and visual alarm except for the indication and alarms in 4), 5) and 7), which are to be independent from each other.

d) The high level and high or low pressure audible and visual alarms for cargo tanks as per 13.3.1 to 13.3.3 and 13.4.1 to 13.4.3 of the IGC Code and the alarm signalling the presence of liquid in the vent main are to be located in such a position as to be clearly heard and identifiable by the personnel in charge of loading operation control.

9.2 Level indicators for cargo tanks

9.2.1 General *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.2.1 and 13.2.2

a) In order to assess whether or not one level gauge is acceptable, the wording "can be maintained" is to be interpreted to mean that any part of the level gauge other than passive parts can be overhauled while the cargo tank is in service.

Passive parts are those parts assumed not subject to failures under normal service conditions.

b) Where level gauges containing cargo are arranged outside the tank they serve, means are to be provided to shut them off automatically in the event of failure.

9.3 Overflow control

9.3.1 Overflow alarm and shutdown *(1/6/2021)*

a) Shut-off valve for overflow control

IGC CODE REFERENCE : Ch. 13, 13.3.2

The sensor for automatic closing of the loading valve for overflow control may be combined with the liquid level indicators required by paragraph 13.2.1 of the IGC Code.

b) Shut-off valve closing time

IGC CODE REFERENCE : Ch. 13, 13.3.1 to 13.3.3

The closing time of the valve referred to in 13.3.2 in seconds (i.e. time from shutdown signal initiation to complete valve closure) is to be not greater than:

$$\frac{3600 \cdot U}{LR}$$

where:

U : Ullage volume at operating signal level (m^3)

LR : Maximum loading rate agreed between ship and shore facility (m^3/h)

The loading rate is to be adjusted to limit surge pressure on valve closure to an acceptable level taking into account the loading hose or arm, and the ship and shore piping systems, where relevant.

9.4 Pressure gauges

9.4.1 Pressure gauges in cargo tanks *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.4.1

The low pressure alarm indicated in paragraph 13.4.1 of the IGC Code is also to be located in the cargo control room.

9.5 Temperature indicating devices

9.5.1 Temperature recording *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.5.1

The temperatures are to be continuously recorded at regular intervals. Audible and visual alarms are to be automatically activated when the hull steel temperature approaches the lowest temperature for which the steel has been approved.

9.6 Gas detection requirements

9.6.1 Gas measurements *(1/6/2021)*

In addition to the provisions of [9.6.2] to [9.6.3], the fitting of gas measuring equipment is subject to the those of Pt C, Ch 4, Sec 1, [5.2.4] b).

9.6.2 Position of sampling heads *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.6.12

Sampling heads in cargo holds are not to be located in positions where bilge water may collect.

9.6.3 Gas sampling lines *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.6.8

Gas sampling lines are to be located outside accommodation spaces, unless they are fitted within gas-tight pipes.

9.6.4 Protected spaces *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.6.2

In addition to the list in paragraph 13.6.2 of the IGC Code, the gas detection system is also to serve spaces adjacent to pump rooms and compressor rooms.

9.6.5 Portable gas detectors *(1/6/2021)*

IGC CODE REFERENCE : Ch. 13, 13.6.19

For ships intended to carry toxic and flammable gases, two sets for toxic gases and two sets for flammable gases are to be provided.

10 Special requirements

10.1 Materials for construction

10.1.1 *(1/6/2021)*

IGC CODE REFERENCE : Ch. 17, 17.2

Materials "exposed to cargo" are those constituting systems, cargo appliances or arrangements which are in contact with (liquid or vapour) cargo in normal operating conditions.

10.2 Inhibition

10.2.1 Polymerisation prevention - Alternative requirement *(1/6/2021)*

IGC CODE REFERENCE : Ch. 17, 17.8.1

a) As an alternative to the addition of inhibited liquid, it may be accepted that, at the end of each refrigeration period, the liquid is completely removed from the refrigeration system by means of vapour from compressors or by means of inert gas. In such case, the following wording is to be entered on the Certificate of Fitness:

   "At the end of each refrigeration period, the liquid is to be completely removed from the refrigeration system by means of vapour from compressors or by means of inert gas."

b) On the cargo compressor delivery side, a temperature switch is to be fitted, set at a suitable temperature, depending on the characteristics of the product carried (e.g. 60°C for butadiene), giving a visual and audible alarm on the navigation bridge and in the cargo control station, if any, which causes the compressor to stop when such temperature is exceeded.

10.3 Chlorine

10.3.1 Cargo containment system *(1/6/2021)*

a) Relief valves

IGC CODE REFERENCE : Ch. 17, 17.13.1.4

Chlorine discharge from pressure relief valves is to be led to an absorption device deemed suitable by the Society.

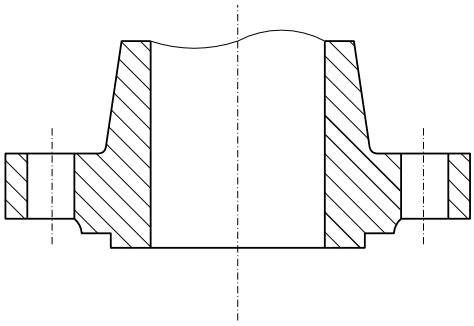
10.3.2 Cargo piping system *(1/6/2021)*

a) Piping design and fabrication

IGC CODE REFERENCE : Ch. 17, 17.13.2.2

A welding neck type flange deemed suitable is shown in Fig 2 as an example.

Figure 2 : Suitable neck type flange



10.3.3 Instrumentation - Safety devices *(1/6/2021)*

a) Gas detection system

IGC CODE REFERENCE : Ch. 17, 17.13.4.3

The gas detection system is to be permanently installed.

10.3.4 Protection of personnel *(1/6/2021)*

a) Additional equipment

IGC CODE REFERENCE : Ch. 17, 17.13.5

In addition to the source of uncontaminated air, two complete and independent air breathing apparatuses, not employing oxygen supplies, each having a capacity of at least 1200 litres of non-compressed air and two sets of protective equipment, complete with gas-tight boots, gloves and eye protection, are to be provided. The above-mentioned equipment and clothing are to be kept in the space indicated in paragraph 17.13.5 of the IGC Code and are additional to those required in other parts of this Chapter.

10.3.5 Filling limits for cargo tanks *(1/6/2021)*

IGC CODE REFERENCE : Ch. 17, 17.13.6.1

When determining the filling limits of the cargo tanks for the transport of chlorine, the effect of the refrigeration plant is not to be considered.

11 Personnel protection requirements for individual products

11.1 Showers and eyes wash

11.1.1 *(1/6/2021)*

IGC CODE REFERENCE : Ch 14, 14.4.3

The showers and eyes wash are to be fitted with a heating system, or other suitable installation, in order to avoid any ice formation in their piping.

12 Summary of minimum requirements

12.1 Additional information on products

12.1.1 *(1/6/2021)*

IGC CODE REFERENCE - CHAPTER 19

Table 3 lists some additional information for those products which are listed in the table in Chapter 19 of the IGC Code.

The list shown in Table 3 gives properties for pure products. The specific gravity to be taken into account for the design of a ship might be altered considering the actual properties of the commercial product.

Information on temperature classes and explosion groups for electrical equipment in connection with the products to be carried is indicated in Sec 8, Tab 4.

Table 3 *(1/6/2021)*

Product name	Boiling temperature (°C)	Specific gravity at boiling point (kg/m^3)	Ratio vapour/air density
Acethaldehyde	20,8	780	1,52
Ammonia, anhhydrous	- 33,4	680	0,60
Butadiene	- 4,5	650	1,87
Butane	-0,5/11,7	600	2,02
Butylenes	- 6,3/- 7	625	1,94
Chlorine	- 34	1560	2,49
Diethyl ether	34,6	640	2,55
Dimethylamine	6,9	670	1,55
Ethane	- 88,6	549	1,04
Ethyl chloride	12,4	920	2,22
Ethylene	- 104	570	0,97
Ethylene oxide	-10,7	870	1,52
Isoprene	34,5	680	2,35
Isopropylamine	32,5	700	2,03
Methane (LNG)	-161,5	420	0,55
Methyl bromide	4,5	1730	3,27
Methyl chloride	-23,7	1000	1,78
Monoethylamine	16,6	690	1,56
Nitrogen	-196	808	0,97
Pentanes (all isomers)	36,1	610	2,6
Pentene (all isomers)	30,1/37	610	2,6
Propane	-42,3	580	1,56
Propylene	-47,7	610	1,50
Propylene oxides	34,5	860	2.00
Refrigerant gases			
Dichlorodifluoromethane (R12)	-30	1486	4,26
Dichloromonofluoroethane (R21)	8,9	1480	3,9
Dichlorotetrafluoroethane (R114)	3,8	1510	1,31
Monochlorodifluoromethane (R22)	-42	1420	2,98
Monochlorotetrafluoroethane (R124)	-	-	4,70
Monochlorotrifluoromethane (R13)	-81,4	1520	3,60
Sulphur dioxide	-10	1460	2,3
Vinyl chloride	-13,9	970	2,15
Vinyl ethyl ether	35,5	754	2,50
Vinylidene chloride	31,7	1250	3,45

SECTION 6 ADDITIONAL REQUIREMENTS FOR MACHINERY AND CARGO SYSTEMS OF BARGE-LNG BUNKER

1 General

1.1 Application

1.1.1 *(1/6/2021)*

These units are to comply with the requirements of Sec 5.

The requirements in this Section are additional to the ones in Sec 5.

Units complying with the requirements of this Section will be granted the additional service feature **LNG bunker** which may be complemented by one or more of the following:

- **IG-Bunker (Inert Gas Bunker)**, where the barge-LNG bunker is designed to also supply inert gas, to ensure gas freeing and aeration, to a LNG fuelled ship.
- **BT (Bunker Trust)** where the barge-LNG bunker is designed with arrangement for the verification of the LNG quality and quantity delivered to the receiving ship.
- **VCS-Bunker (Vapour Control System Bunker)** where the barge-LNG bunker is designed with systems for control of vapour emission from cargo tanks from receiving ship during bunkering.

1.2 Scope

1.2.1 *(1/6/2021)*

This Section addresses:

- the design and installation of the of the piping system of the barge-LNG bunker intended to transfer LNG to the LNG fueled ship and the vapour transfer system to/from these units.
- the safety arrangements.

1.2.2 *(1/6/2021)*

Units intended to load, carry and transfer gases other than LNG will be considered on a case by case basis, and the Society reserves the right to establish additional requirements.

2 Definitions

2.1 Bunker emergency shut-down system (ESD)

2.1.1 *(1/12/2020)*

A bunker ESD is a system that safely and effectively stops the transfer of LNG (and vapour as applicable) between the receiving ship and the bunker ship in the event of an emergency during the bunkering operation, and puts the system in a safe condition.

2.2 Bunkering connections

2.2.1 *(1/12/2020)*

Bunkering connections correspond to the end of the fixed piping of the barge-LNG bunker (i.e. manifold for a system with flexible hose and before the swivel for a system with transfer arm).

2.3 Custody Transfer Measuring system

2.3.1 *(1/12/2020)*

Custody transfer Measuring system in fluid measurement is a metering point (location) where the fluid is being measured for sale from one party to another.

2.4 Emergency release coupling (ERC) or breakaway coupling (BRC)

2.4.1 *(1/6/2021)*

A breakaway coupling or emergency release coupling (ERC) is a coupling located in the LNG transfer system (at one end of the transfer system, either the receiving ship end or the barge-LNG bunker end, or in the middle of the transfer system), which separates at a predetermined section when required, each separated section containing a self-closing shut-off valve, which seals automatically.

An emergency release coupling can be activated:

- by external forces applied to the predetermined section exceeding a predetermined value, and/or
- by manual, remote or automatic control, in case of emergency.

2.5 ESD link system or Ship-ship link (SSL)

2.5.1 *(1/6/2021)*

ESD link system or Ship-ship or ship-shore link (SSL) is a communication system to transmit ESD signals and other signals between two different ESD systems (ship to shore/ship or vice versa) via compatible system technologies such as pneumatic, electric, fiber-optic or radio telemetry.

2.6 LNG bunkering station

2.6.1 *(1/6/2021)*

LNG bunkering station means the following equipment and the area where they are fitted:

- bunkering connections (see [2.2]) for hoses and piping used for liquid and vapour return lines,
- isolating valves and emergency shut-down valves,
- drip trays, draining arrangement and other arrangements such as water curtain intended for the protection of the ship structure from cold leakages,
- gas detection system through thermal camera or gas detectors for enclosed space,
- bunkering system ESD indication,
- inerting and purging system connections,
- pressure relieving system for the Bunkering manifold.

2.7 LNG transfer system

2.7.1 *(1/6/2021)*

A LNG transfer system is a system used to connect the barge-LNG bunker and the receiving ship in order to transfer LNG or both LNG and vapours.

The LNG transfer system includes:

- loading arms and transfer hoses, as applicable
- manifold including valves and instrumentation,
- QCDC,
- breakaway coupling (BRC) or Emergency release coupling (ERC),
- isolation flanges.

2.8 MID

2.8.1 *(1/6/2021)*

Measuring Instruments Directive (MID). The Measuring Instruments Directive (MID) for Custody Transfer metering for liquids, is the European directive law that sets down the essential requirements for a wide range of measuring instruments. It provides options for the manufacturer as to how the requirements are met and which organizations to apply to for conformity assessment.

2.9 OIML R117-1

2.9.1 *(1/6/2021)*

OIML R117-1 is a recommendation issued by the ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE (OIML). The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological

services, or related organizations, of its Member States. R117-1 addresses the Dynamic measuring systems for liquids other than water.

2.10 Pendant

2.10.1 *(1/6/2021)*
Pendant (for ESD system) is a portable device provided by one ship to another ship or shore terminal or provided by the shore to the ship for the manual tripping of its ESD system by the other party in the absence of a compatible ship-ship link (SSL).

2.11 Quick connect and disconnect coupling (QCDC)

2.11.1 *(1/6/2021)*
A QCDC is a manual or powered mechanical device used to connect the LNG transfer system to the receiving ship manifold. The coupling consists of a Nozzle (male) and a receptacle (female). The nozzle allows quick connection and disconnection of the fuel supply hose to the receptacle, mounted on the LNG manifold.

2.12 Safety zone

2.12.1 *(1/6/2021)*
The safety zone is a zone around the barge-LNG bunker, the bunkering station of the receiving ship and the LNG transfer system, where the only activities to be performed are the bunkering operations and related activities and where safety measures are taken to cope with a possible leakage of LNG or vapour.

2.13 Transfer arm

2.13.1 *(1/6/2021)*
Transfer arm refers to any system allowing supporting transfer hoses or rigid pipes during bunkering operations.

3 Document to be submitted

3.1 General

3.1.1 *(1/6/2021)*
The drawings and related information to be submitted are listed in Tab 1.

3.1.2 *(1/6/2021)*
The operating manuals and procedures to be submitted are listed in Tab 2.

Table 1 : Documents to be submitted *(1/6/2021)*

No	A/I	Documents
1	A	Arrangement of the ship showing the location of the bunkering station and bunkering control station
2	I	Risk assessment report including operational constraints for the bunkering operation such as minimum visibility, day/night, maximum wind and wave, weather condition
3	I	List of all bunkering equipment with their technical specification (including hoses)
4	A	Details of LNG transfer system and vapor return line system
5	A	Purging and Inerting system supplying inert gas to the bunker station and bunkering equipment
6	I	Custody Transfer Measuring Instruments system (Including evidence of approval according to MID or OIML R117-1 requirements)
7	A	ESD Bunkering Concept including cause and effect matrix
8	A	Block diagram of Control, Monitoring and Safety System
9	A	ESD link system (SSL) description and list of communication devices used for the bunkering operation with their specification
Note 1: A = to be submitted for approval I = to be submitted for information		

No	A/I	Documents
10	A	Drip trays and water curtain arrangement
11	I	Instrumentation list and relevant Safety certificates for electrical equipment located in hazardous areas and concerning the bunkering, where applicable
12	A	Drawings of transfer arm
13	I	Fender and mooring arrangement for bunkering operation with mooring analysis
14	A	Bunkering station manifold specification and drawings, with strength calculation including values of maximum allowable working pressure and allowable loads at manifold flange
15	A	Access and walkway arrangement to bunkering station
Note 1: A = to be submitted for approval I = to be submitted for information		

Table 2 : Operating manuals and procedures to be submitted *(1/6/2021)*

No	A/I	Documents
1	I	Operational manual including bunkering procedure (with details of maximum allowable bunkering flow and maximum allowable working pressure), all information required in IGF Code 18.4.2 and IGC Code 18.2 and procedure for the boil off gas and vapour return management
2	I	Bunkering Safety Checklist according to IGF Code 18.4.3
3	I	Safety Zones Layout for the bunkering operation
4	I	Maintenance and storage instruction manual for the bunkering equipment
Note 1: A = to be submitted for approval I = to be submitted for information		

4 General design requirements

4.1 Risk Assessment

4.1.1 LNG transfer system *(1/6/2021)*

A risk assessment shall be conducted according to IGC Code 1.1.11 and IGF Code 4.2 as far as applicable.

The goal of the risk assessment is to identify all safety, environmental and asset hazards associated to the LNG Transfer system during bunkering operation and their possible mitigation where required. The risk analysis can be of qualitative or semi-quantitative type and shall be based on international recognized standards and TASNEEF Guide for Risk Analysis.

4.1.2 *(1/6/2021)*

The risk assessment is to be performed using the most appropriate techniques such HAZID (Hazards Identification), FMEA (Failure Mode and Effect Analysis) or HAZOP (Hazard and Operability study) as far as applicable and at least the following items shall be assessed:

- Bunkering station including manifold arrangement
- ESD Bunkering System
- Bunkering Equipment
- ESD Link system (SSL)
- Voice communication System between barge-LNG bunker and receiving ship
- Monitoring, Control and Safety System of bunkering operation
- Fender and mooring arrangement

taking into account the following operations:

- Arrival, approach and mooring of barge-LNG bunker close to the receiving ship
- Connection and testing of LNG transfer system including ESD system and communication link
- LNG bunkering procedure (including hose handling, hose connection, gassing up, cooling down)
- LNG bunkering in parallel with other activities (SIMOPs)

- Disconnection of the LNG bunker hose in normal and emergency condition (including draining, purging and inerting).

4.1.3 *(1/6/2021)*

The SIMOPs shall be defined with reference to international recognized standards or guidelines such as IACS Rec. 142, SGMF FP08-01 "Simultaneous Operations (SIMOPS) during LNG Bunkering" and other activities identified by the risk assessment experts considering the expected port operations of the receiving ship.

4.2 Hazardous area

4.2.1 General *(1/6/2021)*

In general, safety and security zones are to comply with IACS Rec. 142, Section 2 and they are to be addressed during the risk assessment for the LNG bunkering operation.

4.2.2 *(1/6/2021)*

In addition to the hazardous areas in accordance with IGC Code, the following are to be included:

- LNG bunkering station and 3 m beyond these, up to a height of 2,4 m above the deck
- areas on the open deck within spillage coamings surrounding LNG bunkering connections and manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck
- when applicable, transfer arm operating area extended by 3 m on either direction.

4.3 Materials

4.3.1 *(1/6/2021)*

Materials used in LNG transfer systems, piping system for liquefied gas and other systems or components in contact with LNG or gas are to be in accordance with IGC Code, Chapter 6.

4.4 Arrangement of bunkering system

4.4.1 LNG bunkering station *(1/6/2021)*

The LNG bunkering station is to be located on open deck so that sufficient natural ventilation is provided. Closed or semi-enclosed bunkering stations will be subject to special consideration and are subject to risk assessment as specified in [4.1]. Access to closed or semi-enclosed bunkering station from other closed or semi-enclosed space shall be granted via airlock.

The LNG bunkering station when not located in the cargo area shall be separated from accommodation and control stations through gas tight divisions and the layout is subject to risk assessment.

LNG bunkering station may be accepted at the ship bow and stern provided that the relevant requirements of IGC Code 3.8 are complied with.

The maximum allowable loads are to be indicated on a warning plate fitted on the manifold or nearby.

The manifold shall be arranged at least with the following instruments and fittings:

- Pressure gauge
- Pressure transmitter
- Temperature gauge
- Temperature transmitter
- Sampling point for gas detection
- Safety relief valve fitted in between the presentation flange and ESD bunkering valve.

4.4.2 Drip trays and protection of ship hull *(1/6/2021)*

Drip trays are to be fitted below the liquid bunkering connections and where leakage may occur which can cause damage to the ship structure.

Thermal sensors are to be positioned in the drip trays.

The drip trays are to be made of stainless steel and can be drained overboard.

When LNG boiling point at atmospheric pressure is lower than design temperature of the hull steel, a water piping system is to be fitted, providing a low-pressure water curtain in way of the hull under the bunkering manifold for additional protection of the hull steel and the ship's structure; other solutions will be considered on a case by case basis.

The operating platforms in way of the manifold operating position are to be fitted with raised gratings made of a material suitable for the LNG boiling point at atmospheric pressure.

4.4.3 Bunkering control station *(1/6/2021)*

Control of the bunkering operation should be possible from a bunkering control station that is placed in a safe location with regards to bunkering operations. The bunkering control station may be within the cargo control room. At this location, overfilling alarm and automatic and manual shutdown are be indicated.

Unobstructed direct or camera view of the LNG bunkering station is to be available from the Bunkering control station.

An LNG system schematic/piping and instrumentation diagram (P&ID) shall be reproduced and permanently mounted in the bunkering control station.

4.4.4 LNG Transfer Systems *(1/6/2021)*

The manifold for transfer of liquid shall be fitted with manually operated stop valve and a remotely/automatically operated valve (ESD valve) fitted in series.

The LNG transfer system is to include at least an emergency release coupling (ERC) and an insulation flange. A Quick Connect Disconnect Coupling (QCDC) may be installed together with above mentioned components.

The ERC is to be fitted on the receiving ship side, but may be accepted also fitted on LNG transfer system side provided that the relevant scenario is considered during the risk analysis required in [4.1].

In case the ERC is fitted on the LNG transfer system side, the nearest pressure relief valve on the receiving ship shall have sufficient capacity to accommodate the trapped liquid in the bunkering hose or pipe.

The hoses are to be adequately supported and protected to prevent potential damage or sparks in the event of activation of the ERC.

The manifolds are to be capable to withstand the allowable loads as defined in an international recognized standard or guideline such as SGMF TGN-06-04 "Technical Guidance Manifold" or equivalent.

The LNG transfer system is to be designed to avoid the release of gas to the atmosphere during bunkering operations.

The bunkering transfer rate is to be capable of being controlled to match with the capabilities and requirements of the receiving ship.

The maximum LNG transfer rate is to be declared and justified, taking into consideration:

- The management of the BOG generated during bunkering operation
- The temperature of the LNG supplied to the ship
- The maximum flow permitted by the ERC and or break away coupling
- The maximum flow permitted by the hose
- The maximum flow permitted by the QCDC
- The maximum allowable working pressure of the receiving ship bunkering station.

The GAS/LNG velocity in the piping system is not to exceed 10 m/s in order to avoid the generation of static electricity and to limit the heat transfer due to friction inside the pipes; higher velocity may be considered provided they are duly justified.

In order to prevent cryogenic liquid spills, the design of the transfer system is to be such that the lines can be drained and purged by nitrogen after a normal or emergency disconnection.

Any pipeline or component containing liquid, which may be isolated due to the ESD activation, is to be provided with pressure relief valve.

4.4.5 LNG Bunkering ESD system *(1/6/2021)*

A bunkering ESD system is to be installed in addition to the ESD required by IGC Code, if a separate transfer system is provided.

All electrical components of the ESD systems are to be of suitable safe type taking into account the hazard categorization of the area where they are located.

4.4.6 Lighting *(1/6/2021)*

Lighting shall illuminate the bunker station area, and if installed in a hazardous area should be compliant with applicable hazardous area equipment requirements. Lighting shall adequately illuminate the bunkering operation work area as follows:

- LNG bunker hose(s),
- Connection and couplings on both receiving ship and bunkering facility,
- ESD system call points,

- Communication systems,
- Fire-fighting equipment,
- Passage ways / gangways intended to be used by the personnel in charge of the bunkering operation, and
- Vent mast(s).

4.5 Mooring and fendering

4.5.1 *(1/6/2021)*

Steel to steel contact between barge-LNG bunker and receiving ship e.g. via mooring lines, ladders, gangways, chains for fender support etc. shall be avoided through the use of insulation. Bunker hoses/pipes shall be supported and isolated to prevent electrical contact with the receiving ship.

4.5.2 *(1/6/2021)*

The rubber fenders used for keeping the distance between the barge-LNG bunker and receiving ship shall be built according to an international recognized standard such as ISO 17357-2 or equivalent. The dimensions and arrangement of fenders shall be verified during risk assessment as required in [4.1] taking into consideration the interferences of the hazardous areas of both ships and the minimum bend radius of the bunkering hose.

5 Hoses and pumps

5.1 Hose design requirements

5.1.1 General *(1/6/2021)*

The hoses used for bunkering are to comply with the requirements in IGC Code 5.11.7.

For bunkering hoses the following characteristics are to be defined by the designer and submitted to the Society:

- Minimum/Maximum Allowable Working Temperature
- Maximum Allowable Working Pressure
- Minimum Bend Radius
- Maximum Allowable Crush Load
- Maximum Allowable Axial Load.

5.1.2 Hose Maximum Working Pressure and Strength *(1/6/2021)*

The maximum working pressure specified by manufacturer is not to be less than 1 MPa in accordance with IGC Code 5.11.7.3.

The strength of the hoses is to be compatible with the maximum release forces of the ERC.

5.1.3 Materials *(1/6/2021)*

All materials of hose assembly are to be suitable for marine environment, compatible with each other and with the fluid conveyed (LNG and LNG vapours).

5.1.4 End connection and coupling *(1/6/2021)*

The end fittings are to be made of corrosion resistant material and in accordance with IGC Code Table 6.4.

5.2 Type approval, testing and certification of LNG bunkering hoses

5.2.1 *(1/6/2021)*

Bunkering hoses are to be type approved by the Society.

Flexible hoses intended for the handling of LNG are to be in compliance with design and testing requirements standards EN1474-2, or EN21012 or equivalent standards and IGC Code 5.11.7.

5.2.2 *(1/6/2021)*

All hoses are to be individually certified by the Society at satisfactory outcome of testing according to [5.3], carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

5.3 Testing of Hoses at workshop

5.3.1 Pressure test *(1/6/2021)*

Each hose assembly is to be subjected to a hydraulic pressure test at ambient temperature to a pressure not less than 1,5 times the maximum operating (nominal) pressure, to demonstrate that the hose assembly is capable of withstanding pressure without leaking.

5.3.2 Non destructive testing of welding *(1/6/2021)*

Welds of the hose assembly are to be subjected to non destructive testing (NDT) according to international recognized standards.

5.4 Hoses documentation

5.4.1 *(1/6/2021)*

A hose technical file containing the following information is to be kept on board:

- Hose identification number
- Type approval certificate issued by Society
- Product test certificate issued by Society
- Overall weight of the hose and end fittings assembly
- Date of entry into service
- Inspection intervals and lifetime
- Instructions for the handling, storage and installation of hose

5.5 Marking of products

5.5.1 *(1/6/2021)*

Each hose is to be permanently marked according to a recognized international standard or the following information:

- Manufacturer's name or logo
- Hose designation and size
- Maximum Allowable Working Pressure
- Maximum and minimum allowable working temperature
- Date of manufacture
- Marking from Society

5.6 Transfer pumps

5.6.1 *(1/6/2021)*

The transfer pumps if different from cargo pumps shall comply with requirements specified in Ch 9, Sec 5, [3.2] and they shall be type approved.

All pumps are to be pressure tested in the presence of the Surveyor.

6 Quick connect disconnect coupler (QCDC)

6.1 Type approval, testing and certification of QCDC

6.1.1 *(1/6/2021)*

QCDC are t be type approved by the Society.

6.1.2 *(1/6/2021)*

All QCDC are to be individually certified by the Society at satisfactory outcome of testing according to [6.3] carried out by the manufacturer in the presence of the Surveyor, unless an alternative certification scheme is agreed with the Society.

6.2 Type testing

6.2.1 *(1/6/2021)*

The QCDC is to be subjected to a type test to confirm the release performance under ice built up condition according to an international recognized standard such as ISO 21593, ISO 16904 or equivalent.

6.3 Workshop testing

6.3.1 Pressure test *(1/6/2021)*

The QCDC is to be subjected to a hydrostatic pressure test, at ambient temperature, to a pressure not less than 1,5 times the Maximum Allowable Working Pressure to demonstrate that the QCDC is capable of withstanding pressure without leakage.

7 Emergency release coupling (ERC)

7.1 Type approval, testing and certification of QCDC

7.1.1 General *(1/6/2021)*

Transfer arms and hoses shall be fitted with an emergency release coupling (ERC) designed to minimize the release of LNG on emergency disconnection. The emergency release coupling is to be designed as breakaway coupling i.e. with automatic disconnection in case the allowable loads of manifold as defined in [4.4.4] are exceeded. Additionally the emergency release coupling may be designed with manual or remote and automatic activation by the ESD bunkering system.

7.1.2 *(1/6/2021)*

Each separate section is to contain a self-closing shut-off valve, which seals automatically on disconnection.

7.1.3 *(1/6/2021)*

All electrical components of the emergency release coupling are to be certified of a suitable safe type.

When applicable, the availability of power to the ERC is to be monitored and arranged so that bunkering operation is automatically stopped in case of loss of power supply to the ERC.

7.1.4 *(1/6/2021)*

The bunkering line is to be designed and arranged to withstand the surge pressure that may result from the activation of the ERC.

7.2 Type approval, testing and certification of ERC

7.2.1 *(1/12/2020)*

ERC are to be type approved by the Society.

7.2.2 *(1/12/2020)*

All ERCs are to be individually certified by the Society at satisfactory outcome of testing according to [7.4] carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

7.3 Type testing

7.3.1 *(1/12/2020)*

The ERC are to be subjected to a type test according to an international recognized standard such as ISO 18683 or equivalent to confirm the values of axial and shear forces at which it automatically separates. Additionally the tightness of the self-closing shut-off valves after separation is to be tested.

7.3.2 *(1/12/2020)*

The ERC are to be subjected to a type test to confirm the release performance under ice built up condition.

7.3.3 *(1/12/2020)*

When applicable, the ERC is to be subjected to a type test to confirm the release in case of remote or automatic activation.

7.4 Workshop testing

7.4.1 Pressure test *(1/12/2020)*

The ERC are to be subjected to a hydrostatic pressure test, at ambient temperature, to a pressure not less than 1,5 times the Maximum operating (nominal) pressure, to demonstrate that the ERC are capable of withstanding pressure without leaking.

8 Electrical insulation flanges

8.1 General

8.1.1 *(1/6/2021)*
Each insulation flange is to be subjected to a test of electrical resistance in air and the resistance is to be of at least 1000 Ω but less than 1 MΩ.

8.1.2 *(1/6/2021)*
The resistance of each insulation flange is to be measured after installation in the complete LNG transfer system and the resistance is to be not less than 1000 Ω.

9 Hose Supports and transfer arms

9.1 General

9.1.1 *(1/6/2021)*
Hoses are to be suitably supported in such a way that the minimum allowable bending radius is complied with.

9.1.2 *(1/6/2021)*
Arrangements such as cranes or winches are to be available for the handling of hoses whose size or weight does not allow a safe manual handling.

9.1.3 *(1/6/2021)*
Non electrical equipment located in hazardous area and belonging to items such as cranes, winches, etc. is to be suitable for explosive atmosphere according to international recognized standard (e.g. ISO 80079-36 or equivalent).

9.1.4 *(1/6/2021)*
Electrical equipment located in hazardous area is to comply with IGC Code 10.2.

9.2 Transfer arms

9.2.1 *(1/6/2021)*
Transfer arms are to be approved by the Society.

9.2.2 *(1/6/2021)*
Transfer arms are to be designed and constructed in accordance with a recognized national or international standards acceptable to the Society as EN1474-1.

9.2.3 *(1/6/2021)*
The maximum allowable operating amplitude and forces acting on the loading arm during the bunkering operations are to be defined and compatible with the hoses and ERC. The exceeding of transfer arm envelope is to activate two stages alarms in bunker control station and on the navigation bridge.

The initiation of the first stage is to activate a visual and audible alarm.

The initiation of the second stage is to activate the ESD and ERC system.

9.2.4 *(1/12/2020)*
All transfer arms are to be individually certified by the Society at satisfactory outcome of tests, as required for lifting appliances and operational tests, or per recognized international standards, carried out by the manufacturer in the presence of a Society Surveyor, unless an alternative certification scheme is agreed with the Society.

9.2.5 *(1/6/2021)*
The operational test per [9.2.4] is to give evidence of compliance with the design criteria per [9.2.3].

10 Inert Gas System

10.1 Installation and inerting capacity

10.1.1 *(1/6/2021)*
An inert gas system is to be fitted on board, to enable purging and inerting of the bunkering lines; the system is to be in compliance with IGC Code 9.4 and 9.5.

10.1.2 *(1/6/2021)*
The inerting capacity is to be designed according the bunkering operations and when based on inert gas storage on board, the capacity is not to be less than 5 times the volume of the hose and pipes to be purged.

11 Gas detection

11.1 Gas detection in enclosed spaces

11.1.1 *(1/6/2021)*
Permanently installed gas detectors are to be fitted in all hazardous areas including bunkering station if of enclosed or semi-enclosed type, LNG process room and other enclosed spaces containing LNG piping or other equipment not equipped with double walled piping.

11.1.2 *(1/6/2021)*
The number of detectors in each space is to be considered taking into account the size, layout and ventilation of the space. At least two independent gas detectors are required in each hazardous area.

11.1.3 *(1/6/2021)*
The detection equipment is to be located where gas may accumulate and in the ventilation outlets. Gas dispersion analysis or a physical smoke test is to be used to find the best arrangement.

11.1.4 *(1/6/2021)*
An audible and visual alarm is to be activated before the vapour concentration reaches 30% of the lower explosive limit (LEL).

11.1.5 *(1/6/2021)*
Audible and visual alarms from the gas detection equipment are to be located on the bridge and in the bunkering control station.

11.2 Gas detection in open spaces

11.2.1 *(1/6/2021)*
The installation of thermal imaging camera is to be evaluated on the basis of the risk assessment as defined in [4.1], for open spaces classed as hazardous areas (e.g. bunkering station, hose handling areas).

Monitoring of thermal imaging camera is to be available in the bunkering control station.

12 Control and safety systems

12.1 General

12.1.1 *(1/6/2021)*
Appropriate segregation shall be maintained between control, monitoring/alarm and safety functions to limit the effects of single failures during bunkering.

Failure of one part of the integrated system shall not affect the functionality of other parts, except for those functions directly dependent on the defective part.

Being the bunkering control system combined with the cargo control system all relevant requirements specified in the IGC Code 13.9 are to be complied with.

12.2 Emergency shut-down systems (ESD)

12.2.1 *(1/6/2021)*
An ESD system is to be fitted to safely and effectively stop the transfer of LNG (and vapour as applicable) between the receiving ship and the bunkering ship in the event of an emergency during the bunkering operation and in general it is to be in compliance with IGC Code 18.10.

The ESD safety system is to be designed so as to limit the consequence of failures. It is to be constructed on the fail-to safety principle.

The ESD system is to be of the self-check type; as a rule, failure within the ESD including the outside connection, is to activate an alarm.

The control systems involved in the ESD, which is a linked system to allow both parties (on board receiving ship and the barge-LNG bunker) to shut down the transfer in an emergency situation, is to be capable of being activated automatically or manually.

The ESD system normally includes two stages:

- ESD-stage 1, a stage in which the LNG transfer process is shut down in a controlled manner
- ESD-stage 2, a stage in which decoupling of the transfer system between the transfer vessels or between a vessel and an LNG port facility is activated.

The ESD-1 and ESD-2 logic shall be verified and agreed among stakeholders during the risk assessment as required in [4.1] also considering applicable international recognized standard or guidelines (e.g. SIGTTO ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers).

Where provided, override command of ESD system has to be clearly indicated in the Bunkering control station.

The ESD-1 and ESD-2 trips are to trigger visual and audible alarms in the navigation bridge, engine control room, cargo and bunkering control room and manifold area.

12.2.2 *(1/6/2021)*

At least one local manual activation position for the ESD system is to be made available for the LNG fueled ship being bunkered, this may be in the form of an ESD System pendant with sufficient length of cable or an ESD link system (SSL ship/shore link or ship/ship link). The SSL may be various type (e.g.: electric, fibre-optic, radio telemetry, pneumatic). The SSL is to have an adequate reliability and redundancy level according to a recognized international standard or guideline (e.g.: SIGTTO ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers).

12.2.3 *(1/6/2021)*

At least one local manual activation position for the ESD system is to be fitted in a place that have a clear view of the manifold area (the 'clear view' may be provided via CCTV) but is at a safe distance from the manifold.

12.2.4 *(1/6/2021)*

Any activation of the ESD systems is to be implemented simultaneously on both bunkering facility and receiving ship.

12.2.5 *(1/6/2021)*

The timing sequence is to ensure that the involved pumps and compressors (if any) stop before the complete closure of any manifold valve.

12.2.6 *(1/6/2021)*

The bunkering lines are to be designed and arranged to withstand the surge pressure that may result from the activation of the emergency release coupling and quick closing of ESD valves. If not demonstrated to be required at a higher value due to pressure surge considerations, a default time of 5 seconds from the trigger of the alarm to full closure of the ESD valves is to be arranged.

12.2.7 *(1/6/2021)*

The components of the ESD system located in hazardous and safety zones are to be of a suitable safe type.

12.2.8 *(1/6/2021)*

LNG bunker transfer should not be resumed until the transfer system and associated safety systems (fire detection, etc.) are returned to normal operation condition.

12.2.9 *(1/6/2021)*

All electrical components of the emergency release coupling actuator and of the ESD systems that are provided by the barge-LNG bunker are to be approved and certified by the Society.

12.3 Alarms and safety actions

12.3.1 *(1/6/2021)*

The alarms and safety function/actions required for the transfer system are given in Tab 3 and they are additional to those required in the IGC Code Table 18.1. The extent of alarms and safety functions may be reconsidered on the basis of outcome from risk assessment.

The receiving ship is expected to be capable of transmitting at least an ESD signal via an hardwired system.

Table 3 : Alarms and safety actions required for the transfer system *(1/6/2021)*

Parameters	Alarm	Activation of the Bunker ESD systems (ESD-1)	Automatic activation of the emergency release coupling (ESD-2) **(1)**
Fire Detection in way of tank domes or manifold area for receiving ship and barge-LNG bunker **(1)**	X	X	
Shutdown signal from shore or receiving ship	X	X	
Loss of ESD linked system **(1)**	X	X	
Loss of power supply to LNG bunkering control system	X	X	
ESD logic failure	X	X	
Low Pressure in cargo valve remote control system	X		
Low Low Pressure in cargo valve remote control system	X	X	
Stop of the ventilation of enclosed or semi-enclosed bunkering station	X	X	
Loss of actuating power to the common loading arm maneuvering system or to the ERC of individual loading arms	X	X	
High level in surge drum (where provided)	X		
High High level in surge drum (where provided)	X	X	
Low pressure in the supply cargo tank	X		
Low Low pressure in the supply cargo tank	X	X	
Sudden pressure drop at the transfer pump discharge	X	X	
High level in the LNG storage tank of receiving ship **(1)**	X		
High High level in the LNG storage tank of receiving ship **(1)**	X	X	
High pressure in the LNG storage tank of receiving ship **(1)**	X		
High High pressure in the LNG storage tank of receiving ship **(1)**	X	X	
High pressure in the manifold vapor return system	X		
High high pressure in the manifold vapor return system	X	X	
High pressure in the manifold liquid supply system	X		
High High pressure in the manifold liquid supply system	X	X	
LNG cold leakage in the manifold drip tray	X	X	
Gas detection in bunkering station of receiving ship **(1)**	X	X	
Gas detection in bunkering station of bunkering ship	X	X	
Excessive movement of ship from berth/ship	X	X	X
Disconnection of the ERC	X	X	
(1) when the receiving ship is equipped with an SSL compatible with the barge-LNG bunker SSL			

12.4 Communication systems

12.4.1 *(1/6/2021)*

A two-way voice communication system is to be provided between the barge-LNG bunker and the receiving ship.

12.4.2 *(1/6/2021)*

The components of the communication system located in hazardous and safety zones are to be of a suitable safe type.

13 Testing of the LNG transfer system at workshop

13.1 Pressure test

13.1.1 *(1/6/2021)*

All piping and tanks the LNG transfer system are to be subjected to a hydraulic pressure test in the presence of a Society Surveyor, at ambient temperature, to a pressure not less than 1,5 times the nominal pressure, to demonstrate the capability to withstand pressure without leaking.

13.2 Inspection of welds

13.2.1 *(1/6/2021)*

When applicable, the welds of the LNG transfer system are to be subjected to a non-destructive testing and all butt welds are to be subjected to a 100% radiographic or ultrasonic examination.

14 Testing and trials of the LNG transfer system at yard

14.1 Onboard tests and trials

14.1.1 *(1/6/2021)*

After assembly on board, the following tests and trials are to be carried out in the presence of a Surveyor.

14.2 Piping leak test

14.2.1 *(1/6/2021)*

A leak test, using air or other suitable medium, of the completely assembled and equipped LNG transfer and vapour return systems, in steps of 10-20% up to 90% of the operational pressure of the LNG/gas system is to be carried out in the presence of a Society Surveyor, to detect leakage with soap/leak detection spray. Holding time is depending of the volume/part of the installation being Leak tested.

14.3 Inerting

14.3.1 *(1/6/2021)*

Inerting of the total LNG/gas system including LNG storage tank(s), following the approved inerting procedure.

15 Implementation survey

15.1 Survey at the first LNG bunkering

15.1.1 *(1/6/2021)*

Upon issuance of the additional service feature LNG bunker, a dedicated survey if to be carried out on occasion of the first LNG bunkering, as follows:

a) The first LNG bunkering is to be carried out according to the relevant LNG bunkering procedure.

b) During the survey the following is to be carried out:

- Examination of transfer piping systems including supporting arrangements.
- Verification of satisfactory operation of:
  - Control and monitoring systems
  - Connections systems (QCDC).
  - ESD system
  - piping purging and inerting systems.

16 Additional features

16.1 IG-Bunker (Inert Gas Bunker)

16.1.1 General *(1/6/2021)*

The additional feature **IG-Bunker (Inert Gas Bunker)** is assigned to barge-LNG bunker designed to also supply inert gas to a LNG fuelled ship to ensure inerting of the receiving ship systems, and complying with the following requirements.

16.1.2 Inert Gas system *(1/6/2021)*

The inert gas system is to comply with IGC Code 9.4 and 9.5 and Chapter 9.

16.1.3 Piping system *(1/6/2021)*

The lines used for the inert gas are to be independent from the LNG liquid and vapour lines used for normal operation.

16.1.4 Document to be submitted *(1/6/2021)*

The following documents are to be submitted to the Society for approval in addition to the information required in [3]:

- Diagram of the Inert gas system
- Procedure for supplying inert gas to the receiving ship.

16.2 BT (Bunker Trust)

16.2.1 General *(1/6/2021)*

The additional feature **BT (Bunker Trust)** is assigned to barge-LNG bunker designed with arrangement for the verification of the LNG quality and quantity delivered to the receiving ship according to international recognized standard (e.g. ISO 23306) or equivalent or according to a gas fuel specification agreed among the stakeholders.

16.2.2 Documents to be submitted *(1/6/2021)*

The following documents are to be submitted to the Society for approval in addition to the information required in [3]:

- Diagram of the LNG sampling arrangement
- Technical specification of LNG analyzer
- LNG Sampling procedure
- Evidence of approval of the measuring system according to MID or OIML R117-1.

16.2.3 Sampling System *(1/6/2021)*

The unit has to be fitted with a sampling system in accordance with international recognized standard (e.g. ISO 8943) or equivalent. Other type of system or piping arrangement are subject to special consideration and they are evaluated case by case.

The sampling connections shall be in compliance with requirements specified in IGC Code 5.6.5.

The sampling procedure shall be in compliance with requirements specified in IGC Code 18.9 and included in the risk assessment as required in [4.1.2].

The LNG analyzer is to be type approved.

16.2.4 Custody Transfer Measuring System *(1/6/2021)*

A Custody Transfer Measuring System is to be installed on the barge-LNG bunker.

A recognized thirty party should approve the design and instruments against MID or OIML R117-1; evidence of this is required to be supplied to the Society.

16.3 VCS-Bunker (Vapour Control System Bunker)

16.3.1 General *(1/6/2021)*

The additional feature **VCS-Bunker (Vapour Control System Bunker)** is assigned to barge-LNG bunker in compliance with Pt F, Ch 13, Sec 7 for the assignment of notation **VCS-Transfer**.

16.3.2 Vapour return handling *(1/6/2021)*

The barge-LNG bunker is to be capable of handling all or part of the vapours from receiving ship generated during the LNG bunkering operation, in addition to its own boil-off gas (BOG), without release to the atmosphere. The vapour handling capacity of the barge-LNG bunker is to be indicated and justified.

Different ways to dispose of the vapours may be considered, such as:

- re-liquefaction
- utilization by the gas consuming equipment of the barge-LNG bunker (e.g. gas or dual-fuel engines or boilers)
- gas combustion unit.

A combination of these means is possible and other solutions may be accepted if they are duly justified to the Society.

SECTION 7 ADDITIONAL REQUIREMENTS FOR MACHINERY AND CARGO SYSTEMS OF BARGE-CHEMICAL

1 General

1.1 Application

1.1.1 *(1/6/2021)*

These units are to comply with the requirements of Sec 3.

The requirements in this Section are additional to the ones in Sec 3.

These units are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), as amended, as specified in Ch 8, [1.1.1] to [1.1.3].

The requirements in this chapter applicable to barge-chemical apply to units intended to carry products listed in the table in Chapter 17 of the IBC Code. For the carriage of products listed in the table in Chapter 18 of the IBC Code and products not at present listed in either of the tables in Chapter 17 or Chapter 18 of the IBC Code, the Society reserves the right to establish specific requirements.

The requirements of this Section supplement those of the IBC Code.

All the requirements of this Section are cross referenced to the applicable Chapters, Sections or paragraphs of the IBC Code, as appropriate.

1.2 Documents to be submitted

1.2.1 *(1/6/2021)*

The documents listed in Tab 1 are to be submitted for approval.

1.3 Exemptions

1.3.1 *(1/6/2021)*

The requirements in Pt C, Ch 1, Sec 10, [11.4.1] b) do not apply to service tanks.

The requirements in Pt C, Ch 1, Sec 10, [11.4.6] a) do not apply.

Table 1 : Documents to be submitted *(1/6/2021)*

No.	A/I	Document
1	I	List of products to be carried, including maximum vapour pressure, maximum liquid cargo temperature and other important design conditions
2	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
3	A	General layout of cargo pump room with details of: - bulkhead penetrations - gas detection system - other alarms and safety arrangement
4	A	Diagram of the cargo tank venting system with: - indication of the outlet position - details of the pressure/vacuum valves and flame arrestors - details of the draining arrangements, if any
5	A	Diagram of the cargo tank cleaning system
6	A	Diagram of the cargo heating systems
7	A	Diagram of inert gas system with details of the inert gas plant
8	A	Plans and calculations of safety relief valves

No.	A/I	Document
9	A	Details of cargo handling, including arrangements and details of piping and fittings
10	A	Details of cargo pumps
11	A	Details of process pressure vessels and relative valving arrangement
12	A	Bilge and ballast system in cargo area
13	A	Gas freeing system in cargo tanks including inert gas system
14	A	Ventilation system in cargo area
15	A	Gas detection system
16	A	Cargo tank instrumentation
17	I	Loading and unloading operation description, including cargo tank filling limits, where applicable
Note 1: A = to be submitted for approval in four copies I = to be submitted for information in duplicate Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.		

2 Cargo pump rooms

2.1 Machinery driven by shafting passing through pump room bulkheads

2.1.1 *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.3.7

a) Bulkhead or deck penetrations of cargo pump rooms, or of pump rooms intended for runs of shafts driving pumps and/or fans, are to be provided with gas-tight sealing devices to the satisfaction of the Society.

b) Lubrication or other means of ensuring permanence of gas-tightness of the above-mentioned sealing devices is to be arranged in such a way that it can be checked from outside the cargo pump room.

3 Fuel tanks in cargo area

3.1 Definition

3.1.1 *(1/6/2021)*

Cargo tank block is the part of the ship as indicated in Fig 1 extending from the aft bulkhead of the aftmost cargo or slop tank to the forward bulkhead of the forward most cargo or slop tank, extending to the full depth and beam of the ship, but not including the area above the deck of the cargo or slop tank.

3.2 Location of fuel tanks in cargo area

3.2.1 *(1/6/2021)*

a) These requirements apply to chemical tankers carrying toxic (see Note 1) liquid cargoes.

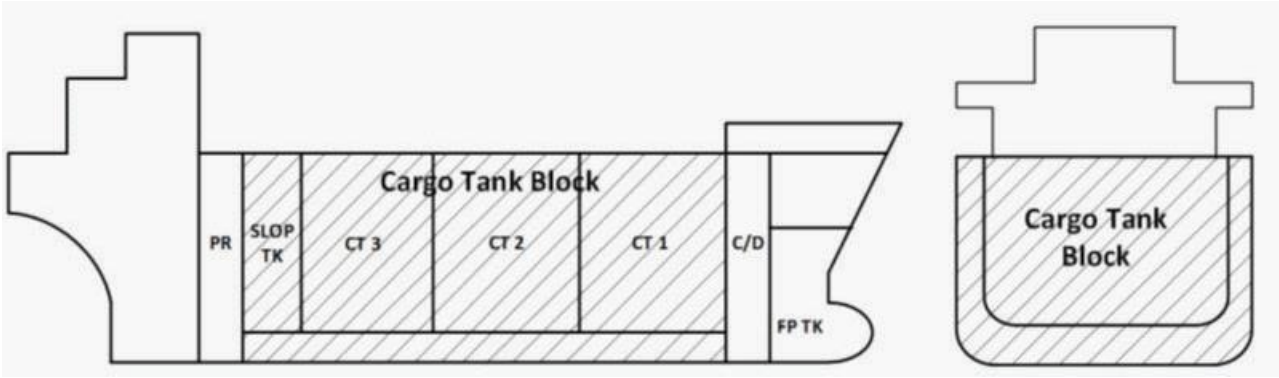
b) Fuel tanks located with a common boundary to cargo or slop tanks shall not be situated within nor extend partly into the cargo tank block. Such tanks may, however, be situated aft and/or forward of the cargo tank block.

c) They may be accepted when located as independent tanks on open deck in the cargo area subject to spill and fire safety considerations.

d) The arrangement of independent fuel tanks and associated fuel piping systems, including the pumps, can be as for fuel tanks and associated fuel piping systems located in the machinery spaces. For electrical equipment, requirements to hazardous area classification must however be met.

Note 1: toxic liquid cargoes include those for which toxic vapour detection is specified in column "k" of the table of chapter 17 of the IBC Code.

Figure 1 *(1/6/2021)*



4 Bilge and ballast arrangements

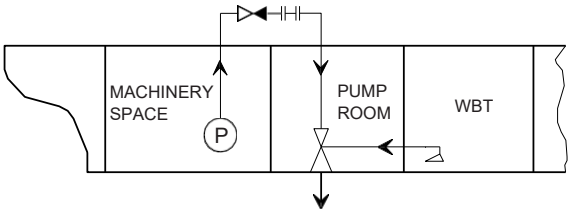
4.1 Ballast segregation

4.1.1 Eductors *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.5.1

An eductor situated in the cargo area using water power from pumps in the machinery spaces may be accepted as a means to discharge permanent ballast from tanks and/or double bottoms adjacent to cargo tanks, provided the supply line is above deck level and a non-return valve and removable spool piece are fitted in the supply line outside the machinery space (see Fig 2).

Figure 2 : Discharge arrangement *(1/6/2021)*



4.2 Ballast filling arrangement

4.2.1 Clarification *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.5.2

The filling of cargo tanks with ballast may be performed at deck level by means of pumps serving permanent ballast tanks, as specified in IBC Code 3.5.2, provided that a removable spool piece or flexible hose plus a shut-off valve are fitted on the inlet to the cargo tank. The shut-off valve is in addition to the required non-return valve. Consideration is to be given to the arrangement of the in-tank piping and the possible creation of static electricity (see Fig 2).

4.3 Bilge

4.3.1 Arrangement *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.5.3

The relaxation relevant to the bilge system for spaces which are separated from cargo tanks by a double bulkhead is to be understood as limited to spaces not enclosing piping which may contain cargo.

4.3.2 Use of cargo pumps as bilge pumps *(1/6/2021)*

IBC CODE REFERENCE : Ch 3, 3.5.3

a) Cargo pumps may also be used as bilge pumps provided they are connected to the bilge piping through a shut-off valve and a non-return valve arranged in series.

b) In the case of carriage of corrosive liquids, one of the cargo pumps, as specified in IBC Code 3.5.3, may be used for bilge service provided it is connected to the bilge piping through two shut-off valves plus a non-return valve arranged in series.

c) In cargo pump rooms of ships carrying toxic or corrosive products, suitable means for conveying spills from cargo pumps and valves to collecting trays are to be fitted. Trays may also consist of part of the pump room bottom, suitably bounded and protected against the corrosive action of products. Spills may be disposed of by means of suitable pumps or eductors. In the case of carriage of mutually incompatible products, the above-mentioned means for collecting and disposing of spills are to be different and separated from each other.

5 Piping systems other than cargo piping system

5.1 General

5.1.1 Materials *(1/6/2021)*

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

5.1.2 Independence of piping systems *(1/6/2021)*

Fuel oil systems are to:

- be independent from the cargo piping system
- have no connections with pipelines serving cargo or slop tanks.

5.1.3 Passage through cargo tanks and slop tanks *(1/1/2025)*

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted, ballast pipes passing through cargo tanks are to fulfil the following provisions:

- they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
- they are to be of extra-reinforced wall thickness as per Pt C, Ch 1, Sec 10, Tab5
- they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

5.2 Bilge system

5.2.1 Draining of spaces located outside the cargo area *(1/6/2021)*

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 10, [6].

5.2.2 Draining of pump rooms *(1/6/2021)*

a) Arrangements are to be provided to drain the pump rooms by means of power pumps or bilge ejectors.

Note 1: On units of less than 500 gross tonnage, the pump rooms may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

b) Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:

- a screw-down non-return valve is fitted on the bilge suctions, and

c) Bilge pipe internal diameter is not to be less than 50 mm.

d) High liquid level in the bilges is to activate an audible and visual alarm in the cargo control room and on the navigation bridge.

5.2.3 Drainage of hold spaces, cofferdams and void spaces located within the cargo area *(1/6/2021)*

Hold spaces, cofferdams and void spaces located within the cargo area and not intended to be filled with water ballast are to be fitted with suitable means of drainage.

5.3 Ballast system

5.3.1 General *(1/6/2021)*

a) Every unit is to be provided with segregated ballast tanks

b) The capacity of the segregated ballast tanks is to be considered by the Society on a case-by-case basis. In general, the capacity of segregated ballast tanks is to be at least such that, in any ballast condition at any part of the voyage, including the conditions consisting of lightweight plus segregated ballast only, the ship's draught and trim satisfy minimum and maximum values deemed reasonable by the Society

c) Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo and fuel oil systems

d) In the unit of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

5.3.2 Pumping arrangements for ballast tanks within the cargo area *(1/6/2021)*

Segregated ballast tanks located within the cargo area are to be served by two different means. At least one of these means is to be a pump or an eductor used exclusively for dealing with ballast.

The ballast system serving the spaces located outside the cargo area may be used for this purpose.

5.3.3 Emergency discharge of segregated ballast *(1/6/2021)*

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of chemical products to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

5.3.4 Carriage of ballast water in cargo tanks *(1/6/2021)*

a) Provisions are to be made for filling cargo tanks with sea water, where permitted. Such ballast water is to be processed and discharged as per [4.2.1] and [6.3.8].

b) The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

c) Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges.

d) Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

5.3.5 Ballast pipes passing through tanks *(1/1/2025)*

a) In the ship of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with [5.1.3] b).

b) Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

5.3.6 Integrated cargo and ballast system *(1/6/2021)*

The requirements for integrated cargo and ballast systems are given in Ch 7, Sec 4, [3.5].

5.4 Scupper pipes

5.4.1 *(1/6/2021)*

Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt C, Ch 1, Sec 10, Tab 22, column 1.

5.5 Cargo temperature control

5.5.1 Cargo heating and cooling systems *(1/6/2021)*

a) Cargo temperature control systems

IBC CODE REFERENCE : Ch 7, 7.1.1

Wherever a particular temperature (higher or lower than the ambient temperature) is required to be maintained for the preservation of the cargo, one of the following systems is to be adopted:

1) thermally insulated tanks capable of maintaining the temperature of the cargo within acceptable limits for the time of the voyage.
2) a heating or cooling plant or refrigerating plant.
3) a combination of 1) and 2) above.

b) Additional requirements for heating and cooling plants

IBC CODE REFERENCE : Ch 7, 7.1.1

1) Manifolds for the delivery and backflow of heating media are to be fitted on the weather deck; connections to cargo tanks for inlet and outlet are to be in way of the cargo tank top.
2) Where the heat exchanger room is located in the accommodation area and considered as gas-safe, it is to be treated as a machinery space (not a category A machinery space) and provided with independent mechanical extraction ventilation as well as with scuppers discharging directly into the machinery space.
3) The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

c) Reference temperature

IBC CODE REFERENCE : Ch 7, 7.1.1

Wherever the cargo temperature is maintained by a heating or refrigerating plant, unless otherwise indicated in the contract specification, the system is to be designed taking into account the reference temperatures indicated in Tab 2.

Table 2 *(1/6/2021)*

Reference temperature (°C)		
	Heating system	Cooling system
Sea	0	32
Air	5	45

d) Redundancy

IBC CODE REFERENCE : Ch 7, 7.1.1

Wherever the heating or cooling system is essential for the preservation of the cargo, the following components are to be duplicated:

1) heating or cooling sources; in cargo heating systems, the Society may permit only one fired boiler capable of supplying the requested heating capacity to be installed, provided that sufficient spares for the burner and relevant auxiliaries are carried on board to enable any failure of the burner to be rectified by the ship's crew
2) circulating pumps for cargo and heating or cooling media; if suitable for the use, cargo pumps may be employed for the circulation of the heating or cooling media
3) refrigeration plant.

5.5.2 Valves and other fittings *(1/6/2021)*

a) Means for purging

IBC CODE REFERENCE : Ch 7, 7.1.3

Cargo heating or cooling systems are to be fitted with the necessary connections to purge, by inert gas or compressed air, the heating or cooling circuit of each cargo tank and to perform the pressure testing of the system.

5.5.3 Cargo temperature measuring system *(1/6/2021)*

a) Alarm

IBC CODE REFERENCE : Ch 7, 7.1.5

1) An alarm system is required for those products which are carried in a heated condition (see paragraph 15.13.6 of the IBC Code) and for which, in column "o" of the tables in Chapter 17 of the IBC Code, reference is made to the requirements of paragraph 15.13 of the IBC Code.
2) An alarm system is required for those products for which a carrying temperature not greater than certain limits is required by Chapter 15 of the IBC Code, such as elementary phosphorus and molten sulphur.
3) An alarm connection to the navigating bridge and to the cargo control station, if fitted, is to be provided.

5.5.4 Requirements for special products *(1/6/2021)*

a) Products which may damage the cargo heating or cooling system

IBC CODE REFERENCE : Ch 7, 7.1.6

1) The provisions of paragraph 7.1.6 of the IBC Code also apply to products which may damage the cargo heating or cooling system.

2) If the sampling equipment mentioned in paragraph 7.1.6.3 of the IBC Code consists of an observation tank for drains, this tank is generally to comply with the following requirements:

- it is to be located in the cargo area and provided with an air pipe with the end fitted with a flame screen, as per the Rules, and arranged at not less than 3 m from openings of accommodation spaces and from sources of ignition
- it is to be fitted with a connection for discharge into the slop tanks with associated shut-off valves and sight glass and equipped with a sampling cock for backflowing medium analysis.

6 Cargo pumping and piping systems

6.1 General

6.1.1 *(1/6/2021)*

A complete system of pumps and piping is to be fitted for handling the cargo.

6.1.2 *(1/6/2021)*

Except where expressly permitted, and namely for the bow and stern cargo loading and unloading stations, this system is not to extend outside the cargo area and is to be independent of any other piping system on board.

6.2 Cargo pumping system

6.2.1 Number and location of cargo pumps *(1/6/2021)*

a) Each cargo tank is to be served by at least two separate fixed means of discharging and stripping. However, for tanks fitted with an individual submerged pump, the second means may be portable.

b) Cargo pumps are to be located:

- in a dedicated pump room, or
- on deck, or
- when designed for this purpose, within the cargo tanks.

6.2.2 Use of cargo pumps *(1/6/2021)*

a) Except where expressly permitted in [5.2] and [5.3], cargo pumps are to be used exclusively for handling the liquid cargo and are not to have any connections to compartments other than cargo tanks.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

6.2.3 Cargo pumps drive *(1/6/2021)*

a) Prime movers of cargo pumps are not to be located in the cargo area, except in the following cases:

- steam driven machine supplied with steam having a temperature not exceeding 220 °C
- hydraulic motors
- electric motors of certified type.

b) Pumps with a submerged electric motor are not permitted in cargo tanks.

c) Where cargo pumps are driven by a machine which is located outside the cargo pump room, the following arrangements are to be made:

1) drive shafts are to be fitted with flexible couplings or other means suitable to compensate for any misalignment;

2) the shaft bulkhead or deck penetration is to be fitted with a gas-tight gland of a type approved by the Society. The gland is to be efficiently lubricated from outside the pump room and so designed as to prevent overheating. The seal parts of the gland are to be of material that cannot initiate sparks;

3) temperature sensing devices are to be fitted for bulkhead shaft gland bearings; see [6.2.5].

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

6.2.4 Design of cargo pumps *(1/6/2021)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

c) Pump casings are to be fitted with temperature sensing devices; see [6.2.5].

6.2.5 Monitoring of cargo pumps *(1/6/2021)*

Cargo pumps are to be monitored as required in Tab 3.

6.2.6 Control of cargo pumps *(1/6/2021)*

Cargo pumps are to be capable of being stopped from:

- a position outside the pump room, and
- a position next to the pumps.

Table 3 : Monitoring of cargo pumps *(1/6/2021)*

Equipment, parameter	Alarm **(1)**	Indication **(2)**	Comments
pump, discharge pressure		L	• on the pump **(3)**, or • next to the unloading control station
pump casing, temperature	H		visual and audible, in cargo control room or pump control station
bulkhead shaft gland bearing, temperature	H		visual and audible, in cargo control room or pump control station
(1) H = high **(2)** L = low **(3)** and next to the driving machine if located in a separate compartment			

6.3 Cargo transfer

6.3.1 Piping scantlings *(1/6/2021)*

a) Pipe wall thickness calculation

1) Piping subjected to green seas

IBC CODE REFERENCE : Ch 5, 5.1.1

For piping subjected to green seas, the design pressure P, in bar, in the formula in paragraph 5.1.1 of the IBC Code is to be replaced by an equivalent pressure P' given by the following formula:

$$P' = \frac{1}{2}\left(P + \sqrt{P^2 + 0{,}006R'K\frac{D_C}{D}}\right)$$

where:

D_C : External diameter of the pipe taking into account the insulation (in mm), whose thickness is to be taken at least equal to:

40 mm if $D \leq 50$ mm

80 mm if $D \geq 150$ mm

Intermediate values are to be determined by interpolation.

R' : Drag corresponding to the effect of green seas, in da N/m^2, such as given in Tab 4 as a function of the location of the pipes and of their height H (in m) above the deepest loadline; intermediate values are to be determined by interpolation.

K : permissible stress, in N/mm^2

b) Corrosion allowance

IBC CODE REFERENCE : Ch 5, 5.1.1

The coefficient c (added corrosion thickness) for the formula in paragraph 5.1.1 of the IBC Code is normally to be equal to at least 3 mm. The Society may accept a lesser value for pipes made of austenitic or austenitic-ferritic stainless steel, pipes with internal lining or, if applicable, pipes with acceptable external protective lining or painting.

6.3.2 Piping fabrication and joining details *(1/6/2021)*

a) Pipes not required to be joined by welding

1) IBC CODE REFERENCE : Ch 5, 5.2.2

Cargo piping is to be welded except for necessary flanged connections to valves, expansion joints (as permitted in paragraph 5.2.2.1 of the IBC Code), spool pieces and similar fittings or where required for coating, lining, fabrication, inspection or maintenance.

2) Flanged connections

IBC CODE REFERENCE: Ch 5, 5.3.1

Flange types A and B in Pt C, Ch 1, Sec 10, Fig 1 are acceptable in piping systems with design pressure p > 1,6 MPa.

Flange types A, B, C1, C2 and C3 are acceptable in piping systems with design pressure p ≤ 1,6 MPa.

The type of flanges on open-ended cargo piping or cargo piping placed inside cargo tanks may be considered by the Society on a case-by-case basis.

b) Expansion joints

IBC CODE REFERENCE : Ch 5, 5.2.4

The use of bellows is not permitted for corrosive and polymerising products, except if provision is made to prevent stagnation of liquids.

c) Non-destructive testing of welding

1) IBC CODE REFERENCE : Ch 5, 5.2.5

- Butt welded pipes and accessories are to be radiographic at random and entirely checked by means of a dye-penetrant test or an equivalent method.
- radiographic examinations are to cover at least 10% of the connections and may be extended, at the request of the Surveyor depending on the results of the inspection.
- Relaxation of the above requirements may be considered by the Society on a case-by-case basis for pipes welded at workshops. However, this only applies to ships exclusively intended to carry cargoes with minor fire risk.

d) Certification, inspection and testing of piping system

Pipes, valves, fittings and other components are to be tested according to Tab 5.

Table 4 *(1/6/2021)*

External diameter of pipe **(1)**	Aft of the quarter of the ship's length			Forward of the quarter of the ship's length		
	H≤8	H=13	H≥18	H≤8	H=13	H≥18
≤25	1500	250	150	2200	350	150
50	1400	250	150	2000	350	150
75	1100	250	150	1600	350	150
100	700	250	150	700	350	150
≥150	500	250	150	700	350	150
(1) D_C if the pipe is insulated, D otherwise.						

Table 5 *(1/6/2021)*

No.	Item	Tests for materials **(1)**		Inspections and tests for the products **(1)**		
		Tests required	Type of material certificate **(2) (3)**	During manufacturing (NDT)	After completion	Type of product certificate **(2)**
1	pipes, flanges and fittings	X	C **(4)**		X	C
2	valves	X	C **(4)**	X **(5)**	X	C
3	pumps	X	W		X	C
4	cargo tank P/V and high velocity valves	X	C	X	X	C

(1) X = test required.
(2) C = class certificate, W = works' certificate.
(3) W is requested for pipes of open-ended piping and piping within cargo tanks.
(4) W is accepted for d < 100 mm
(5) if of welded construction

6.3.3 Materials *(1/6/2021)*

a) Cargo piping is, in general, to be made of steel or cast iron.

b) Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.

c) Spheroidal graphite cast iron may be used for cargo oil piping.

d) Grey cast iron may be accepted for cargo oil lines:
- within cargo tanks, and
- on the weather deck for pressure up to 1,6 Mpa.

It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.

e) Plastic pipes may be used in the conditions specified in Pt C, Ch 1, App 3. Arrangements are to be made to avoid the generation of static electricity.

6.3.4 Piping arrangements *(1/6/2021)*

a) Arrangement of cargo piping

1) Arrangement of cargo piping under deck

IBC CODE REFERENCE : Ch 5, 5.5.2

The intent of the provisions in paragraph 5.5.2 of the IBC Code is to preclude the hazard of cargo leaking past a shut-off valve gland into the space where the valve is located.

2) Arrangement of cargo piping on deck

IBC CODE REFERENCE : Ch 5, 5.5.2

Cargo piping on cargo tanks is to be extended down to the bottom of each tank.

3) Aluminised pipes

IBC CODE REFERENCE : Ch 5, 5.5

Aluminised pipes may be permitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

4) Cargo pipes passing through tanks or compartments
- Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [5.1.3], item b).
- Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [5.1.3], item b) are complied with.

5) Cargo piping passing through bulkheads

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

6) Valves
- Stop valves are to be provided to isolate each tank.
- A stop valve is to be fitted at each end of the cargo manifold.

- When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.
- Main cargo valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

b) Removable piping systems

IBC CODE REFERENCE : Ch 5, 5.5

Pumps, piping and associated fittings are to constitute a permanently fitted system; in general, removable parts are not allowed, except for specific cases for which it can be proved, to the satisfaction of the Society, that no effective alternative solutions are available. In such circumstances, the safety measures deemed necessary will be considered by the Society on a case-by-case basis.

6.3.5 Cargo transfer control systems *(1/6/2021)*

a) General

IBC CODE REFERENCE : Ch 5, 5.6.1

- One blank flange is to be provided in addition to the stop valve required in paragraph 5.6.1.2 of the IBC Code at each cargo hose connection.
- The requirements of paragraph 5.6.1 of the IBC Code are not intended to be additional to those for piping below deck in 5.5.2 and 5.5.3 of the IBC Code.

b) Control, monitoring and alarm devices and cargo control room

IBC CODE REFERENCE : Ch 5, 5.6

a) The cargo pump control is to be fitted in a position which is readily accessible, even in the event that the cargo piping or hoses break. This position is to be clearly indicated.

b) Where a cargo control room is fitted, the following controls, monitoring and alarms are to be connected to this room:

- cargo pump control
- control of loading/unloading valves
- level gauges
- temperature indicators
- high level alarms
- very high level alarms
- high/low temperature alarms
- high/low pressure alarms
- fixed gas detecting system alarms.

c) In general, high/low temperature alarms are also to be transduced to the navigating bridge.

d) The cargo control room is to be located above the weather deck and may be considered as a dangerous space or a safe space, depending on its location and on the possible presence of a product or of its vapours. If it is considered a dangerous space, it is to be provided with a ventilation system capable of supplying at least 20 air changes per hour, it is not to be located in the accommodation area and only safe type electrical equipment is allowed.

e) A cargo control room without cargo pump and valve control is defined as a "cargo control station".

6.3.6 Ship's cargo hoses *(1/6/2021)*

a) Compatibility

1) Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

2) Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 4 times the maximum pressure under cargo transfer conditions.

3) The ohmic electrical resistance of cargo hoses is not to exceed $10^6\ \Omega$.

IBC CODE REFERENCE : Ch 5, 5.7.1

The requirement of paragraph 5.7.1 of the IBC Code applies to cargo hoses carried on board the vessel and "compatibility with the cargo" means that:

a) the cargo hose does not lose its mechanical strength or deteriorate unduly when in contact with the cargo, and

b) the cargo hose material does not affect the cargo in a hazardous way.

Consideration is to be given to internal and external surfaces with respect to the above where hoses may be used as an integral part of, or connected to, emergency cargo pumps and submerged in the cargo tank.

6.3.7 Bonding *(1/6/2021)*

a) Static electricity

1) Acceptable resistance

IBC CODE REFERENCE : Ch 10, 10.3

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than 10^6 Ω.

2) Bonding straps

IBC CODE REFERENCE : Ch 10, 10.3

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

d) wafer-style valves with non-conductive (e.g. PTFE) gaskets or seals.

Where bonding straps are required, they are to be:

- clearly visible so that any shortcoming can be clearly detected
- designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint
- easy to install and replace.

6.3.8 Discharge of contaminated water *(1/6/2021)*

a) Location of discharge outlet

- For discharge of cargo contaminated water, an outlet located below the waterline in vicinity of the turn of the bilge, shall be arranged within the cargo area.
- The outlet(s) shall be located such that the cargo contaminated discharges will not enter the ship's seawater intakes.

b) Sizing of the discharge outlet

The internal diameter of the outlet shall not be less than:

D = QD / 5L

where: QD = discharge rate [m^3/h]

L = distance of outlet from forward perpendicular [m].

In the case of angled outlets, only the velocity component of the discharge perpendicular to the ship's shell plating shall be considered when determining QD.

The discharge rate assumed as the basis for outlet(s) sizing shall not be less than the aggregate throughput of the washing machines in anyone tank.

7 Cargo tanks and fittings

7.1 Application

7.1.1 *(1/6/2021)*

The provisions of this paragraph apply to cargo tanks and slop tanks.

7.2 Cargo tank venting

7.2.1 Large amounts of drainage *(1/6/2021)*

IBC CODE REFERENCE: Ch 8, 8.2.2

When large amounts of drainage from vent lines of the cargo tanks are envisaged, a hose connection to the drain line of the slop tank is to be provided.

7.2.2 Position of vent outlets from tanks intended for flammable and toxic products *(1/6/2021)*

IBC CODE REFERENCE: Ch 8, 8.3.3

Vent outlets of cargo tanks intended for the carriage of flammable or toxic products are to be arranged at a distance of not less than 3 m from exhaust ducts and as far as possible from inlet ducts to pump rooms and cargo pump rooms.

7.3 Cargo tank gas freeing

7.3.1 Fans *(1/6/2021)*

IBC CODE REFERENCE : Ch 8, 8.5

a) The impellers and housing of either fixed or portable fans fitted in dangerous spaces are to be of non-sparking materials according to paragraph 12.1.8 of the IBC Code.

b) In the case of fans installed in safe spaces, two non-return devices are to be fitted to avoid return of flammable and/or toxic cargo vapours to safe spaces when the ventilation system is shut down. These non-return devices are to operate in all normal conditions of ship trim and list.

7.4 Environmental control

7.4.1 Control by inerting or padding *(1/6/2021)*

IBC CODE REFERENCE : Ch 9, 9.1.3

The padding medium is to be compatible from the point of view of safety with the products to be carried, it is not to react with them and with air and it is to have chemical and physical properties deemed suitable by the Society. The system is to comply with the requirements for inert gas systems, as applicable.

7.4.2 Control by drying *(1/6/2021)*

IBC CODE REFERENCE : Ch 9, 9.1.4

In the case of simultaneous carriage of mutually incompatible products, dry gas supply piping systems to each cargo space are to be separate from each other.

7.4.3 Special requirements for inert gas systems on barge-chemical *(1/6/2021)*

a) Applicability

IBC CODE REFERENCE : Ch 9, 9.1

Pt C, Ch 4, Sec 1, [8.2] applies.

b) Simultaneous carriage of incompatible products

IBC CODE REFERENCE : Ch 9, 9.1

The inert gas system is to comply with the requirements of paragraph 9.1.5.1 of the IBC Code, adapted, to the satisfaction of the Society, to the individual characteristics of the products to be carried. In the case of simultaneous carriage of mutually incompatible products, inert gas supply piping systems to each cargo space are to be separate from each other.

c) Ships with no fixed inert gas system

IBC CODE REFERENCE : Ch 9, 9.1

Where no fixed installation for inert gas and/or dry gas production is provided for on board, the minimum quantity to be kept on board is established by the Master, based on the duration of the voyage, the anticipated daily temperature variations, gas leakage through cargo tank seals and experience of previous similar cases.

d) Additional requirements

IBC CODE REFERENCE : Ch 9, 9.1

1) These requirements apply where an inert gas system based on oil fired inert gas generators is fitted on board chemical tankers. Any proposal to use other sources of inert gas will be specially considered.

2) In addition to the provisions in paragraph 9.1.5.1 of the IBC Code, the inert gas system is to comply with the requirements of IMO Resolution A.567(14). Any use of the word "Administration" in the Resolution is to be considered as meaning the Society.

3) As an alternative to the water seal in the inert gas line on deck, an arrangement consisting of two shut-off valves in series with a venting valve in between may be accepted. The following conditions apply:

- The operation of the valve is to be automatically executed. Signals for opening/closing are to be taken from the process directly, e.g. inert gas flow or differential pressure.

- An alarm for faulty operation of the valves is to be provided, e.g. the operation status of "blower stop" and "supply valve(s) open" is an alarm condition.

4) In addition to the requirements detailed in Resolution A.567(14), the followings are to be complied with:
   - Plans in diagrammatic form are to be submitted for appraisal and are to include the following:
     - details and arrangement of inert gas generating plant including all control monitoring devices
     - arrangement of piping system for distribution of the inert gas.
   - In all cases, automatic combustion control, capable of producing suitable inert gas under all service conditions, is to be fitted.
   - When two blowers are provided, the total required capacity of the inert gas system is preferably to be divided equally between the two and in no case is one blower to have a capacity less than 1/3 of the total required.
   - Materials used in inert gas systems are to be suitable for their intended purpose in accordance with the Rules. In particular those parts of scrubbers, blowers, non-return devices, scrubber effluent and other drain pipes which may be subjected to corrosive action of the gases and/or liquids are to be either constructed of corrosion-resistant material or lined with rubber, glass fibre, epoxy resin or other equivalent coating material.
   - A compartment in which any oil fired inert gas generator is situated is to be treated as a machinery space of category A in respect of fire protection.
   - All of the equipment is to be installed on board and tried under working conditions to the satisfaction of the Surveyor.

7.4.4 Ventilation *(1/6/2021)*

IBC CODE REFERENCE : Ch 9, 9.1

When a cargo space ventilation system other than the venting system mentioned under paragraph 8.2 of the IBC Code is required by these provisions, such system is to comply with the requirements established by the Society in each case.

7.4.5 Mechanical ventilation in the cargo *(1/6/2021)*

a) Spaces normally entered during cargo handling operations

1) Miscellaneous requirements
   - Ventilation system stopping

     IBC CODE REFERENCE : Ch 12, 12.1

     All required ventilation systems are to be capable of being stopped from a position located outside the served spaces and above the weather deck.
   - Warning notices

     IBC CODE REFERENCE : Ch 12, 12.1

     In the proximity of entrances to all spaces served by the required mechanical ventilation systems, a clearly visible warning is to be posted requiring such spaces to be adequately ventilated prior to entering and relevant ventilation systems to be kept in operation all the time persons are present in the spaces themselves.
   - Prevention of dangerous operation of electric Motors

     IBC CODE REFERENCE : Ch 12, 12.1

     A suitable automatic device is to be fitted to prevent operation of electric motors driving cargo pumps and operation of other electrical equipment not of a certified safe type prior to ventilating the spaces where such motors or equipment are located, in order to render them gas-safe (to this end it is pointed out that IEC provisions require at least 10 changes of air based on the volume of the served space).
   - Prevention of dangerous operation of cargo pumps

     IBC CODE REFERENCE : Ch 12, 12.1

     An automatic device is to be fitted capable of stopping motors driving cargo pumps and de-energising any other electrical equipment not of a certified safe type in the case of stoppage of ventilation in spaces where such motors and equipment are fitted. This provisions does not apply to motors and other electrical equipment fitted in the engine room.
   - Alternative to extraction type ventilation systems

     IBC CODE REFERENCE : Ch 12, 12.1

     As an alternative to ventilation systems of the extraction type, required in a)1) bullet 4), a ventilation system of the positive pressure type may be accepted:
     - in the case of cargo pump rooms adjacent to cargo tanks or to other gas-dangerous spaces, or

- where, in adjacent gas-safe spaces, inclusive of spaces containing motors of cargo pumps, an adequate over-pressure is kept in relation to the cargo pump rooms themselves.

• Location of upper end of inlet ducts

IBC CODE REFERENCE : Ch 12, 12.1

With reference to the requirements of a)1) bullet 5), the upper ends of inlet ducts are generally to be located at a distance not less than 3 m from ventilation ducts and air intakes serving the safe spaces mentioned therein.

• Minimum distance between inlet and extraction ducts

IBC CODE REFERENCE : Ch 12, 12.1

With reference to 12.1.6 of IBC Code, the upper ends of (inlet and extraction) ventilation ducts serving the same space are to be located at a distance from each other, measured horizontally, of not less than 3 m and, in general, at an adequate height above the weather deck, but in any case not less than 2,4 m. Greater heights are required in paragraph 15.17 of the IBC Code.

• Upper ends of ventilation ducts in ships carrying materials producing flammable

IBC CODE REFERENCE : Ch 12, 12.1

For flammable products, or for products which may react with the ship's materials producing flammable vapours (such as strong acids), the upper ends of ventilation ducts are to be located at a distance of not less than 3 m from any source of ignition, as per the provisions of Ch 8, Sec 8, [2.1].

• Dampers

IBC CODE REFERENCE : Ch 12, 12.1

Ventilation ducts are to be provided with metallic dampers, fitted with the indication "open" and "closed". The dampers are to be located above the weather deck, in a readily accessible position.

• Location of electric motors of fans

IBC CODE REFERENCE : Ch 12,12.1

Electric motors driving fans are to be placed outside the served spaces and outside the ventilation ducts, in a suitable position with respect to the presence of flammable vapours.

• Penetration of motor shafts through bulkheads

IBC CODE REFERENCE : Ch 12, 12.1

Runs of shafts of electric motors driving fans through bulkheads or decks of gas-dangerous spaces or through ventilation ducts are to be provided with gas-tight seals, with oil glands or equivalent means, deemed suitable by the Society.

2) Additional requirements for non-sparking fans

• Non-sparking fans

IBC CODE REFERENCE : Ch 12, 12.1

- A fan is considered as non-sparking if in both normal and abnormal conditions it is unlikely to produce sparks.
- The air gap between the impeller and the casing is to be not less than 0,1 of the shaft diameter in way of the impeller bearing and not less than 2 mm. It need not be more than 13 mm.

• Materials for non-sparking fans

IBC CODE REFERENCE : Ch 12, 12.1

- The impeller and the housing in way of the impeller are to be made of alloys which are recognised as being spark proof by appropriate tests.
- Electrostatic charges in both the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation on board of the ventilation units is to be such as to ensure their safe bonding to the hull.
- Tests may not be required for fans having the following combinations:
  - impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity
  - impellers and housings of non-ferrous materials
  - impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous materials is fitted in way of the impeller
  - any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm design tip clearance.

- The following impellers and housings are considered as sparking and are not permitted:
  - impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance
  - housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
  - any combination of ferrous impeller and housing with less than 13 mm design tip clearance.
- Type test for non-sparking fans

  IBC CODE REFERENCE : Ch 12, 12.1

  Type tests on the finished product are to be carried out in accordance with the requirements of the Society or an equivalent national or international standard.

b) Pump rooms and other enclosed spaces normally entered

1) Clarification of general requirement

IBC CODE REFERENCE : Ch 12, 12.2

- The arrangements for the ventilation system of spaces to which paragraph 12.2 of the IBC Code applies are to comply, in general, with the provisions set out in the previous item a), as applicable.
- The provisions of paragraph 12.2 of the IBC Code apply to all pump rooms, whether or not the control for pumps and valves which are installed in such rooms is fitted externally.
- The distance of the upper ends of extraction and inlet ducts from air intakes and other openings of spaces mentioned in paragraph 12.1.5 of the IBC Code is not to be less than 3 m measured horizontally. These systems are to be capable of being controlled from outside the spaces they serve and, in the proximity of the entrances to such spaces, the warning notice mentioned in a)1)bullet 2) is to be posted.

c) Spaces not normally entered

1) Portable fans

IBC CODE REFERENCE : Ch 12, 12.3

- The type of portable fans and their connections to spaces to be ventilated are to be deemed suitable by the Society. Portable fans driven by electric or internal combustion motors are not acceptable.
- The arrangements for the ventilation of these spaces are to comply, in general, with the provisions set out in the previous item a), as applicable.

7.5 Instrumentation

7.5.1 Gauging *(1/6/2021)*

a) Types of gauging devices

1) Arrangement

IBC CODE REFERENCE : Ch 13, 13.1.1

- In almost all cases a cargo code which requires a high level alarm and overflow control also requires a closed gauging device. A cargo tank containing such a product therefore requires three sensors:

  I) one level gauging

  II) one high level alarm

  III) one overflow control
- The sensing elements for I), II) and III) are to be separated, although sensors for II) and III) (reed switches, float chambers, electronic devices, etc.) may be contained in the same tube.
- Electronic, pneumatic and hydraulic circuits required for sensors I), II) and III) are to be independent of each other such that a fault on any one will not render either of the others inoperative.
- Where processing units are used to give digital or visual indication, such as in a bridge space, the independence ofcircuitry is to be maintained at least beyond this point.
- The power is to be supplied from distribution boards.
- Where a control room or a bridge space containing a modular unit is envisaged, separate level indication and visual alarms are to be provided for each of the functions I), II) and III). An audible alarm is also to be provided but since this is not directional it need not be separate.
- An audible alarm is also to be arranged in the cargo area
- Where there is no control room, an audible and visual alarm is to be arranged at the cargo control station.
- Testing of sensors is to be arranged from outside the tanks, although entry into product clean tanks is not precluded.

- Simulation testing of electronic circuits or circuits which are self-monitored is acceptable.

2) Example of restricted gauging device

IBC CODE REFERENCE : Ch 13, 13.1.1

A restricted gauging device may consist of a sounding pipe with an inside diameter not greater than 200 mm, fitted with a gastight plug. The pipe is to have holes in order to make its internal pressure equal to that of the tank. Therefore the holes are to be located inside the cargo tank in the proximity of the top.

7.5.2 Vapour detection *(1/6/2021)*

a) Vapour detection instruments

1) Spaces to be monitored

IBC CODE REFERENCE : Ch 13, 13.2.1

Vapour detection instruments, either fixed or portable, are to be of a type recognised suitable by the Society for the products to be carried. The spaces to be monitored are:

- cargo pump rooms
- spaces containing motors driving cargo pumps, except for the machinery space
- enclosed spaces containing cargo piping, equipment connected with cargo handling, cofferdams, enclosed spaces and double bottoms adjacent to cargo tanks
- pipe tunnels
- other spaces, in the opinion of the Society, depending on the ship type.

Where a fixed system is installed, it is to serve the spaces among those listed above which are normally entered by the crew.

b) Gas Measurements

The fitting of gas measuring equipment is subject to the pro visions of Pt C, Ch 4, Sec 1, [5.2.4] b)1).

7.6 Tank washing systems

7.6.1 General *(1/6/2021)*

Adequate means are to be provided for cleaning the cargo tanks.

7.6.2 Washing machines *(1/6/2021)*

a) Tank washing machines are to be of a type approved by the Society.

b) Washing machines are to be made of steel or other electricity conducting materials with a limited propensity to produce sparks on contact.

7.6.3 Washing pipes *(1/6/2021)*

Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 10, depending on the kind of washing fluid.

7.6.4 Installation of washing systems *(1/6/2021)*

a) Tank cleaning openings are not to be arranged in enclosed spaces.

b) The complete installation is to be permanently earthed to the hull.

8 Certification, inspection and testing of piping systems

8.1 Application

8.1.1 *(1/6/2021)*

The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt C, Ch 1, Sec 10, [21] for piping systems other than cargo piping and [6.3.2] d) for cargo piping.

8.2 Workshop tests

8.2.1 Tests for materials *(1/6/2021)*

Where required in Tab 5, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt C, Ch 1, Sec 10, [21.3.2].

8.2.2 Hydrostatic testing *(1/6/2021)*

a) Where required in Tab 5, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

c) Where fitted, bellow pieces of gastight penetration glands are to be pressure tested.

8.2.3 Tightness tests *(1/6/2021)*

Tightness of the following devices is to be checked:

- gastight penetration glands
- cargo tank P/V and high velocity valves.

Note 1: These tests may be carried out in the workshops or on board.

8.2.4 Check of the safety valves setting *(1/6/2021)*

The setting pressure of the pressure/vacuum valves is to be checked in particular with regard to Sec 4, [2.3.7].

8.3 Shipboard tests

8.3.1 Pressure test *(1/6/2021)*

After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

9 Special Requirements

9.1 Ammonium nitrate solution (93%or less)

9.1.1 Ammonia injection procedure *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.2.6

Gaseous ammonia may be injected into the cargo while the latter is circulated by the cargo pump.

9.1.2 Cargo pumps seal *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.2.7

The seal for the centrifugal pump is to be a stuffing box provided with a lantern ring. Fresh water under pressure is to be injected into the stuffing box at the location of the lantern ring (see Fig 3).

9.2 Hydrogen peroxide solutions

9.2.1 Hydrogen peroxide solutions over 60% but not over 70% - Water spray system *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.5.10

It is specified that, for the purpose of evaluating the estimated size of the cargo spill in the case of failure, cargo piping/hose failure is to be assumed to be total.

9.3 Propylene oxide and mixtures of ethylene oxide/propylene oxide with an ethylene oxide content of not more than 30% by mass

9.3.1 Tank cleaning *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.8.3

Until an amendment in this respect is prepared at IMO, it is specified that the initial wording of the text of paragraph 15.8.3 of the IBC Code "Before loading, ..." is to be intended as follows: "Before initial loading of these products and before each loading of these products subsequent to loading of other products....."

9.3.2 Joints in cargo lines *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.8.12

Screwed connections are only allowed for accessory and instrumental lines with an external diameter of 25 mm or less.

9.3.3 Oxygen content in tank vapour spaces *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.8.28

Analysing equipment to determine oxygen and propylene oxide contents is to be of a type recognised as suitable by the Society. When portable analysers are used, there are to be at least two. When a fixed system is installed, a portable analyser is also to be provided.

9.3.4 Valves at cargo hose connections *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.8.30

The closing time of shut-off valves provided at each cargo hose connection is to take account of the loading/unloading rate and is to be such as to avoid dangerous overpressure in cargo piping and hoses.

9.4 Sulphur (molten)

9.4.1 Fire-fighting system *(1/6/2021)*

a) Cargo tank protection

IBC CODE REFERENCE: Ch 15, 15.10

Cargo tanks are to be protected by a fixed CO_2 extinguishing system in accordance with Part C, Chapter 4, or a steam extinguishing system. In the latter case, tank drying arrangements are to be provided to prevent corrosion after use of steam.

b) CO_2 nozzles

IBC CODE REFERENCE: Ch 15, 15.10

Under normal service conditions, CO_2 tank feed nozzles are to be blanked off by means of a breaking disk to prevent pipes from being chocked by sulphur. Nozzles are to be located at the upper part of the tank, above liquid level.

9.5 Acids

9.5.1 Lining *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.11.2

"Lining" is an acid-resistant material that is applied to the tank or piping system in a solid state with a defined elasticity property.

9.5.2 Electrical arrangements *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.11.15

In enclosed spaces adjacent to cargo tanks, electrical materials and equipment complying with the provisions of paragraph 10.1.2 of the IBC Code are allowed.

9.5.3 Leak detection system *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.11.7

There are to be at least two leak detection apparatuses designed and calibrated to detect leakage of cargo into spaces adjacent to cargo tanks. The apparatuses may consist of a pH-meter, a gas detector suitable for the detection of hydrogen/air mixtures, of a type deemed suitable by the Society, or of other suitable systems. These apparatuses may be fixed or portable; if a fixed system is installed, a portable apparatus is also to be provided.

9.6 Toxic products

9.6.1 Vapour return line to shore installation *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.12.2

The tank venting systems are to be fitted with a shut-off valve and a blank flange in way of the vapour return line to the shore installation.

9.7 Cargoes protected by additives

9.7.1 Prevention of blockage by polymerisation *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.13.6

In addition to being designed so as to avoid internal obstructions due to polymer formation, the venting systems are to be fitted with pressure/vacuum valves and devices to prevent the passage of flame which are accessible for inspection and maintenance.

9.8 Cargoes with a vapour pressure greater than 0,1013 MPa (1,013 bar) absolute at 37,8°C

9.8.1 System for maintaining cargo temperature below boiling point *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.14.1

Any system installed for the purpose of keeping the cargo temperature below its boiling point is to be constructed to the satisfaction of the Society.

9.8.2 Return of expelled gases *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.14.4

The tank venting systems are to be fitted with a shut-off valve and a blank flange in way of the vapour return line to the shore installation.

9.9 Special cargo pump room requirements

9.9.1 Clarification *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.18

As far as concerns the possibility of allowing the arrangement of cargo pump rooms below deck in specific cases, it is specified that, in practice, no circumstance can be foreseen where such an arrangement may be permitted.

9.10 Overflow control - Independence of systems

9.10.1 Gauging devices *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.19

In almost all cases where, for the carriage of a product, a cargo high level alarm or cargo overflow control is required, a closed gauging device is also required.

9.10.2 Separation of device sensing elements *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.19

A cargo tank intended to carry such a product therefore requires:

a) level gauging

b) high level alarm

c) overflow control.

The sensing elements for the devices under a), b) and c) are to be separated, although sensors for b) and c) (micro-switches, float chambers, electronic devices, etc.) may be contained in the same metal tube sections.

9.10.3 Electronic and hydraulic circuits for sensors *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.19

Electronic, pneumatic and hydraulic circuits required for sensors for a), b) and c) are to be independent of each other such that a fault on any one of them will not render either of the others inoperative. Where processing units are used to give digital or visual indication such as in a bridge space, the independence of circuitry is to be maintained at least up to such units. The power is to be supplied from distribution boards.

9.10.4 Alarms in cargo control room *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.19

Where a cargo control room or a bridge space containing a modular unit is envisaged, separate level indications and visual alarms are to be provided for each of the functions a), b) and c). An audible alarm is also to be provided; there need not be a separate alarm for each function since separate alarms could not be distinguished. An audible alarm is also to be arranged in the cargo area.

9.10.5 Alarms where cargo control room is not provided *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.19

a) Where no cargo control room is provided, an audible and visual alarm is to be arranged at the cargo control station, which generally coincides with the navigating bridge.

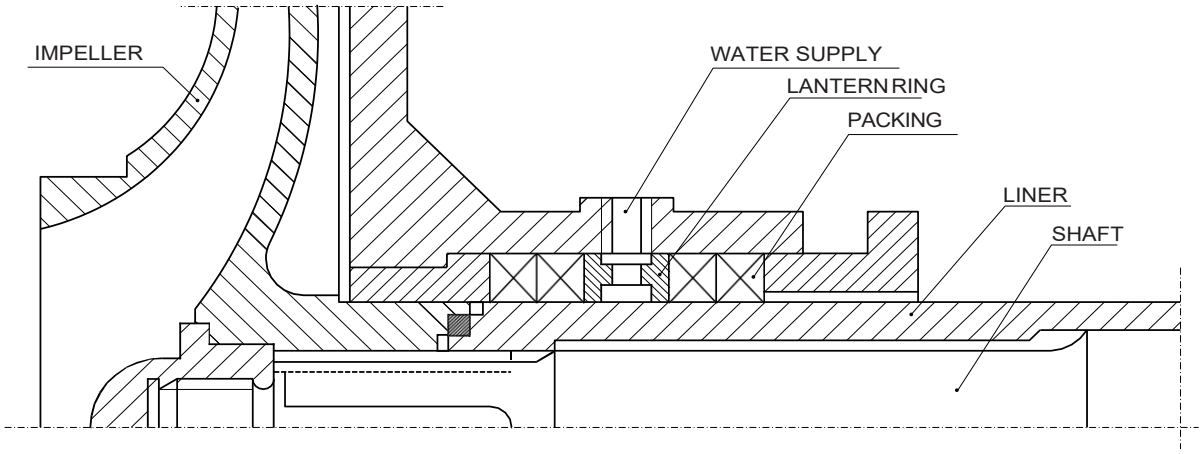
b) The audible and visual high level and cargo overflow alarms are to be located so as to be easily heard and noticed by the personnel in charge of loading/unloading operations. Attention is drawn to the fact that such alarms are generally grouped together into two independent signals; therefore it is not possible to single out directly the cargo tank from which the alarm signal is coming. In such cases, the Master is to arrange for a person to be present at the cargo control station, in order to be able to warn the personnel in charge of loading operations on deck.

9.10.6 **Testing of sensors** *(1/6/2021)*

IBC CODE REFERENCE: Ch 15, 15.19

Testing of sensors is to be arranged from outside the tanks, although entry into product clean tanks is not prohibited. Simulation testing of electronic circuits or circuits which are self-monitoring is acceptable.

Figure 3 : Seal *(1/6/2021)*



SECTION 8 ELECTRICAL INSTALLATIONS

1 Electrical installations for units with service notation "barge-oil"

1.1 Application

1.1.1 *(1/6/2021)*

The requirements in this item [1] apply, in addition to those contained in Part C, Chapter 2, to ships with the service notation **barge-oil**.

1.2 Exemptions

1.2.1 *(1/5/2013)*

The requirements in Pt C, Ch 2, Sec 3, [2.2.1] and [2.3.1] are not applicable in the case of vessels without persons on board.

1.3 Documentation to be submitted

1.3.1 *(1/5/2013)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.4 System of supply

1.4.1 *(1/5/2013)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

1.4.2 *(1/5/2013)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.4.3 *(1/5/2013)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

1.5 Electrical equipment

1.5.1 *(1/5/2013)*

Electrical equipment, cables and wiring are not to be installed in hazardous locations unless they conform with standards not inferior to those given in IEC 60092-502 Standard.

However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Society, to ensure that an equivalent level of safety is assured.

1.6 Earth detection

1.6.1 *(1/5/2013)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [1.3.1].

1.7 Precautions against inlet of gases or vapours

1.7.1 *(1/5/2013)*

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

1.8 Electrical equipment permitted in hazardous areas

1.8.1 *(1/5/2013)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5], and Pt C, Ch 2, Sec 3, [10.1.6].

1.8.2 *(1/5/2013)*

In addition to the requirements of [1.8.1], in Zone 1 and Zone 2 the installation of the following is permitted:

hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of animpressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

1.8.3 *(1/5/2013)*

The explosion group and temperature class of electrical equipment of a certified safe type are to be at least IIA and T3 in the case of ships arranged for the carriage of crude oil or other petroleum products.

Other characteristics may be required for dangerous products other than those above.

1.8.4 *(1/5/2013)*

Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

1.9 Hazardous area classification

1.9.1 *(1/6/2021)*

For hazardous area classification see:

a) Tab 1 for barge-oil carrying flammable liquids having:
   - a flash point not exceeding 60°C, or
   - a flash point exceeding 60°C, heated to a temperature above their flash point, or
   - a flash point exceeding 60°C, heated to a temperature within 15°C of their flash point;

b) Tab 2 for barge-oil carrying flammable liquids having a flash point exceeding 60°C, unheated or heated to a temperature below and not within 15°C of their flash point.

Table 1 : Classification of hazardous areas for barge-oil carrying flammable liquids having a flash point not exceeding 60°C *(1/5/2013)*

Spaces		Hazardous area
N.	Description	
1	Interior of cargo tanks, slop tanks, any pipework of pressure relief or other venting systems for cargo and slop tanks, pipes and equipment containing cargo or developing flammable gases or vapours.	Zone 0
2	Void spaces adjacent to, above or below integral cargo tanks.	Zone 1
3	Hold spaces containing independent cargo tanks.	Zone 1
4	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks.	Zone 1
5	Cargo pump rooms.	Zone 1
6	Enclosed or semi-enclosed spaces immediately above cargo tanks (e.g. 'tweendecks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the Society.	Zone 1
7	Spaces other than cofferdams, adjacent to and below the top of a cargo tank (e.g. trunks, passageways and holds) as well as double bottoms and pipe tunnels below cargo tanks.	Zone 1
8	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump room ventilation outlets and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation.	Zone 1
9	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6m radius centred upon the centre of the outlet, and within a hemisphere of 6m radius below the outlet.	Zone 1
10	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5m of cargo pump room entrances, cargo pump room ventilation inlets, openings into cofferdams or other Zone 1 spaces.	Zone 1
11	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck.	Zone 1
12	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where structures are restricting the natural ventilation and to the full breadth of the ship plus 3m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4m above the deck.	Zone 1
13	Compartments for cargo hoses.	Zone 1
14	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located.	Zone 1
15	Areas 2m beyond the area defined in item 8.	Zone 2
16	Areas of 1,5 m surrounding open or semi-enclosed spaces of Zone 1.	Zone 2
17	Areas 4m beyond the cylinder and 4m beyond the sphere defined in item 9.	Zone 2
18	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service areas and 3m beyond these up to a height of 2,4m above the deck.	Zone 2
19	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4m above the deck surrounding open or semi-enclosed spaces of Zone 1.	Zone 2
20	Spaces forward of the open deck areas to which reference is made in item 12 and item 18, below the level of the main deck, and having an opening on the main deck or at a level less than 0,5m above the main deck, unless: a) the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilation system inlets and exhausts, are situated at least 5m from the foremost cargo tank and at least 10m measured horizontally from any cargo tank outlet or gas or vapour outlet; and b) the spaces are mechanically ventilated.	Zone 2

Table 2 : Hazardous areas classification for barge-oil carrying flammable liquids having a flash point exceeding 60°C unheated or heated to a temperature below and not within 15°C of their flash point *(1/5/2013)*

Spaces		Hazardous area
No.	Description	
1	Interior of cargo tanks, slop tanks, any pipework of pressure relief or other venting systems for cargo and slop tanks, pipes and equipment containing cargo.	Zone 2

2 Electrical installations for units with service notation "barge-accommodation"

2.1 Application

2.1.1 *(1/7/2014)*

The requirements in this item [2] apply, in addition to those contained in Part C, Chapter 2, to ships with the service notation **barge-accommodation**.

2.2 Documentation to be submitted

2.2.1 *(1/7/2014)*

The documentation dealing with the electrical system for watertight door and fire door systems is to be submitted for approval.

2.3 Electrical distribution and protection

2.3.1 *(1/7/2014)*

Distribution systems are to be so arranged that a fire in any main vertical zone as defined in Part C, Chapter 4 will not interfere with services essential for safety in any other such zone.

This requirement will be met if main and emergency feeders passing through any such zone are separated both vertically and horizontally as widely as is practicable.

2.3.2 *(1/7/2014)*

For generators arranged to operate in parallel and for individually operating generators, arrangements are to be made to disconnect automatically the excess load when the generators are overloaded in such a way as to prevent a sustained loss of speed. The operation of such a device is to activate a visual and audible alarm.

2.3.3 *(1/7/2014)*

Supplementary lighting is to be provided in all cabins to clearly indicate the exit so that occupants will be able to find their way to the door. Such lighting, which may be connected to an emergency source of power or have a self-contained source of electrical power in each cabin, is to automatically illuminate when power to the normal cabin lighting is lost and remain on for a minimum of 30 min.

2.4 Control station

2.4.1 *(1/7/2014)*

Where the navigation bridge is not provided, all the control, alarm, indication and communication equipment is to be centralized at a central control station which is to be continuously manned by a responsible member of the staff.

2.5 Main source of electrical power

2.5.1 *(1/7/2014)*

The main source of electrical power is to consist of at least two generating sets.

The capacity of these main sets is to be such that in the event of any one generating set being stopped it will still be possible to supply those services necessary to provide:

a) normal operational conditions and safety;

b) minimum comfortable conditions of habitability.

Minimum comfortable conditions of habitability include at least adequate services for lighting, cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water; they also include refrigerators for air-conditioning, unless the unit is only operated in cold-temperate and cold areas.

Such capacity is, in addition, to be sufficient to start the largest motor without causing any other motor to stop or having any adverse effect on other equipment in operation.

2.5.2 *(1/7/2014)*

Pt C, Ch 2, Sec 3, [2.2.5] does not apply.

2.6 Emergency source of electrical power and emergency installations

2.6.1 General *(1/7/2014)*

a) Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits.

Exceptionally, is understood to mean conditions such as:

1) blackout situation
2) dead ship situation
3) routine use for testing
4) short-term parallel operation with the main source of electrical power for the purpose of load transfer.

b) Pt C, Ch 2, Sec 3, [2.3.2] does not apply

c) The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the services stated in [2.6.2] a) for the period specified, if they depend upon an electrical source for their operation.

d) The transitional source of emergency electrical power, where required, is to be of sufficient capacity to supply at least the services stated in [2.6.2] d) for the periods specified therein, if they depend upon an electrical source for their operation.

e) An indicator is to be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in c) and d) are being discharged.

f) If the services which are to be supplied by the transitional source receive power from an accumulator battery by means of semiconductor converters, means are to be provided for supplying such services also in the event of failure of the converter (e.g. providing a bypass feeder or a duplicate converter).

g) Provision is to be made for the periodical testing of the complete emergency system and is to include the testing of automatic starting arrangements. Testing at regular intervals is to also cover load operation.

h) The emergency source of electrical power may be either a generator or an accumulator battery, which are to comply with the provisions of i) or j), respectively.

i) Where the emergency source of electrical power is a generator, it is to be:

1) driven by a suitable prime mover with an independent supply of fuel having a flashpoint (closed cup test) of not less than 43°C;
2) started automatically upon failure of the electrical supply to the emergency switchboard from the main source of electrical power and are to be automatically connected to the emergency switchboard; those services referred to in [2.6.2] a) shall then be transferred automatically to the emergency generating set. The automatic starting system and the characteristics of the prime mover are to be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 s; and
3) provided with a transitional source of emergency electrical power according to k).

j) Where the emergency source of electrical power is an accumulator battery, it is to be capable of:

1) carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage;
2) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and
3) immediately supplying at least those services specified in [2.6.2] d).

k) The transitional source of emergency electrical power required by i) (3) is to consist of an accumulator battery which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within

12% above or below its nominal voltage and be so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the services in [2.6.2] d) if they depend upon an electrical source for their operation.

2.6.2 Distribution of electrical power *(1/7/2014)*

a) The emergency source of electrical power is to be capable of supplying simultaneously at least the following services for the periods specified hereafter, if they depend upon an electrical source for their operation:

1) for a period of 36 hours, emergency lighting:
   - at every muster and embarkation station and over the sides;
   - in alleyways, stairways and exits giving access to the muster and embarkation stations;
   - in all service and accommodation alleyways, stairways and exits, personnel lift cars;
   - in the machinery spaces and main generating stations including their control positions;
   - in all control stations, machinery control rooms, and at each main and emergency switchboard;
   - at all stowage positions for firemen's outfits;
   - at emergency hospitals, if any;
   - at the fire pump, the sprinkler pump and the emergency bilge pump referred to in (d) below and at the starting position of their motors;
   - in all cabins, unless this supplementary lighting has a self-contained source of electrical power in each cabin;
2) for a period of 36 hours:
   - the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force; and
   - the radio installations
3) for a period of 36 hours:
   - all internal communication equipment required in an emergency (see b));
   - the fire detection and fire alarm system, the fire door holding and release system; and
   - intermittent operation of the daylight signalling lamp, the ship's whistle, the manually operated call points and all internal signals (see c)) that are required in an emergency,

   unless such services have an independent supply for the period of 36 hours from an accumulator battery suitably located for use in an emergency;
4) for a period of 36 hours:
   - one of the fire pumps required by the relevant provisions of Part C, Chapter 4;
   - the automatic sprinkler pump, if any; and
   - the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves;
   - the sanitary and mechanical ventilation to provide minimum comfortable conditions of habitability;
5) for a period of half an hour:
   - any watertight doors required by Pt B, Ch 2, Sec 1, [6] to be power operated together with their indicators and warning signals;
   - the emergency arrangements to bring the lift cars to deck level for the escape of persons. The lift cars may be brought to deck level sequentially in an emergency.

b) Internal communication equipment required in an emergency generally includes:

1) the means of communication between the navigating bridge and the position in the machinery space or control room from which the engines are normally controlled
2) the means of communication which is provided between the officer of the watch and the person responsible for closing any watertight door which is not capable of being closed from a central control station
3) the public address system or other effective means of communication throughout the accommodation, public and service spaces
4) the means of communication between the navigating bridge and the main fire control station.

c) Internal signals required in an emergency generally include:

1) general alarm
2) watertight door indication
3) Fire door indication.

d) The transitional source of emergency electrical power required is to supply at least the following services if they depend upon an electrical source for their operation:

1) for half an hour:
   - the lighting required by [2.6.2] a) 1) and a) 2);
   - all services required by [2.6.2] a) 3) first two bullets) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

2) It is also to supply power to close the watertight doors as required by Pt B, Ch 2, Sec 1, [6], but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided.

3) Power to the control, indication and alarm circuits as required by Pt B, Ch 2, Sec 1, [6], for half an hour.

2.7 Escape lighting system

2.7.1 *(1/7/2014)*

In addition to the emergency lighting required in [2.6.2] a) 1), an escape lighting system is to be provided that is to be switched on automatically in the event of failure of the main and emergency power supply and that can operate for at least three hours.

Note 1: Alternatively, any other means of lighting which is at least as effective may be accepted by the Society.

2.7.2 *(1/7/2014)*

The escape lighting systems are to be supplied by batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard.

Any failure of the lamp will be immediately apparent. Any accumulator battery provided is to be replaced at intervals having regard to the specified service life in the ambient conditions that they are subject to in service.

2.7.3 *(1/7/2014)*

The escape lighting systems are to:

a) illuminate all escape routes;

b) illuminate lifeboat stations and the sea where life boats and life rafts are to be launched.

2.8 General emergency alarm and public address systems

2.8.1 **General emergency alarm system** *(1/7/2014)*

a) Electrical cables and apparatus for the general emergency alarm system and their power supply are to be arranged so that the loss of the system in any one area due to localised fire is minimised.

b) Where the fire alarm to summon the crew/staff operated from the navigating bridge or fire control station is part of the ship's general alarm system, it is to be capable of being sounded independently of the alarm in the public spaces.

2.8.2 **Public address system** *(1/7/2014)*

a) The public address system is to be one complete system consisting of a loudspeaker installation which enables simultaneous broadcast of messages from the navigation bridge and at least one other location on board for use when the navigation bridge has been rendered unavailable due to the emergency, to all spaces where crew/staff members or guests, or both, are normally present (accommodation and service spaces and control stations and open decks), and to assembly stations (i.e. muster stations).

b) The public address system is to be arranged to operate on the main source of electrical power, the emergency source of electrical power and transitional sources of electrical power as required by [2.6.2].

c) The controls of the system on the navigation bridge are to be capable of interrupting any broadcast on the system from any other location on board.

d) The system is not to require any action by the addressee.

e) It is to be possible to address crew/staff accommodation and work spaces separately from guest spaces.

f) In addition to any function provided for routine use aboard the ship, the system is to have an emergency function control at each control station which:

1) is clearly indicated as the emergency function,

2) is protected against unauthorised use,

3) automatically overrides any other input system or program, and

4) automatically overrides all volume controls and on/off controls so that the required volume for the emergency mode is achieved in all spaces.

g) The system is to be installed with regard to acoustically marginal conditions, so that emergency announcements are clearly audible above ambient noise in all spaces where crew/staff members or guests, or both, are normally present (accommodation and service spaces and control stations and open decks), and at assembly stations (i.e. muster stations).

h) With the ship in normal conditions, the minimum sound pressure level for broadcasting emergency announcements is to be:

1) in interior spaces 75 dB (A) and at least 20 dB (A) above the speech interference level, and

2) in exterior spaces 80 dB (A) and at least 15 dB (A) above the speech interference level.

i) The system is to be arranged to prevent feedback or other interference.

j) The system is to be arranged to minimise the effect of a single failure so that the emergency messages are still audible (above ambient noise levels) also in the event of failure of any one circuit or component.

k) Each loudspeaker is to be individually protected against short-circuits.

l) For cables used for the public address system, see Pt C, Ch 2, Sec 3, [9.6], Pt C, Ch 2, Sec 11, [5.2.1] and Pt C, Ch 2, Sec 11, [5.2.4].

m) All areas of each fire zone are to be served by at least two dedicated loops of flame-retardant cables which are to be sufficiently separated throughout their length and supplied by two separate and independent amplifiers.

2.9 Installation

2.9.1 Section and distribution boards *(1/7/2014)*

Cubicles and cupboards in areas which are accessible to any guest are to be lockable.

2.10 Type approved components

2.10.1 *(1/7/2014)*

Components for Low-Location Lighting systems (LLL) in escape routes are to be type approved or in accordance with [2.10.2].

2.10.2 *(1/7/2014)*

Case-by-case approval based on the submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

3 Electrical installations for units with service notation "barge-chemical"

3.1 Application

3.1.1 *(1/6/2021)*

The requirements in this item [3] apply, in addition to those contained in Part C, Chapter 2, to barge-chemical.

3.2 Exemptions

3.2.1 *(1/6/2021)*

The requirements in Pt C, Ch 2, Sec 3, [2.2.1] and [2.3.1] are not applicable in the case of vessels without persons on board.

3.3 Documentation to be submitted

3.3.1 *(1/6/2021)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

3.4 System of supply

3.4.1 *(1/6/2021)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

3.4.2 *(1/6/2021)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

3.4.3 *(1/6/2021)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

3.5 Electrical equipment

3.5.1 *(1/6/2021)*

Electrical equipment, cables and wiring are not to be installed in hazardous locations unless they conforms with standards not inferior to those given in IEC 60092-502 Standard.

3.6 Earth detection

3.6.1 *(1/6/2021)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [3.4.1].

3.7 Precautions against inlet of gases or vapours

3.7.1 *(1/6/2021)*

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

3.8 Electrical equipment permitted in hazardous areas

3.8.1 *(1/6/2021)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5] and Pt C, Ch 2, Sec 3, [10.1.6].

3.8.2 *(1/6/2021)*

In addition to the requirements of [3.8.1], in Zone 1 and Zone 2 the installation of the following is permitted: hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of an impressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

3.8.3 *(1/6/2021)*

Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

3.9 Hazardous area classification

3.9.1 *(1/6/2021)*

For hazardous area classification see:

a) Tab 1 for barge-oil carrying flammable liquids having:
   - a flash point not exceeding 60°C, or
   - a flash point exceeding 60°C, heated to a temperature above their flash point, or
   - a flash point exceeding 60°C, heated to a temperature within 15°C of their flash point;

b) Tab 2 for barge-oil carrying flammable liquids having a flash point exceeding 60°C, unheated or heated to a temperature below and not within 15°C of their flash point.

4 Electrical installations for units with service notation "barge-liquefied gas" and units with service notation "barge-LNG Bunker"

4.1 Application

4.1.1 *(1/6/2021)*

The requirements in this item apply, in addition to those contained in Part C, Chapter 2, to ships with the service notation **barge-liquefied gas** and **barge-LNG Bunker.**

4.2 Exemptions

4.2.1 *(1/6/2021)*

The requirements in Pt C, Ch 2, Sec 3, [2.2.1] and [2.3.1] are not applicable in the case of vessels without persons on board.

4.3 Documentation to be submitted

4.3.1 *(1/6/2021)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

4.4 System of supply

4.4.1 *(1/6/2021)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

4.4.2 *(1/6/2021)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

4.4.3 *(1/6/2021)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

4.5 Earth detection

4.5.1 *(1/6/2021)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [4.4.1].

4.6 Precautions against inlet of gases or vapours

4.6.1 *(1/6/2021)*

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

4.7 Electrical equipment permitted in hazardous areas

4.7.1 *(1/6/2021)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5] and Pt C, Ch 2, Sec 3, [10.1.6].

4.7.2 *(1/6/2021)*

In addition to the requirements of [4.7.1], in Zone 1 and Zone 2 the installation of the following is permitted: hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of an impressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

4.7.3 *(1/6/2021)*

Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

4.8 Hazardous area classification

4.8.1 *(1/6/2021)*

For hazardous area classification see Tab 3.

4.9 Submerged cargo pumps

4.9.1 Exception *(1/6/2021)*

Submerged cargo pumps are not permitted in connection with the following cargoes:

- diethyl ether
- vinyl ethyl ether
- ethylene oxide
- propylene oxide
- mixtures of ethylene oxide and propylene oxide.

4.9.2 Submerged electric motors *(1/6/2021)*

a) Where submerged electric motors are employed, means are to be provided, e.g. by the arrangements specified in paragraph 17.6 of the IGC Code, to avoid the formation of explosive mixtures during loading, cargo transfer and unloading.

b) Arrangements are to be made to automatically shut down the motors in the event of low liquid level. This may be accomplished by sensing low pump discharge pressure, low motor current, or low liquid level. This shutdown is to be alarmed at the cargo control station. Cargo pump motors are to be capable of being isolated from their electrical supply during gas-freeing operations.

4.10 Product classification

4.10.1 Temperature class and explosion group *(1/6/2021)*

Tab 4 specifies temperature class and explosion group data for the products indicated in Chapter 19 of the IGC Code. The data shown in brackets have been derived from similar products.

Table 3 : Classification of hazardous areas for tankers carrying flammable liquefied gases *(1/6/2021)*

Spaces		Hazardous area
No.	Description	
1	Cargo containment systems	Zone 0
2	Hold spaces where cargo is carried in a cargo containment system requiring a secondary barrier	Zone 0
3	Hold spaces where cargo is carried in a cargo containment system not requiring a secondary barrier	Zone 1
4	Space separated from a hold space where cargo is carried in a cargo containment system requiring a secondary barrier by a single gas-tight steel boundary	Zone 1
5	Cargo pump and cargo compressor rooms	Zone 1
6	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump and cargo compressor room ventilation outlets and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation	Zone 1
7	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet	Zone 1
8	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5 m of cargo pump and cargo compressor room entrance, cargo pump and cargo compressor room ventilation inlet, openings into cofferdams or other zone 1 spaces	Zone 1
9	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck	Zone 1
10	Areas on open deck over all cargo tanks (including ballast tanks within the cargo tank area) where structure restricts natural ventilation and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck	Zone 1
11	Compartment for cargo hoses	Zone 1
12	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located	Zone 1
13	Enclosed or semi-enclosed spaces in which pipes containing cargo products for boil-off gas fuel burning systems are located, unless special precautions approved by the Society are provided to prevent product gas escaping into such spaces	Zone 1
14	Areas of 1,5 m surrounding open or semi-enclosed spaces of Zone 1 **(1)**	Zone 2
15	Areas 4 m beyond the cylinder and 4 m beyond the sphere defined in item 7	Zone 2
16	Spaces forming an air-lock	Zone 2
17	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service areas and 3m beyond these up to a height of 2,4m above the deck	Zone 2
(1) For ships subject to the SOLAS Convention, an area within 2m beyond the 3m of cargo tank ventilation outlets which permit the flow of small volumes of vapour gas mixtures caused by thermal variation is to be considered Zone 2		

Spaces		Hazardous area
No.	Description	
18	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck surrounding open or semi-enclosed spaces of Zone 1	Zone 2
19	Spaces forward of the open deck areas to which reference is made in item 10 and item 18, below the level of the main deck, and having an opening on the main deck or at a level less than 0,5 m above the main deck, unless: a) the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilation system inlets and exhausts, are situated at least 5 m from the foremost cargo tank and at least 10 m measured horizontally from any cargo tank outlet or gas or vapour outlet; and b) the spaces are mechanically ventilated	Zone 2
20	Areas within 2,4 m of the outer surface of a cargo tank where such surface is exposed to the weather	Zone 2
(1) For ships subject to the SOLAS Convention, an area within 2m beyond the 3m of cargo tank ventilation outlets which permit the flow of small volumes of vapour gas mixtures caused by thermal variation is to be considered Zone 2		

Table 4 : Temperature class and explosion group of certain products *(1/6/2021)*

Product name	Temperature class	Explosion group	Product name	Temperature class	Explosion group
Acetaldehyde	T4	II A	Methane	T1	II A
Ammonia anhydrous	T1	II A	Methyl acetylene propadiene mixture	T4	II A
Butadiene	T2	II B	Methyl bromide	T3	II A
Butane	T2	II A	Methyl chloride	T1	II A
Butane/propane mixture	T2	II A	Monoethylamine	T2	II A
Butylenes	T3	II A	Nitrogen	NF	NF
Chlorine	NF	NF	Pentane (all isomers)	(T2)	(II A)
Diethyl ether	T4	II B	Pentene (all isomers)	(T3)	(II B)
Dimethylamine	T2	II A	Propane	T2	II A
Ethane	T2	II A	Propylene	T2	II B
Ethyl chloride	T2	II A	Propylene oxide	T2	II B
Ethylene	T2	II B	Refrigerant gases	NF	NF
Ethylene oxide	T2	II B	Sulphur dioxide	(T3)	(II B)
Ethylene oxide propylene oxide mixture (max. 30% mass/mass ethylene oxide)	T2	II B	Vinyl chloride	T2	II A
Isoprene	T3	II B	Vinyl ethyl ether	T3	II B
Isopropylamine	T2	II A	Vinylidene chloride	T2	II A

Chapter 20
FISHING VESSELS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **fishing vessel**, as defined in Pt A, Ch 1, Sec 2, [4.10].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to fishing vessels.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to fishing vessels.

Table 1 *(1/1/2007)*

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery	Sec 4
Electrical installations	Sec 5
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for fishing vessels are given in this Chapter.	

SECTION 2 SHIP ARRANGEMENT

1 General arrangement design

1.1 Subdivision arrangement

1.1.1 General

Fishing vessels are to be fitted with at least the following transverse watertight bulkheads:

- one collision bulkhead
- one after peak bulkhead
- two bulkheads forming the boundaries of the machinery space in ships with machinery amidships, and a bulkhead forward of the machinery space in ships with machinery aft.

1.1.2 Disposition of collision bulkhead *(1/7/2006)*

For vessels equal to or greater than 45 m in length, the collision bulkhead is to be located at a distance from the forward perpendicular FP_{LL} of not less than 5% and no more than 8% of the length L_{LL} of the ship.

For vessels less than 45 m in length, the collision bulkhead is to be located at a distance from the forward perpendicular FP_{LL} of not less than 5% of the length L_{LL} of the ship and not more than 5% of the length L_{LL} + 1,35 m. In no case is this distance to be less than 2 m. For vessels less than 24 m in length it is not necessary that the minimum distance is 2 m. In any case for vessels less than 12 m in length with navigation notation up to “coastal area” it is not necessary to install a collision bulkhead.

Where any part of the ship below the waterline extends forward of the forward perpendicular, e.g a bulbous bow, the above distances, in m, are to be measured from a point either:

- at the mid-length of such extension, or
- at a distance 1,5% of the length L_{LL} of the ship forward of the forward perpendicular, where this distance is lesser.

1.1.3 Height of transverse watertight bulkheads *(1/7/2006)*

The bulkheads in [1.1.1] are to be watertight up to the working deck.

Where a long forward superstructure is fitted, the collision bulkhead is to be extended weathertight to the next deck above the freboard deck. The extension need not be fitted directly above the bulkhead below provided it is located within the limits prescribed in [1.1.2] and the part of the deck which forms the step is made effectively watertight.

1.1.4 Openings in collision bulkhead

Openings in the collision bulkhead below the working deck are not allowed.

Where penetration of the collision bulkhead is necessary for piping, arrangements are to be fitted to maintain the watertight integrity and strength, with suitable valves operable from above the freeboard deck, whose valve chest is to be secured at the bulkhead inside the fore peak.

Where the collision bulkhead extends above the working deck, openings above the working deck are allowed provided that they are supplied with weathertight means of closure.

1.1.5 Openings in watertight bulkheads

The number of openings in watertight bulkheads is to be kept to a minimum compatible with the design and proper working of the ship.

Where penetration of watertight bulkheads and internal decks is necessary for access, piping, ventilation, electrical cables, etc., arrangements are to be fitted to maintain the watertight integrity and strength.

1.2 Cofferdams

1.2.1 Cofferdams are to be provided between compartments intended for liquid hydrocarbons (fuel oil, lubricating oil) and those intended for fresh water or boiled feed water.

1.2.2 Cofferdams separating fuel oil tanks from lubricating oil tanks and such tanks from those intended for the carriage of fresh water or boiler feed water may not be required when deemed impracticable or unreasonable by the Society in relation to the characteristics and dimensions of such tanks, provided that:

- the thickness of common boundary plates of adjacent tanks is increased by 1 mm with respect to that obtained according to Pt B, Ch 7, Sec 1
- the tank structural test is carried out with a head increased by 1 m with respect to that specified in Pt B, Ch 12, Sec 3, [2].

1.2.3 Spaces intended for the carriage of flammable liquids are to be separated from accommodation and service spaces by means of a cofferdam. Where accommodation and service spaces are arranged immediately above such spaces, the cofferdam may be omitted only where the deck is not provided with access openings and is coated with a layer of material recognised as suitable by the Society.

The cofferdam may also be omitted where such spaces are adjacent to a passageway, subject to the conditions in [1.2.2] for the avoidance of cofferdams between fuel oil and lubricating oil tanks.

2 Bow height

2.1 Vessels of not less than 24 m in length

2.1.1 *(1/7/2006)*

For vessels of not less than 24 m in length the following requirements are to be applied:

a) where, during the fishing operations, the catch is to be stowed in fish holds through hatchways which are situated on an exposed working deck forward of the deckhouse or superstructure, the minimum bow height is to be calculated in accordance with the following method:

   1) the bow height is defined as the minimum vertical distance from the deepest waterline to the top of the highest exposed deck measured at the forward perpendicular;

   2) the determination of the bow height (H_B) required may be based upon the following formula:

$$H_B = K_1 L \cdot \left(1 + \frac{L}{K_2}\right)$$

      where:

      L is the length of the vessel, in m;

      K_1 and K_2 are coefficients depending upon the areas of operation and L as in Tab 1;

   3) for vessels with navigation notation “coastal area” the value of the bow height calculated according to the formula in a) 2) may be reduced by 15%;

   4) where the bow height required is obtained by sheer, this is to be extended from the stem for a length of at least 0,15 L abaft the forward perpendicular, or, if a forecastle is fitted it is to be extended for a length of at least 0,07 L abaft the forward perpendicular;

b) where, during the fishing operation, the catch is to be stowed in fish holds through hatchways which are situated on an exposed working deck protected by a deckhouse or superstructure, the minimum bow height is to be in accordance with Regulation 39 of Annex I to the International Loadline Convention 1966, but is to be not less than 2000 mm. In this respect the maximum permissible operating draught is to be used in place of the assigned summer freeboard for the purpose of determining the minimum bow height.

2.2 Vessels of length less than 24 m

2.2.1 *(1/7/2006)*

For vessels of length less than 24 m and having navigation notation greater than “coastal area”, the bow height is to be not less than the following:

$$H_B = 0,09L \cdot \left(1 - \frac{L}{270}\right)$$

For the evaluation of H_B the same requirements as stated in [2.1.1]a)3) and [2.1.1]a)4) may be applied.

2.2.2 *(1/7/2006)*

For vessels less than 24 m in length and having navigation notation “coastal area”, the minimum freeboard height is to be not less than 0,1 B. In any case such value is to be not less than 0,30 m.

Table 1 *(1/7/2006)*

Area of operation	L	K_1	K_2
Extreme conditions with significant wave height up to and including 8 m	$24 \le L \le 110$ m	0,09	- 270
	L > 110 m	4,959/L	600
Extreme conditions with significant wave height above 8 m	$24 \le L \le 110$ m	0,117	- 220
	L > 110 m	5,991/L	1484

SECTION 3 HULL AND STABILITY

Symbols

x, y, z : X, Y and Z co-ordinates, in m, of the calculation point with respect to the reference co-ordinate system defined in Pt B, Ch 1, Sec 2, [4]

k : Material factor for steel, defined in Pt B, Ch 4, Sec 1, [2.3]

p_E : Side and bottom design pressure, in kN/m², for ships less than 65 m in length, to be obtained from the following formula:

$$p_E = 5L^{1/3}\left[1 - \frac{(T-z)}{2T}\right] + 10(T-z) + p_A \quad \text{for } z \le T$$

$$p_E = (5L^{1/3} + p_A)\frac{10}{10 + (z-T)} \quad \text{for } z > T$$

p_A : Additional pressure, in kN/m², for ships less than 65 m in length, to be obtained from the following formulae:

$p_A = 0,17L - 1,7x$ for $0 \le x < 0,1L$

$p_A = 0$ for $0,1L \le x < 0,8L$

$p_A = 2,25(x - 0,8L)$ for $0,8L \le x \le L$

p_D : Bottom design pressure, in kN/m², for ships less than 65 m in length, to be obtained from the following formulae:

$p_D = \max(10T; 6,6D)$ for $T/D \ge 0,5$

$p_D = 10T + 2,5L^{1/3} + p_A$ for $T/D < 0,5$

p_L : Liquid design pressure, for ships less than 65 m in length, to be taken as the greater of the values obtained, in kN/m² from the following formulae:

$$p_L = 10[(h_a + z_{TOP}) - z]$$

$$p_L = 10\left[\frac{2}{3}(z_{AP} - z)\right]$$

h_a : Distance, to be obtained, in m, from the following formula:

h_a = 1+0,05(L-50) without being taken less than 1m,

z_{TOP} : Z co-ordinate, in m, of the highest point of the tank in the z direction

z_{AP} : Z co-ordinate, in m, of the top of the air pipe of the tank in the z direction

s : Length, in m, of the shorter side of the plate panel or spacing, in m, of ordinary stiffeners, or spacing, in m, of primary supporting members, as applicable

ℓ : Length, in m, of the longer side of the plate panel or span, in m, of ordinary stiffeners, measured between the supporting members, or span, in m, of primary supporting members, as applicable (to be taken according to Pt B, Ch 4, Sec 3, [3.2] and Pt B, Ch 4, Sec 3, [4.1]).

1 Stability

1.1 Intact stability

1.1.1 Application

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.13], with the assumptions in [1.1.2], is to be in compliance with the requirements in [1.1.3].

1.1.2 Assumptions for calculating loading conditions

The assumptions for calculating the loading conditions in Pt B, Ch 3, App 2, [1.2.13] are as follows:

- *allowance is to be made for the weight of the wet fishing nets and tackle, etc., on deck*
- *allowance for icing, where this is anticipated to occur, is to be made in accordance with Pt B, Ch 3, Sec 2, [6]*

- *in all cases the cargo is to be assumed to be homogenous unless this is inconsistent with practice*
- *deck cargo is to be included if such a practice is anticipated*
- *water ballast is normally to be included only if carried in tanks which are specially provided for this purpose.*

1.1.3 Intact stability criteria

- *The general intact stability criteria in Pt B, Ch 3, Sec 2, [2] are to be applied to fishing vessels equal to or greater than 24 m in length, except for the requirements below.*
- *The initial metacentric height GM_o is to be not less than 0,35 m for single deck vessels.*
- *The metacentric height GM_o may be reduced to the satisfaction of the Society but in no case is GM_o to be less than 0,15 m for vessels with complete superstructure or vessels equal to or greater than 70 m in length.*

Where arrangements other than bilge keels are provided to limit the angle of roll, the above stability criteria are to be maintained in all operating conditions.

1.1.4 Relaxation of the Rules for ships of length L < 24 m *(1/7/2003)*

For decked ships of length less than 20 m, when a practical stability test has been carried out as foreseen in Pt B, Ch 3, Sec 1, [3.2], the initial metacentric height GMo is to be not less than 0,50 m in all the expected loading conditions during the ship's service.

For ships without decks, the residual freeboard on the heeled side due to the practical crowding test is to be not less than 0,20 m.

For ships of length less than 24 m, the requirements relevant to the righting arm diagrams need not be complied with; in any event, for ships of length greater than 20 m, the inclining experiment is to be carried out and the booklet with instructions for the Master is to be prepared.

1.1.5 Severe wind and rolling criterion (weather criterion)

The requirements in Pt B, Ch 3, Sec 2, [3] are to be complied with by:

- *fishing vessels equal to or greater than 45 m in length*
- *fishing vessels in the length range between 24 m and 45 m, with the values of wind pressure defined in Tab 1, depending on the vertical distance h, in m, measured from the centre of the projected vertical area of the ship above the waterline to the waterline.*

Table 1 : Values of wind pressure

Vertical distance h, in m	Wind pressure, in kN/m^2
1	0,316
2	0,386
3	0,429
4	0,460
5	0,485
6 and over	0,504

1.1.6 Icing

For vessels operating in areas where ice accretion is expected, the requirements in Pt B, Ch 3, Sec 2, [6] are to be complied with.

2 Hull scantlings of ships equal to or greater than 65 m in length

2.1 Plating

2.1.1 The net thickness of bottom, side and deck plating is to be increased by 0,5 mm with respect to that calculated according to Pt B, Ch 7, Sec 1 or Pt B, Ch 8, Sec 3, as applicable.

2.2 Aft ramp

2.2.1 Plating of the aft ramp and the lower part of the aft ramp side

The net thickness of plating of the aft ramp and the lower part of the aft ramp side is to be increased by 2 mm with respect to that calculated according to Pt B, Ch 9, Sec 2, [3] for side plating with the same plate panel dimensions.

In any case, these net thicknesses are to be not less than 11mm.

2.2.2 Plating of the upper part of the aft ramp side

The net thickness of plating of the upper part of the aft ramp side is to be not less than the value calculated according to Pt B, Ch 9, Sec 2, [3] for side plating with the same plate panel dimensions.

3 Hull scantlings of ships less than 65 m in length

3.1 General

3.1.1 Application

The requirements in [3.1] to [3.12] apply to structures located aft of the collision bulkhead. The remaining requirements of [3] apply to other items, as specified.

3.1.2 Scantling reduction depending on the navigation notation

The requirements of [3] apply for the structural scantling of ships having the **unrestricted navigation** notation.

For ships with restricted navigations, the required scantling may be reduced by the percentages specified in Tab 2, depending on the navigation notation assigned to the ship.

Table 2 : Scantling reduction percentages depending on the navigation notation

Navigation notation	Reduction
Summer zone	5%
Tropical zone **Coastal area**	10%
Sheltered area	16%
Note 1: For sternframes, bulkheads and decks, 50% of the reduction applies.	

3.1.3 Gross scantling

All scantlings referred to in [3] are gross, i.e. they include the margins for corrosion.

3.2 Longitudinally framed single bottom

3.2.1 Scantlings of plating, ordinary stiffeners and primary supporting members

The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 3 and the minimum values in the table.

3.3 Transversely framed single bottom

3.3.1 Scantlings of plating, ordinary stiffeners and primary supporting members

The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 4 and the minimum values in the table.

3.4 Bilge

3.4.1 Bilge plating thickness

The thickness of bilge plating is to be not less than that of the adjacent bottom or side plating, whichever is the greater.

Table 3 : Scantlings of longitudinally framed single bottom structures

Element	Formulae	Minimum value
Plating	Thickness, in mm **(1)**: $t = 7{,}2\ s\ (Tk)^{1/2}$	Minimum thickness, in mm: $t = 0{,}06\ Lk^{0.5} + 4{,}0$
Ordinary stiffeners	Section modulus, in cm^3: $w = 0{,}8\ s\ell^2\ p_D k$	

(1) For ships equal to or greater than 30 m in length, this thickness may be gradually tapered such as to reach, at the collision and after peak bulkheads, 80% of the value obtained from this formula, without being less than 5 mm.

(2) For ships equal to or greater than 30 m in length, the web thickness and the flange area may be gradually tapered such as to reach, at the collision and after peak bulkheads, 80% of the values obtained from these formulae.

Element	Formulae	Minimum value
Floors	Section modulus, in cm^3: $w = s\ \ell^2\ p_D k$	Minimum web plate thickness, in mm: t = 6,0
Girders **(2)**	Web thickness, in mm: • $t = 0,06\ Lk^{1/2} + 5,0$ for centre girders • $t = 0,06\ Lk^{1/2} + 4,0$ for side girders.	
		Minimum face plate area, in cm^2: • A = 8,0 for centre girders • A = 5,0 for side girders.
	Where considered as floor supports, section modulus, in cm^3: $w = s\ \ell^2\ p_D k$	
(1) For ships equal to or greater than 30 m in length, this thickness may be gradually tapered such as to reach, at the collision and after peak bulkheads, 80% of the value obtained from this formula, without being less than 5 mm. **(2)** For ships equal to or greater than 30 m in length, the web thickness and the flange area may be gradually tapered such as to reach, at the collision and after peak bulkheads, 80% of the values obtained from these formulae.		

Table 4 : Scantlings of transversely framed single bottom structures

Element	Formula	Minimum value
Plating	Thickness, in mm **(1)**: $t = 8,5\ s\ (Tk)^{1/2}$	Minimum thickness, in mm: $t = 0,06\ Lk^{1/2} + 4,0$
Floors	Section modulus, in cm^3 **(2)**: $w = 0,43\ s\ \ell^2\ p_D k$ Web plate thickness, in mm: $t = 10\ h_W + 2,0$	
Girders **(3)**	Web thickness, in mm: • $t = 0,06\ Lk^{1/2} + 5,0$ for centre girders • $t = 0,06\ Lk^{1/2} + 4,0$ for side girders.	
		Minimum face plate area, in cm^2: • A = 8,0 for centre girders • A = 5,0 for side girders.
Note 1: h_w : Height, in m, of floors at the centreline to be taken not less than B/16. **(1)** For ships equal to or greater than 30 m in length, this thickness may be gradually tapered such as to reach, at the collision and after peak bulkheads, 80% of the value obtained from this formula, without being less than 5 mm. **(2)** For ordinary stiffeners located within the engine room area, the required section modulus is to be increased by 40% with respect to that obtained from this formula. **(3)** For ships equal to or greater than 30 m in length, the web thickness and the flange area may be gradually tapered such as to reach, at the collision and after peak bulkheads, 80% of the values obtained from these formulae.		

3.5 Double bottom

3.5.1 Scantlings of plating, ordinary stiffeners and primary supporting members

The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 5 and the minimum values in the table.

3.6 Open floors in transversely framed double bottom

3.6.1 Frames

The section modulus of frames constituting open floors is to be not less than the value obtained, in cm^3, from the following formula:

$w = 0,8 s \ell^2 p_D$

where:

ℓ : Span, in m, of transverse ordinary stiffeners constituting the open floor (see Pt B, Ch 4, Sec 3, [3.2.2]).

3.6.2 Reverse frames

The section modulus of reverse frame constituting open floors is to be not less than the value obtained, in cm^3, from the following formula:

$w = 0,7s\ell^2p_D$

where:

ℓ : as indicated in [3.6.1].

3.7 Side

3.7.1 Sheerstrake width

For ship greater than 20 m in length, the width of the sheerstrake is to be not less than the value obtained, in mm, from the following formula:

$b = 500 + 100\ D$

3.7.2 Plating, ordinary stiffeners and primary supporting members

The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 6 and the minimum values in the table.

3.7.3 Sheerstrake thickness

For ship greater than 20 m in length, the thickness of the sheerstrake is to be increased by 1 mm with respect to that obtained from the formulae in [3.7.2]. In any case, it is to be not less than that of the stringer plate.

3.8 Decks

3.8.1 Stringer plate width

The width of the stringer plate is to be not less than the value obtained, in mm, from the following formula:

$b = 800 + 5\ L$

3.8.2 Minimum scantlings of pillars

The thickness, in mm, of hollow (tubular or rectangular) pillars is to be not less than the greater of 5 mm and d / 35, where d is the nominal diameter, in mm, for tubular pillar cross-sections or the larger side, in mm, for rectangular pillar cross-sections.

The thickness, in mm, of the face plate of built-up pillars is to be not less than b_f / 36, where b_f is the face plate width, in mm.

3.8.3 Scantlings of plating, ordinary stiffeners and primary supporting members

The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 8 and the minimum values in the table.

Table 5 : Scantlings of double bottom structures

Element	Formula	Minimum value
Bottom plating	As specified in: • [3.2] for longitudinally framed structure • [3.3] for transversely framed structure.	Minimum thickness, in mm: $t = 0,06\ Lk^{1/2} + 4,0$
Bottom ordinary stiffeners	Section modulus, in cm^3: $w = 0,8\ s\ \ell^2\ p_D k$	
Inner bottom plating	Thickness, in mm, the greater of: **(1) (2) (3)**: • $t = 0,04\ Lk^{1/2} + 5\ s + 2$ • $t = 1,35 s (p_L k)^{1/2}$ **(6)**	Minimum thickness, in mm: $t = 5,0$
Inner bottom ordinary stiffeners	Section modulus, in mm, the greater of: • $w = 0,8\ s\ \ell^2\ p_D k$ • $w = 0,465 s \ell^2 p_L k$ **(6)**	
Centre girder	Web thickness, in mm **(4)**: $t = \frac{22B + 25(T + 10)}{100} k^{0,5} + 4$	Minimum web thickness, in mm: $t = 6,0$
Side girders	Web thickness, in mm **(4)**: • For transversely framed structure: $t = \frac{22B + 25(T + 10)}{100} k^{0,5} + 3$ • For longitudinally framed structure: $t = 0,054\ Lk^{1/2} + 4,5$	Minimum web thickness, in mm: $t = 6,0$
Floors	Web thickness, in mm **(5)**: $t = f_s \left(\frac{22B + 25(T + 10)}{100} k^{0,5} + 1 \right)$	Minimum web thickness, in mm: $t = 6,0$

Note 1:

f_s : Coefficient to be taken equal to:

- 1,1 for longitudinally framed structure
- 1,0 for transversely framed structure.

(1) For ships equal to or greater than 30 m in length, this thickness may be gradually tapered such as to reach, at the collision and after peak bulkheads, 90% of the value obtained from this formula.

(2) For plating located within the engine room area, this thickness is to be increased by 10% with respect to that obtained from this formula.

(3) For margin plates inclined downward with respect to the inner bottom plating, this thickness is to be increased by 20% with respect to that obtained from this formula.

(4) For ships equal to or greater than 30 m in length, this thickness may be gradually tapered such as to reach, at the collision and after peak bulkheads, a thickness reduced by 2 mm with respect to that obtained from this formula.

(5) For floors located within the engine room with transversely framed structure, this thickness is to be increased by 1 mm with respect to that obtained from this formula.

(6) To be considered only for double bottoms intended for the carriage of ballast.

Table 6 : Scantlings of side structures

Element	Formula	Minimum value
Plating	Thickness, in mm **(1)**: • for longitudinally framed structure: $t = 6,1\ s\ (Tk)^{1/2}$ • for transversely framed structure: $t = 7,2\ s\ (Tk)^{1/2}$	Minimum thickness, in mm: t = 4,0
Ordinary stiffeners	Section modulus, in cm^3: • for longitudinal ordinary stiffeners: $w = 0,675\ s\ \ell^2\ p_E k$ • for transverse frames **(2)** : $w = 0,75 s \ell^2 p\ f_{Hc} R k$	Minimum section modulus, in cm^3: w = 20
Primary supporting members	Section modulus, in cm^3: • for longitudinal and vertical primary supporting members: $w = K_{CR} s \ell\ p_H^2 k$ • in addition, for vertical primary supporting members not associated with side girders, in ships with a transversely framed side: $w = 0,75 s \ell^2 \left(p_E + \frac{n_S h_2 B}{12} \right) k$	

Note 1:

p_H : Design pressure, in kN/m^2, to be obtained from the following formula:

$p_H = p_E + 0,083 h_2 B$

For transverse frames of 'tweendecks:

- p_H is to be taken not less than 0,37L where the upper end is located below the full load waterline
- p_H is to be taken not less than 0,23L - $2d_P$ where the upper end is located above the full load waterline and aft of the collision bulkhead
- p_H is to be taken not less than 0,3L where the upper end is located above the full load waterline and forward of the collision bulkhead.

d_p : Vertical distance, in m, measured between the design deck (first deck above the full load waterline extending for at least 0,6L) and the deck above the frame

h_2 : Sum of the heights, in m, of all 'tweendecks above the deck located at the top of the frame without being taken less than 2,5m; for 'tweendecks intended as accommodation decks and located above the design deck (first deck above the full load waterline extending for at least 0,6L), half of the height may be taken; for 'tweendecks above a deck which is longitudinally framed and supported by deck transverses, a height equal to 0 may be taken

f_c : Coefficient depending on the type of connection and the type of frame as defined in Tab 7

R : Coefficient depending on the location of the ordinary stiffeners:

- R = 0,8 for ordinary stiffeners in hold and engine room
- R = 1,4 for ordinary stiffeners in 'tweendecks.

K_{CR} : Coefficient to be taken equal to:

- K_{CR} = 0,4 for vertical primary supporting members located outside machinery spaces and not associated with side girders, in ships with a transversely framed side
- K_{CR} = 0,5 for vertical primary supporting members located inside machinery spaces and not associated with side girders, in ships with a transversely framed side
- K_{CR} = 0,9 in other cases.

n_S : Number of transverse ordinary stiffener spaces between vertical primary supporting members.

(1) For ships equal to or greater than 30 m in length, this thickness may be gradually tapered such as to reach, at the collision and fore peak bulkheads, 80% of the value obtained from this formula, without being less than 5 mm.

(2) Where the span is the same, it is not necessary to assume a section modulus of 'tweendeck frame greater than that of the frame below.

Table 7 : Coefficient f_C

Type of connection	Type of frame	f_C
Brackets at both ends	Hold frames	0,62
	'Tweendeck frames	0,80
Bracket at one end and without bracket at the other	Hold or 'tweendeck frames	1,20
Without brackets at both ends	Hold or 'tweendeck frames	1,20

3.8.4 Scantlings of pillars subjected to compressive axial load

The area of solid, tubular or prismatic pillars made of steel, having ultimate minimum tensile strength within the range 400-490 N/mm^2, and of pillars consisting of hollow profiles made of steel, having ultimate minimum tensile strength within the range 400-540 N/mm^2, subjected to compression axial load is to be not less than the value obtained, in cm^2, from the following formula:

$$A = \frac{0,7 A_D p_2 + Q_N}{12,5 - 0,045\lambda}$$

where:

p_2 : Design pressure, in kN/m^2, to be taken equal to:

- the greater of:

  $p_2 = 3,0$

  $p_2 = 1,3\ p_1$

  for pillars located below exposed deck areas
- $p_2 = 0,6\ p_0$, for pillars located below unexposed accommodation areas and above the strength deck
- $p_2 = p_0$ in other cases

p_0, p_1 : Design pressures, in kN/m^2, defined in Tab 9

λ : Slenderness of the pillar, to be obtained from the following formula:

$\lambda = 100\ \ell / \rho$

ρ : Minimum radius of gyration, in cm, of the pillar cross-section

A_D : Area, in m^2, of the portion of the deck supported by the pillar considered

Q_N : Load from pillar above, in kN, if any, or any other concentrated load

d : Nominal diameter, in mm, for tubular pillar cross-sections or the larger side, in mm, for rectangular pillar cross-sections

b_f : face plate width, in mm

Scantlings of pillars other than those above are to be considered by the Society on a case-by-case basis.

Table 8 : Scantlings of deck structures

Element	Formula	Minimum value
Strength deck plating	Thickness, in mm **(1)**: • $t = 5\,s + 0{,}022\,Lk^{1/2} + 2{,}5$ for longitudinally framed structure • $t = 6\,s + 0{,}026\,Lk^{1/2} + 3{,}0$ for transversely framed structure.	Minimum thickness, in mm: t = 6,0
Lower deck and platform plating	Thickness, in mm **(1)**: • for longitudinally framed structure, the greater of: - $t = 5\,s + 0{,}022\,Lk^{1/2} + 1{,}5$ - $t = 10\,s$ • for transversely framed structure, the greater of: - $t = 6\,s + 0{,}026\,Lk^{1/2} + 2{,}0$ - $t = 10\,s$	Minimum thickness, in mm: t = 5,0
Ordinary stiffeners	Section modulus, in cm^3: $w = 0{,}45\,C_1\,s\,\ell^2\,(p_0 + p_1)\,k$	
Primary supporting members	Section modulus, in cm^3: $w = 0{,}1\,C_2\,C_3\,s\,\ell^2\,(p_0 + p_1)\,k$ Moment of inertia, in cm^4: $I = 2{,}5\,w\,\ell$	

Note 1:

p_0, p_1 : Design pressure, in kN/m^2, defined in Tab 9

C_1 : Coefficient, defined in Tab 10

C_2 : Coefficient, defined in Tab 11

C_3 : Coefficient equal to:

- $C_3 = 1{,}00$ for weather deck area located forward of the collision bulkhead
- $C_3 = 0{,}50$ in other cases.

(1) For ships equal to or greater than 30 m in length, this thickness may be gradually tapered such as to reach, at the collision bulkhead, 80% of the value obtained from this formula.

Table 9 : Deck design pressure

Type of deck **(2)**	Location	p_0, in kN/m^2	p_1, in kN/m^2
Decks located below the design deck	Any location	• $10h_{TD}$ in general • 9 for accommodation decks	0
Design deck	Exposed area, forward of 0,075L	15	• $37\text{-}d_p$ for primary supporting members • 23 for ordinary stiffeners
	Exposed area, aft of 0,075L	11	Girders and longitudinal ordinary stiffeners: • 14 for single deck ships • 10 for other ships Other structures: • 18 for single deck ships • 12 for other ships
	Unexposed area	• $10h_{TD}$ in general • 9 for accommodation decks	0

Note 1:

d_p : Vertical distance, in m, measured from the deck under consideration to the design deck **(2)**

h_{TD} : 'Tweendeck height, in m

D_0 : Vertical distance, in m, measured from the design deck to the base line.

(1) For platforms and flats located in the machinery space, p_0+p_1 is to be not less than 25 kN/m^2.

(2) Design deck: first deck above the full load waterline extending for at least 0,6L.

Type of deck **(2)**	Location	p_0, in kN/m^2	p_1, in kN/m^2
Decks located above the design deck and to which side plating extends	Exposed area, forward of 0,075L	15	• 37-d_p for primary supporting members • 23-d_p for ordinary stiffeners
	Exposed area, aft of 0,075L	• 10 in general • 3 for shelter decks	• 15,4(T/D_0)-d_p with $0,7 \leq T/D_0 \leq 0,85$ in general • 0 for higher decks
	Unexposed area	• 10h_{TD} in general • 9 for accommodation decks	0
Decks located above the design deck and to which side plating does not extend	Exposed area, aft of 0,075L	• 5 in general • 3 for shelter decks	• 15,4(T/D_0)-d_p with $0,7 \leq T/D_0 \leq 0,85$ in general • 0 for higher decks
	Unexposed area	• 10h_{TD} in general • 9 for accommodation decks	0

Note 1:

d_p : Vertical distance, in m, measured from the deck under consideration to the design deck **(2)**

h_{TD} : 'Tweendeck height, in m

D_0 : Vertical distance, in m, measured from the design deck to the base line.

(1) For platforms and flats located in the machinery space, p_0+p_1 is to be not less than 25 kN/m^2.

(2) Design deck: first deck above the full load waterline extending for at least 0,6L.

Table 10 : Coefficient C_1

Type of ordinary stiffener	Location	C_1
Longitudinal	Strength deck and decks below, within 0,4 L amidships	1,44
	Strength deck, forward of 0,12 L from the fore end	1,00
	Other	0,63
Transverse	Single span or end span	0,56
	Intermediate span	0,63

Table 11 : Coefficient C_2

Type of primary supporting member	Location	C_2
Longitudinal (deck girder)	Constituting longitudinal coamings of hatchways on the strength deck	7,25
	Other	4,75
Transverse (deck beam)	Constituting front beams of hatchways on the strength deck	5,60
	Other	4,75

3.8.5 Scantlings of pillars subjected to compressive axial load and bending moments

The scantlings of pillars subjected to compression axial load and bending moments are to be considered by the Society on a case-by-case basis.

3.8.6 Stringer plate thickness

The thickness of the stringer plate is to be increased by 1 mm with respect to that obtained from the formulae in [3.8.3]. In any case, it is to be not less than that of the sheerstrake.

3.8.7 Deck plating in way of masts and fishing devices

In way of masts and fishing devices, the deck thickness is to be increased by 25% with respect to that obtained from the formulae in [3.8.3].

3.8.8 Deck plating protected by wood sheathing or deck composition

The thickness of deck plating protected by wood sheathing, deck composition or other arrangements deemed suitable by the Society may be reduced by 10% with respect to that obtained from the formulae in [3.8.3]. In any case, this thickness is to be not less than 5 mm.

3.9 Tank bulkheads

3.9.1 The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 12 and the minimum values in the table.

3.10 Watertight bulkheads

3.10.1 Scantlings of plating, ordinary stiffeners and primary supporting members

The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 13 and the minimum values in the table.

3.11 Non-tight bulkheads

3.11.1 Scantlings of plating, ordinary stiffeners and primary supporting members

The scantlings of plating, ordinary stiffeners and primary supporting members are to be not less than both the values obtained from the formulae in Tab 14 and the minimum values in the table.

Table 12 : Scantlings of tank bulkheads

Element	Formula	Minimum value
Plating	Thickness, in mm: $t=1,35s(p_Lk)^{1/2}$	Minimum thickness, in mm: t = 5,5
Ordinary stiffeners	Section modulus, in cm^3 **(1)**: $w = 0,465s\ell^2p_Lk$	Minimum section modulus, in cm^3 w=20,0
Primary supporting members	Section modulus, in cm^3 $w = s\ell^2p_Lk$	
(1) For ordinary stiffeners without brackets at both ends, this modulus is to be increased by 90% with respect to that obtained from this formula.		

Table 13 : Scantlings of watertight bulkheads

Element	Formula	Minimum value
Plating	Thickness, in mm **(1)**: $t = 3,8\ s\ (hk)^{1/2}$	Minimum thickness, in mm: t = 5,0
Ordinary stiffeners	Section modulus, in cm^3 **(2)**: $w = 3\ s\ \ell^2\ h_Bk$	Minimum section modulus, in cm^3: w = 10,0
Primary supporting members	Section modulus, in cm^3 **(3)**: $w = 6\ s\ \ell^2\ h_Bk$	
Note 1: h : Vertical distance, in m, between the lowest point of the plating and the highest point of the bulkhead. h_B : Vertical distance, in m, between the mid-span point of the ordinary stiffener and the highest point of the bulkhead. **(1)** For the lower strake, this thickness is to be increased by 1 mm with respect to that obtained from this formula. **(2)** For ordinary stiffeners without brackets at both ends, this modulus is to be increased by 90% with respect to that obtained from this formula. **(3)** For the collision bulkhead, this modulus is to be increased by 12,5% with respect to that obtained from this formula.		

Table 14 : Scantlings of non-tight bulkheads

Element	Formula
Plating	Minimum thickness, in mm: • t = 5,0 for bulkhead acting as pillar • t = 4,0 for bulkhead not acting as pillar.
Vertical ordinary stiffeners	Net section modulus, in cm^3: • $w = 2,65\ s\ \ell^2 k$ for bulkhead acting as pillar • $w = 2,00\ s\ \ell^2 k$ for bulkhead not acting as pillar.

3.12 Connection of the fore part with the structures located aft of the collision bulkhead

3.12.1 Where the area between 0,15 L from the forward perpendicular and the collision bulkhead is transversely framed, side girders are to be fitted in line with those of the fore peak.

The web of such side girders is to be made of intercostal plates and the face plate is to be made of a flat bar continuous across the vertical primary supporting members and connected to them.

The thickness t of plates, in mm, and the area A of the flat bar, in cm^2, are to be not less than the values obtained from the following formula:

$t = 0,032\ Lk^{1/2} + 6$

without being taken less than 6,5 mm.

$A = 0,11\ Lk + 5,5$

without being taken less than 8 cm^2.

3.12.2 The above mentioned side girders may be omitted provided that the thickness of the side plating in the corresponding zone of the ship is increased by 20% with respect to that obtained from the formulae in [3.7].

3.13 Fore peak longitudinally framed bottom

3.13.1 Floors

Floors are to be fitted at every four frame spaces and, in general, spaced no more than 2,5 m apart.

The floor dimensions and scantlings are to be not less than the values obtained from Tab 15.

In no case may the above scantlings be less than the values obtained from the formulae in Pt B, Ch 9, Sec 1, [2.6.2] for the corresponding side transverses.

3.13.2 Centre girder

Where no centreline bulkhead is fitted, a centre bottom girder is to be fitted having dimensions and scantlings not less than those specified in [3.13.1] for floors.

The centre bottom girder is to be connected to the collision bulkhead by means of a large end bracket.

3.13.3 Side girders

Side girders, having dimensions and scantlings not less than those specified in [3.13.1] for floors, are generally to be fitted every two longitudinals, in line with bottom longitudinals located aft of the collision bulkhead. Their extension is to be compatible in each case with the shape of the bottom.

3.14 Fore peak transversely framed bottom

3.14.1 Floors

The floor dimensions and scantlings are to be not less than those specified in Tab 15.

3.14.2 Centre girder

Where no centreline bulkhead is fitted, a centre bottom girder is to be fitted in accordance with Pt B, Ch 9, Sec 1, [2.4.3].

3.15 Fore peak longitudinally framed side

3.15.1 Side transverses

Side transverses are to extend to the upper deck and the ends of every span are to be amply faired in way of bottom and deck transverses.

The section modulus is to be not less than the value obtained, in cm^3, from the following formula:

$w = s\ \ell^2\ p_E k$

3.15.2 Horizontal rings

The platforms in Pt B, Ch 9, Sec 1, [2.9] may be replaced by equivalent structures consisting of horizontal rings (side girders, horizontal webs on the collision bulkhead and longitudinal centreline bulkhead, if any, or a substantial breasthook on the stem) supported by struts in way of side transverses. The struts are to be firmly connected by means of vertical pillars and longitudinal primary supporting members.

Table 15 : Longitudinally framed bottoms - Floor dimensions and scantlings

Dimension or scantling	Value
Web height, in m	$h_M = 0,085\ D + 0,15$
Web thickness, in mm	To be not less than the value obtained from the formulae in [3.5] for double bottom floors aft of the collision bulkhead; in any case, it need not be taken greater than 11,5 mm.
Floor flange sectional area, in cm^2	$A_P = 1,85\ D$

3.16 Fore peak transversely framed side

3.16.1 Ordinary stiffeners (side frames)

Side frames fitted at every frame spacing are to have the same vertical extension as the collision bulkhead.

The section modulus is to be not less than the value obtained, in cm^3, from the following formula:

$w = 0,9\ s\ \ell^2\ p_E k$

3.16.2 Side girders

Depending on the hull body shape and structure aft of the collision bulkhead, one or more adequately spaced side girders per side are to be fitted.

The section modulus of the side girder is to be not less than the value obtained in [3.7].

Moreover, the breadth b, in mm, and the thickness t, in mm, of the side girder web are generally to be not less than the values obtained from the following formulae:

$b_A = 2,5\ (180 + L)$

$t_A = 6,5 + 0,02\ L k^{1/2}$.

3.16.3 Panting structures

In order to withstand the panting loads, horizontal structures are to be provided. These structures are to be fitted at a spacing in general not exceeding 1,2 m and consist of side girders supported by panting beams, so as to form a strengthened ring structure.

Panting beams, which generally consist of sections having the longer side vertically arranged, are to be fitted every two frames.

3.16.4 Connection between panting beams, side frames and side girders

Every panting beam is to be connected to the side transverses by means of brackets whose lengths are generally to be not less than twice the panting beam depth.

3.16.5 Connection between side frames and side girders

Side transverses not supporting panting beams are to be connected to side girders by means of brackets having the same thickness as that of the side girder and arms which are to be not less than one half of the breadth of the side girder.

3.16.6 Panting beam scantlings

The area A_B, in cm^2, and the inertia J_B, in cm^4, of the panting beam section are to be not less than the values obtained from the following formulae:

$A_B = 0,55\ L - 20$

$J_B = 0,37\ (0,5\ L - 18)\ b_B^2$

where:

b_B : Beam length, in m, measured between the internal edges of side girders or the internal edge of the side girder and any effective central or lateral support.

Where side girder spacing is other than 2 m, the values A_B and J_B are to be modified according to the relation between the actual spacing and 2 m.

3.16.7 Panting beam of considerable length

Panting beams of considerable length are generally to be supported at the centreline by a wash bulkhead or pillars arranged both horizontally and vertically.

3.16.8 Non-tight platforms

Non-tight platforms may be fitted in lieu of side girders and panting beams. Their scantlings are to be in accordance with [3.17].

3.17 Fore peak platforms

3.17.1 General

The number and depth of non-tight platforms within the peak is to be considered by the Society on a case-by-case basis.

3.17.2 Minimum thickness of non-tight platforms

The thickness of non-tight platforms is to be not less than 4 mm.

3.17.3 Ordinary stiffeners of non-tight platforms

The section modulus of ordinary stiffeners of non-tight platforms is to be not less than the value obtained, in cm^3, from the following formula:

$w = 0,2\ s\ \ell^2 k$

3.17.4 Platform transverse primary supporting members

The sectional area of platform transverse primary supporting members, calculated considering a width of attached plating whose sectional area is equal to that of the transverse flange, is to be not less than the value obtained, in cm^2, from the following formula:

$$A = \frac{p_E d_S b_S k}{10 C_P}$$

where:

p_E : Design pressure, acting at the ends of the platform transverse primary supporting member in the direction of its axis

d_S : Half of the longitudinal distance, in m, between the two transverse primary supporting members longitudinally adjacent to that under consideration

b_S : Half of the vertical distance, in m, between the two transverse primary supporting members vertically adjacent to that under consideration

C_P : Coefficient, to be taken equal to:

$$C_P = 1 \quad \text{for} \quad \frac{d_P}{r_P} \le 70$$

$$C_P = 1,7 - 0,01\frac{d_P}{r_P} \quad \text{for} \quad 70 < \frac{d_P}{r_P} \le 140$$

When $d_P / r_P > 140$, the scantlings of the transverse primary supporting member are to be considered by the Society on a case-by-case basis.

d_P : Distance, in cm, from the face plate of the side transverse and that of the bulkhead vertical web, connected by the platform transverse primary supporting member, measured at the level of the transverse primary supporting member

r_P : Radius of gyration of the transverse primary supporting member, to be obtained, in cm, from the following formula:

$$r_P = \sqrt{\frac{J}{A_E}}$$

J : Minimum moment of inertia, in cm^4, of the transverse primary supporting member considered

A_E : Actual sectional area, in cm^2, of the transverse section of the transverse primary supporting member considered.

3.18 Bulbous bow

3.18.1 General

Where a bulbous bow is fitted, fore peak structures are to effectively support the bulb and are to be adequately connected to its structures.

3.18.2 Plating

The thickness of the shell plating of the fore end of the bulb and the first strake above the keel is generally to be not less than that required in [3.20.2] for plate stems. This thickness is to be extended to the bulbous zone.

3.18.3 Connection with the fore peak

Fore peak structures are to be extended inside the bulb as far as its size and shape permit.

3.18.4 Longitudinal stiffeners

Bottom and side longitudinals are to extend inside the bulb, forward of the fore perpendicular, by at least 30% of the bulb length measured from the perpendicular to the fore end of the bulb.

The fore end of longitudinals is to be located in way of a reinforced transverse ring; forward of such ring, longitudinals are to be replaced by ordinary transverse rings.

3.18.5 Floors

Solid floors are to be part of reinforced transverse rings generally spaced not more than 3 frame spaces apart.

3.18.6 Breasthooks

Breasthooks, to be placed in line with longitudinals, are to be extended on the sides aft of the stem, so as to form longitudinal side girders.

3.19 Reinforcement of the flat bottom forward area

3.19.1 Area to be reinforced

The flat bottom forward area is located over the bottom between 0,25 L aft of the fore end and the collision bulkhead.

The reinforcement of the bottom forward area is to be considered if:

$T_F < 0{,}03\ L$

where T_F is the minimum forward draught, in m, among those foreseen in operation for all the loading conditions.

3.19.2 Arrangement of longitudinally framed bottom

Solid floors are to be fitted at every two frame spaces.

Adequately spaced side girders are to be fitted or, as an alternative, ordinary stiffeners having increased scantlings may be fitted.

3.19.3 Arrangement of transversely framed bottom

Solid floors are to be fitted at every frame spacing.

Side girders with a depth equal to that of the floors are to be fitted.

3.19.4 Plating

The thickness of the flat bottom forward area plating is to be not less than the value obtained, in mm, from the following formula:

$t = 0{,}1\ L k^{1/2} + 10\ s$

3.19.5 Ordinary stiffeners and primary supporting members

For a longitudinally framed bottom, the scantlings of ordinary stiffeners and primary supporting members are to be not less than those obtained from [3.2], where the span length ℓ of ordinary stiffeners is to be taken not less than 1,8 m.

For a transversely framed bottom, the scantlings of ordinary stiffeners and primary supporting members are to be not less than those obtained from [3.3].

3.20 Stems

3.20.1 Arrangements

Adequate continuity of strength is to be ensured at the connection of stems to the surrounding structure.

Abrupt changes in sections are to be avoided.

3.20.2 Plate stems

The plating forming the stems is to be supported by horizontal diaphragms spaced not more than 1200 mm apart and connected, as far as practicable, to the adjacent frames and side girders.

If considered necessary, and particularly where the stem radius is large, a centreline stiffener or web of suitable scantlings is to be fitted.

The thickness of the plates below the load waterline is to be not less than the value obtained, in mm, from the following formula:

$t = 1,37\ (0,95 + L^{1/2})k^{1/2}$

Above the load waterline this thickness may be gradually tapered towards the stem head, where it is to be not less than that required for side plating at ends.

3.20.3 Bar stems

The area of bar stems constructed of forged or rolled steel is to be not less than the value obtained, in cm^2, from the following formula:

$$A = \left(0,40 + \frac{10T}{L}\right)(0,009L^2 + 20)k$$

where the ratio T/L in the above formulae is to be taken neither less than 0,05 nor more than 0,075.

The cross-sectional area of the stem may be gradually tapered from the load waterline to the upper end, where it may be equal to two thirds of the value as calculated above.

The thickness of the bar stem is to be not less than the value obtained, in mm, from the following formula:

$t = 0,4\ Lk^{1/2} + 13$

The lower part of the stem may be constructed of cast steel; where necessary, a vertical web is to be fitted for welding of the centre keelson.

Welding of the bar stem with the bar keel and the shell plating is to be in accordance with Pt B, Ch 12, Sec 1, [3.4].

3.21 Sternframes

3.21.1 Application

These requirements apply to sternframes of single screw ships.

Sternframes of twin screw ships are to be considered by the Society on a case-by-case basis.

3.21.2 General

Sternframes may be constructed of cast or forged steel, with a hollow section, or fabricated from plates.

Cast steel and fabricated sternframes are to be strengthened by adequately spaced horizontal plates.

In castings, abrupt changes of section are to be avoided; all sections are to have adequate tapering radius.

3.21.3 Connections with the hull structure

Sternframes are to be effectively attached to the aft structure and the lower part of the sternframe is to be extended forward of the propeller post to a length not less than 1500 + 6 L mm, in order to provide an effective connection with the keel. However, the sternframe need not extend beyond the after peak bulkhead.

The thickness of bottom plating connected with the sternframe is to be not less than that obtained, in mm, from the following formula:

$t = 0,05\ Lk^{1/2} + 7$

3.21.4 Connection with the keel

The thickness of the lower part of the sternframes is to be gradually tapered to that of the solid bar keel or keel plate.

Where a keel plate is fitted, the lower part of the sternframe is to be so designed as to ensure an effective connection with the keel.

3.21.5 Connection with centre keelson

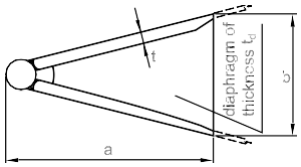
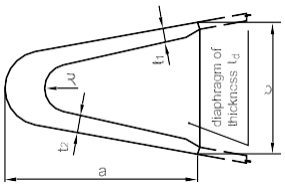
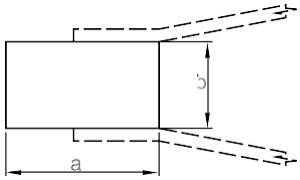
Where the sternframe is made of cast steel, the lower part of the sternframe is to be fitted, as far as practicable, with a longitudinal web for connection with the centre keelson.

3.21.6 Scantlings of propeller posts

The scantlings of propeller posts are to be not less than the values obtained from the formulae in Tab 16.

Scantlings and proportions of the propeller post which differ from those above may be considered acceptable provided that the section modulus of the propeller post section about its longitudinal axis is not less than that calculated with the propeller post scantlings in Tab 16.

Table 16 : Single screw ships - Scantlings of propeller posts

Gross scantlings of propeller posts	Fabricated propeller post	Cast propeller post	Bar propeller post, cast or forged, having rectangular section
			
a, in mm	$50\ L^{1/2}$	$33\ L^{1/2}$	$10\sqrt{2,5(L+10)}$
b, in mm	$35\ L^{1/2}$	$23\ L^{1/2}$	$10\sqrt{1,6(L+10)}$
t_1, in mm	$2,5\ L^{1/2}$	$3,2\ L^{1/2}$	ϕ
t_2, in mm	ϕ	$4,4\ L^{1/2}$	ϕ
t_D, in mm	$1,3\ L^{1/2}$	$2,0\ L^{1/2}$	ϕ
R, in mm	ϕ	$50\ L^{1/2}$	ϕ

Note 1:
ϕ = not applicable.

3.21.7 Propeller shaft bossing

In single screw ships, the thickness of the propeller shaft bossing, included in the propeller post, is to be not less than 60% of that required in Pt B, Ch 9, Sec 2, [6.3.2] for bar propeller posts with a rectangular section.

3.22 Machinery casings

3.22.1 Engine room skylight coamings

If the engine room skylights are fitted with opening-type covers providing light and air, the height of coamings is to be not less than:

- 900 mm, for skylights located on working decks
- 300 mm, for skylights located on superstructure decks.

3.22.2 Casing plating

The plating thickness of unprotected casing bulkheads is to be not less than the value obtained from the formulae in [3.23]. In any case, the plating thickness of protected or unprotected casing bulkheads is to be not less than 5 mm.

3.22.3 Casing vertical ordinary stiffeners

The section modulus of vertical ordinary stiffeners is to be not less than the value obtained, in cm^3, from the following formula:

$w = 2,6\ s\ \ell^2 k$

In addition to the above, the section modulus of vertical ordinary stiffeners of casings acting as pillars is to be not less than the value obtained from the formulae in [3.8], where the width, in mm, of the attached plating is to be less than 50 times the attached plating thickness.

3.22.4 Scantlings of engine room skylight coamings

The thickness of engine room skylight coamings is to be not less than 6 mm.

Where the height of engine room skylight coamings is greater than 900 mm, the section modulus of vertical ordinary stiffeners with spacing not greater than 760 mm is to be increased by 10% with respect to that obtained from the formula in [3.23] for vertical ordinary stiffeners of deckhouses.

3.23 Superstructures and deckhouses

3.23.1 Load point

Lateral pressure is to be calculated at:

- mid-height of the bulkhead, for plating
- mid-span, for stiffeners.

3.23.2 Design pressure

The design pressure to be used for the determination of scantlings of the structure of front, side and aft bulkheads of superstructures and deckhouses is to be obtained, in kN/m^2, from the following formula:

$p = 10\ a\ c\ [b\ f - (z - T)]$

without being less than p_{min},

where:

a : Coefficient defined in Tab 17

Table 17 : Lateral pressure for superstructures and deckhouses - Coefficient a

Type of bulkhead	Location	a
Unprotected front	Lowest half	$2 + \frac{L}{120}$
	Second half	$1 + \frac{L}{120}$
Aft end	Any location, when x/L ≤ 0,5	$0,7 + \frac{L}{1000}, \frac{x}{L}$
	Any location, when x/L > 0,5	$0,5 + \frac{L}{1000}, \frac{x}{L}$
Other	Any location	0,5 + 0,0067 L

c : Coefficient taken equal to:

$$c = 0,3 + 0,7\frac{b_1}{B_1}$$

For exposed parts of machinery casings, c is to be taken equal to 1

b_1 : Breadth of deckhouse, in m, at the position considered, to be taken not less than 0,25 B_1

B_1 : Actual maximum breadth of ship on the exposed weather deck, in m, at the position considered

b : Coefficient defined in Tab 18

Table 18 : Lateral pressure for superstructures and deckhouses - Coefficient b

Location of bulkhead **(1)**	b
$\frac{x}{L} \leq 0,45$	$1 + \left(\frac{\frac{x}{L} - 0,45}{C_B + 0,2}\right)^2$
$\frac{x}{L} > 0,45$	$1 + 1,5\left(\frac{\frac{x}{L} - 0,45}{C_B + 0,2}\right)^2$

Note 1:

C_B : Block coefficient, with $0,6 \leq C_B \leq 0,8$

(1) For deckhouse sides, the deckhouse is to be subdivided into parts of approximately equal length, not exceeding 0,15L each, and x is to be taken as the co-ordinate of the centre of each part considered.

f : Coefficient equal to:

$$f = \frac{L}{10} e^{-L/300} - \left[1 - \left(\frac{L}{150}\right)^2\right]$$

p_{min} : Minimum lateral pressure defined in Tab 19.

3.23.3 Plating

The plating thickness is to be not less than the value obtained from Tab 20.

3.23.4 Deck ordinary stiffeners

The section modulus of ordinary stiffeners is to be not less than the value obtained from the formulae in [3.8].

Table 19 : Lateral minimum pressure for superstructures and deckhouses

Type of bulkhead	Location	p_{min}, in kN/m^2
Unprotected front	Lowest tier	30
	Second and third tiers	15
Protected front, side and aft end	Lowest, second and third tiers	15

3.23.5 Bulkhead vertical ordinary stiffeners

The section modulus of bulkhead ordinary stiffeners, connected at their ends by lugs or directly welded to the decks, is to be not less than the value obtained, in cm^3, from the following formula:

$w = 0{,}35\ s\ \ell^2\ pk$

where:

p : Design pressure, in kN/m^2, defined in Pt B, Ch 9, Sec 4, [2.2.2]

ℓ : Span, in m, of primary supporting members, to be taken not less than 2 m.

The scantlings of ordinary stiffeners connected at their ends other than as above are to be considered by the Society on a case-by-case basis.

3.23.6 Vertical ordinary stiffeners (frames) of complete or partial superstructures

The section modulus of vertical ordinary stiffeners of complete or partial superstructures is to be not less than both the value obtained from the formulae in [3.7] for 'tweendeck ordinary stiffeners and the value obtained from the formula in [3.23.5].

3.24 Hatch covers

3.24.1 Height of hatch coamings

The height above the deck of hatch coamings closed by portable covers is to be not less than:

- 600 mm, for hatch covers located on exposed areas of the working deck
- 300 mm, for hatch covers located on exposed areas of the lowest tier of superstructures.

3.24.2 Height of hatch coamings on exposed decks of ships having L < 18 m and navigation notation "coastal area" *(1/7/2006)*

The height above the deck of hatch coamings closed by portable covers, located on exposed areas of ships having L < 18 m and navigation notation **coastal area**, is to be not less than:

- 400 mm, for hatch covers located on the working deck
- 150 mm, for hatch covers located on the lower tier of superstructures.

3.24.3 Hatch coaming thickness

The thickness of hatch coaming plating is to be not less than the value obtained from the formulae in [3.8] for the ship's deck.

Table 20 : Plating thickness

Plating	Location	Thickness, in mm **(1) (2)**	Minimum thickness, in mm
Front bulkheads	Lowest tier	$3\ s\ (pk)^{1/2}$	$6k^{1/2}$
	Second tier and above	$3\ s\ (pk)^{1/2}$	$5k^{1/2}$
Side and aft bulkheads	All tiers	$3\ s\ (pk)^{1/2}$	$5k^{1/2}$
Unprotected deck of deckhouses	Lowest tier	$3,3\ s + 0,0085\ Lk^{1/2} + 3,2$	$6k^{1/2}$
	Second tier	$3,0\ s + 0,0077\ Lk^{1/2} + 2,9$	$5k^{1/2}$
	Third tier and above	$2,8\ s + 0,0072\ Lk^{1/2} + 2,7$	$5k^{1/2}$
Unprotected deck of bridge and forecastle	Lowest tier	$c_1\ (5\ s + 0,013\ Lk^{1/2} + 2,5)$	$6k^{1/2}$
	Second tier	$0,9\ c_1\ (5\ s + 0,013\ Lk^{1/2} + 2,5)$	$5k^{1/2}$
	Third tier and above	$0,85\ c_1\ (5\ s + 0,013\ Lk^{1/2} + 2,5)$	$5k^{1/2}$
Unprotected deck of poop	Lowest tier	$c_1\ (4,5\ s + 0,01\ Lk^{1/2} + 2,5)$	$6k^{1/2}$
	Second tier	$0,9\ c_1\ (4,5\ s + 0,01\ Lk^{1/2} + 2,5)$	$5k^{1/2}$
	Third tier and above	$0,85\ c_1\ (4,5\ s + 0,01\ Lk^{1/2} + 2,5)$	$4k^{1/2}$

Note 1:

c_1 : Coefficient, to be taken equal to:

- $c_1 = 0,9$ for $T / D < 0,7$
- $c_1 = 1 - (0,56 - 0,66\ (T / D))$ for $0,7 \leq T / D < 0,85$
- $c_1 = 1$ for $T / D \geq 0,85$

p : Design pressure, in kN/m^2, defined in [3.23.2].

(1) For decks of superstructures and deckhouses protected by other superstructures or deckhouses housing accommodation or service spaces, the thickness may be reduced by 10% with respect to that obtained from this formula.

(2) For decks sheathed with wood, the thickness may be reduced by 10% with respect to that obtained from this formula.

3.25 Aft ramp

3.25.1 Minimum net thickness of the aft ramp and the lower part of the aft ramp side

The net thickness of plating of the aft ramp and the lower part of the aft ramp side is to be not less than 11 mm.

3.25.2 Plating of the aft ramp and the lower part of the aft ramp side

The net thickness of plating of the aft ramp and the lower part of the aft ramp side is to be increased by 2 mm with respect to that calculated according to [3.7] for side plating with the same plate panel dimensions.

3.25.3 Plating of the upper part of the aft ramp side

The net thickness of plating of the upper part of the aft ramp side is to be not less than the value calculated according to [3.7] for side plating with the same plate panel dimensions.

3.26 Arrangement for hull and superstructure openings

3.26.1 Sidescuttles

Sidescuttles may not be fitted in such a position that their sills are below a line drawn parallel to the sheer at side and having its lowest point 0,5 m above the summer load waterline.

No sidescuttles may be fitted in any spaces which are appropriated exclusively for the carriage of cargo.

3.26.2 Freeing ports

The freeing port area in bulwarks is to be not less than the value obtained from the formulae in Pt B, Ch 9, Sec 9, [5].

For ships with L < 24 m and navigation notation **coastal area**, the freeing port area in bulwarks on each side of the ship may be not less than the value obtained from the following formula:

$A = 0,035\ \ell_B + A_C$

where:

ℓ_B : Length, in m, of bulwark in the well, to be taken not greater than 0,7 L

A_C : Area, in m^2, to be taken, with its sign, equal to:

$A_C = 0,04\ \ell_B\ (h_B - 1,2)$ for $h_B > 1,2$

$A_C = 0$ for $0,9 \leq h_B \leq 1,2$

$A_C = 0,04\ \ell_B\ (h_B - 0,9)$ for $h_B < 0,9$

h_B : Mean height, in m, of bulwark in the well of length ℓ_B.

3.26.3 Openings in bulkheads of enclosed superstructures and other outer structures

All access openings in bulkheads of enclosed superstructures and other outer structures (e.g. machinery casings) through which water can enter and endanger the ship are to be fitted with doors of steel or other equivalent material, permanently and strongly attached to the bulkhead, and framed, stiffened and fitted so that the whole structure is of equivalent strength to the unpierced bulkhead and weathertight when closed. The doors are to be capable of being operated from both sides and generally to open outwards to give additional protection against wave impact.

These doors are to be fitted with gaskets and clamping devices or other equivalent means permanently attached to the bulkhead or to the door themselves.

Other openings are to be fitted with equivalent covers, permanently attached in their proper position.

3.26.4 Door sills *(1/7/2006)*

a) The height of the sill of the doors is to be not less than:
   - 600 mm above the working deck
   - 300 mm above the deck of the lower tier of superstructures.

   For doors protected from the direct impact of waves, except for those giving direct access to machinery spaces, the height of the sill may be taken not less than:
   - 380 mm above the working deck
   - 150 mm above the deck of the lower tier of superstructures.

b) For vessels less than 24 m in length, depending on their navigation notation and the relevant position on the exposed deck, the Society may accept reduced height door sills in respect of the values given above.

3.26.5 Ventilator coamings

The height of ventilator coamings is to be not less than the value obtained from Tab 21.

The thickness of ventilator coaming plating is to be not less than both the value obtained from the formulae in [3.8] for the ship's deck and the value obtained from the formulae in [3.23] for a deckhouse in the same position as the ventilator.

Ventilator coamings are to be provided with weathertight closing appliances to be used in rough weather. These appliances may be omitted when the ventilator height is greater than the minimum value specified in Tab 21.

Table 21 : Ventilator coamings

Ship's length, in m	Coaming height **(1)**, in mm		Minimum height of ventilators, in m	
	Ventilators openings on working decks	Ventilators openings on decks of lower tier of superstructure	Ventilators openings on working decks	Ventilators openings on decks of lower tier of superstructure
$L > 45$	900	760	4,5	2,3
$24 \leq L \leq 45$	760	450	3,4	1,7
$12 \leq L < 24$	760	450	2,5	1,0
$L < 12$	300	300	2,5	1,0

(1) When necessary, the coaming height is to be adequately increased in the machinery space, in order to avoid free entry of sea water.

4 Scantlings of masts and fishing devices (e.g. gantries and trawl gallows)

4.1 Design loads

4.1.1 The design loads to be considered for the strength check of masts and fishing devices are:

- the weights of booms and net hauling fittings
- the cargo loads, to be taken equal to the maximum break loads of the winches.

4.1.2 Adequate safety factors are to be used when designing supporting structure for fishing gear, taking into account operational conditions and wave effects.

4.2 Strength check

4.2.1 Calculation of stresses in the structural elements

The stresses in the structural elements of masts and fishing devices are to be obtained by means of direct calculations, using the design loads specified in [4.1].

4.2.2 Yielding check

The von Mises equivalent stresses in the structural elements of masts and fishing devices are to comply with the following formula:

$\sigma_E \leq 0{,}5R_{eH}$

where:

σ_E : Von Mises equivalent stress, in N/mm^2, to be obtained as a result of direct calculations

R_{eH} : Minimum yield stress, in N/mm^2, of the material, defined in Pt B, Ch 4, Sec 1, [2].

4.2.3 Buckling check

The buckling strength of the structural elements of masts and fishing devices is to be checked in compliance with Part B, Chapter 7 or Part B, Chapter 8, as applicable.

5 Hull outfitting

5.1 Rudder stock scantlings

5.1.1 The rudder stock diameter is to be increased by 5% with respect to that obtained from the formula in Pt B, Ch 10, Sec 1, [4].

5.2 Propeller shaft brackets

5.2.1 General

Propeller shafting is either enclosed in bossing or independent of the main hull and supported by shaft brackets.

5.2.2 Double arm propeller shaft brackets

The scantlings of double arm propeller shaft brackets are to be obtained from the formulae in Pt B, Ch 10, Sec 3, [1.2].

5.2.3 Single arm propeller shaft brackets

For ships less than 30 m in length, single arm propeller shaft brackets may be fitted. Their scantling are to be considered by the Society on a case-by-case basis.

5.3 Equipment

5.3.1 General

Fishing vessels are to be provided with equipment in anchors, chain cables and ropes to be obtained from Tab 22, based on their Equipment Number EN, to be calculated according to Pt B, Ch 10, Sec 4, [2].

The equipment in anchors, chain cables and ropes of fishing vessels with the navigation notation **coastal area** may be obtained from Tab 22 based on the Equipment Number EN corresponding to the row above that relevant to the Equipment Number calculated for the ship considered.

In general, stockless anchors are to be adopted.

For ships with EN greater than 720, the determination of the equipment is to be considered by the Society on a case-by-case basis.

5.3.2 Anchors

The required mass for each anchor is to be obtained from Tab 22.

The individual mass of a main anchor may differ by ±7% from the mass required for each anchor, provided that the total mass of anchors is not less than the total mass required in Tab 22.

The mass of the head of an ordinary stockless anchor, including pins and accessories, is to be not less than 60% of the total mass of the anchor.

Where a stock anchor is provided, the mass of the anchor, excluding the stock, is to be not less than 80% of the mass required in Tab 22 for a stockless anchor. The mass of the stock is to be not less than 25% of the mass of the anchor without the stock but including the connecting shackle.

5.3.3 Scantlings of stud link chain cables

The mass and geometry of stud link chain cables, including the links, are to be in compliance with the requirements in Pt D, Ch 4, Sec 1, [2].

The diameter of stud link chain cables is to be not less than the value in Tab 22.

5.3.4 Chain cable arrangement

Chain cables are to be made by lengths of 27,5 m each, joined together by Dee or lugless shackles.

The total length of chain cables, as required in Tab 22, is to be divided into approximately equal parts between the two anchors ready for use.

Where different arrangements are provided, they are to be considered by the Society on a case-by-case basis.

5.3.5 Wire ropes *(1/7/2018)*

As an alternative to the stud link chain cables mentioned, wire ropes may be used for both the anchors, for ship's length less than 40 m.

The wire ropes above are to have a total length equal to 1,5 times the corresponding required length of stud link chain cables, obtained from Tab 22, and a minimum breaking load equal to that given for the corresponding stud link chain cable (see [5.3.3]).

A short length of chain cable is to be fitted between the wire rope and the anchor, having a length equal to 12,5 m or the distance from the anchor in the stowed position to the winch, whichever is the lesser.

All surfaces being in contact with the wire are to be rounded with a radius of not less than 10 times the wire rope diameter (including stem).

When chain cables are replaced by trawl warps, the anchor is to be positioned on the forecastle deck so that it may be readily cast after it has been shackled to the trawl warp. Chocks or rollers are to be fitted at suitable locations, along the path of the trawl warps, between the winch and the mooring chocks.

6 Protection of hull metallic structures

6.1 Protection of deck by wood sheathing

6.1.1

Before fitting the wood sheathing, deck plating is to be protected with suitable protective coating.

The thickness of wood sheathing of decks is to be not less than:

- 65 mm, if made of pine
- 50 mm, if made of hardwood, such as teak.

The width of planks may not exceed twice their thickness.

6.2 Protection of cargo sides by battens

6.2.1 In cargo spaces, where thermal insulation is fitted, battens formed by spaced planks are generally to be fitted longitudinally.

6.3 Deck composition

6.3.1 The deck composition is to be of such a material as to prevent corrosion and is to be effectively secured to the steel structures underneath by means of suitable connections.

Table 22 : Equipment *(1/1/2022)*

Equipment number EN A< EN ≤ B		Stockless anchors		Stud link chain cables for anchors			Mooring lines		
A	B	N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		N	Length of each line, in m	Ship Design Minimum Breaking load, in kN
					mild steel	high strength steel			
30	40	2	80	165	11		2	50	29
40	50	2	100	192,5	11		2	60	29
50	60	2	120	192,5	12,5		2	60	29
60	70	2	140	192,5	12,5		2	80	29
70	80	2	160	220	14	12,5	2	100	34
80	90	2	180	220	14	12,5	2	100	37
90	100	2	210	220	16	14	2	110	37
100	110	2	240	220	16	14	2	110	39
110	120	2	270	247,5	17,5	16	2	110	39
120	130	2	300	247,5	17,5	16	2	110	44
130	140	2	340	275	19	17,5	2	120	44
140	150	2	390	275	19	17,5	2	120	49
150	175	2	480	275	22	19	2	120	54
175	205	2	570	302,5	24	20,5	2	120	59
205	240	2	660	302,5	26	22	2	120	64
240	280	2	780	330	28	24	3	120	71
280	320	2	900	357,5	30	26	3	140	78
320	360	2	1020	357,5	32	28	3	140	86
360	400	2	1140	385	34	30	3	140	93
400	450	2	1290	385	36	32	3	140	101
450	500	2	1440	412,5	38	34	3	140	108
500	550	2	1590	412,5	40	34	4	160	113
550	600	2	1740	440	42	36	4	160	118
600	660	2	1920	440	44	38	4	160	123
660	720	2	2100	440	46	40	4	160	127

SECTION 4 MACHINERY

1 General

1.1 Application

1.1.1 Machinery systems fitted on board ships having the notation **fishing vessel** are to comply with the relevant sections of Part C, Chapter 1, with the exception of the following systems:

- bilge system
- scuppers and sanitary discharges
- air pipes and sounding devices
- refrigerating installations,

for which substitutive requirements are provided in this Section.

1.1.2 This Section does not cover the design and performances of the fishing equipment. However, the piping systems and pressure vessels serving the fishing equipment are required to comply with the relevant Sections of Part C.

1.2 Documents to be submitted

1.2.1 In addition to the documents listed in Part C, Chapter 1, the diagram of the piping systems (hydraulic system, etc.) serving the fishing equipment is to be submitted for approval.

2 Bilge system

2.1 General

2.1.1 Application

The following provisions supersede those given in Pt C, Ch 1, Sec 10, [6].

2.1.2 Principle

a) Fishing vessels are to be provided with an efficient bilge pumping system capable of pumping from and draining, under all practical conditions, any watertight compartment other than spaces exclusively intended for the carriage of fresh water, water ballast or fuel oil, for which other efficient means of pumping are to be provided.

b) In fishing vessels where fishing handling or processing may cause quantities of water to accumulate in enclosed spaces, adequate drainage is to be provided.

c) The bilge pumping system is to consist of pumps connected to a bilge main line so arranged as to allow the draining of all spaces mentioned in a).

d) Bilge pumping arrangement may be dispensed with in particular compartments provided the safety of the ship is not impaired.

e) Where expressly permitted, some small compartments may be drained by means of hand pumps.

f) Bilge and ballast systems are to be so designed as to prevent the possibility of water passing from the sea and from water ballast spaces into the cargo and machinery spaces, or from one compartment to another. Provisions are to be made to prevent any space having bilge and ballast connections being inadvertently flooded from the sea when containing cargo, or being discharged through the bilge system when containing water ballast.

2.2 Design of the bilge system

2.2.1 General

a) All suction pipes up to the connection with the bilge pumps are to be independent from any other piping system of the ship.

b) Non-return valves are to be fitted on:
   - the pipe connections to bilge distribution boxes

- the suctions of pumps also having connections from the sea or from compartments normally intended to contain liquid
- the direct suctions connected to independent bilge pumps, where required.

c) All compartments are to be provided with at least one suction on each side. However, in the case of short and narrow compartments, a single suction ensuring an efficient draining may be accepted.

2.2.2 Draining of machinery spaces

a) Machinery spaces of ships with double bottom, or where the rise of floor is less than 5°, are to be provided on each side with one bilge suction connected to the bilge main.

b) Machinery spaces of ships without double bottom, or where the rise of floor is equal to or exceeds 5°, may be provided with only one bilge suction located in the centreline and connected to the bilge main.

c) In addition to the bilge suctions required in a) and b), machinery spaces of ships of 24 m length or more are to be provided with a direct suction, which is to be led direct to an independent power bilge pump and so arranged that it can be used independently of the bilge main.

2.2.3 Draining of holds

a) Holds of ships with double bottom, or where the rise of floor is less than 5°, are to be provided on each side with one bilge suction connected to the bilge main.

b) Holds of ships without double bottom, or where the rise of floor is equal to or exceeds 5°, may be provided with only one bilge suction located in the centreline and connected to the bilge main.

2.2.4 Draining of refrigerated spaces

Refrigerated spaces are to be provided with drainage arrangement allowing the continuous drainage of condensates.

2.2.5 Draining of fore and aft peaks

a) Fore and aft peaks, where not used as tanks, are to be fitted with a bilge suction connected to the bilge main. Passage through the collision bulkhead is to comply with Pt C, Ch 1, Sec 10, [5.3.3].

b) Peaks of small dimensions may be drained by means of a hand pump provided that the suction lift is well within the capacity of the pump and in no case exceeds 7,30 m.

2.2.6 Draining of double bottom compartments

Double bottom compartments, where not used as tanks, are to be provided with bilge suctions. Their number and location are to comply with the provisions of [2.2.3]. However, if deemed acceptable by the Society, the cofferdams fitted between two different compartments of the double bottom may be provided with one bilge suction only.

2.2.7 Draining of other compartments

a) Provision is to be made for the drainage of chain lockers and other fore spaces by means of hand or power pump suctions or hydraulic ejectors.

b) Provision is to be made for the drainage of the steering gear compartment and other spaces located above the aft peak by means of suctions connected to the bilge main or by means of hand pumps or hydraulic ejectors.

These spaces may, however, be drained by means of scuppers discharging to the shaft tunnel, provided that the discharge pipes are fitted with self-closing valves situated in easily visible and accessible positions.

2.3 Bilge pumps

2.3.1 Number and arrangement of pumps

a) Fishing vessels are to be provided with at least two power bilge pumps of the self-priming type connected to the bilge main and having the capacity required in [2.3.4]. One of these pumps may be driven by the propulsion machinery.

b) Each bilge pump may be replaced by two or more pumps, provided that they are connected to the bilge main and that their total capacity is not less than that required in [2.3.4].

c) One of the bilge pumps required in a) may be replaced by a hydraulic ejector having the capacity required in [2.3.4] and connected to a high pressure water pump.

d) For ships of less than 24 m in length and having the navigation notation **coastal area**, one of the bilge pumps required in a) may be replaced by hand pumps, to the satisfaction of the Society.

e) Where permitted, hand pumps are to be operable from an easily accessible position above the load waterline.

2.3.2 Location of bilge pumps

Bilge pumps are to be located on the aft side of the collision bulkhead. This may not apply to those pumps only used for the draining of the spaces located on the fore side of the collision bulkhead.

2.3.3 Use of pumps intended for other duties

a) Pumps used for sanitary service, general service or ballast may be considered as independent bilge pumps provided that:
   - they have the capacity required in [2.3.4]
   - they are of the self-priming type
   - they are connected to the bilge system.

b) Non-return valves are to be provided in accordance with [2.2.1], item b).

2.3.4 Bilge pump capacity *(1/1/2001)*

a) The capacity Q of each bilge pump is to be not less than the value given by:

$$Q = 0,00565d^2$$

where:

Q : Minimum capacity of each pump, in m^3/h

d : Internal diameter of the bilge main as defined in [2.4.1].

b) If the capacity of one of the pumps is less than the rule capacity, the deficiency may be compensated by an excess capacity of the other pumps. Such deficiency is, however, not to exceed 30% of the rule capacity.

2.4 Size of bilge pipes

2.4.1 Bilge main line

a) The diameter of the bilge main is to be calculated according to the following formulae:
   - for ships of 24 m in length or more:

$$d = 25 + 1,68\sqrt{L(B + D)}$$

and

$$d \geq 60$$

   - for ships of less than 24 m in length:

$$d = 25 + 0,85L$$

where:

d : Internal diameter of the bilge main, in mm

L : Length of the ship between perpendiculars, in m

B : Breadth of the ship, in m

D : Depth of the ship, measured up to the bulkhead deck, in m

b) The actual diameter is in no case to be more than 5 mm smaller than that obtained from the formulae given in a).

2.4.2 Branch bilge suction pipes

a) The diameter of the pipes situated between the distribution boxes and the suctions in the various spaces (holds, machinery space, etc) is to be calculated according to the following formulae:
   - for ships of 24 m in length or more:

$$d_1 = 25 + 2,16\sqrt{L_1(B + D)}$$

and

$$d_1 \geq 50$$

   - for ships of less than 24 m in length:

$$d_1 = 25 + 2,16\sqrt{L_1(B + D)}$$

or

$$d_1 = 25 + 0,85L$$

whichever is the lesser

where:

d_1 : Internal diameter of the suction pipe, in mm

L_1 : Length of the space considered, in m

L, B, D : Length, breadth and depth of the ship as defined in [2.4.1]

b) The actual diameter is in no case to be more than 5 mm smaller than that obtained from the formulae given in a).

2.5 Bilge piping arrangement

2.5.1 Passage through double bottom compartments and tanks

Bilge pipes are not to pass through double bottom compartments or tanks unless they are enclosed in appropriate pipe tunnels. Where this is not practicable, pipes are to be of reinforced thickness as per Pt C, Ch 1, Sec 10, Tab 5 and made of either one piece or several pieces assembled by welding or by reinforced flanges.

2.5.2 Bilge suctions in machinery spaces and shaft tunnels

In machinery spaces and shaft tunnels, the termination pipes of the bilge suctions are to be straight and vertical and are to be led to mud boxes so arranged as to be easily inspected and cleaned. The lower end of the termination pipe is not to be fitted with a strum box.

2.5.3 Bilge suctions in other compartments

In compartments other than machinery spaces and shaft tunnels, the open ends of bilge suction pipes are to be fitted with strum boxes or strainers having holes not more than 10 mm in diameter. The total area of such holes is not to be less than twice the required cross-section of the suction pipe.

3 Scuppers and sanitary discharges

3.1 General

3.1.1 Discharges led through the shell either from spaces below the working deck or from within enclosed superstructures or deckhouses on the working deck fitted with weathertight doors are to be fitted with accessible means for preventing water from passing inboard.

3.1.2 Each separate discharge is to have an automatic non-return valve with a positive means of closing it from an accessible position, except when:

- satisfactory analysis is submitted to the Society, demonstrating that the entry of water into the vessel through the opening is not likely to lead to dangerous flooding, and
- the piping is of reinforced thickness as per Pt C, Ch 1, Sec 10, Tab 5.

3.1.3 The means for operating the positive action valve is to be provided with an indicator showing whether the valve is open or closed.

3.2 Discharges through manned machinery spaces

3.2.1 In manned machinery spaces, main and auxiliary discharges essential for the operation of machinery may be controlled locally. The controls are to be accessible and are to be provided with indicators showing whether the valves are open or closed.

3.3 Materials

3.3.1 Fittings attached to the shell and the valves required in [3.1.2] are to be of steel, bronze or other ductile material.

3.3.2 *(1/7/2002)*

All pipes between the shell and the valves are to be of steel.

4 Air pipes and sounding devices

4.1 Air pipes

4.1.1 General

Air pipes are to be fitted to all spaces which are not fitted with alternative ventilation arrangements.

4.1.2 Exposed parts of air pipes

Where air pipes to tanks and void spaces below deck extend above the working or the superstructure decks, the exposed parts of the pipes are to be of strength equivalent to the adjacent structures and fitted with the appropriate protection.

4.1.3 Means of closing

Openings of air pipes are to be provided with means of closing, permanently attached to the pipe or adjacent structure.

4.1.4 Height of air pipes *(1/7/2006)*

The height of air pipes above deck to the point where water may have access below is to be at least:

- 760 mm on the working deck, and
- 450 mm on the superstructure deck.

The Society may accept reduction of the height of an air pipe to avoid interference with the fishing operations.

In any case, for ships less than 24 m and with navigation notation “coastal area”, air pipes fitted at a height above the working deck of 450 mm may be accepted.

4.2 Sounding devices

4.2.1 General

Sounding devices are to be fitted:

- to the bilges of those compartments which are not readily accessible at all times during voyages, and
- to all tanks and cofferdams.

4.2.2 Termination of sounding pipes

Where sounding pipes are fitted, their upper ends are to extend to a readily accessible position and, where practicable, above the working deck.

4.2.3 Means of closing

The openings of the sounding pipes are to be provided with permanently attached means of closing. Sounding pipes which are not extended above the working deck are to be fitted with automatic self-closing devices.

4.2.4 Special arrangements for sounding pipes of flammable oil tanks

Where tanks containing fuel oil or flammable oil are fitted with sounding pipes, their upper ends are to terminate in safe positions and are to be fitted with suitable means of closure. Gauges made of glass of substantial thickness and protected with a metal case may be used, provided that automatic closing valves are fitted. Other means of ascertaining the amount of oil contained in the tank may be permitted provided their failure or overfilling will not permit release of fuel.

5 Refrigeration systems for the preservation of the catch

5.1 General

5.1.1 Refrigeration systems are to be so designed, constructed, tested and installed as to take account of the safety of the system and also the emission of chlorofluorocarbons (CFCs) or any other ozone-depleting substances from the refrigerant held in quantities or concentrations which are hazardous to human health or to the environment.

5.1.2 Methylchloride or CFCs whose ozone-depleting potential is higher than 5% of CFC-11 are not to be used as refrigerants.

5.1.3 Adequate guidance for the safe operation of the refrigeration system and emergency procedures are to be provided by means of suitable notices displayed on board the vessel.

5.2 Design of refrigeration systems

5.2.1 Refrigeration systems are to be adequately protected against vibration, shock, expansion, shrinkage, etc. and are to be provided with an automatic safety control device to prevent a dangerous rise in temperature and pressure.

5.2.2 Refrigeration systems in which toxic or flammable refrigerants are used are to be provided with drainage devices leading to a place where the refrigerant presents no danger to the vessel or to persons on board.

5.3 Arrangement of the refrigerating machinery spaces and refrigerating rooms

5.3.1 Separation of spaces

a) Any space containing refrigerating machinery, including condensers and gas tanks utilising toxic refrigerants, is to be separated from any adjacent space by gas-tight bulkheads. Any space containing refrigerating machinery, including condensers and gas tanks, is to be fitted with a leak detection system having an indicator outside the space adjacent to the entrance and is to be provided with an independent ventilation system and a water-spraying system.

b) When such containment is not practicable, due to the size of the vessel, the refrigeration system may be installed in the machinery space provided that the quantity of refrigerant used will not cause danger to persons in the machinery space, should all the gas escape, and provided that an alarm is fitted to give warning of a dangerous concentration of gas should any leakage occur in the compartment.

5.3.2 Exits from spaces

In refrigerating machinery spaces and refrigerating rooms, alarms are to be connected to the wheelhouse or control stations or escape exits to prevent persons being trapped. At least one exit from each such space is to be capable of being opened from the inside. Where practicable, exits from spaces containing refrigerating machinery using toxic or flammable gas are not to lead directly into accommodation spaces.

5.4 Breathing apparatus

5.4.1 Where any refrigerant harmful to persons is used in a refrigeration system, at least two sets of breathing apparatus are to be provided, one of which is to be placed in a position not likely to become inaccessible in the event of leakage of refrigerant. Breathing apparatus provided as part of the vessel's fire-fighting equipment may be considered as meeting all or part of this provision provided its location meets both purposes. Where self-contained breathing apparatus is used, spare cylinders are to be provided.

SECTION 5 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 The requirements contained in Part C, Chapter 2 apply to fishing vessels, except for those contained in Pt C, Ch 2, Sec 1, [2], Pt C, Ch 2, Sec 15, [2], Pt C, Ch 2, Sec 3, [2], Pt C, Ch 2, Sec 3, [3], Pt C, Ch 2, Sec 11, [1], Pt C, Ch 2, Sec 11, [2], Pt C, Ch 2, Sec 11, [3], Pt C, Ch 2, Sec 11, [4], and Pt C, Ch 2, Sec 11, [5], which are replaced by all those contained in this Section.

2 Documentation to be submitted

2.1 Standard list of documents

2.1.1 The documents listed in Tab 1 are to be submitted.

The list of documents requested is to be intended as guidance for the complete set of information to be submitted, rather than an actual list of titles.

The Society reserves the right to request the submission of additional documents regarding unconventional design or where deemed necessary for the evaluation of the system, equipment or components.

Unless otherwise agreed with the Society, documents for approval are to be sent in triplicate if submitted by the shipyard and in four copies if submitted by the equipment supplier. Documents requested for information are to be sent in duplicate.

In any case, the Society reserves the right to require additional copies when deemed necessary.

3 Type approved components

3.1 Type approval and case by case approval

3.1.1 The following components are to be type approved case-by-case based on submission of adequate documentation and execution of tests:

- electrical cables
- switching devices (circuit-breakers, contactors, disconnectors, etc.) and overcurrent protective devices
- electronic components used for tasks essential to safety.

4 General requirements for system design, location and installation

4.1 Design and construction

4.1.1 The design and construction of electrical installations are to be such as to provide:

a) the services necessary to maintain the vessel in normal operational and habitable conditions without having recourse to an emergency source of power,

b) the services essential to safety when failure of the main source of electrical power occurs, and

c) protection of the crew and vessel from electrical hazards.

Table 1 : Documents to be submitted

No.	I/A **(1)**	Document
1	A	Single line diagram of main and emergency power and lighting systems.
2	A	Electrical power balance (main and emergency supply).

(1) A: to be submitted for approval
I: to be submitted for information.

No.	I/A **(1)**	Document
3	A	Calculation of short-circuit currents for each installation in which the sum of rated power of the energy sources which may be connected contemporaneously to the network is greater than 500 kVA (kW).
4	A	List of circuits including, for each supply and distribution circuit, data concerning the nominal current, the cable type, length and cross-section, the nominal and setting values of the protective and control devices.
5	A	Single line diagram and detailed diagram of the main switchboard.
6	A	Single line diagram and detailed diagram of the emergency switchboard.
7	A	Diagram of the most important section boards and motor control centres (above 100 kW).
8	A	Detailed diagram of the navigation-light switchboard.
(1) A: to be submitted for approval I: to be submitted for information.		

4.2 Main source of electrical power

4.2.1 Where the electrical power constitutes the only means of maintaining auxiliary services essential for the propulsion and safety of the vessel, a main source of electrical power is to be provided which is to include at least two generating sets, one of which may be driven by the main engine. The Society may accept other arrangements having equivalent electrical capability.

4.2.2 The power of these sets is to be such as to ensure the functioning of the services referred to in [4.1.1] a), excluding the power required in fishing activities, processing and preservation of the catch, in the event of any one of the generating sets being stopped. However, in vessels of less than 45 m, in the event of any one of the generating sets being stopped, it is only necessary to ensure the functioning of the services essential for the propulsion and safety of the vessel.

4.2.3 The arrangement of the vessel's main source of electrical power is to be such that the services referred to in [4.1.1] a) can be maintained regardless of the number of revolutions and direction of the main propelling engines or shafting.

4.2.4 Where transformers constitute an essential part of the supply system required by this item, the system is to be so arranged as to ensure continuity of the supply.

4.2.5 The arrangement of the main electric lighting system is to be such that a fire or other casualty in spaces containing the main source of electrical power, including transformers, if any, will not render the emergency lighting system inoperative.

4.2.6 The arrangement of the emergency electric lighting system is to be such that a fire or other casualty in spaces containing the emergency source of electrical power, including transformers, if any, will not render the main lighting system inoperative.

4.2.7 Navigation lights, if solely electrical, are to be supplied through their own separate switchboard and adequate means for the monitoring of such lights are to be provided.

4.3 Emergency source of electrical power

4.3.1 A self-contained emergency source of electrical power located, to the satisfaction of the Society, outside machinery spaces is to be provided and so arranged as to ensure its functioning in the event of fire or other causes of failure of the main electrical installations.

4.3.2 The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of serving simultaneously for a period of at least three hours for ships whose length is equal to or greater than 24 m and a period of at least eight hours for ships whose length is equal to or greater than 45 m:

a) the VHF radio installation and, if applicable:
   1) the MF radio installation
   2) the ship earth station and
   3) the MF/HF radio installation,
b) internal communication equipment, fire detection systems and signals which may be required in an emergency,

c) the navigation lights if solely electrical and the emergency lights
   1) of launching stations and overside of the vessel,
   2) in all alleyways, stairways and exits,
   3) in spaces containing machinery or the emergency source of power,
   4) in control stations, and
   5) in fishing handling and fish processing spaces, and
d) the operation of the emergency fire pump, if any.

4.3.3 The emergency source of electrical power may be either a generator or an accumulator battery.

4.3.4 Where the emergency source of electrical power is a generator, it is to be provided both with an independent fuel supply and with efficient starting arrangements to the satisfaction of the Society. Unless a second independent means of starting the emergency generator is provided, the single source of stored energy is to be protected to preclude its complete depletion by the automatic starting system.

4.3.5 Where the emergency source of electrical power is an accumulator battery, it is to be capable of carrying the emergency load without recharging whilst maintaining the voltage of the battery throughout the discharge period within plus or minus 12% of its nominal voltage. In the event of failure of the main power supply, this accumulator battery is to be automatically connected to the emergency switchboard and is to immediately supply at least those services specified in [4.3.2] (b) and (c). The emergency switchboard is to be provided with an auxiliary switch allowing the battery to be connected manually, in case of failure of the automatic connection system.

4.3.6 The emergency switchboard is to be installed as near as is practicable to the emergency source of power and is to be located in accordance with [4.3.1]. Where the emergency source of power is a generator, the emergency switchboard is to be located in the same place unless the operation of the emergency switchboard would thereby be impaired.

4.3.7 An accumulator battery, other than batteries fitted for the radio transmitter and receiver in vessels of less than 45 m in length, is to be installed in a well ventilated space which is not to be the space containing the emergency switchboard. An indicator is to be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the battery constituting the emergency source of power is being discharged.

4.3.8 The emergency switchboard is to be supplied in normal operation from the main switchboard by an interconnector feeder which is to be protected at the main switchboard against overload and short-circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

For ships whose length is equal to or greater than 45 m, the arrangement at the emergency switchboard is to be such that in the event of failure of the main power supply an automatic connection of the emergency supply will be provided.

4.3.9 The emergency generator and its prime mover and any emergency accumulator battery are to be so arranged as to ensure that they will function at full rated power when the vessel is upright and when rolling up to an angle of 22,5° either way and simultaneously pitching 10° by bow or stern, or in any combination of angles within those limits.

4.3.10 The emergency source of electrical power and automation starting equipment is to be so constructed and arranged as to enable adequate testing to be carried out by the crew while the vessel is in operating condition.

4.3.11 For ships whose length is less than 24 m the Society may exempt Owners from the installation of the emergency source of electrical power.

4.4 Precaution against shock, fire and other hazards of electrical origin

4.4.1 Exposed permanently fixed metal parts of electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live are to be earthed (grounded) unless:

a) they are supplied at a voltage not exceeding 50 V direct current or 50 V, root mean square between conductors; auto-transformers are not to be used for the purpose of achieving this alternative current voltage, or
b) they are supplied at a voltage not exceeding 250 V by safety isolating transformers supplying one consuming device only, or
c) they are constructed in accordance with the principle of double insulation.

4.4.2 Electrical apparatus is to be so constructed and installed that it will not cause injury when handled or touched in the normal manner.

4.4.3 Main and emergency switchboards are to be so arranged as to afford easy access as may be needed to apparatus and equipment, without danger to attendants. The sides, backs and, where necessary, the fronts of switchboards are to be suitably guarded. Exposed live parts having voltages to earth exceeding a voltage to be specified by the Society are not to be installed on the front of the switchboards. There are to be non-conducting mats or gratings at the front and rear, where necessary.

4.4.4 The hull return system of distribution is not to be used for power, heating or lighting in vessels of 75 m of length and over.

4.4.5 The requirement in [4.4.4] does not preclude, under conditions approved by the Society, the use of:

a) impressed current cathodic protective systems,

b) limited and locally earthed systems, or

c) insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions.

4.4.6 Where the hull return system is used, all final sub-circuits (all circuits fitted after the last protective device) are to be two-wire and special precautions are to be taken to the satisfaction of the Society.

4.4.7 When a distribution system, whether primary or secondary, for power, heating or lighting, with no connection to earth is used, a device capable of monitoring the insulation level to earth is to be provided.

4.4.8 When a distribution system is in accordance with [4.4.7] and a voltage exceeding 50 V direct current or 50 V, root mean square, between conductors, is used, a device capable of continuously monitoring the insulation level to earth and of giving an audible or visual indication of abnormally low insulation values is to be provided.

4.4.9 Distribution systems which are supplied at a voltage not exceeding 250 V direct current or 250 V, root mean square, between conductors, and which are limited in extent, may comply with [4.4.7], subject to the satisfaction of the Society.

4.4.10 Except as permitted by the Society in exceptional circumstances, all metal sheaths and armour of cables are to be electrically continuous and to be earthed.

4.4.11 All electrical cables are to be at least of a flame-retardant type and are to be so installed as not to impair their original flame-retarding properties. The Society may permit the use of special types of cables where necessary for specific applications, such as radio frequency cables, which do not comply with the foregoing.

4.4.12 Cables and wiring serving essential or emergency power, lighting, internal communications or signals are as far as practicable to be routed clear of galleys, machinery spaces of category A and other high fire risk areas and laundries, fish handling and fish processing spaces and other spaces where there is a high moisture content. Cables connecting fire pumps to the emergency switchboard are to be of a fire-resistant type where they pass through high fire risk areas. Where practicable, all such cables are to be run in such a manner as to preclude their being rendered unserviceable by heating of the bulkheads which may be caused by a fire in an adjacent space.

4.4.13 Where cables are installed in spaces where the risk of fire or explosion exists in the event of an electrical fault, special precautions against such risk are to be taken to the satisfaction of the Society.

4.4.14 Wiring is to be supported in such a manner as to avoid chafing or other damage.

4.4.15 Terminations and joints in all conductors are to be made such that they retain the original electrical, mechanical, flame-retarding and, where necessary, fire-resisting properties of the cable.

4.4.16 Cables installed in refrigerated compartments are to be suitable for low temperatures and high humidity.

4.4.17 Circuits are to be protected against short-circuit. Circuits are also to be protected against overload, unless otherwise specified in these Rules or where the Society may exceptionally otherwise permit.

4.4.18 The rating or appropriate setting of the overload protective device for each circuit is to be permanently indicated at the location of the protective device.

4.4.19 Lighting fittings are to be so arranged as to prevent temperature rises which could damage the wiring and to prevent surrounding material from becoming excessively hot.

4.4.20 Lighting or power circuits terminating in a space where the risk of fire or explosion exists are to be provided with isolating switches outside the space.

4.4.21 The housing of accumulator batteries is to be constructed and ventilated to the satisfaction of the Society.

4.4.22 Electrical or other equipment which may constitute a source of ignition of flammable vapours is not permitted in these compartments except as provided for in [4.4.24].

4.4.23 An accumulator battery is not to be located in accommodation spaces unless installed in a hermetically sealed container.

4.4.24 In spaces where flammable mixtures are liable to collect and in any compartments assigned principally to the containment of an accumulator battery, no electrical equipment is to be installed unless the Society is satisfied that it is:

a) essential for operational purposes,

b) of a type which will not ignite the mixture concerned,

c) appropriate for the space concerned, and

d) appropriately certified for safe usage in the dusts, vapours or gases likely to be encountered.

4.5 Engineers' alarm

4.5.1 In vessels of 75 m in length and over, an engineers' alarm is to be provided to be operated from the engine control room or at the manoeuvring platform as appropriate, and is to be clearly audible in the engineers' accommodation.

5 Lightning protection

5.1 General

5.1.1 *(1/7/2002)*
Lightning protection systems are to be fitted to all wooden masts or topmasts.

Chapter 21
RESEARCH SHIPS

SECTION 1 GENERAL

1 Application

1.1 Assignment of service notation and general requirements

1.1.1 *(1/7/2004)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **research ship**, as defined in Pt A, Ch 1, Sec 2, [4.8.8].

1.1.2 *(1/7/2004)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the specific requirements given in [2].

2 Specific requirements

2.1 Research equipment and specific requirements

2.1.1 *(1/7/2004)*

Ships are to comply with the specific requirements for supply vessels given in Chapter 15, as applicable, and are to be provided with special equipment and arrangements suitable for scientific or technological research (laboratories, apparatus, accommodation spaces for research personnel, etc).

The above-mentioned equipment and/or arrangements are listed in the Certificate of Classification.

Chapter 22
PIPE LAYING UNITS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*
Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **pipe laying unit**, as defined in Pt A, Ch 1, Sec 2, [4.8.9].

1.1.2 *(1/1/2022)*
Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to pipe laying units.

1.2 Summary table

1.2.1 *(1/1/2022)*
Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to pipe laying units.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for pipe laying units are given in this Chapter	

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 *(1/1/2005)*

The requirements of this Section apply to the hull structures, support structures and connecting structures related to pipe laying operations.

1.2 Documents to be submitted

1.2.1 *(1/1/2005)*

Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable.

2 Foundation structures, supporting structures and fastening

2.1

2.1.1 *(1/1/2005)*

The structures are assessed on a case-by-case basis, considering the structural model, the load model and the checking criteria, as applicable, specified in Part B, Chapter 7.

3 Connecting structures of the stinger to the hull

3.1

3.1.1 *(1/1/2005)*

The structures are assessed on a case-by-case basis, considering the design forces provided by the Designer and the checking criteria, as applicable, specified in Part B, Chapter 7.

Table 1 : Documents to be submitted *(1/1/2005)*

No.	A/I **(1)**	Document	Containing also information on
1	I	General arrangement of pipe laying equipment	Design loads for all components of pipe laying equipment
2	I	General arrangement of cranes and davits and of the relevant support	Design load for cranes and davits
3	I	Fender arrangement for protection of the side shell	
4	A	Foundation structures, supporting structures and fastening of the equipment for pipe laying operations	Design forces transmitted to the hull structures
5	A	Structures supporting stowed pipes and, if applicable, reels	Design forces transmitted to the hull structures
6	A	Foundation structures of cranes and davits	Design forces transmitted to the hull structures
7	A	Connecting structures of the stinger to the hull	Design forces transmitted to the hull structures

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Application

1.1.1 *(1/1/2005)*

The requirements of this Section apply to:

- Equipment for the pipe laying
- Equipment for positioning during pipe laying.

1.2 Documents to be submitted

1.2.1 *(1/1/2005)*

Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable.

2 Pipe laying equipment

2.1 Case by case acceptance

2.1.1 *(1/1/2005)*

The equipment and installation is considered on a case-by-case basis.

3 Anchoring equipment

3.1 Case by case acceptance

3.1.1 *(1/1/2005)*

The equipment and installation is considered on a case-by-case basis.

4 Dynamic positioning equipment during pipe laying

4.1 General requirements

4.1.1 *(1/1/2005)*

In general, the requirements in Pt F, Ch 13, Sec 6 of the Rules apply.

5 Testing of pipe laying, anchoring and positioning equipment

5.1 Testing of materials

5.1.1 *(1/1/2005)*

In general testing of materials is required according to the applicable requirements of the Rules.

5.2 Hydraulic tests

5.2.1 *(1/1/2005)*

Pressure parts are to be subjected to hydraulic tests in accordance with Pt C, Ch 1, Sec 3 and Pt C, Ch 1, Sec 10, as applicable.

5.3 Tests of mechanical components

5.3.1 *(1/1/2005)*
Running tests of each individual component are to be carried out whenever possible at the Manufacturer's works; as an alternative, the above tests may be performed during equipment trials on board.

5.4 Tests on electrical components

5.4.1 *(1/1/2005)*
The tests required in Part C, Chapter 2 are to be carried out as applicable.

6 Equipment trials on board

6.1 Verification survey

6.1.1 *(1/1/2005)*
Tests are to be carried out to verify the proper operation of all machinery and equipment intended for pipe laying, anchoring and dynamic positioning in different sea and weather conditions, if necessary.

Table 1 : Documents to be submitted *(1/1/2005)*

No.	A/I **(1)**	Document	Containing also information on
1	A	Plans of all components of the pipe laying equipment including gears, pressure vessels, hydraulic systems etc., indicating materials and welding details	
2	I	General arrangement of the anchoring equipment	Design load for anchoring equipment
3	I	General arrangement of the dynamic positioning equipment during pipe laying	
4	A	Documentation relevant to the dynamic positioning system (see [4])	

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

Chapter 23
CEMENT CARRIERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/2/2005)*
Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **cement carrier**, as defined in Pt A, Ch 1, Sec 2, [4.2.10].

1.1.2 *(1/2/2005)*
Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to cement carriers.

1.2 Summary table

1.2.1 *(1/2/2005)*
Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to cement carriers.

Table 1 *(1/2/2005)*

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for cement carriers are given in this Chapter.	

SECTION 2 SHIP ARRANGEMENT, HULL AND STABILITY

1 General

1.1 Documents to be submitted

1.1.1 *(1/2/2005)*

Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable

Table 1 : Documents to be submitted *(1/2/2005)*

No.	A/I **(1)**	Document
1	A	Typical loading and unloading sequences, including conditions with uneven distribution (e.g. part loading conditions with empty cargo holds, as applicable)
2	I	Data regarding properties of cement (e.g. bulk density, angle of repose, humidity limits, etc.)
3	I	Loading and unloading systems manual
(1) A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

2 Ship arrangement

2.1 General

2.1.1 *(1/2/2005)*

Cement carriers are to be fitted with a closed loading and unloading system.

2.1.2 *(1/2/2005)*

In general, the cement carrier holds are to be fitted with a double bottom, a single or double side and a single deck. Hatches to cargo holds are intended for access only or for arrangement of the loading and unloading system.

3 Corrosion additions

3.1 General

3.1.1 *(1/2/2005)*

In lieu of the values specified in Pt B, Ch 4, Sec 2, [3], the corrosion addition relevant to dry bulk cargo holds intended to carry cement only is to be taken equal to 1,0 mm.

4 Stability

4.1 Intact stability

4.1.1 *(1/2/2005)*

Ships carrying cement having an angle of repose $\Phi \leq 30°$ are to comply with the stability requirements of Ch 4, Sec 3, [2.2] relevant to grain loading. As an alternative, the cement is to be trimmed as indicated in [4.1.2] and the ship is to remain alongside for twelve hours to allow escape of entrained air and the settlement of the cargo.

4.1.2 *(1/2/2005)*

Ships carrying cement having an angle of repose $30° < \Phi \leq 35°$ may not comply with the requirements of [4.1.1] provided that the cargo is trimmed according to the following criteria:

a) the unevenness of the cargo surface measured as the vertical distance (Δh) between the highest and lowest levels of the cargo surface is not to exceed B/10, where B, in m, is the beam of the ship with a maximum allowable Δh=1,5m;

b) where Δh cannot be measured, bulk shipment can also be accepted if loading is carried out with suitable trimming equipment.

4.1.3 *(1/2/2005)*
Ships carrying cement having an angle of repose $\Phi > 35°$ are to be loaded in such a way that the cement is distributed in a manner which eliminates the formation of wide, steeply sloped voids beyond the trimmed surface within the boundaries of the cargo space. The cement is to be trimmed to an angle significantly less than the angle of repose..

4.1.4 *(1/2/2005)*
Suitable arrangements are to be provided to check that the cargo is properly trimmed and levelled as requested in [4.1.2] and [4.1.3].

5 Design loads

5.1 Internal pressures due to cement cargo

5.1.1 *(1/2/2005)*
The still water and inertial pressures induced by the cement cargo on the hold structures are to be calculated in accordance with Pt B, Ch 5, Sec 6, [3], on the basis of the cement cargo density and angle of repose.

5.2 Loading conditions to be considered in structural analyses of primary supporting members based on three dimensional models

5.2.1 *(1/2/2005)*
Where primary supporting members are analysed through three dimensional models, in accordance with Pt B, Ch 7, Sec 3, the following loading conditions are to be considered when defining the loads acting on the structural elements represented in the model:

- homogeneous loading conditions,
- ballast loading conditions,
- the most severe non-uniform loading conditions, in which the cargo is unevenly distributed in the cargo holds, at the relevant design draughts,
- the most severe harbour loading conditions, as they result from the various steps envisaged by the loading and unloading sequences.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Documents to be submitted

1.1.1 *(1/2/2005)*

Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable

2 Cement handling system

2.1 General

2.1.1 **Mechanical strength** *(1/2/2005)*

The systems intended for loading and unloading operations and their components (such as conveyors) are to be of sufficient mechanical strength based on the maximum loads expected in service, as specified by the Designer, and are not subject to specific class requirements.

2.1.2 **Piping systems** *(1/2/2005)*

The piping systems intended for cement handling and ancillary systems are to be designed, constructed and tested in accordance with the applicable provisions of Pt C, Ch 1, Sec 10.

2.1.3 **Pressure vessels** *(1/2/2005)*

Where provided, pressure vessels are to be designed, constructed and tested in accordance with the applicable provisions of Pt C, Ch 1, Sec 3.

3 Testing of cement handling equipment

3.1 Workshop testing

3.1.1 General *(1/2/2005)*

The cement handling equipment is to be tested in compliance with the following requirements, with the exception of prime movers and pressure vessels, which are to be tested in compliance with the applicable requirements of the relevant Sections of Part C.

3.1.2 **Testing of materials and components of the machinery** *(1/2/2005)*

a) In general, testing is required for shafts, gearing, pressure parts of pumps and hydraulic motors, and plates of foundations of welded construction.

b) As far as mechanical tests of materials are concerned, internal works' certificates submitted by the Manufacturer may be accepted by the Society at its discretion. In such cases, testing operations may be limited to visual external inspection associated, where necessary, with non-destructive examinations and hardness tests.

3.1.3 **Hydrostatic tests** *(1/2/2005)*

Pressure parts are to be subjected to hydrostatic tests in accordance with the relevant requirements of Pt C, Ch 1, Sec 3 or Pt C, Ch 1, Sec 10, as appropriate.

3.1.4 **Tests on electrical components** *(1/2/2005)*

The tests required in Part C, Chapter 2 are to be carried out as applicable.

3.1.5 **Running tests** *(1/2/2005)*

a) Running tests are to be carried out whenever possible at the Manufacturer's works. As an alternative, the above tests may be performed on board during the trials required after installation of machinery.

b) During the running tests, the suitability of all the arrangements concerned is to be checked in relation to the various expected service conditions.

c) On completion and subject to the result of the above tests, the inspection of components may be required, with dismantling where deemed necessary by the Surveyor in charge of the testing.

3.2 On board testing

3.2.1 Equipment trials *(1/2/2005)*

As far as the cement handling system is concerned, tests are to be carried out to verify the proper operation of all relevant equipment.

Table 1 : Documents to be submitted *(1/2/2005)*

No.	A/I **(1)**	Document **(2)**
1	I	General arrangement of the cement handling equipment
2	I	Design loads on all components of the cement handling equipment
3	A	Plans of all components of the cement handling equipment, including pressure vessels, hydraulic systems, etc, as applicable
4	A	Diagram of the piping system intended for cement handling

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

(2) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems

Chapter 24

COMPRESSED NATURAL GAS (CNG) CARRIERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/7/2012)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **Compressed Natural Gas Carrier**, as defined in Pt A, Ch 1, Sec 2, [4.2.11]. The reference CNG carrier is a double hull construction with double side and double bottom, with holds containing the CNG in separate pressure vessels, equipped with loading/unloading systems, without turret systems. Different ship arrangements may require ad-hoc considerations in addition to, or in lieu of the present Rules.

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of this Chapter, which are specific to Compressed Natural Gas Carrier. These requirements are intended to apply ships regardless of their size, including those of less than 500 tons gross tonnage, engaged in carriage of Compressed Natural Gas.

1.1.2 IGC Code *(1/7/2012)*

In this Chapter, reference to the latest version of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, as amended, is made by the wording "IGC Code".

1.1.3 **Compressed Natural Gas (CNG)** *(1/7/2012)*

Is intended as a mixture typically composed of Methane, Natural Gas Liquids (ethane, propane, butane, pentane, etc), water, carbon dioxide, nitrogen and other non-hydrocarbon contaminants (e.g. H_2S). Cargo is the various compositions of natural gas that will be carried. For the carriage in bulk of products which are not listed in this Chapter, presenting more severe hazards than those covered by the Rules, the Society reserves the right to establish requirements and/or conditions additional to those contained in this Chapter.

1.1.4 **Carriage of products not listed in Section 15** *(1/7/2012)*

The carriage of products not listed in Sec 15, Tab 1 will be considered on a case by case basis by the Society.

1.1.5 **Gas contaminants** *(1/7/2012)*

The requirements relating to the cargo tanks apply only to CNG. The cargo that comes into contact with the cargo tanks and loading/unloading system of the ship is to have water, carbon dioxide, nitrogen and other contaminants removed. If this is not feasible, and the cargo has a presence of contaminants, these must be evaluated and additional measures, not covered in this Chapter, will be required. In particular, at least the scantlings may need to be suitably increased or an effective method of corrosion control is to be adopted and the design assessed for their effects.

1.1.6 Hazards *(1/7/2012)*

Hazards of Compressed Natural Gas considered in this Chapter include fire, toxicity, corrodibility, reactivity, temperature and pressure.

1.2 Fundamental safety requirements

1.2.1 *(1/7/2012)*

The overall safety and security is to be demonstrated to be equivalent or better than comparable liquefied gas carriers built and operated according to Chapter 9.

1.2.2 *(1/7/2012)*

For new concepts, it is recommended to follow the procedure for the Approval in Principle or for the Technology Qualification (see the “Guide for Technology Qualification Processes”). A significant role in such procedure is played by Risk Assessment is to be submitted. The Risk Assessment is to comply with the principles outlined in the “Guide for Risk Analysis”. The choice of a qualitative or quantitative analysis depends on the problem to be studied, but it is likely that at least evaluations of consequences of fire and gas dispersion scenarios will be needed. Modifications to existing systems (e.g. cargo holds, cargo piping, process system, operational procedures etc.) are to be supported by at least a Hazard Identification (HAZID) or other appropriate studies. The whole documentation supporting the design, i.e. risk

assessment, engineering studies, tests etc. is to be submitted to the Society for information, as a part of the classification documentation.

1.2.3 *(1/7/2012)*

The safety requirements are to be based on safety objectives for:

- life (crew and third party personnel)
- environment (oil pollution, gas release to the atmosphere).

Commercial requirements such as availability may be included, if agreed with the Interested Party.

2 Definitions

2.1 Terms

2.1.1 Blow down *(1/7/2012)*

Means the controlled depressurization of an inventory of pressurised gas.

2.1.2 Cargo area *(1/7/2012)*

Is that part of the ship which contains the cargo containment and cargo handling systems and includes deck areas over the full length and breadth of the part of the ship over the above-mentioned spaces.

2.1.3 Cargo hold *(1/7/2012)*

Is the space enclosed by the ship's structure in which cargo tanks are placed.

***2.1.4* Cargo hold vent pipes** *(1/7/2012)*

Are low pressure pipes for venting of cargo hold spaces.

***2.1.5* Cargo load/unload valve** *(1/7/2012)*

Is the valve isolating the cargo piping from external piping.

***2.1.6* Cargo piping** *(1/7/2012)*

Is the piping between the cargo tank valve and the cargo load and or unload valve.

2.1.7 Cargo tank *(1/7/2012)*

Is all pressurised equipment (e.g. cargo container, manifold piping etc.) of a cargo containment system up to the first isolating cargo tank valve.

***2.1.8* Cargo tank valve** *(1/7/2012)*

Is the valve isolating the cargo tank from the cargo piping.

***2.1.9* Design pressure** *(1/7/2012)*

Is the maximum gauge gas pressure at the top of the cargo tank which has been used in the calculation of the scantlings of the cargo tank and cargo piping, at the expected operating environmental conditions.

***2.1.10* Maximum Allowable Working Pressure** *(1/7/2012)*

Is the maximum pressure, corresponding to the relevant temperature, which is allowed during normal operations like storage, loading and unloading. It is 95% of the design pressure. The normal working pressure is not to exceed the maximum allowable working pressure.

***2.1.11* Design temperature** *(1/7/2012)*

For the selection of materials in cargo tanks, piping, supporting structure and inner hull structure is the lowest or highest temperature which can occur in the respective components.

3 Additional requirements

3.1 Emergency towing arrangement

3.1.1 *(1/7/2012)*

Emergency towing arrangements are to be fitted in accordance with Pt B, Ch 10, Sec 4, [4], irrespective of the deadweight of the ship.

3.2 Steering gear

3.2.1 *(1/7/2012)*
Additional requirements for steering gear are given in Ch 7, Sec 4, [7].

4 Documentation to be submitted

4.1 Standard list of documents

4.1.1 *(1/7/2012)*
Tab 1 and Tab 2 list the plans, information, analysis, etc. which are to be submitted in addition to the information required in the other Parts of the Rules for the parts of the ship not affected by the cargo, as applicable.

Table 1 : Documents to be submitted: General *(1/7/2012)*

No	A/I **(1)**	Documents
1	I	List of products to be carried, gas technical specification and all design conditions
2	I	General arrangement plan, showing location of cargo tanks and fuel oil, ballast and other tanks
3	A	Gas-dangerous zones plan
4	A	Location of void spaces and dangerous zones
5	A	Air locks between safe and dangerous zones
6	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
7	A	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.
8	A	Hull stress analysis
9	A	Hull ship motion analysis, where a direct analysis is preferred to the methods indicated in Sec 4
10	A	Intact and damage stability calculations
11	A	Cargo tanks and cargo piping systems
12	A	Cargo control room
13	A	Details of ladders, fittings and towers in tanks and relative stress analysis, if any
14	A	Bilge and ballast system in cargo area
15	A	Gas freeing system in cargo tanks including inert gas system
16	A	Interbarrier space drainage, inerting and pressurisation systems
17	A	Ventilation system in cargo area
18	A	Hull structure heating system, if any
19	A	Refrigeration and reliquefaction plant system diagram, if any
20	A	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
21	A	Schematic electrical wiring diagram in cargo area
22	A	Gas detection system
23	A	Cargo tank instrumentation, including cargo and hull temperature monitoring system
24	A	Emergency shutdown system

Note 1: A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

No	A/I (1)	Documents
25	A	Details of fire-extinguishing appliances and systems in cargo area
26		For machinery using gas as fuel:
	I	a) General arrangement plan of the machinery plant
	I	b) Description of the entire plant
	A	c) Gas piping plans for the machinery plant
	A	d) Complete list of the safety, gas detection and warning equipment
	A	e) Drawings of the boilers
	I	f) Detailed drawings of the gas inlet and fuel inlet equipment
	I	g) Gas characteristics
	A	h) General arrangement plan of the gas treatment plant, including gas compressors, prime movers and gas preheaters
	A	i) Drawings of the gas compressors and preheaters
Note 1: A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

Table 2 : Documents to be submitted: Cargo Tanks and piping *(1/7/2012)*

No	A/I (1)	Documents
1	A	Drawing of tanks, non-destructive testing of welds and strength and tightness testing of tanks
2	A	Design loads and structural analysis of cargo tanks
3	A	Calculation of maximum and minimum design temperature for materials in the cargo tank, supporting structure and inner hull due to loading/unloading/depressurizing
4	A	Prototype testing with full scale fatigue and burst test for cargo tank
5	A	Fatigue crack propagation calculations for the cargo tank piping
6	A	Drawings and calculation of stresses in the cargo tank piping including vibrations and fatigue analysis
7	A	Drawings and calculation of supports for cargo tank cylinders including collision loads
8	I	Operational and emergency procedures for possible incidents in the cargo tanks
9	A	Overpressure protection arrangements for cargo tanks including details of pressure relief devices
10	I	Arrangements and procedure for gas freeing and mechanical ventilation in cargo area
11	A	Scantlings, material and arrangement of the cargo tanks including the liner
12	A	Stress analysis of the cargo tanks, including fatigue analysis and crack propagation analysis for type “B” tanks. This analysis may be integrated with that indicated in item 10
13	A	Details of cargo handling and vapour system, including arrangements and details of piping and fitting
14	A	Details of process pressure vessels and relative valves arrangement
15	A	Details of cargo pumps and cargo compressors
16	A	Blow down system, if any
17	A	Emergency shutdown provisions and arrangements
18	A	Loading and unloading operation description, including cargo tank filling limits
19	A	Cargo tank testing and inspection procedures
20	A	Supporting documentation (risk assessment, engineering analyses, tests etc.)
Note 1: A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

SECTION 2 SHIP ARRANGEMENT

1 Segregation of the cargo area

1.1 Segregation of hold spaces

1.1.1 *(1/7/2012)*

No accommodation space, service space or control station is to be located within the cargo area. The bulkheads of accommodation spaces, service spaces or control stations which face the cargo area are to be so located as to avoid the ingress of gas from the hold space to such spaces through a single failure of a deck or bulkhead.

1.2 Location of cargo holds

1.2.1 General *(1/7/2012)*

Cargo holds are to be segregated, by means of cofferdams, from machinery and boiler spaces, accommodation spaces, service spaces and control stations, chain lockers, drinking and domestic water tanks and from stores. For a conventional ship type, cargo holds are to be located forward of machinery spaces of category A. Bow thrusters, if fitted, may be located forward of the hold spaces. Further requirements may stem from the risk analysis.

Access and spaces for a safe visual and/or instrumental inspection of cargo tanks is to be provided, and the relevant inspection plan is to be sent to the Society for information.

2 Accommodation, service and machinery spaces and control stations

2.1 General

2.1.1 *(1/7/2012)*

If the ship is gas-fuelled, Pt C, Ch 1, App 7 applies.

2.1.2 **Precautions against hazardous vapours** *(1/7/2012)*

In order to guard against the danger of hazardous vapors, due consideration is to be given to the location of air intakes, air outlets and openings into accommodation, service and machinery spaces and control stations in relation to cargo piping, cargo vent systems and machinery space exhausts from gas burning arrangements. For this purpose, IGC Code 3.2.4, 3.8, 8.2.10 and 12.1.6 apply to the aforesaid air intakes, air outlets and openings.

2.1.3 **Spaces located forward of the cargo area** *(1/7/2012)*

IGC Code Ch 3, 3.2.6 applies, with the following additional requirements.

Entrances and openings to service spaces located forward of the cargo area may not face such area.

2.1.4 **Doors facing cargo area** *(1/7/2012)*

IGC Code Ch 3, 3.2.4 applies, with the following additional requirements.

Doors facing the cargo area or located in hazardous areas on the sides are to be restricted to stores for cargo-related and safety equipment, cargo control stations as well as decontamination showers and eye wash.

Where such doors are permitted, the space may not give access to other spaces covered in IGC Code 3.2.4 and the common boundaries with these spaces are to be insulated with A60 class bulkheads.

2.1.5 **Exemptions, ventilation openings and type of closures** *(1/7/2012)*

IGC Code Ch 3, 3.2.6 applies, with the following additional requirements.

The requirement for fitting air intakes and openings with closing devices operable from inside the space in ships intended to carry toxic products is to apply to spaces which are used for the ship's radio and main navigating equipment, cabins, mess rooms, toilets, hospitals, galleys, etc., but does not apply to spaces not normally manned such as deck stores, forecastle stores, engine room casings, steering gear compartments and workshops. The requirement does not apply to cargo control rooms located within the cargo area.

When internal closing is required, this is to include both ventilation intakes and outlets.

The closing devices are to give a reasonable degree of gas-tightness. Ordinary steel fire-flaps without gaskets/seals are normally not considered satisfactory.

2.1.6 Openings for removal of machinery *(1/7/2012)*

IGC Code Ch 3, 3.2.6 applies, with the following additional requirements.

Bolted plates of A60 class for removal of machinery may be accepted on bulkheads facing cargo areas, provided signboards are fitted to warn that these plates may only be opened when the ship is in gas-free condition.

SECTION 3 SHIP SURVIVAL CAPABILITIES

1 Freeboard and intact stability

1.1 Intact stability

1.1.1 *(1/7/2012)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.3] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

1.1.2 *(1/7/2012)*

The cargo holds are to be protected from penetration in the case of minor damage to the vessel (resulting, for example, from contact with a jetty or tug) and given a measure of protection from damage in the case of collision or stranding by locating them at specified minimum distances inboard from the vessel's shell plating.

1.1.3 *(1/7/2012)*

The Master of the ship is to be supplied with a Trim and Stability booklet as specified in Pt B, Ch 3, App 2.

1.2 Damaged stability

1.2.1 *(1/7/2012)*

A probabilistic approach to determining the effects of a collision or grounding is to be considered according to SOLAS Ch II-1 (MSC.Res. 216(82)).

2 Collisions and groundings

2.1 General

2.1.1 *(1/7/2012)*

For conventional double bottom designs the double bottom height is to be at least B/15 or 3,0 m whichever is less, but not less than 1,0 m.

For conventional double side designs the width of the double side shall at least be minimum B/15 or 2.0 m, whichever is the greater.

The above criteria are to be integrated, and possibly superseded, by the additional requirements that may stem from the collision/grounding analysis.

The collision/grounding analysis is to be carried out according to recognized standards and tools, and the Society is to be involved up front and kept informed on the development of the analysis.

The collision analysis is to take into account at least the following aspects:

a) Sizes, types and speed of vessels that may strike the CNG ship, obtained from traffic data of the typical CNG ship trade;

b) Assumptions on collision angles, speed and bow rigidity of the striking vessel.

The grounding analysis is to obtain the raking damage on the basis of an assumed navigating speed and an assumed rock shape.

Other assumptions may be made to the satisfaction of the Society.

Collision and grounding analyses, with the assumptions, calculations, results and conclusions clearly stated, are to be sent to the Society for information.

3 Pipes, ducts and trunks in damaged zones

3.1 Strength of internal structures

3.1.1 *(1/7/2012)*
Tunnels, ducts, pipes, doors, bulkheads and decks which might form watertight boundaries of intact spaces in the case of assumed conventional damage are to have minimum strength adequate to withstand the pressure height corresponding to the deepest equilibrium waterline in damaged conditions.

SECTION 4 CARGO CONTAINMENT

1 General

1.1 Application

1.1.1 *(1/7/2012)*

Cargo tank design is to be evaluated by the Society to determine the design criteria that are to be followed. Since large CNG tanks are a novel application on ships, it is recommended to follow the procedure for the Approval in Principle or for the Technology Qualification (see the “Guide for Technology Qualification Processes”).

1.1.2 *(1/7/2012)*

Whatever the type (e.g. metal, composite, coiled etc.), cargo tanks are to be designed using recognized standards,

model tests, refined analytical tools and analysis methods to determine stress levels, fatigue life and crack propagation characteristics, which are to be submitted by the Society for approval. The uncertainties of the design standards and codes are to be included in the establishment of the design pressure.

1.1.3 *(1/7/2012)*

The cargo tanks, along with their supports, clamps, piping and other fixtures are to be designed taking into account at least the following loads:

- internal pressure
- external pressure
- wave loads
- thermal loads
- still water loads
- tank and cargo weight with the corresponding reactions in way of supports
- insulation mass, if any
- vibrations.

1.1.4 *(1/7/2012)*

In particular, thermal loads are to be determined considering the lowest temperature to which the cargo tank will normally be exposed in service during loading, unloading and storage, along with any accidental cargo release causing jet impingement with cooldown effect to nearby tanks. Appropriate calculations or experimental results are to be submitted to the Society for information. Moreover, transient thermal loads and dynamic effect of pressure variations during loading and unloading are to be considered, taking into account the maximum values they will be exposed to during their lifetime.

1.1.5 *(1/7/2012)*

Cargo tank supports are to comply with the applicable criteria of Ch 9, Sec 4. The loads due to ship motions are to comply with Pt B, Ch 5, Sec 3, and are to verified by adopting the criteria of Part B, Chapter 7 (in particular, Pt B, Ch 7, App 1 and Pt B, Ch 7, App 3), as applicable.

1.1.6 *(1/7/2012)*

Special considerations are to be given to loading rates for cargo tanks made of composites, since these materials have rate dependent properties.

1.1.7 *(1/7/2012)*

Changes to material properties with time due to action of long term still water loads and the environment is also to be considered for composites. The extent to which such loads are to be considered depends on the type of tank.

SECTION 5 PROCESS PRESSURE VESSELS AND PIPING SYSTEMS

1 Gas-fuelled ship

1.1 Application

1.1.1 *(1/7/2012)*
If the ship is gas-fuelled, Pt C, Ch 1, App 7 applies.

2 Process pressure vessels

2.1 General

2.1.1 *(1/7/2012)*
Process pressure vessels handling cargo are to be considered at least as class 1 pressure vessels, in accordance with Pt C, Ch 1, Sec 3, [1.4.1].

3 Cargo and process piping

3.1 General

3.1.1 *(1/7/2012)*
In general, the cargo piping system , as a minimum, is to meet the requirements given in Pt C, Ch 1, Sec 10, [1.3.2], Pt C, Ch 1, Sec 10, [2.5.4], Pt C, Ch 1, Sec 10, [2.9.1], or a standard acceptable to the Society with the following additional requirements.

a) In general, cargo holds should not have piping in common. Otherwise, precautions are to be taken to avoid that a gas release from a pipe in a hold may leak into other holds.

b) Considerations are to be made regarding the cooldown (i.e. Joule-Thomson) effect on nearby structural elements due to gas leaks from sources like joints and fittings.

c) Enclosed spaces in which cargo piping may run are to be protected against overpressure due to high pressure leaks.

d) The pipes are to be seamless or equivalent. Flange connections are to be limited as far as possible.

e) Piping system materials (pipes, fittings and flanges) are to be tested at the presence of a surveyor of the Society.

f) Only butt welded and flanged connections of the welding neck type are allowed.

g) All butt welds are to be subject to 100% radiographic testing.

h) Approval of the welding procedure specifications are required as specified in Part D.

i) After assembly the piping system is to be hydrostatic pressure tested to at least 1.5 times design pressure prior to installation

j) After assembly on board the complete cargo piping shall be subjected to a leak test using air, halides or other suitable medium according to an approved procedure.

Procedures for cargo transfer including emergency procedures are to be submitted for information. The procedures are to address potential accidents related cargo transfer, and information regarding emergency disconnection, emergency shutdown, communication with offshore/onshore terminals etc. are to be included.

3.1.2 **Provisions for protection of piping against thermal stress** *(1/7/2012)*
IGC Code Ch 5, 5.2.1.2 applies, with the following additional requirements.

Expansion joints are to be protected from extensions and compressions greater than the limits fixed for them and the connected piping is to be suitably supported and anchored. Bellow expansion joints are to be protected from mechanical damage.

3.1.3 Segregation of high temperature piping *(1/7/2012)*

IGC Code Ch 5, 5.2.1.3 applies, with the following additional requirements.

High temperature pipes are to be thermally isolated from the adjacent structures. In particular, the temperature of pipelines is not to exceed 220 °C in gas-dangerous zones.

3.1.4 Pressure relief valve setting *(1/7/2012)*

Pt C, Ch 1, Sec 3, [2.4.2] applies.

3.1.5 Means for detecting the presence of liquid cargo (if a liquid separation system is fitted) *(1/7/2012)*

IGC Code Ch 5, 5.2.1 applies as far as practicable, with the following additional requirements.

The means to detect the presence of liquid cargo may be constituted by electrical level switches whose circuit is intrinsically safe. The alarm signals given by the level switches are to be transmitted to the wheelhouse and to the cargo control station, if provided.

3.1.6 Connections of relief valve discharges to cargo tanks *(1/7/2012)*

If relief valves are fitted on the liquid phase piping, the connections from such relief valve discharges up to process tanks are not to be fitted with shut-off valves, but are to be provided with non-return valves in the proximity of the tanks.

3.2 Scantlings based on internal pressure

3.2.1 Piping subject to green seas *(1/7/2012)*

IGC Code Ch 5, 5.2.2 applies as far as practicable, with the following additional requirements.

For piping subject to green seas, the design pressure P, in bar, in the formula in 5.1.1 of the IGC CODE is to be replaced by an equivalent pressure P' given by the following formula:

$$P' = \frac{1}{2}\left(P + \sqrt{P^2 + 0{,}006R'K\frac{D_C}{D}}\right)$$

where:

D_C : External diameter of the pipe taking into account the insulation (in mm), whose thickness is to be taken at least equal to:

40 mm if $D \leq 50$ mm

80 mm if $D \geq 150$ mm

Intermediate values are to be determined by interpolation.

R' : Drag corresponding to the effect of green seas, in da N/m^2, such as given in Tab 1 as a function of the location of the pipes and of their height H (in m) above the deepest loadline; intermediate values are to be determined by interpolation.

K : permissible stress, in N/mm^2

3.2.2 Design pressure and temperature definition *(1/7/2012)*

The design temperature is to be the minimum temperature achieved during all normal and emergency procedures e.g. loading/unloading and pressure relieving are to be considered.

The design pressure is the maximum pressure to which the system may be subjected to in service e.g. the set point of the safety relief valve.

3.3 Permissible stress

3.3.1 Flanges not complying with standards *(1/7/2012)*

For flanges not complying with a standard, the dimensions and type of gaskets are to be to the satisfaction of the Society.

3.3.2 Stress analysis *(1/7/2012)*

If stresses due to particular conditions (e.g. thermal effects) are to be taken into account, ad-hoc analyses are to be examined by the Society on a case by case basis.

3.3.3 Stress intensity *(1/7/2012)*

The stress intensity is to be determined as specified in the formulae in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures:

a) for primary stresses resulting from:
   - pressure
   - weight
   - green seas

b) for primary stresses and secondary stresses resulting from contraction or linear dilatation.

3.3.4 Stress intensity limits *(1/7/2012)*

The stress intensity is to be determined as specified in the formulae in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures:

a) For the first case, the stress intensity is to be limited to the lower of:
   $0,8\ R_e$ and $0,4\ R_m$

b) For the second case, the stress intensity is to be limited to the lower of:
   $1,6\ R_e$ and $0,8\ R_m$.

3.3.5 Piping with expansion devices *(1/7/2012)*

For piping fitted with expansion devices, their characteristics are to be submitted to the Society. Where these characteristics are such that the forces and moments at the ends of the devices are negligible for the contraction they must absorb, the calculation of the loads due to contraction in the corresponding piping is not required. It is, however, to be checked that the stress intensity corresponding to the primary stresses does not exceed the limits given in [3.3.4].

Table 1 *(1/7/2012)*

External diameter of pipe **(1)**	Aft of the quarter of the ship's length			Forward of the quarter of the ship's length		
	H ≤ 8	H = 13	H ≥ 18	H ≤ 8	H = 13	H ≥18
≤ 25	1500	250	150	2200	350	150
50	1400	250	150	2000	350	150
75	1100	250	150	1600	350	150
100	700	250	150	700	350	150
≥150	500	250	150	700	350	150
(1) D_C if the pipe is insulated, D otherwise.						

3.3.6 Flexibility coefficient *(1/7/2012)*

The flexibility coefficient of elbows is to be determined from the formulae given in Pt C, Ch 1, Sec 10, [2.3.2] for pipes intended for high temperatures.

3.3.7 Local stresses *(1/7/2012)*

Particular attention is to be paid to the calculation of local stresses in the assemblies subjected to axial forces and bending moments. The Society reserves the right to request additional justifications or local strengthening where considered necessary.

3.4 Aluminised pipes

3.4.1 *(1/7/2012)*

Aluminised pipes may be fitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

4 Tests of piping components and pumps prior to installation on board

4.1 Valves

4.1.1 Prototype Testing *(1/7/2012)*

IGC Code Ch 5, 5.3 applies as far as practicable, with the following additional requirements.

During the unloading phase, the cooldown due to the Joule-Thomson effect is to be taken into account. either or through a heating system, (which is to be considered as essential) or through material selection. In the latter case, each size and type of valve intended to be used at a working temperature below -55°C is to be approved through design assessment and prototype testing. Prototype testing to the minimum design temperature or lower and to a pressure not lower than the maximum design pressure foreseen for the valves is to be witnessed in the presence of the Society's Surveyor. Prototype testing is to include a hydrostatic test of the valve body at a pressure equal to 1.5 times the design pressure, seat and stem leakage test at a pressure equal to 1.1 times the design pressure, and cryogenic testing consisting of valve operation and leakage verification.

For valves intended to be used at a working temperature above -55°C, prototype testing is not required.

5 Liquid transfer pumps

5.1 General

5.1.1 *(1/7/2012)*

This section applies in case a system for separation of the liquid fractions is fitted onboard.

5.2 Prototype Testing

5.2.1 *(1/7/2012)*

Each size and type of pump is to be approved through design assessment and prototype testing. Prototype testing is to be witnessed in the presence of the Society's Surveyor. In lieu of prototype testing, satisfactory in-service experience of an existing pump design approved by a QSCS Classification Society submitted by the Manufacturer may be considered.

Prototype testing is to include a hydrostatic test of the pump body equal to 1.5 times the design pressure and a capacity test. For submerged electric motor driven pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature.

5.3 Unit Production Testing

5.3.1 Pumps *(1/7/2012)*

All pumps are to be tested at the Manufacturer's plant in the presence of the Society's Surveyor. Testing is to include a hydrostatic test of the pump body equal to 1.5 times the design pressure and a capacity test. For submerged electric motor driven pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature.

As an alternative to the above, if so requested by the relevant Manufacturer, the certification of a pump may be issued subject to the following:

- the pump has been approved as required by [3.3.1] and
- the Manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodical audits, and
- the quality control plan contains a provision to subject each pump to a hydrostatic test of the pump body equal to 1,5 times the design pressure and a capacity test. The Manufacturer is to maintain records of such tests.

5.3.2 Centrifugal pumps *(1/7/2012)*

Overpressure relief valves on cargo pumps may be omitted in the case of centrifugal pumps having a maximum delivery head, the delivery valve being completely closed, not greater than that permitted for the piping.

6 Cargo valves

6.1 General

6.1.1 *(1/7/2012)*

Cargo valves are to be so designed as to ensure a quick isolation in case of gas leak detection. For this purpose, the following specific requirements apply.

a) All remotely operated valves are to be capable of local manual operation.

b) Each cargo tank is to be isolated from the cargo piping by a manually operated stop valve and a remotely operated valve in series.

c) The loading/unloading connection point is to be equipped with a manually operated stop valve and a remotely operated valve in series.

d) The remotely operated isolation valves and are to be actuated by the emergency shutdown (ESD) system, in case of high pressure, sudden pressure drop during loading/unloading operations and fire. The ESD valves are to be arranged to be operated manually from cargo control room and other suitable locations

e) The valve sizing and operating time is to take into account surge phenomena.

f) The cargo compressors are to shutdown automatically if the ESD system is activated.

6.1.2 Unit Production Testing *(1/7/2012)*

Valves intended to be used at a working temperature below -55°C are to be tested at the Manufacturer's plant in the presence of the Society's Surveyor.

Testing is to include a hydrostatic test of the valve body at a pressure equal to 1.5 times the design pressure, seat and stem leakage test at a pressure equal to 1.1 times the design pressure, as well as cryogenic testing consisting of valve operation and leakage verification for a minimum of 10% of each type and size of valve for valves intended to be used at a working temperature below -55°C.

As an alternative to the above, if so requested by the relevant Manufacturer, certification of a valve may be issued subject to the following:

- the valve has been approved as required by [3.1.1] for valves intended to be used at a working temperature below -55°C, and
- the Manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodical audits, and
- the quality control plan contains a provision to subject each valve to a hydrostatic test of the valve body at a pressure equal to 1.5 times the design pressure and seat and stem leakage test at a pressure equal to 1.1 times the design pressure. The Manufacturer is to maintain records of such tests, and
- cryogenic testing is performed, in the presence of the Society's representative, consisting of valve operation and leakage verification for a minimum of 10% of each type and size of valve for valves intended to be used at a working temperature below -55°C.

7 Emergency shutdown

7.1 Clarification on location of fusible elements

7.1.1 *(1/7/2012)*

The cargo stations in way of which the fusible elements mentioned in paragraph 5.6.4 of the IGC Code are to be fitted are to be intended as the loading and unloading manifolds.

8 Bonding

8.1 Static electricity

8.1.1 **Acceptable resistance** *(1/7/2012)*

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than $10^6\,\Omega$.

8.1.2 **Bonding straps** *(1/7/2012)*

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

a) clearly visible so that any shortcoming can be clearly detected

b) designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint

c) easy to install and replace.

SECTION 6 MATERIALS FOR CONSTRUCTION

1 General

1.1

1.1.1 *(1/7/2012)*
In general, the requirements of Part D apply. For particular cases, the acceptance of materials of construction will be considered by the Society on a case-by-case basis, taking into consideration the specific arrangements.

SECTION 7 OVERPRESSURE PROTECTION FOR CARGO CONTAINMENT AND PIPING SYSTEM

1 General

1.1 Accident scenarios and risk assessment

1.1.1 *(1/7/2012)*

Accident scenarios like fire and gas leak are to be subjected to risk assessment (refer to ·TASNEEF Guide for Risk Analysis· for guidance). In particular, it is strongly recommended to resort to consequence analysis (typically, gas dispersion, heat radiation, high-pressure leaks etc.) to support the design of protection systems, carried out by recognized methods and tools. The Society should be involved in the risk assessment activities early in the design process, and will retain the final documentation for information.

2 Cargo Tanks and piping

2.1 General

2.1.1 *(1/7/2012)*

In general, the requirements of IGC Code, 8.1 and 8.2 apply for pressure relieving systems.

Cargo tanks containing gas (i.e. fluid that remains in gaseous phases in all expected conditions of utilization) are not subjected to 8.2.2, 8.2.3, 8.2.16 and 8.2.17.

Tanks containing two-phase fluids (e.g. if liquid separation processes are fitted) are also to comply with the requirements of IGC Code 8.3, 8.2.3, 8.2.16 and 8.2.17.

Additional requirements are given in the following.

The pressure in the cargo tanks, after filling, is to be limited to 95% of the design pressure in any condition, including transportation.

a) Every cargo tank is to be provided with safety systems to protect from overpressure. At least a purely mechanically-actuated safety valve of adequate capacity is to be fitted. A single failure of the safety system is not to hamper the overpressure protection of the cargo tank.

b) Safety devices ensuring protection of pressure vessels in normal service are to be rated to operate before the pressure exceeds the maximum working pressure by more than 5%.

c) Cargo tanks and associated piping are to be protected against low temperature effects arising from nearby high-pressure gas leaks.

d) Cargo tanks and associated piping are to be protected against fire scenarios.

e) Cargo holds are to be protected against overpressure and vacuum conditions, avoiding the ingress of air.

2.1.2 *(1/7/2012)*

In general, a venting system is to be provided, with the following characteristics:

- it is to ensure the possibility of relief from individual cargo tanks, or groups thereof, in case of leakage
- it is to be provided with remote control to vent individual cargo tanks, or groups thereof
- a detection system is to be fitted, to promptly detect leakages in individual cargo tanks, or groups thereof; the detection system is to follow the criteria laid down in Part C, Chapter 3 for automation systems intended for essential service
- the outlets of all venting systems are to be led to an area where heat radiation (for flares) or gases (for cold vents, relief valves etc.) does not cause hazard to the vessel, personnel and equipment
- if the cold venting option is selected, its size and height is to be supported by gas dispersion studies carried out by recognized methods and tools; as a minimum, the vent exits are to arranged at a distance of at least 5 m from exhaust ducts and at least 10 m from intake ducts serving machinery spaces
- if the flare option is selected, its size, height and emitted radiation is to be supported by heat radiation studies in addition to gas dispersion.

- the failure to open of a single valve is not to hamper the overpressure protection of any item of the cargo system.
- vent piping are to be protected against cooldown due to Joule-Thomson effects
- it is to be designed to maintain its structural integrity in any operating and environmental condition of the ship.

Overpressure protection measures equivalent, in terms of safety and reliability, to venting systems may be considered by the Society on a case-by-case basis, if properly supported by risk assessment and other relevant studies carried out by recognized methods and tools.

3 Information to the Master

3.1 Requirements

3.1.1 *(1/7/2012)*
The requirements of IGC Code, 15.2 apply.

SECTION 8 ENVIRONMENTAL CONTROL

1 Precautions against fire

1.1 Static electricity and general requirements

1.1.1 *(1/7/2012)*

IGC Code Ch 9, 9.4.1 applies, with the additional requirements provided in the following.

Precautions are to be taken to minimize the risk that static electricity generated by the inert gas system may become a source of ignition.

2 Environmental Control within Cargo Tanks and Cargo Piping Systems

2.1 General

2.1.1 *(1/7/2012)*

A piping system is to be provided to enable each cargo hold to be safely gas-freed or purged. The system is to be arranged to minimize the possibility of pockets of gas or air remaining after gas-freeing or purging.

2.1.2 *(1/7/2012)*

Gas sampling connections at the inlet and outlet above the main deck are to be provided for each cargo hold in order to adequately monitor the progress of purging and gas-freeing.

2.1.3 *(1/7/2012)*

The system is to be arranged to minimize the possibility of a flammable mixture existing in the cargo hold during any part of the gas-freeing operation by utilizing an inerting medium as an intermediate step.

2.1.4 *(1/7/2012)*

Piping systems which may contain cargo are to be capable of being gas-freed and purged, as provided in [2.1.1] and [2.1.3].

2.1.5 *(1/7/2012)*

Inert gas utilized in these procedures may be provided from the shore or from the ship.

3 Environmental Control within the Hold Spaces for Cargo Tanks

3.1 General

3.1.1 *(1/7/2012)*

Hold spaces associated with cargo containment systems are to be inerted with a suitable dry inert gas and kept inerted with make-up gas provided by a shipboard inert gas generation system or by shipboard storage, which is to be sufficient for normal consumption for at least 30 days.

4 Inerting

4.1 Application of IGC Code

4.1.1 *(1/7/2012)*

IGC Code 9.4.1 to 9.4.5 applies.

5 Inert gas production on board

5.1 Exemptions

5.1.1 *(1/7/2012)*

Inert gas generating systems are to be considered as essential services and are to comply with the applicable Sections of the Rules.

Where, in addition to inert gas produced on board, it is possible to introduce inert gas from a supply existing on board, it is not necessary that standby or spare components for the inert gas system are kept on board.

SECTION 9 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/7/2012)*

The requirements in this Section apply, in addition to those contained in Part C, Chapter 2, to ships with the service notation Compressed natural Gas carriers. If the ship is gas-fuelled, Pt C, Ch 1, App 7 applies.

1.2 Documentation to be submitted

1.2.1 *(1/7/2012)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 *(1/7/2012)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

1.3.2 *(1/7/2012)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.3 *(1/7/2012)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply.

1.4 Earth detection

1.4.1 *(1/7/2012)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [1.3.1].

1.5 Precautions against inlet of gases or vapours

1.5.1 *(1/7/2012)*

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

1.6 Electrical equipment permitted in hazardous areas

1.6.1 *(1/7/2012)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5] and Pt C, Ch 2, Sec 3, [10.1.6].

1.6.2 *(1/7/2012)*

In addition to the requirements of [1.6.1], in Zone 1 and Zone 2 the installation of the following is permitted: hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of an impressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

1.6.3 *(1/7/2012)*

Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

2 Hazardous locations

2.1 Hazardous area classification

2.1.1 *(1/7/2012)*

The extension of the gas dangerous zones in this section is given for guidance only. It is to be confirmed by risk assessment, taking into account high pressure relief sources and onboard equipment.

2.1.2 *(1/7/2012)*

For hazardous area classification see Tab 1. Risk assessment activities, in particular the gas dispersion studies, are to confirm the adequacy of such classification or provide additional or different criteria.

3 Product classification

3.1 Temperature class and explosion group

3.1.1 *(1/7/2012)*

Tab 2 specifies temperature class and explosion group data for the products eligible to be carried by CNG ships.

Table 1 : Classification of hazardous areas for CNG ships *(1/7/2012)*

Spaces		Hazardous area
No.	Description	
1	Cargo containment systems	Zone 0
2	Hold spaces where cargo is carried in a cargo containment system	Zone 1
3	Cargo pump (for liquid phase, if any) and cargo compressor rooms	Zone 1
4	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump and cargo compressor room ventilation outlets	Zone 1
5	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet	Zone 1

Spaces		Hazardous area
No.	Description	
6	Areas on open deck, or semi-enclosed spaces on open deck, within 1.5 m of cargo pump and cargo compressor room entrance, cargo pump and cargo compressor room ventilation inlet, openings into cofferdams or other zone 1 spaces	Zone 1
7	Areas on open deck over all cargo holds (including ballast tanks within the cargo hold area) where structure restricts natural ventilation and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2.4 m above the deck	Zone 1
8	Compartment for cargo hoses and equipment	Zone 1
9	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located	Zone 1
10	Enclosed or semi-enclosed spaces in which pipes containing cargo products for boil-off gas fuel burning systems are located, unless special precautions approved by the Society are provided to prevent product gas escaping into such spaces	Zone 1
11	Areas of 1,5 m surrounding open or semi-enclosed spaces of Zone 1	Zone 2
12	Areas 4 m beyond the cylinder and 4 m beyond the sphere defined in item 5	Zone 2
13	Spaces forming an air-lock	Zone 2
14	Areas on open deck over all cargo holds (including all ballast tanks within the cargo holds or tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2.4 m above the deck surrounding open or semi-enclosed spaces of Zone 1	Zone 2
15	Spaces forward of the open deck areas to which reference is made in item 10 and item 18, below the level of the main deck, and having an opening on the main deck or at a level less than 0,5 m above the main deck, unless: a) the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilation system inlets and exhausts, are situated at least 5 m from the foremost cargo tank and at least 10 m measured horizontally from any cargo tank outlet or gas or vapour outlet; and b) the spaces are mechanically ventilated	Zone 2
16	Areas within 2,4 m of the outer surface of a cargo tank where such surface is exposed to the weather	Zone 2

Table 2 : Temperature class and explosion group of certain products *(1/7/2012)*

Product name	Temperature class	Explosion group
Butadiene	T2	II B
Butane	T2	II A
Butane/propane mixture	T2	II A
Butylenes	T3	II A
Ethane	T2	II A
Methane	T1	II A
Nitrogen	NF	NF
Propane	T2	II A
Propylene	T2	II B

SECTION 10 FIRE PROTECTION AND FIRE EXTINCTION

1 Application

1.1 General

1.1.1 *(1/7/2012)*

The requirements of this Section are not applicable for the purpose of classification, except where the Society carries out surveys relevant to fire protection statutory requirements on behalf of the Flag Administration. In such cases, unless otherwise provided by the Flag Administration, fire protection statutory requirements as contained in this Section are considered a matter of Class and their compliance is verified by the Society for classification purposes.

1.1.2 *(1/7/2012)*

The ship is to comply with SOLAS Ch II-2 and IGC Code as far as applicable, irrespective of tonnage, including ships of less than 500 tons gross tonnage. The cargo area is to comply with the additional requirements specified in this Section. If the ship is gas-fuelled, Pt C, Ch 1, App 7 applies. Risk Assessment activities are in any case mandatory, (in particular, consequence analysis of fire scenarios), which are expected to originate further, more specific criteria for passive and active fire protection.

2 Additional criteria

2.1 Structural fire protection

2.1.1 *(1/7/2012)*

If a process system with gas under high pressure, or any other potential source of gas release, is placed on the weather deck in way of the cargo holds, deck cargo system, accommodation and other essential areas or equipment which may be exposed to heat loads, additional means of protection are to be considered against events resulting from risk assessment studies. Examples of such events are jet fire and impingement of low temperature gas due to Joule-Thomson expansion effects.

In particular, cargo piping is to run in inerted ducts with means of detection of gas leakage, or is to be arranged in such a way as to provide an equivalent safety level.

2.1.2 *(1/7/2012)*

Hold spaces are to have the following characteristics:

- resistance to fire load in scenarios ascertained by risk assessment studies, taking into account the heat resistance properties of cargo tanks materials
- sufficient strength and tightness to ensure effective inert atmosphere within hold spaces during both normal and abnormal conditions as ascertained by risk assessment studies.

2.1.3 *(1/7/2012)*

Process area and cargo holds are to be separated from accommodations, service spaces and engine room below the weather deck by means of cofferdams, having minimum distance between the bulkheads of 600 mm.

3 Means of escape

3.1

3.1.1 *(1/7/2012)*

Escape routes are to enable the crew to safely reach the assembly stations from any location during accident scenarios peculiar to CNG ships, e.g. the gas release and the heat radiation due to hydrocarbon fires. For this purpose, such routes are to be sheltered from cargo and process areas. Further criteria, such as the degree of protection from heat radiation of the escape routes and of the life-saving appliances, are expected to stem from risk assessment activities.

4 Fire Extinction

4.1

4.1.1 *(1/7/2012)*

The primary means of extinction of fires consequent to gas escape is the isolation of the leak by means of the ESD system.

4.1.2 *(1/7/2012)*

The fire fighting systems, in addition to SOLAS Ch II-2 are to comply with the following minimum requirements and criteria, which are to be integrated by the results of the risk assessment.

a) The fire fighting system is to be specially sized to cool down the areas and the systems of the CNG ship containing pressurized gas, and the structures of manned areas and fire hazardous spaces which may be engulfed by hydrocarbon fires.

b) The following items are typically to be protected by water spray:
   1) weather deck in way of cargo holds, and any exposed parts of cargo tanks;
   2) on-deck process systems;
   3) cargo discharge and loading manifolds with all the control, relief and isolation valves;
   4) ESD system
   5) boundaries of superstructures and deckhouses normally manned, cargo compressor rooms, cargo pump rooms, flare mast, storerooms containing high fire risk items and cargo control rooms, all facing the cargo area.

c) The arrangement is to be such that at least two jets of water can reach any part of the weather deck in way of the cargo holds and any part of the process and safety systems on deck and above. For this purpose, the capacity of fire pumps, fire mains and water service pipe diameters is not to be limited by requirements of SOLAS Ch II-2, Reg. 10.2.2.4.1 and 10.2.1.3. In particular, each fire pump is to have 100% capacity. Additional capacity is required if the main fire pumps are also used to supply water spray with the characteristics above indicated. In any case, a connection system with an isolating valve is to be provided between the water spray system and the water mains in a protected area, easily accessible by operators.

d) One pump is to be located forward of the cargo area and one pump aft of the cargo area and both pumps are to be arranged with remote control from both the bridge and the engine room. Both main fire pumps are to be available at any time for start and delivery of water during operation. The fire pumps shall start automatically upon low pressure detection in the fire mains. The remote operation of fire pumps and valves is to be possible from suitable locations protected by fire and gas, outside the cargo areas.

e) The number and position of hydrants is to be such that at least two jets of water not emanating from the same hydrant, one of which is to be from a single length of hose, may reach any part of the weather deck in way of the cargo holds and any part of the process and safety systems on deck and above.

f) Considerations are to be given to the layout of the fire mains, to protect it from the possibility of jet fire impingement.

SECTION 11 MECHANICAL VENTILATION IN THE CARGO AREA

1 General

1.1 Safety

1.1.1 *(1/7/2012)*

The ventilation system is to discharge to outlets ensuring safe environment for crew during release of inert gas.

1.2 Shutdown philosophy

1.2.1 *(1/7/2012)*

Shut down philosophy for gas detection in cargo area, air ventilation intakes for accommodation and machinery spaces shall be evaluated.

2 Spaces required to be entered during normal cargo handling operations

2.1 Location of discharges from dangerous spaces

2.1.1 **Ventilation duct arrangement** *(1/7/2012)*

The ventilation duct arrangement is to comply with the applicable requirements of IGC Code, 12.1.1 to 12.1.6 .

a) Ventilation ducts are to be arranged at a suitable height from the weather deck. This height is not to be less than 2,4 m for intake ducts.

b) Ventilation ducts are to be fitted with metallic fire dampers provided with "open" and "closed" signs. These dampers are to be arranged in the open, in a readily accessible position.

2.2 Recirculation prevention

2.2.1 *(1/7/2012)*

The requirements of IGC Code, 12.1.7 and 12.1.8 apply.

2.3 Non-sparking fans

2.3.1 *(1/7/2012)*

IGC Code, 12.1.9 to 12.1.11 apply, with the following additional requirements.

a) A fan is considered as non-sparking if in both normal or abnormal conditions it is unlikely to produce sparks.

b) The air gap between the impeller and the casing is to be not less than 0,1 of the shaft diameter in way of the impeller bearing and not less than 2 mm. It need not be more than 13 mm.

2.3.2 Materials *(1/7/2012)*

a) The impeller and the housing in way of the impeller are to be made of alloys which are recognised as being spark proof by appropriate tests.

b) Electrostatic charges both in the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation on board of the ventilation units is to be such as to ensure their safe bonding to the hull.

c) Tests may not be required for fans having the following combinations:

- impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity
- impellers and housings of non-ferrous materials
- impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous materials is fitted in way of the impeller
- any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm design tip clearance.

d) The following impellers and housings are considered as sparking and are not permitted:
- impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance
- housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
- any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

2.3.3 Type test for non-sparking fans *(1/7/2012)*

Type tests on the finished product are to be carried out in accordance with the requirements of the Society or an equivalent national or international standard.

2.3.4 Motor shafting *(1/7/2012)*

The shafting penetration of motors driving fans through bulkheads and decks of dangerous spaces or through ventilation ducts is to be fitted with a gas-tight sealing device, of the oil-seal type or equivalent, deemed suitable by the Society.

3 Spaces not normally entered

3.1 General requirements

3.1.1 Minimum number of air changes *(1/7/2012)*

IGC Code, 12.2 applies, with the following additional requirements.

Both fixed and portable systems are to guarantee the efficient ventilation of such spaces in relation to the relative density, in respect of the air, and to the toxicity of the gases transported. Such ventilation system is to be capable of effecting not less than 8 air changes per hour. The type of portable fans and their connection to the spaces served are to be approved by the Society. In no case are portable electrical fans acceptable.

SECTION 12 INSTRUMENTATION (GAUGING, GAS DETECTION)

1 General

1.1 Application of gas-fuelled ship

1.1.1 *(1/7/2012)*

If the ship is gas-fuelled, Pt C, Ch 1, App 7 applies.

1.2 Cargo tank instrumentation

1.2.1 *(1/7/2012)*

The instrumentation is to be of a type approved by the Society.

1.3 Drainage

1.3.1 *(1/7/2012)*

Hold spaces are to be provided with a suitable drainage arrangement not connected with machinery spaces. Means for detecting leakage of water into the hold space are to be provided.

1.4 Indicator location

1.4.1 **Monitoring list** *(1/7/2012)*

IGC Code, 13.1.3 applies, with the following additional requirements.

The following information and alarms are to be concentrated in the positions specified in this paragraph.

a) The following is to be located in the "cargo control room" and the "control stations" defined in 1.3 of the IGC Code:
   1) indication signalling the presence of water in holds or interbarrier spaces
   2) cargo heater (if fitted) low temperature alarm
   3) indication of the pressure with appropriate high pressure alarm in each cargo tank and in each hold space gas detection equipment alarm required in 13.6.4 of the IGC Code
   4) cargo compressor high temperature alarm
   5) the alarm for automatic shutdown of the cargo compressor for high pressure or high temperature
   6) Indication of temperature and oxygen of each hold space
   7) Monitoring of the temperature in the appropriate locations during pressure relief situations such as unloading or vent, to ensure that the temperature does not decrease below the minimum design temperature
   8) Detection of moisture and H_2S at the load/unload or shore connection.

   When the cargo system is not remote controlled and therefore the aforesaid "control positions" are not required, the above-mentioned controls, information and alarms are to be located in a suitable, easily accessible location.

   If this position is an enclosed space, it is to comply with the requirements of 13.6.7 of the IGC Code.

b) Independently of the above, the following is to be transduced to the wheelhouse:
   1) the alarm signalling the presence of water in cargo holds
   2) the cargo heater (if fitted) low temperature alarm.

1.4.2 **Indication of the pressure value in each cargo tank** *(1/7/2012)*

Such indication is to give the setting pressure value of the relief valve and the maximum allowable pressure value in the cargo tank concerned. The audible and visual alarms for cargo tanks are to be located in such a position as to be clearly heard and identifiable by the personnel in charge of loading operation control.

1.4.3 **Temperatures of the heating circuits** *(1/7/2012)*

The temperatures of the heating circuits, if fitted to prevent hydrate formation or to prevent Joule-Thomson effects, are to be monitored, and low and high temperature alarms are to be provided, as appropriate.

2 Gas detection requirements

2.1 Application of IGC Code and additional requirements

2.1.1 *(1/7/2012)*
In addition to the applicable requirements of IGC Code, 13.6, the following requirements are to be complied with.

2.2 Gas Measurements

2.2.1 *(1/7/2012)*
In addition to the provisions of [2.2] to [2.3], the fitting of gas measuring equipment is subject to those of Pt C, Ch 4, Sec 1, [5.2.4] b). An independent gas detection system is to be installed on the deck cargo area to monitor the presence of leaks, and activate the ESD in case of leak detection. As a minimum, the presence of gas is to be checked in the following spaces:

a) every hold space
b) deck piping
c) ventilation inlets/outlets for gas dangerous spaces
d) air inlets to machinery spaces
e) manifold area.

2.3 Position of sampling heads

2.3.1 *(1/7/2012)*
In addition to the requirements of IGC Code 13.6.5, gas sampling lines are to be located outside accommodation spaces, unless they are fitted within gas-tight pipes.

3 Protected spaces

3.1 Application of IGC Code and additional requirements

3.1.1 *(1/7/2012)*
In addition to the list in paragraph 13.6.7 of the IGC Code, the gas detection system is also to serve spaces adjacent to pump rooms and compressor rooms.

4 Portable gas detectors

4.1 Provision of portal gas detectors

4.1.1 *(1/7/2012)*
Every ship is to be provided with at least two sets of portable gas detection equipment acceptable to the Administration and suitable for the product to be carried.

If it is expected that the gases to be carried are both toxic and flammable, two sets for toxic gases and two sets for flammable gases are to be provided.

SECTION 13 USE OF CARGO AS FUEL

1 Application

1.1 General

1.1.1 *(1/7/2012)*
In general, Pt C, Ch 1, App 7 applies.

1.1.2 *(1/7/2012)*
Further requirements are as follows.

a) Gas used for fuel is to be purified from entrained liquids and substances that may damage the users, according to the manufacturers' requirements.

b) Gas containing H_2S is to be sweetened if it is conveyed to enclosed machinery spaces, which are to be equipped with H_2S gas detectors set to give an alarm at 10 ppm and to activate the shut-off of the master gas valve at 50 ppm.

c) If gas-fired equipment is located in enclosed spaces on the cargo deck, such spaces are to have ventilation system providing at least 30 air changes per hour. These spaces are to be fitted with gas detection system to give an alarm at 20% LEL and to activate the shut-off of the master gas valve at 60% LEL.

1.2 Testing

1.2.1 *(1/7/2012)*
Piping, valves and fittings are to be hydrostatically tested, after assembly onboard, to 1.5 times the working pressure. Subsequently, they are to be pneumatically tested to ascertain that all the joints are perfectly tight.

SECTION 14 SPECIAL REQUIREMENTS

1 Materials for construction

1.1

1.1.1 *(1/7/2012)*

IGC Code 17.2.2 applies.

Materials "exposed to cargo" are those constituting systems, cargo appliances or arrangements which are in contact with cargo gas or vapor in normal operating conditions.

2 Independent tanks

2.1 Carriage of gas

2.1.1 *(1/7/2012)*

The gas is to be carried in independent pressure vessels only.

3 Deck cargo piping

3.1 NDE for butt-welded joints

3.1.1 *(1/7/2012)*

One hundred per cent radiography of all butt-welded joints in cargo piping is required, irrespective of the diameter.

4 Exclusion of air from vapor spaces

4.1 Purging and inerting

4.1.1 *(1/7/2012)*

Air is to be removed from the cargo tanks and associated piping before loading and then subsequently excluded by introducing inert gas.

5 Moisture control

5.1 Cargo tank drying

5.1.1 *(1/7/2012)*

Moisture control is to be provided to ensure that cargo tanks are dry at all times.

6 Permanently installed toxic gas detectors

6.1 Application of IGC Code

6.1.1 *(1/7/2012)*

IGC Code 17.9 applies.

7 Flame screens on vent outlets

7.1 Application of IGC Code

7.1.1 *(1/7/2012)*

IGC Code 17.10 applies.

SECTION 15 ADDITIONAL INFORMATIONS ON PRODUCTS

1 General

1.1 List of additional products

1.1.1 *(1/7/2012)*

The list shown in Tab 1 gives properties for pure products, expected to be carried on CNG carriers. The specific gravity to be taken into account for the design of a ship might be altered considering the actual properties of the commercial product.

Information on temperature classes and explosion groups for electrical equipment in connection with the products to be carried is indicated in Sec 9, Tab 2.

Table 1 *(1/7/2012)*

Product name	Boiling temperature (°C)	Specific gravity at boiling point (kg/m^3)	Ratio vapour/air density
Butadiene	- 4,5	650	1,87
Butane	-0,5/11,7	600	2,02
Butylenes	- 6,3/- 7	625	1,94
Ethane	- 88,6	549	1,04
Ethylene	- 104	570	0,97
Ethylene oxide	-10,7	870	1,52
Nitrogen	-196	808	0,97
Pentanes (all isomers)	36,1	610	2,6
Pentene (all isomers)	30,1/37	610	2,6
Propane	-42,3	580	1,56
Propylene	-47,7	610	1,50

Chapter 25

OIL CARRIERS - ASSISTED PROPULSION

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Service notation oil carrier *(1/5/2013)*

a) The requirements of this Chapter apply to ships having the service notations oil tanker, as defined in Pt A, Ch 1, Sec 2, [4.5.2]

As indicated in Pt A, Ch 1, Sec 2, [4.5.11] these units are to be assigned with the additional service feature **assisted propulsion**.

Note 1: As recalled in Part A, Chapter 1, Sec 1, [3.1.1], the classification of a ship does not absolve the Interested Party from compliance with any requirements issued by Administrations and any other applicable international and national regulations for the safety of life at sea and protection of the marine environment.

b) Departures are given for oil carriers that have the additional service feature **oil carriers, flashpoint > 60°C** and are intended only for the carriage of bulk cargoes:

- at a temperature below and not within 15°C of their flashpoint, or
- having a flashpoint above 100°C.

c) The list of substances the carriage in bulk of which is covered by the service notations

- **oil carrier**
- **oil carrier, flashpoint > 60°C**

is the one in MARPOL 73/78 annex Convention, except “naphta solvent”, the carriage of which is subject to compliance with Chapter 8.

1.2 Summary tables

1.2.1 *(1/5/2013)*

Tab 1 indicates, for easy reference, the Sections or Appendixes of this Chapter dealing with requirements applicable to ships having the following service notations:

- **oil carrier**
- **oil carrier, flashpoint > 60°C**.

1.3 Definitions

1.3.1 Cargo area *(1/5/2013)*

The cargo area is that part of the ship that contains cargo tanks as well as slop tanks, cargo pump rooms including pump rooms, cofferdams, ballast or void spaces adjacent to cargo tanks or slop tanks as well as deck areas throughout the entire length and breadth of the part of the ship above these spaces.

When independent tanks are installed in hold spaces, the cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space are excluded from the cargo area.

Table 1 : Sections or Appendixes with requirements applicable to ships having the Service Notations indicated in [1.2.1] *(1/5/2013)*

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery and cargo system	Sec 4 and Sec 5
Electrical installations	Sec 6
Automation	**(1)**

Main subject	Reference
Fire protection, detection and extinction	**(1)**
Devices to prevent the passage of flames into cargo tanks	Ch 7, App 1
Crude oil washing system	Ch 7, App 2
(1) No specific requirements are given in this Chapter.	

1.3.2 **Cargo pump room** *(1/5/2013)*

Cargo pump room is a space containing pumps and their accessories for the handling of products covered by the service notation granted to the ship.

1.3.3 **Cargo service spaces** *(1/5/2013)*

Cargo service spaces are spaces within the cargo area used for workshops, lockers and storerooms of more than 2 m^2 in area, intended for cargo handling equipment.

1.3.4 **Clean ballast** *(1/5/2013)*

Clean ballast means the ballast in a tank which since oil was last carried therein, has been so cleaned that the effluent therefrom if it were discharged from a ship which is stationary into clean calm water on a clear day would not produce visible traces of oil on the surface of the water or on adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. If the ballast is discharged through an oil discharge monitoring and control system approved by the Society, evidence based on such a system to the effect that the oil content of the effluent did not exceed 15 parts per million is to be determinative that the ballast was clean, notwithstanding the presence of visible traces.

1.3.5 Crude oil *(1/5/2013)*

Crude oil means any liquid hydrocarbon mixture occurring naturally in the earth whether or not treated to render it suitable for transportation and includes:

a) crude oil from which certain distillate fractions have been removed, and

b) crude oil to which certain distillate fractions may have been added.

1.3.6 Crude oil carrier *(1/5/2013)*

Crude oil carrier means an oil carrier engaged in the trade of carrying crude oil.

1.3.7 Hold space *(1/5/2013)*

Hold space is the space enclosed by the ship’s structure in which an independent cargo tank is fitted

1.3.8 Fuel oil *(1/5/2013)*

Fuel oil means any oil used as fuel in connection with the propulsion and auxiliary machinery of the ship on which such oil is carried.

1.3.9 **Integrated cargo and ballast system** *(1/5/2013)*

Integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps (including active control and safety systems and excluding passive components, e.g. piping).

1.3.10 **Oil mixture** *(1/5/2013)*

Oil mixture means a mixture with any oil content.

1.3.11 **Product carrier** *(1/5/2013)*

Product carrier means an oil carrier engaged in the trade of carrying oil other than crude oil.

1.3.12 Pump room *(1/5/2013)*

Pump room is a space, located in the cargo area, containing pumps and their accessories for the handling of ballast and fuel oil, or cargoes other than those covered by the service notation granted to the ship.

1.3.13 Segregated ballast *(1/5/2013)*

Segregated ballast means the ballast water introduced into a tank which is completely separated from the cargo oil and fuel oil system and which is permanently allocated to the carriage of ballast or to the carriage of ballast or cargoes other than oil or noxious substances as variously defined in Chapter 7 or Chapter 8.

1.3.14 Slop tank *(1/5/2013)*
Slop tank means a tank specifically designated for the collection of tank draining, tank washings and other oily mixtures.

1.3.15 Void space *(1/5/2013)*
Void space is an enclosed space in the cargo area external to a cargo tank, except for a hold space, ballast space, fuel oil tank, cargo pump room, pump room, or any space normally used by personnel.

SECTION 2 SHIP ARRANGEMENT

1 General

1.1 Application

1.1.1 *(1/5/2013)*

The requirements in Sec 2 apply to single deck ships, integral cargo tanks with machinery aft, double bottom throughout the cargo tank area, double side skin and possible longitudinal bulkheads, or single side skin and one or more longitudinal bulkheads throughout the cargo tank area. The deck may be single or double skin, with or without a trunk.

The application of these requirements to other ship types is to be considered by the Society on a case-by-case basis.

1.1.2 Deviations *(1/5/2013)*

The requirements in [2.1.2] and [2.1.3], apply only to ships with the service notations:

- **oil carrier**.

The requirements in [2.2], [3] and [4], apply only to ships with the service notations:

- **oil carrier**
- **oil carrier, flashpoint > 60°C**.

1.1.3 Exemptions *(1/5/2013)*

The requirements in Pt B, Ch 2, Sec 2, [3] b) and [5] do not apply.

2 General arrangement design

2.1 General

2.1.1 Cofferdams *(1/5/2013)*

A cofferdam or similar compartment of width not less than 760 mm is to be provided at the aft end of the cargo tank area. Its bulkheads are to extend from keel to deck across the full breadth of the ship.

For the purpose of this requirement, the term “cofferdam” is intended to mean an isolating compartment between two adjacent steel bulkheads or decks. The minimum distance between the two bulkheads or decks is to be sufficient for safe access and inspection.

In order to meet the single failure principle, in the particular case when a corner-to-corner situation occurs, this principle may be met by welding a diagonal plate across the corner.

The cofferdams are also to be constructed so as to enable adequate ventilation.

2.1.2 Cargo segregation *(1/5/2013)*

Unless expressly provided otherwise, in ships enabled to carry cargoes having a flashpoint below 60°C, tanks containing cargo or cargo residues are to be placed forward of and segregated from accommodation, service and machinery spaces, drinking water and stores for human consumption by means of a cofferdam, or any other similar compartment and arranged in such a way that a single failure of a deck or bulkhead will not permit the entry of gas or vapour from the cargo tank into control stations, accommodation and service spaces (see Fig 1 and Fig 2).

Figure 1 *(1/5/2013)*

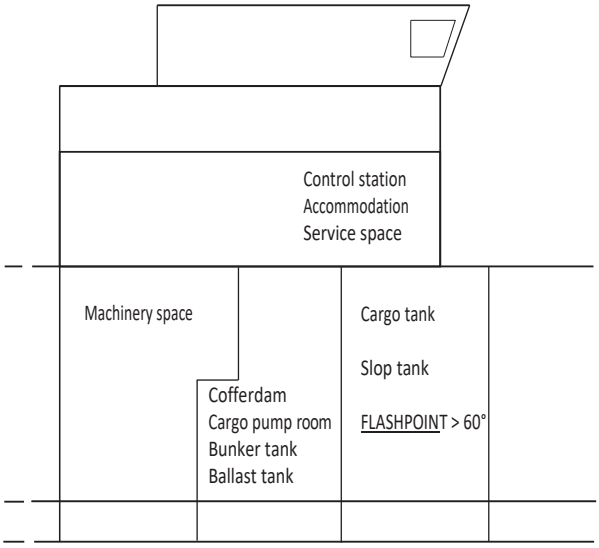
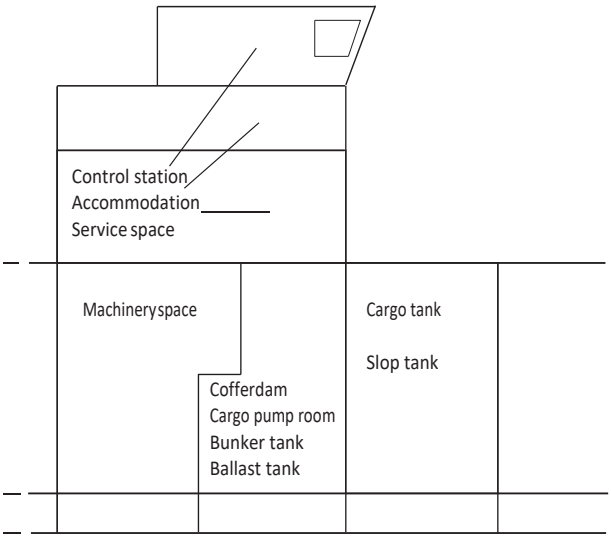


Figure 2 *(1/5/2013)*



2.1.3 Deck spills *(1/5/2013)*

Means are to be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by providing a permanent continuous coaming of a suitable height extending from side to side.

Where gutter bars are installed on the weather decks of oil carriers in way of cargo manifolds and are extended aft as far as the aft bulkhead of superstructures for the purpose of containing cargo spills on deck during loading and discharge operations, the free surface effects caused by containment of a cargo spill during liquid transfer operations or of boarding seas while underway are to be considered with respect to the vessel's available margin of positive initial stability (GM_o).

Where the gutter bars installed are higher than 300 mm, they are to be treated as bulwarks with freeing ports arranged in accordance with Pt B, Ch 9, Sec 9, [5] and effective closures provided for use during loading and discharge operations. Attached closures are to be arranged in such a way that jamming cannot occur while at sea, ensuring that the freeing ports will remain fully effective.

On ships without deck camber, or where the height of the installed gutter bars exceeds the camber, and for oil carriers having cargo tanks exceeding 60% of the vessel's maximum beam amidships regardless of gutter bar height, gutter bars may not be accepted without an assessment of the initial stability (GM_o) for compliance with the relevant intact stability requirements taking into account the free surface effect caused by liquids contained by the gutter bars.

2.2 Double bottom tanks or compartments

2.2.1 General *(1/5/2013)*

Double bottom tanks adjacent to cargo tanks may not be used as fuel oil tanks.

2.2.2 Oil carriers of 5000 t deadweight and above *(1/5/2013)*

At any cross-section, the depth of each double bottom tank or compartment is to be such that the distance h between the bottom of the cargo tanks and the moulded line of the bottom shell plating measured at right angles to the bottom shell is not less than B/15, in m, with a minimum value of 0,76 m.

In the turn of the bilge area and at locations without a clearly defined turn of the bilge, the cargo tank boundary line is to run parallel to the line of the midship flat bottom as shown in Fig 3.

Figure 3 : Cargo tank boundary lines *(1/5/2013)*

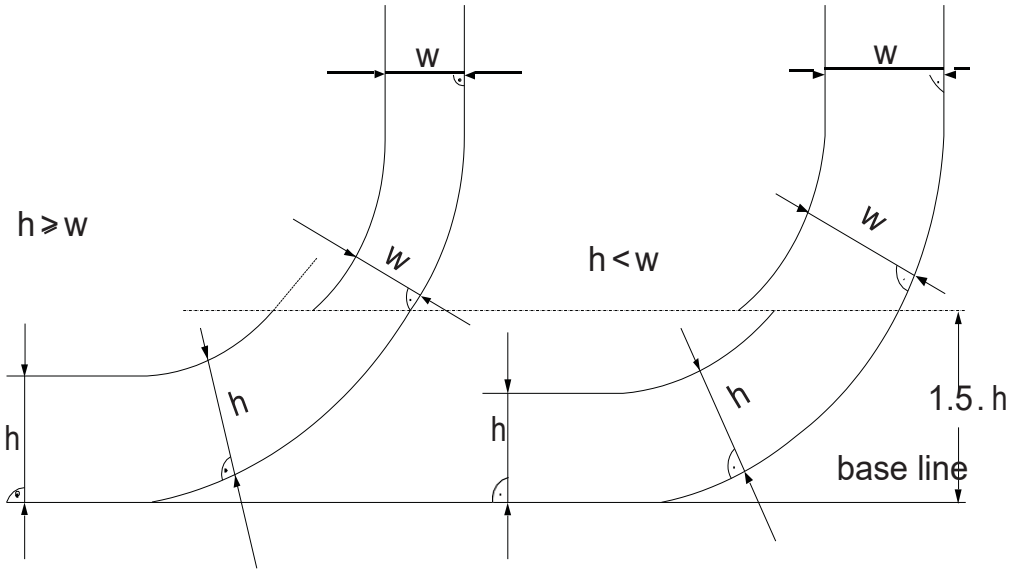
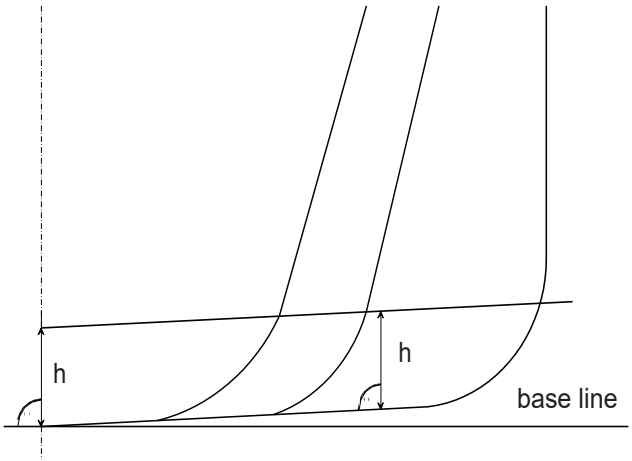


Figure 4 : Cargo tank boundary lines *(1/5/2013)*



2.3 Navigation position

2.3.1 *(1/5/2013)*

When it is proven necessary to provide a navigation station above the cargo area, such station is to be for navigation purposes only and is to be separated from the cargo tank deck by an open space of at least 2 m in height.

3 Size and arrangement of cargo tanks and slop tanks

3.1 Cargo tanks

3.1.1 General *(1/5/2013)*

Oil carriers of 600 t deadweight and above are not allowed to carry oil in any compartment extending forward of a collision bulkhead located in accordance with Pt B, Ch 2, Sec 1, [2].

3.1.2 Size of cargo tanks *(1/5/2013)*

The length of each cargo tank is not to exceed 10 metres or one of the values of Tab 1, as applicable, whichever is the greater.

Oil carriers are to be provided with cargo tanks so arranged that the capacity of each cargo tank does not exceed 700 m3 unless wing tanks or compartments are arranged, extending either for the full depth of the ship side or from the top of the double bottom to the uppermost deck, disregarding a rounded gunwale where fitted. They are to be arranged such that the cargo tanks are located inboard of the moulded line of the side shell plating, nowhere less than the distance w which, as shown in Fig 4, is measured at any cross-section at right angles to the side shell, as specified below:

$$w = 0,4 + \frac{2,4DW}{20000}$$ with a minimum value of 0,76 m

DW is the deadweight, in t.

3.1.3 Piping through cargo tanks *(1/5/2013)*

Lines of piping which run through cargo tanks in a position less than 0,30 B_s from the ship's side or less than 0,30 D_s from the ship's bottom are to be fitted with valves or similar closing devices at the point at which they open into any cargo tank. These valves are to be kept closed at sea at any time when the tanks contain cargo oil, except that they may be opened only for cargo transfer needed for essential operations.

3.1.4 Suction wells in cargo tanks *(1/5/2013)*

Suction wells in cargo tanks may protrude into the double bottom below the boundary line defined by the distance h in [2.2.2] or, as applicable, provided that such wells are as small as practicable and the distance between the well bottom and bottom shell plating is not less than 0,5 h.

3.2 Slop tanks

3.2.1 Oil carriers of 150 gross tonnage and above *(1/5/2013)*

The arrangements of the slop tank or combination of slop tanks are to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is to be not less than 3 per cent of the oil carrying capacity of the ships, except that the Society may accept:

- 2% for such oil carriers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system
- 2% where segregated ballast tanks are provided. This capacity may be further reduced to 1,5% for such oil carriers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for ejectors, without the introduction of additional water into the system.

The society may accept slop tanks of any size, including absence of dedicated slop tanks, for units which:

- are dedicated to the same type of cargo for many consecutive voyages, and
- are arranged with segregated ballast tanks, and
- do not carry out tank washing on a regular basis, and
- retain on board (in cargo tanks) the total quantity of washing media, and discharge it ashore.

4 Access arrangement

4.1 General

4.1.1 *(1/5/2013)*

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo tanks and ballast compartments.

4.1.2 *(1/5/2013)*

Means of access to side and centre tanks may not be provided in the same transverse section.

Table 1 : Length of cargo tanks *(1/5/2013)*

Longitudinal bulkhead arrangement	Cargo tank	Condition **(1)**	Centreline bulkhead arrangement	Length of cargo tanks, in m
No bulkhead	-	-	-	(0,5 b_i / B + 0,1) L **(2)**
Centreline bulkhead	-	-	-	(0,25 b_i / B + 0,15) L
Two or more bulkheads	Wing cargo tank	-	-	0,2 L
	Centre cargo tank	b_i / B ≥ 1/5	-	0,2 L
		b_i / B < 1/5	No	(0,5 b_i / B + 0,1) L
			Yes	(0,25 b_i / B + 0,15) L

(1) b_i is the minimum distance from the ship side to the outer longitudinal bulkhead of the i-th tank, measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.

(2) Not to exceed 0,2 L

4.2 Access to pipe tunnel and opening arrangement

4.2.1 Access to the pipe tunnel in the double bottom *(1/5/2013)*

The pipe tunnel in the double bottom is to comply with the following requirements:

- it may not communicate with the engine room
- provision is to be made for at least two exits to the open deck arranged at a maximum distance from each other. One of these exits fitted with a watertight closure may lead to the cargo pump room.

4.2.2 Doors between pipe tunnel and main pump room *(1/5/2013)*

Where there is a permanent access from a pipe tunnel to the main pump room, a watertight door is to be fitted complying with the requirements in Pt B, Ch 2, Sec 1, [6.2.1] for watertight doors open at sea and located below the freeboard deck. In addition the following is to be complied with:

- in addition to bridge operation, the watertight door is to be capable of being manually closed from outside the main pump room entrance
- the watertight door is to be kept closed during normal operations of the ship except when access to the pipe tunnel is required. A notice is to be affixed to the door to the effect that it may not be left open.

4.3 Access to compartments in the cargo area

4.3.1 General *(1/5/2013)*

Access to cofferdams, ballast tanks, cargo tanks and other compartments in the cargo area is to be direct from the open deck and such as to ensure their complete inspection. Access to double bottom compartments may be through a cargo pump room, pump room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

4.3.2 Access to the fore peak tank *(1/1/2026)*

The requirements for access to the fore peak tank in Ch 7, Sec 2, [7.2] and [7.3] apply.

Indirect access from the open deck to the fore peak tank through an enclosed space may be accepted if the unit is only enabled to carry products having a flashpoint exceeding 60°C.

4.3.3 Access through horizontal openings *(1/5/2013)*

For access through horizontal openings the dimensions are to be sufficient to allow a person wearing a self-contained, air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the compartment. The minimum clear opening is to be not less than 600 mm by 600 mm.

4.3.4 Access through vertical openings *(1/5/2013)*

For access through vertical openings the minimum clear opening is to be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

4.3.5 Oil carriers less than 5000 t deadweight *(1/5/2013)*

For oil carriers of less than 5000 t deadweight smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

SECTION 3 STABILITY

1 Stability

1.1 Application

1.1.1 *(1/5/2013)*

The requirements in [1.2.2] apply to ships with the service notations:

- **Oil carrier**
- **Oil carrier, flashpoint > 60°C**.

1.2 Intact stability

1.2.1 General *(1/5/2013)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.6] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2. In addition, the requirements in [1.2.2] are to be complied with.

1.2.2 Liquid transfer operations *(1/5/2013)*

Ships with certain internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling, the design of oil carriers of 5000 t deadweight and above is to be such that the following criteria are complied with:

a) The intact stability criteria reported in b) is to be complied with for the worst possible condition of loading and ballasting as defined in c), consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.

b) The initial metacentric height GMo, in m, corrected for free surface measured at 0° heel, is to be not less than 0,15. For the purpose of calculating GMo, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.

c) The vessel is to be loaded with:
   - all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank
   - cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value
   - full departure consumable
   - 1% of the total water ballast capacity.The maximum free surface moment is to be assumed in all ballast tanks.

SECTION 4 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Application

1.1.1 *(1/5/2013)*

The requirements of this Section apply to ships having the service notation:

- **oil carrier**

intended to carry products having any flashpoint.

Some departures from these requirements may be accepted for ships of less than 500 gross tonnage as indicated in Tab 1.

1.1.2 Exemptions *(1/5/2013)*

The requirements in Part C, Ch 1, Sec 10, [11.4.1] b) do not apply to service tanks.

1.2 Documents to be submitted

1.2.1 *(1/5/2013)*

The documents listed in Tab 2 are to be submitted for approval in four copies.

2 Piping systems other than cargo piping system

2.1 General

2.1.1 Materials *(1/5/2013)*

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

2.1.2 **Independence of piping systems** *(1/5/2013)*

a) Bilge, ballast and scupper systems serving spaces located within the cargo area:
   - are to be independent from any piping system serving spaces located outside the cargo area
   - are not to lead outside the cargo area.

b) Fuel oil systems are to:
   - be independent from the cargo piping system
   - have no connections with pipelines serving cargo or slop tanks.

2.1.3 **Passage through cargo tanks and slop tanks** *(1/1/2025)*

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted, ballast pipes passing through cargo tanks are to fulfil the following provisions:
   - they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
   - they are to be of extra-reinforced wall thickness as per Pt C, Ch 1, Sec 10, Tab5
   - they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

2.1.4 Pumps *(1/5/2013)*

One or more driven pumps are to be fitted, in a suitable space forward of cargo tanks, for bilge, ballast and, where relevant, fuel oil services.

Note 1: On ships of less than 500 gross tonnage, such pumps may be omitted provided that the above services are ensured by means of equivalent arrangements, subject to the approval of the Society.

Table 1 *(1/5/2013)*

Subject	Reference to this Section	Feature of the ship to which departures apply	Departures
Driven pumps for bilge, ballast, etc.	[2.1.4]	< 500 GRT	equivalent arrangements accepted
Drainage of pump rooms	[2.2.3]	< 500 GRT	hand pumps permitted
Drainage of cofferdams	[2.2.5]	< 500 GRT	hand pumps permitted

Table 2 : Documents to be submitted *(1/5/2013)*

No.	Description of the document **(1)**
1	General layout of cargo pump room with details of: • bulkhead penetrations • gas detection system • other alarms and safety arrangements
2	Diagram of cargo piping system
3	Diagram of the cargo tank venting system with: • indication of the outlet position • details of the pressure/vacuum valves and flame arrestors • details of the draining arrangements, if any
4	Diagram of the cargo tank level gauging system with overfill safety arrangements
5	Diagram of the cargo tank cleaning system
6	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
7	Diagram of the cargo heating systems
8	Diagram of inert gas system with details of the inert gas plant
9	Diagram of gas measurement system for double hull and double bottom spaces
(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.	

2.2 Bilge system

2.2.1 Bilge pumps *(1/5/2013)*

a) At least one bilge pump is to be provided for draining the spaces located within the cargo area. Cargo pumps or stripping pumps may be used for this purpose.

b) Bilge pumps serving spaces located within the cargo area are to be located in the cargo pump room or in another suitable space within the cargo area.

2.2.2 Draining of spaces located outside the cargo area *(1/5/2013)*

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 10, [6].

2.2.3 Draining of pump rooms *(1/5/2013)*

a) Arrangements are to be provided to drain the pump rooms by means of power pumps or bilge ejectors.

Note 1: On carriers of less than 500 gross tonnage, the pump rooms may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

b) Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:

- a screw-down non-return valve is fitted on the bilge suctions, and
- a remote control valve is fitted between the pump suction and the bilge distribution box.

c) Bilge pipe internal diameter is not to be less than 50 mm.

d) The bilge system of cargo pump rooms is to be capable of being controlled from outside.

e) High liquid level in the bilges is to activate an audible and visual alarm in the cargo control room and on the navigation bridge.

2.2.4 Draining of tunnels and pump rooms other than cargo pump rooms *(1/5/2013)*

Arrangements are to be provided to drain tunnels and pump rooms other than cargo pump rooms. Cargo pumps may be used for this service under the provisions of [2.2.3], item b).

2.2.5 Draining of cofferdams located at the fore and aft ends of the cargo spaces *(1/5/2013)*

a) When they are not intended to be filled with water ballast, cofferdams located at the fore and aft ends of the cargo spaces are to be fitted with drainage arrangements.

b) Aft cofferdams adjacent to the cargo pump room may be drained by a cargo pump in accordance with the provisions of [2.2.3], items b) and c), or by bilge ejectors.

c) Cofferdams located at the fore end of the cargo spaces may be drained by the bilge or ballast pumps required in [2.1.4], or by bilge ejectors.

d) Drainage of the after cofferdam from the engine room bilge system is not permitted.

Note 1: On carriers of less than 500 gross tonnage, cofferdams may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

2.2.6 Drainage of other cofferdams and void spaces located within the cargo area *(1/5/2013)*

Other cofferdams and void spaces located within the cargo area and not intended to be filled with water ballast are to be fitted with suitable means of drainage.

2.3 Ballast system

2.3.1 General *(1/5/2013)*

a) Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo oil and fuel oil systems.

b) In oil carriers of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

2.3.2 Ballast pumps *(1/5/2013)*

a) Ballast pumps are to be located in the cargo pump room, or a similar space within the cargo area not containing any source of ignition.

b) Where installed in the cargo pump room, ballast pumps are to comply with the applicable provisions of [3.2.3] and [3.2.4].

2.3.3 Pumping arrangements for ballast tanks within the cargo area *(1/5/2013)*

a) Ballast systems serving segregated ballast in the cargo area are to be entirely located within the cargo area and are not to be connected to other piping systems.

b) Segregated ballast tanks located within the cargo area are to be served by two different means. At least one of these means is to be a pump or an eductor used exclusively for dealing with ballast.

2.3.4 Pumping arrangement for cofferdams located at the fore and aft ends of the cargo spaces *(1/5/2013)*

Where they are intended to be filled with water ballast, the cofferdams located at the fore and aft ends of the cargo spaces may be emptied by a ballast pump located inside the machinery compartment or the forward space mentioned in [2.1.4], whichever is the case, provided that:

- the suction is directly connected to the pump and not to a piping system serving machinery spaces
- the delivery is directly connected to the ship side.

2.3.5 Emergency discharge of segregated ballast *(1/5/2013)*

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

2.3.6 Carriage of ballast water in cargo tanks *(1/5/2013)*

a) Provisions may be made for filling cargo tanks with sea water, where permitted. Such ballast water is to be processed and discharged using the equipment referred to in [5].

b) The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

c) Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges. See also [5.3.4].

d) Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

2.3.7 Ballast pipes passing through tanks *(1/1/2025)*

a) In oil carriers of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

2.3.8 Fore peak ballast system on oil carriers *(1/1/2026)*

The fore peak tank can be ballasted with the system serving ballast tanks within the cargo area, provided the requirements in Ch 7, Sec 2, [7.2.1] are complied with.

2.3.9 Integrated cargo and ballast system *(1/5/2013)*

The requirements for integrated cargo and ballast systems are given in [3.5].

2.4 Air and sounding pipes of spaces other than cargo tanks

2.4.1 General *(1/5/2013)*

The air and sounding pipes fitted to the following spaces:

- cofferdams located at the fore and aft ends of the cargo spaces
- tanks and cofferdams located within the cargo area and not intended for cargo

are to be led to the open.

2.4.2 Air pipes *(1/5/2013)*

The air pipes referred to in [2.4.1] are to be arranged as per Pt C, Ch 1, Sec 10, [9] and are to be fitted with easily removable flame screens at their outlets.

2.4.3 Passage through cargo tanks *(1/5/2013)*

In oil carriers of 600 tonnes deadweight and above, the air and sounding pipes referred to in [2.4.1] are not to pass through cargo tanks except in the following cases:

- short lengths of piping serving ballast tanks
- lines serving double bottom tanks located within the cargo area, except in the case of oil carriers of 5000 tonnes deadweight and above

where the provisions of [2.1.3], item b) are complied with.

2.5 Scupper pipes

2.5.1 *(1/5/2013)*

Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt C, Ch 1, Sec 10, Tab 22, column 1.

2.6 Heating systems intended for cargo

2.6.1 General *(1/5/2013)*

a) Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 10.

b) The steam and heating media temperature within the cargo area is not to exceed 220° C.

c) Blind flanges or similar devices are to be provided on the heating circuits fitted to tanks carrying cargoes which are not to be heated.

d) Heating systems are to be so designed that the pressure maintained in the heating circuits is higher than that exerted by the cargo oil. This need not be applied to heating circuits which are not in service provided they are drained and blanked-off.

e) Isolating valves are to be provided at the inlet and outlet connections of the tank heating circuits. Arrangements are to be made to allow manual adjustment of the flow.

f) Heating pipes and coils inside tanks are to be built of a material suitable for the heated fluid. They are to have welded connections only.

2.6.2 Steam heating *(1/5/2013)*

To reduce the risk of liquid or gaseous cargo returns inside the engine or boiler rooms, steam heating systems of cargo tanks are to satisfy either of the following provisions:

- they are to be independent of other ship services, except cargo heating or cooling systems, and are not to enter machinery spaces, or
- they are to be provided with an observation tank on the water return system located within the cargo area. However, this tank may be placed inside the engine room in a well-ventilated position remote from boilers and other sources of ignition. Its air pipe is to be led to the open and fitted with a flame arrester.

2.6.3 Hot water heating *(1/5/2013)*

Hot water systems serving cargo tanks are to be independent of other systems. They are not to enter machinery spaces unless the expansion tank is fitted with:

- means for detection of flammable vapours
- a vent pipe led to the open and provided with a flame arrester.

2.6.4 Thermal oil heating *(1/5/2013)*

Thermal oil heating systems serving cargo tanks are to be arranged by means of a separate secondary system, located completely within the cargo area. However, a single circuit system may be accepted provided that:

- the system is so arranged as to ensure a positive pressure in the coil of at least 3 m water column above the static head of the cargo when the circulating pump is not in operation
- means are provided in the expansion tank for detection of flammable cargo vapours. Portable equipment may be accepted.
- valves for the individual heating coils are provided with a locking arrangement to ensure that the coils are under static pressure at all times.

3 Cargo pumping systems

3.1 General

3.1.1 *(1/5/2013)*

A complete system of pumps and piping is to be fitted for handling the cargo.

3.1.2 *(1/5/2013)*

Except where expressly permitted, and namely for the bow and stern cargo loading and unloading stations, this system is not to extend outside the cargo area and is to be independent of any other piping system on board.

3.2 Cargo pumping system

3.2.1 Number and location of cargo pumps *(1/5/2013)*

a) Each cargo tank is to be served by at least one fixed mean of discharging and stripping.

In addition, arrangements are to be adopted to make discharge by pumps in the oil terminal possible, taking into account the NPSHD at the pumps, or a second separate fixed mean of discharging is to be fitted.

b) Cargo pumps are to be located:
- in a dedicated pump room, or
- on deck, or
- when designed for this purpose, within the cargo tanks.

3.2.2 Use of cargo pumps *(1/5/2013)*

a) Except where expressly permitted in [2.2] and [2.3], cargo pumps are to be used exclusively for handling the liquid cargo and are not to have any connections to compartments other than cargo tanks.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

3.2.3 Cargo pumps drive *(1/5/2013)*

a) Prime movers of cargo pumps are not to be located in the cargo area, except in the following cases:
- steam driven machine supplied with steam having a temperature not exceeding 220°C
- hydraulic motors
- electric motors of certified explosion proof type.

b) Pumps with a submerged electric motor are not permitted in cargo tanks.

c) Where cargo pumps are driven by a machine which is located outside the cargo pump room, the following arrangements are to be made:
1) drive shafts are to be fitted with flexible couplings or other means suitable to compensate for any misalignment
2) the shaft bulkhead or deck penetration is to be fitted with a gas-tight gland of a type approved by the Society. The gland is to be efficiently lubricated from outside the pump room and so designed as to prevent overheating. The seal parts of the gland are to be of material that cannot initiate sparks.
3) Temperature sensing devices are to be fitted for bulkhead shaft gland bearings; see [3.2.5].

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

3.2.4 Design of cargo pumps *(1/5/2013)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

c) Pump casings are to be fitted with temperature sensing devices; see [3.2.5].

3.2.5 Monitoring of cargo pumps *(1/5/2013)*

Cargo pumps are to be monitored as required in Tab 3.

3.2.6 Control of cargo pumps *(1/5/2013)*

Cargo pumps are to be capable of being stopped from:
- a position outside the pump room, and
- a position next to the pumps.

3.3 Cargo piping design

3.3.1 General *(1/5/2013)*

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 10 applicable to piping systems of class III.

b) For tests, refer to [6].

3.3.2 Materials *(1/5/2013)*

a) Cargo piping is, in general, to be made of steel or cast iron.

b) Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.

c) Spheroidal graphite cast iron may be used for cargo oil piping.

d) Grey cast iron may be accepted for cargo oil lines:
- within cargo tanks, and

- on the weather deck for pressure up to 1,6 Mpa.

It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.

e) Plastic pipes may be used in the conditions specified in Pt C, Ch 1, App 3. Arrangements are to be made to avoid the generation of static electricity.

3.3.3 Connection of cargo pipe lengths *(1/5/2013)*

Cargo pipe lengths may be connected either by means of welded joints or, unless otherwise specified, by means of flange connections.

Table 3 : Monitoring of cargo pumps *(1/5/2013)*

Equipment, parameter	Alarm **(1)**	Indication **(1)**	Comments
pump, discharge pressure		L	• on the pump **(2)**, or • next to the unloading control station
pump casing, temperature	H		visual and audible, in cargo control room or pump control station
bulkhead shaft gland bearing, temperature	H		visual and audible, in cargo control room or pump control station
(1) H = high **(2)** L = low **(3)** and next to the driving machine if located in a separate compartment			

3.3.4 Expansion joints *(1/5/2013)*

a) Where necessary, cargo piping is to be fitted with expansion joints or bends.

b) Expansion joints including bellows are to be of a type approved by the Society.

c) Expansion joints made of non-metallic material may be accepted only inside tanks and provided they are:

- of an approved type
- designed to withstand the maximum internal and external pressure
- electrically conductive.

d) Sliding type couplings are not to be used for expansion purposes where lines for cargo oil pass through tanks for segregated ballast.

3.3.5 Valves with remote control *(1/5/2013)*

a) Valves with remote control are to comply with Pt C, Ch 1, Sec 10, [2.7.3].

b) Submerged valves are to be remote controlled. In the case of a hydraulic remote control system, control boxes are to be provided outside the tank, in order to permit the emergency control of valves.

c) Valve actuators located inside cargo tanks are not to be operated by means of compressed air.

3.3.6 Cargo hoses *(1/5/2013)*

a) Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

b) Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 4 times the maximum pressure under cargo transfer conditions.

c) The ohmic electrical resistance of cargo hoses is not to exceed $10^6\ \Omega$.

3.4 Cargo piping arrangement and installation

3.4.1 Cargo pipes passing through tanks or compartments *(1/5/2013)*

a) Cargo piping is not to pass through tanks or compartments located outside the cargo area.

b) Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [2.1.3], item b).

c) Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [2.1.3], item b) are complied with.

d) Piping through cargo tanks, see also Sec 2, [3.1.4].

3.4.2 Cargo piping passing through bulkheads *(1/5/2013)*

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

3.4.3 Valves *(1/5/2013)*

a) Stop valves are to be provided to isolate each tank.

b) A stop valve is to be fitted at each end of the cargo manifold.

c) When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

d) Main cargo oil valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

3.4.4 Prevention of the generation of static electricity *(1/5/2013)*

To avoid the hazard of an incendive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the following requirements are to be complied with:

- the loading pipes are to be led as low as practicable in the tank
- the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than 10^6 Ω.

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

- clearly visible so that any shortcoming can be clearly detected
- designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint
- easy to install and replace.

3.4.5 Bow or stern cargo loading and unloading arrangements *(1/5/2013)*

Where the ship is arranged for loading and unloading outside the cargo area, the following provisions are to be complied with:

a) the piping outside the cargo area is to be fitted with a shut-off valve at its connection with the piping system within the cargo area and separating means such as blank flanges or removable spool pieces or equivalent (see Note 1) are to be provided when the piping within the cargo area is not in use

Note 1: Those indicated in the IMO MSC/Circ. 474 are acceptable as equivalent

b) the shore connection is to be fitted with a shut-off valve and a blank flange

c) pipe connections outside the cargo area are to be of welded type only

d) arrangements are made to allow the piping outside the cargo area to be efficiently drained and purged.

3.4.6 Draining of cargo pumps and oil lines *(1/5/2013)*

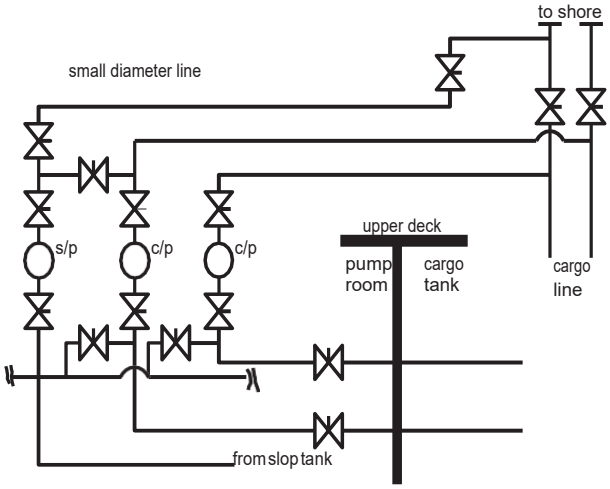
Every oil carrier required to be provided with segregated ballast tanks or fitted with a crude oil washing system is to comply with the following requirements:

a) it is to be equipped with oil piping so designed and installed that oil retention in the lines is minimised, and

b) means are to be provided to drain all cargo pumps and all oil lines at the completion of cargo discharge, where necessary by connection to a stripping device. The line and pump drainings are to be capable of being discharged both ashore and to a cargo tank or slop tank. For discharge ashore, a special small diameter line having a cross-sectional area not exceeding 10% of the main cargo discharge line is to be provided and is to be connected on the downstream side of the carrier's deck manifold valves, both port and starboard, when the cargo is being discharged; see Fig 1.

For oil carriers fitted with a crude oil washing system, refer also to Ch 7, App 2, [2.4.5].

Figure 1 : Connection of small diameter line to the manifold valve *(1/5/2013)*



3.4.7 Cleaning and gas-freeing *(1/5/2013)*

a) The cargo piping system is to be so designed and arranged as to permit its efficient cleaning and gas-freeing.

b) Requirements for inert gas systems are given in Part C, Chapter 4.

3.5 Integrated cargo and ballast systems design

3.5.1 Functional requirements *(1/5/2013)*

The operation of cargo and/or ballast systems may be necessary, under certain emergency circumstances or during the course of navigation, to enhance the safety of carriers.

As such, measures are to be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems. The same criteria apply to control systems of cargo and ballast valves.

3.5.2 Design features *(1/5/2013)*

The following design features are, inter alia, to be fitted:

a) the emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems. A single failure in the control system circuits or the emergency stop circuits is not to render the integrated cargo and ballast system inoperative;

b) manual emergency stops of the cargo pumps are to be arranged such that they do not cause the shutdown of the power pack making ballast pumps inoperable;

c) the control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

d) in the event of failure of the automatic or remote control systems, a secondary means of control is to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

4 Cargo tanks and fittings

4.1 Application

4.1.1 *(1/5/2013)*

The provisions of [4] apply to cargo tanks and slop tanks.

4.2 Cargo tank venting

4.2.1 Principle *(1/5/2013)*

Cargo tanks are to be provided with venting systems entirely distinct from the air pipes of the other compartments of the ship. The arrangements and position of openings in the cargo tank deck from which emission of flammable vapours can occur are to be such as to minimise the possibility of flammable vapours being admitted to enclosed spaces containing

a source of ignition, or collecting in the vicinity of deck machinery and equipment which may constitute an ignition hazard.

4.2.2 Design of venting arrangements *(1/5/2013)*

The venting arrangements are to be so designed and operated as to ensure that neither pressure nor vacuum in cargo tanks exceeds design parameters and be such as to provide for:

a) the flow of the small volumes of vapour, air or inert gas mixtures caused by thermal variations in a cargo tank in all cases through pressure/vacuum valves, and

b) the passage of large volumes of vapour, air or inert gas mixtures during cargo loading and ballasting, or during discharging,

c) a secondary means of allowing full flow relief of vapour, air or inert gas mixtures to prevent overpressure or underpressure in the event of failure of the arrangements in b). Alternatively, pressure sensors may be fitted in each tank protected by the arrangement required in b), with a monitoring system in the ship's cargo control room or the position from which cargo operations are normally carried out. Such monitoring equipment is also to provide an alarm facility which is activated by detection of overpressure or underpressure conditions within a tank.

4.2.3 Combination of venting arrangements *(1/5/2013)*

a) The venting arrangements in each cargo tank may be independent or combined with other cargo tanks and may be incorporated into the inert gas piping.

b) Where the arrangements are combined with other cargo tanks, either stop valves or other acceptable means are to be provided to isolate each cargo tank. Where stop valves are fitted, they are to be provided with locking arrangements which are to be under the control of the responsible ship's officer. There is to be a clear visual indication of the operational status of the valves or other acceptable means. Where tanks have been isolated, it is to be ensured that relevant isolating valves are opened before cargo loading or ballasting or discharging of those tanks is commenced. Any isolation must continue to permit the flow caused by thermal variations in a cargo tank in accordance with [4.2.2] a).

c) If cargo loading or ballasting or discharging of a cargo tank or cargo tank group is intended, which is isolated from a common venting system, that cargo tank or cargo tank group is to be fitted with a means for overpressure or underpressure protection as required in [4.2.2] c).

4.2.4 Arrangement of vent lines *(1/5/2013)*

The venting arrangements are to be connected to the top of each cargo tank and are to be self-draining to the cargo tanks under all normal conditions of trim and list of the ship. Where it may not be possible to provide self-draining lines, permanent arrangements are to be provided to drain the vent lines to a cargo tank.

Plugs or equivalent means are to be provided on the lines after the safety relief valves.

4.2.5 Openings for pressure release *(1/5/2013)*

Openings for pressure release required by [4.2.2] a) are to:

a) have as great a height as is practicable above the cargo tank deck to obtain maximum dispersal of flammable vapours but in no case less than 2 m above the cargo tank deck,

b) be arranged at the furthest distance practicable but not less than 5 m from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery and equipment which may constitute an ignition hazard. Anchor windlass and chain locker openings constitute an ignition hazard.

4.2.6 Pressure/vacuum valves *(1/5/2013)*

a) One or more pressure/vacuum-breaking devices are to be provided to prevent the cargo tanks from being subject to:

   1) a positive pressure, in excess of the test pressure of the cargo tank, if the cargo were to be loaded at the maximum rated capacity and all other outlets were left shut; and

   2) a negative pressure in excess of 700 mm water gauge if cargo were to be discharged at the maximum rated capacity of the cargo pumps and the inert gas blowers were to fail.

   Such devices are to be installed on the inert gas main unless they are installed in the venting system required by this item [4.2] or on individual cargo tanks.

b) Pressure/vacuum valves are to be set at a positive pressure not exceeding 0,021 MPa and at a negative pressure not exceeding 0,007 MPa. Higher setting values not exceeding 0,07 MPa may be accepted in positive pressure if the scantlings of the tanks are appropriate.

c) Pressure/vacuum valves required by item a) of [4.2.2] may be provided with a bypass when they are located in a vent main or masthead riser. Where such an arrangement is provided, there are to be suitable indicators to show whether the bypass is open or closed.

d) Pressure/vacuum valves are to be of a type approved by the Society in accordance with Ch 7, App 1.

e) Pressure/vacuum valves are to be readily accessible.

f) Pressure/vacuum valves are to be provided with a manual opening device so that valves can be locked on open position. Locking means on closed position are not permitted.

4.2.7 Vent oulets *(1/5/2013)*

Vent outlets for cargo loading, discharging and ballasting required by [4.2.2] b) are to:

a) permit:
- the free flow of vapour mixtures, or
- the throttling of the discharge of the vapour mixtures to achieve a velocity of not less than 30 m/s,

b) be so arranged that the vapour mixture is discharged vertically upwards,

c) where the method is by free flow of vapour mixtures, be such that the outlet is not less than 6 m above the cargo tank deck or fore and aft gangway if situated within 4 m of the gangway and located not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard,

d) where the method is by high velocity discharge, be located at a height not less than 2 m above the cargo tank deck and not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard. These outlets are to be provided with high velocity devices of a type approved by the Society,

e) be designed on the basis of the maximum designed loading rate multiplied by a factor of at least 1,25 to take account of gas evolution, in order to prevent the pressure in any cargo tank from exceeding the design pressure. The Master is to be provided with information regarding the maximum permissible loading rate for each cargo tank and in the case of combined venting systems, for each group of cargo tanks.

The arrangements for the venting of vapours displaced from the cargo tanks during loading and ballasting are to comply with this item [4.2] and are to consist of either one or more mast risers, or a number of high-velocity vents. The inert gas supply main may be used for such venting.

4.2.8 High velocity valves *(1/5/2013)*

a) High velocity valves are to be readily accessible.

b) High velocity valves not required to be fitted with flame arresters (see [4.2.9]) are not to be capable of being locked on open position.

4.2.9 Prevention of the passage of flame into the tanks *(1/5/2013)*

a) The venting system is to be provided with devices to prevent the passage of flame into the cargo tanks. The design, testing and locating of these devices are to comply with Ch 7, App 1.

Ullage openings are not to be used for pressure equalisation. They are to be provided with self-closing and tightly sealing covers. Flame arresters and screens are not permitted in these openings.

b) A flame arresting device integral to the venting system may be accepted.

c) Flame screens and flame arresters are to be designed for easy overhauling and cleaning.

4.2.10 Prevention of liquid rising in the venting system *(1/5/2013)*

a) Provisions are to be made to prevent liquid rising in the venting system; refer to [4.5].

b) Cargo tanks gas venting systems are not to be used for overflow purposes.

c) Spill valves are not considered equivalent to an overflow system.

4.3 Cargo tank purging and/or gas-freeing

4.3.1 General *(1/5/2013)*

a) Arrangements are to be made for purging and/or gas-freeing of cargo tanks. The arrangements are to be such as to minimise the hazards due to the dispersal of flammable vapours in the atmosphere and to flammable mixtures in a cargo tank. Accordingly, the provisions of [4.3.2] and [4.3.3], as applicable, are to be complied with.

b) In the case of fans installed in safe spaces, two non-return devices are to be fitted to avoid return of cargo vapours to safe spaces when the ventilation system is shut down. These non-return devices are to operate in all normal conditions of ship trim and list.

c) Discharge outlets are to be located at least 10 m measured horizontally from the nearest air intake and openings to enclosed spaces with a source of ignition and from deck machinery equipment which may constitute an ignition hazard.

4.3.2 Ships provided with an inert gas system *(1/5/2013)*

When the ship is provided with an inert gas system, the cargo tanks are first to be purged in accordance with the provisions of Part C, Chapter 4 until the concentration of hydrocarbon vapours in the cargo tanks has been reduced to less than 2% by volume. Thereafter, gas-freeing may take place at the cargo tank deck level.

4.3.3 Ships not provided with an inert gas system *(1/5/2013)*

When the ship is not provided with an inert gas system, the operation is to be such that the flammable vapour is discharged initially:

a) through the vent outlets as specified in [4.2.7], or

b) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 30 m/s maintained during the gas-freeing operation, or

c) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 20 m/s and which are protected by suitable devices to prevent the passage of flame.

The above outlets are to be located not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery, which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard.

When the flammable vapour concentration at the outlet has been reduced to 30% of the lower flammable limit, gas-freeing may thereafter be continued at cargo tank deck level.

4.4 Cargo tank level gauging systems

4.4.1 General *(1/5/2013)*

a) Each cargo or slop tank is to be fitted with a level gauging system indicating the liquid level along the entire height of the tank. Unless otherwise specified, the gauge may be portable or fixed with local reading.

b) Gauging devices and their remote reading systems are to be type approved.

c) Ullage openings and other gauging devices likely to release cargo vapour to the atmosphere are not to be arranged in enclosed spaces.

4.4.2 Definitions *(1/5/2013)*

a) A “restricted gauging device” means a device which penetrates the tank and which, when in use, permits a small quantity of vapour or liquid to be exposed to the atmosphere. When not in use, the device is completely closed. Examples are sounding pipes.

b) A “closed gauging device” means a device which is separated from the tank atmosphere and keeps tank contents from being released. It may:
   - penetrate the tank, such as float-type systems, electric probe, magnetic probe or protected sight glass,
   - not penetrate the tank, such as ultrasonic or radar devices.

c) An “indirect gauging device” means a device which determines the level of liquid, for instance by means of weighing or pipe flow meter.

4.4.3 Oil carriers fitted with an inert gas system *(1/5/2013)*

a) In carriers fitted with an inert gas system, the gauging devices are to be of the closed type.

b) Use of indirect gauging devices will be given special consideration.

4.4.4 Oil carriers not fitted with an inert gas system *(1/5/2013)*

a) In carriers not fitted with an inert gas system, the gauging devices are to be of the closed or restricted types. Ullage openings may be used only as a reserve sounding means and are to be fitted with a watertight closing appliance.

b) Where restricted gauging devices are used, provisions are to be made to:
   - avoid dangerous escape of liquid or vapour under pressure when using the device
   - relieve the pressure in the tank before the device is operated.

c) Where used, sounding pipes are to be fitted with a a self-closing blanking device.

4.5 Protection against tank overload

4.5.1 General *(1/5/2013)*

a) Provisions are to be made to guard against liquid rising in the venting system of cargo or slop tanks to a height which would exceed the design head of the tanks. This is to be accomplished by high level alarms or overflow control systems or other equivalent means, together with gauging devices and cargo tank filling procedures.

b) Sufficient ullage is to be left at the end of tank filling to permit free expansion of liquid during carriage.

c) High level alarms, overflow control systems and other means referred to in a) are to be independent of the gauging systems referred to in [4.4].

4.5.2 High level alarms *(1/5/2013)*

a) High level alarms are to be type approved.

b) High level alarms are to give an audible and visual signal at the control station, where provided.

4.5.3 Other protection systems *(1/5/2013)*

a) Where the tank level gauging systems, cargo and ballast pump control systems and valve control systems are centralised in a single location, the provisions of [4.5.1] may be complied with by the fitting of a level gauge for the indication of the end of loading, in addition to that required for each tank under [4.4]. The readings of both gauges for each tank are to be as near as possible to each other and so arranged that any discrepancy between them can be easily detected.

b) Where a tank can be filled only from other tanks, the provisions of [4.5.1] are considered as complied with.

4.6 Tank washing systems

4.6.1 General *(1/5/2013)*

a) Adequate means are to be provided for cleaning the cargo tanks, except on units which:
- are dedicated to the same type of cargo for many consecutive voyages, and
- are arranged with segregated ballast tanks according to Sec 2, [5], and
- do not carry out tank washing on a regular basis, and
- use shore services for tank washing and disposal of washing media and residues, when needed.

b) Crude oil washing, when fitted, are to comply with the provisions of Ch 7, App 2 related to safety.

4.6.2 Washing machines *(1/5/2013)*

a) Tank washing machines are to be of a type approved by the Society.

b) Washing machines are to be made of steel or other electricity conducting materials with a limited propensity to produce sparks on contact.

4.6.3 Washing pipes *(1/5/2013)*

a) Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 10, depending on the kind of washing fluid, water or crude oil.

b) Crude oil washing pipes are also to satisfy the requirements of [3.3].

4.6.4 Use of crude oil washing machines for water washing operations *(1/5/2013)*

Crude oil washing machines may be connected to water washing pipes, provided that isolating arrangements, such as a valve and a detachable pipe section, are fitted to isolate water pipes.

4.6.5 Installation of washing systems *(1/5/2013)*

a) Tank cleaning openings are not to be arranged in enclosed spaces.

b) The complete installation is to be permanently earthed to the hull.

5 Prevention of pollution by cargo oil

5.1 General

5.1.1 Application *(1/5/2013)*

Unless otherwise specified, the provisions of [5.2] and [5.3] apply only to oil carriers of 150 gross tonnage and above.

5.1.2 Provisions for oil carriers of less than 150 gross tonnage *(1/5/2013)*

The control of discharge for **oil carriers** of less than 150 gross tonnage is to be effected by the retention of oil on board with subsequent discharge of all contaminated washings to reception facilities unless adequate arrangements are made to ensure that the discharge of any effluent into the sea, where allowed, is effectively monitored to ensure that the total quantity of oil discharged into the sea does not exceed 1/30 000 of the total quantity of the particular cargo of which the residue formed a part.

5.1.3 Exemptions *(1/5/2013)*

The provisions of [5.2] and [5.3] may be waived in the following cases:

- oil carriers engaged exclusively on voyages within 50 miles from the nearest land and of 72 hours or less in duration and limited to trades between ports or terminals agreed by the Society, provided that oily mixtures are retained on board for subsequent discharge to reception facilities
- carrying products which through their physical properties inhibit effective product/water separation and monitoring, for which the control of discharge is to be effected by the retention of residues on board with discharge of all contaminated washings to reception facilities

5.2 Retention of oil on board

5.2.1 General *(1/5/2013)*

Adequate means are to be provided for transferring the dirty ballast residue and tank washings from the cargo tanks into a slop tank approved by the Society.

5.2.2 Capacity of slop tanks *(1/5/2013)*

The arrangement of the slop tank or combination of slop tanks is to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is not to be less than 3% of the oil carrying capacity of the ship, except that the Society may accept:

a) 2% for oil carriers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without the introduction of additional water into the system

b) 2% where segregated ballast tanks are provided in accordance with Sec 2, [3], or where a cargo tank cleaning system using crude oil washing is fitted in accordance with [4.6]. This capacity may be further reduced to 1,5% for oil carriers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without introduction of additional water into the system.

c) slop tanks of any size, including absence of dedicated slop tanks, for units which:
   - are dedicated to the same type of cargo for many consecutive voyages, and
   - are arranged with segregated ballast tanks according to [5], and
   - do not carry out tank washing on a regular basis.

Oil carriers of 70 000 tonnes deadweight and above are to be fitted with at least two slop tanks.

5.2.3 Design of slop tanks *(1/5/2013)*

Slop tanks are to be so designed particularly in respect of the position of inlets, outlets, baffles or weirs where fitted, as to avoid excessive turbulence and entrainment of oil or emulsion with the water.

5.3 Pumping, piping and discharge arrangements

5.3.1 Discharge manifold *(1/5/2013)*

In every oil carrier, a discharge manifold for connection to reception facilities for the discharge of dirty ballast water or oil contaminated water is to be located on the open deck on both sides of the ship.

5.3.2 Discharge pipelines *(1/5/2013)*

In every oil carrier, pipelines for the discharge of ballast water or oil contaminated water from cargo tank areas to the sea, where permitted, are to be led to the open deck or to the ship side above the waterline in the deepest ballast condition, except that:

a) segregated ballast and clean ballast may be discharged below the waterline:
   - in ports or at offshore terminals, or
   - at sea by gravity,

provided that the surface of the ballast water has been examined immediately before the discharge to ensure that no contamination with oil has taken place.

b) on every oil carrier at sea, dirty ballast water or oil contaminated water from tanks in the cargo area, other than slop tanks, may be discharged by gravity below the waterline, provided that sufficient time has elapsed in order to allow oil/water separation to have taken place and the water ballast has been examined immediately before the discharge with an oil/water interface detector, in order to ensure that the height of the interface is such that the discharge does not involve any increased risk of harm to the marine environment.

5.3.3 Discharge stopping *(1/5/2013)*

Means are to be provided for stopping the discharge into the sea of ballast water or oil contaminated water from cargo tank areas, other than those discharges below the waterline permitted under [5.3.2], from a position on the upper deck or above located so that the manifold in use referred to in [5.3.1] and the discharge to the sea from the pipelines referred to in [5.3.2] may be visually observed. Means for stopping the discharge need not be provided at the observation position if a positive communication system such as a telephone or radio system is provided between the observation position and the discharge control position.

5.3.4 Cargo piping connections to sea chests *(1/5/2013)*

On every oil carrier where a sea chest is permanently connected to the cargo pipeline system, it is to be equipped with both a sea chest valve and an inboard isolation valve. In addition to these valves, the sea chest is to be capable of isolation from the cargo piping system whilst the carrier is loading, transporting or discharging cargo by use of a positive means that is to the satisfaction of the Society. Such a positive means is a facility that is installed in the pipeline system in order to prevent the section of pipeline between the sea chest valve and the inboard valve being filled with cargo under all circumstances.

Examples of positive means may take the form of blanks, spectacle blanks, pipeline blinds, evacuation or vacuum systems, or air or water pressure systems. In the event that evacuation or vacuum systems, or air or water pressure systems are used, then they are to be equipped with both a pressure gauge and alarm system to enable the continuous monitoring of the status of the pipeline section, and thereby the valve integrity, between the sea chest and inboard valves.

6 Certification, inspection and testing

6.1 Application

6.1.1 *(1/5/2013)*

The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt C, Ch 1, Sec 10, [21] for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials *(1/5/2013)*

Where required in Tab 4, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt C, Ch 1, Sec 10, [21.3.2].

6.2.2 Hydrostatic testing *(1/5/2013)*

a) Where required in Tab 4, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

c) Where fitted, bellow pieces of gas-tight penetration glands are to be pressure tested.

6.2.3 Tightness tests *(1/5/2013)*

Tightness of the following devices is to be checked:

- gas-tight penetration glands
- cargo tank P/V and high velocity valves.

Note 1: These tests may be carried out in the workshops or on board.

6.2.4 Check of the safety valves setting *(1/5/2013)*

The setting pressure of the pressure/vacuum valves is to be checked in particular with regard to [4.2.6].

6.2.5 Summary table *(1/5/2013)*

Inspections and tests required for cargo piping and other equipment fitted in the cargo area are summarised in Tab 4.

6.3 Shipboard tests

6.3.1 Pressure test *(1/5/2013)*

a) After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

b) The piping system used in crude oil washing systems is to be submitted to hydrostatic tests in accordance with Ch 7, App 2, [3.2.1].

6.3.2 Survey of pollution prevention equipment *(1/5/2013)*

Every oil carrier of 150 gross tonnage and above is to be subjected to an initial survey before the ship is put in service, to ensure that the equipment, systems, fittings, arrangements and materials fully comply with the relevant provisions of [4.6] and [5].

Table 4 : Inspection and testing at works *(1/5/2013)*

No.	Item	Tests for materials		Inspections and tests for the products			References
		Y/N **(1)**	Type of material certificate **(2)**	during manufacturing **(1)**	after completion **(1) (3)**	Type of product certificate **(2)**	
1	expansion joints and cargo hoses	Y **(4)**	W	N	Y	C	[6.2.1] [6.2.3]
2	cargo pumps	Y	W	Y **(5)**	Y	C	see note **(5)** [6.2.3]
3	gas-tight penetration glands	N		N	Y	C	[6.2.3], [6.2.4]
4	cargo tank P/V and high velocity valves	Y	C	Y	Y	C	[6.2.1] [6.2.2] [6.2.3], [6.2.4], [6.2.5]
5	flame arresters	N		N	Y	C	see note **(3)**

(1) Y = required, N = not required.
(2) C = class certificate, W = works' certificate.
(3) includes the checking of the rule characteristics according to the approved drawings.
(4) if metallic.
(5) inspection during manufacturing is to be carried out according to a program approved by the Society.

SECTION 5 MACHINERY AND CARGO SYSTEMS FOR OIL CARRIER, FLASHPOINT > 60°C

1 General

1.1 Application

1.1.1 *(1/5/2013)*

The requirements of this Section apply to ships having the service notation:

- **oil carried, flashpoint > 60°C**

intended to carry products having flashpoint > 60°C, at a temperature below and not within 15°C of their flashpoint.

1.2 Documents to be submitted

1.2.1 *(1/5/2013)*

The documents listed in Tab 1 are to be submitted for approval in four copies.

2 Piping systems other than cargo piping system

2.1 General

2.1.1 Materials *(1/5/2013)*

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

***2.1.2* Independence of piping systems** *(1/5/2013)*

a) Fuel oil systems are to:

- be independent from the cargo piping system
- have no connections with pipelines serving cargo or slop tanks.

***2.1.3* Passage through cargo tanks and slop tanks** *(1/1/2025)*

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted (see [2.3.5]), ballast pipes passing through cargo tanks are to fulfil the following provisions:

- they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
- they are to be of extra-reinforced wall thickness as per Pt C, Ch 1, Sec 10, Tab5
- they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

2.2 Bilge system

***2.2.1* Draining of spaces located outside the cargo area** *(1/5/2013)*

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 10, [6].

***2.2.2* Draining of pump rooms** *(1/5/2013)*

a) Arrangements are to be provided to drain the pump rooms by means of power pumps or bilge ejectors.

Note 1: On carriers of less than 500 gross tonnage, the pump rooms may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

b) Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:
   - a screw-down non-return valve is fitted on the bilge suctions.

c) Bilge pipe internal diameter is not to be less than 50 mm.

d) High liquid level in the bilges is to activate an audible and visual alarm in the cargo control room and on the navigation bridge.

2.2.3 Drainage of hold spaces, cofferdams and void spaces located within the cargo area *(1/5/2013)*

Hold spaces, cofferdams and void spaces located within the cargo area and not intended to be filled with water ballast are to be fitted with suitable means of drainage.

2.3 Ballast system

2.3.1 General *(1/5/2013)*

a) Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo oil and fuel oil systems.

b) In oil carriers of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

Table 1 : Documents to be submitted *(1/5/2013)*

No.	Description of the document **(1)**
1	Diagram of cargo piping system
2	Diagram of the cargo tank venting system with indication of the outlet position
3	Diagram of the cargo tank level gauging system with overfill safety arrangements
4	Diagram of the cargo tank cleaning system
5	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
6	Diagram of the cargo heating systems
(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.	

2.3.2 Pumping arrangements for ballast tanks within the cargo area *(1/5/2013)*

Segregated ballast tanks located within the cargo area are to be served by two different means. At least one of these means is to be a pump or an eductor used exclusively for dealing with ballast. The ballast system serving the spaces located outside the cargo area may be used for this purpose.

2.3.3 Emergency discharge of segregated ballast *(1/5/2013)*

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

2.3.4 Carriage of ballast water in cargo tanks *(1/5/2013)*

a) Provisions may be made for filling cargo tanks with sea water, where permitted. Such ballast water is to be processed and discharged using the equipment referred to in [5].

b) The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

c) Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges. See also [5.3.4].

d) Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

2.3.5 Ballast pipes passing through tanks *(1/1/2025)*

a) In oil carriers of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

2.3.6 Integrated cargo and ballast system *(1/5/2013)*

The requirements for integrated cargo and ballast systems are given in [3.5].

2.4 Scupper pipes

2.4.1 *(1/5/2013)*

Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt C, Ch 1, Sec 10, Tab 22, column 1.

2.5 Heating systems intended for cargo

2.5.1 General *(1/5/2013)*

Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 10.

3 Cargo pumping and piping systems

3.1 General

3.1.1 *(1/5/2013)*

A complete system of pumps and piping is to be fitted for handling the cargo.

3.2 Cargo pumping system

3.2.1 Number and location of cargo pumps *(1/5/2013)*

Each cargo tank is to be served by at least one fixed mean of discharging and stripping. In addition, arrangements are to be adopted to make discharge by pumps in the oil terminal possible, taking into account the NPSHD at the pumps, or a second separate fixed mean of discharging is to be fitted.

3.2.2 Use of cargo pumps *(1/5/2013)*

a) Except where expressly permitted in [2.2] and [2.3], cargo pumps are to be used exclusively for handling the liquid cargo.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

3.2.3 Cargo pump drive *(1/5/2013)*

Pumps with a submerged electric motor are not permitted in cargo tanks.

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

3.2.4 Design of cargo pumps *(1/5/2013)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

3.2.5 Monitoring of cargo pumps *(1/5/2013)*

Cargo pumps are to be monitored as required in Tab 2.

3.2.6 Control of cargo pumps *(1/5/2013)*

Cargo pumps are to be capable of being stopped from:

- a position outside the pump room, and
- a position next to the pumps.

3.3 Cargo piping design

3.3.1 General *(1/5/2013)*

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 10 applicable to piping systems of Class III.

b) For tests, refer to [6].

3.3.2 Materials *(1/5/2013)*

a) Cargo piping is, in general, to be made of steel or cast iron.

b) Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.

c) Spheroidal graphite cast iron may be used for cargo oil piping.

d) Grey cast iron may be accepted for cargo oil lines:

- within cargo tanks, and
- on the weather deck for pressure up to 1,6 MPa.

It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.

e) Plastic pipes may be used in the conditions specified in Pt C, Ch 1, App 3. Arrangements are to be made to avoid the generation of static electricity.

3.3.3 Connection of cargo pipe lengths *(1/5/2013)*

Cargo pipe lengths may be connected either by means of welded joints or, unless otherwise specified, by means of flange connections.

3.3.4 Expansion joints *(1/5/2013)*

a) Where necessary, cargo piping is to be fitted with expansion joints or bends.

b) Expansion joints including bellows are to be of a type approved by the Society.

c) Expansion joints made of non-metallic material may be accepted only inside tanks and provided they are:

- of an approved type
- designed to withstand the maximum internal and external pressure
- electrically conductive
- sliding type couplings are not to be used for expansion purposes where lines for cargo oil pass through tanks for segregated ballast.

3.3.5 Valves with remote control *(1/5/2013)*

a) Valves with remote control are to comply with Pt C, Ch 1, Sec 10, [2.7.3].

b) Submerged valves are to be remote controlled. In the case of a hydraulic remote control system, control boxes are to be provided outside the tank, in order to permit the emergency control of valves.

c) Valve actuators located inside cargo tanks are not to be operated by means of compressed air.

Table 2 : Monitoring of cargo pumps *(1/5/2013)*

Equipment, parameter	Alarm	Indication **(1)**	Comments
pump, discharge pressure		L	• on the pump **(2)**, or • next to the unloading control station
(1) L = low **(2)** and next to the driving machine if located in a separate compartment			

3.3.6 Cargo hoses *(1/5/2013)*

a) Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

b) Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 4 times the maximum pressure under cargo transfer conditions.

c) The ohmic electrical resistance of cargo hoses is not to exceed 10^6 Ω.

3.4 Cargo piping arrangement and installation

3.4.1 Cargo pipes passing through tanks or compartments *(1/5/2013)*

a) Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [2.1.3], item b) are complied with.

c) Piping through cargo tanks, see also Sec 2, [3.1.4].

3.4.2 Cargo piping passing through bulkheads *(1/5/2013)*

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

3.4.3 Valves *(1/5/2013)*

a) Stop valves are to be provided to isolate each tank.

b) A stop valve is to be fitted at each end of the cargo manifold.

c) When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

d) Main cargo oil valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

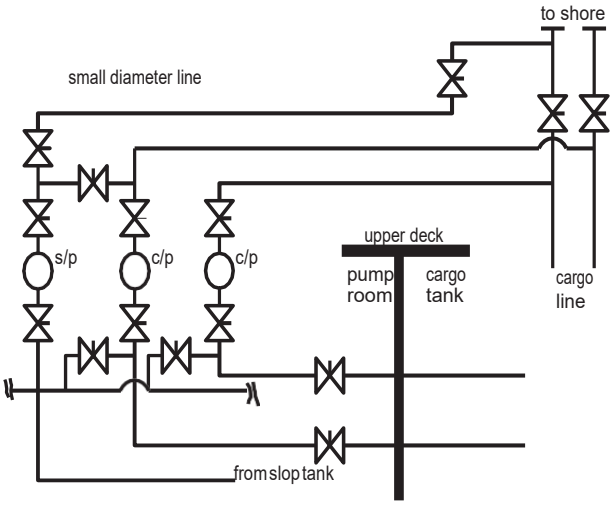
3.4.4 Draining of cargo pumps and oil lines *(1/5/2013)*

Every oil carrier and asphalt carrier required to be provided with segregated ballast tanks is to comply with the following requirements:

a) it is to be equipped with oil piping so designed and installed that oil retention in the lines is minimised, and

b) means are to be provided to drain all cargo pumps and all oil lines at the completion of cargo discharge, where necessary by connection to a stripping device. The line and pump drainings are to be capable of being discharged both ashore and to a cargo tank or slop tank. For discharge ashore, a special small diameter line having a cross-sectional area not exceeding 10% of the main cargo discharge line is to be provided and is to be connected on the downstream side of the carrier's deck manifold valves, both port and starboard, when the cargo is being discharged; see Fig 1.

Figure 1 : Connection of small diameter line to the manifold valve



3.5 Integrated cargo and ballast systems design

3.5.1 Functional requirements *(1/5/2013)*

The operation of cargo and/or ballast systems may be necessary, under certain emergency circumstances or during the course of navigation, to enhance the safety of carriers.

As such, measures are to be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems. The same criteria apply to control systems of cargo and ballast valves.

3.5.2 Design features *(1/5/2013)*

The following design features are, inter alia, to be fitted:

a) the emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems. A single failure in the control system circuits or the emergency stop circuits is not to render the integrated cargo and ballast system inoperative;

b) manual emergency stops of the cargo pumps are to be arranged such that they do not cause the shutdown of the power pack making ballast pumps inoperable;

c) the control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

d) in the event of failure of the automatic or remote control systems, a secondary means of control is to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

4 Cargo tanks and fittings

4.1 Application

4.1.1 *(1/5/2013)*

The provisions of [4] apply to cargo tanks and slop tanks.

4.2 Cargo tank venting

4.2.1 *(1/5/2013)*

The relevant provisions of Pt C, Ch 1, Sec 10, [9] and Pt C, Ch 1, Sec 10, [11] are to be complied with.

Tank venting systems are to open to the atmosphere at a height of at least 760 mm above the weather deck.

Tanks may be fitted with venting systems of the open type provided with a flame screen. For ships carrying bulk cargoes with flashpoint > 100°C, the flame screen may be omitted.

4.3 Protection against tank overload

4.3.1 General *(1/5/2013)*

a) Provisions are to be made to guard against liquid rising in the venting system of cargo or slop tanks to a height which would exceed the design head of the tanks. This is to be accomplished by high level alarms or overflow control systems or other equivalent means, together with gauging devices and cargo tank filling procedures.

b) Sufficient ullage is to be left at the end of tank filling to permit free expansion of liquid during carriage.

c) High level alarms, overflow control systems and other means referred to in a) are to be independent of the gauging systems.

4.3.2 High level alarms *(1/5/2013)*

a) High level alarms are to be type approved.

b) High level alarms are to give an audible and visual signal at the cargo control station, where provided.

4.3.3 Other protection systems *(1/5/2013)*

a) Where the tank level gauging systems, cargo and ballast pump control systems and valve control systems are centralised in a single location, the provisions of [4.3.1] may be complied with by the fitting of a level gauge for the indication of the end of loading, in addition to that required for each tank. The readings of both gauges for each tank

are to be as near as possible to each other and so arranged that any discrepancy between them can be easily detected.

b) Where a tank can be filled only from other tanks, the provisions of [4.3.1] are considered as complied with.

4.4 Tank washing systems

4.4.1 General *(1/5/2013)*

a) Adequate means are to be provided for cleaning the cargo tanks except on units which:

- are dedicated to the same type of cargo for many consecutive voyages, and
- are arranged with segregated ballast tanks, and
- do not carry out tank washing on a regular basis, and
- use shore services for tank washing and disposal of washing media and residues, when needed.

4.4.2 Washing machines *(1/5/2013)*

a) Tank washing machines are to be of a type approved by the Society.

b) Washing machines are to be made of steel or other electricity conducting materials with a limited propensity to produce sparks on contact.

4.4.3 Washing pipes *(1/5/2013)*

Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 10, depending on the kind of washing fluid or water.

4.4.4 Installation of washing systems *(1/5/2013)*

Tank cleaning openings are not to be arranged in enclosed spaces.

5 Prevention of pollution by cargo oil

5.1 General

5.1.1 Application *(1/5/2013)*

Unless otherwise specified, the provisions of [5.2] and [5.3] apply only to oil carriers of 150 gross tonnage and above.

5.1.2 Provisions for oil carriers of less than 150 gross tonnage *(1/5/2013)*

The control of discharge for **oil carriers** of less than 150 gross tonnage is to be effected by the retention of oil on board with subsequent discharge of all contaminated washings to reception facilities unless adequate arrangements are made to ensure that the discharge of any effluent into the sea, where allowed, is effectively monitored to ensure that the total quantity of oil discharged into the sea does not exceed 1/30 000 of the total quantity of the particular cargo of which the residue formed a part.

5.1.3 Exemptions *(1/5/2013)*

The provisions of [5.2] and [5.3] may be waived in the following cases:

- oil carriers engaged exclusively on voyages within 50 miles from the nearest land and of 72 hours or less in duration and limited to trades between ports or terminals agreed by the Society, provided that oily mixtures are retained on board for subsequent discharge to reception facilities
- oil carriers carrying products which through their physical properties inhibit effective product/water separation and monitoring, for which the control of discharge is to be effected by the retention of residues on board with discharge of all contaminated washings to reception facilities

5.2 Retention of oil on board

5.2.1 General *(1/5/2013)*

Adequate means are to be provided for transferring the dirty ballast residue and tank washings from the cargo tanks into a slop tank approved by the Society.

5.2.2 Capacity of slop tanks *(1/5/2013)*

The arrangement of the slop tank or combination of slop tanks is to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues. The total capacity of the slop tank or tanks is not to be less than 3% of the oil carrying capacity of the ship, except that the Society may accept:

a) 2% for oil carriers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without the introduction of additional water into the system

b) 2% where segregated ballast tanks are provided. This capacity may be further reduced to 1,5% for oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without introduction of additional water into the system.

c) Slop tanks of any size, including absence of dedicated slop tanks, for units which:
   - are dedicated to the same type of cargo for many consecutive voyages, and
   - are arranged with segregated ballast tanks, and
   - do not carry out tank washing on a regular basis.

5.2.3 Design of slop tanks *(1/5/2013)*

Slop tanks are to be so designed particularly in respect of the position of inlets, outlets, baffles or weirs where fitted, as to avoid excessive turbulence and entrainment of oil or emulsion with the water.

5.3 Pumping, piping and discharge arrangements

5.3.1 Discharge manifold *(1/5/2013)*

In every oil carrier, a discharge manifold for connection to reception facilities for the discharge of dirty ballast water or oil contaminated water is to be located on the open deck on both sides of the ship.

5.3.2 Discharge pipelines *(1/5/2013)*

In every oil carrier, pipelines for the discharge of ballast water or oil contaminated water from cargo tank areas to the sea, where permitted, are to be led to the open deck or to the ship side above the waterline in the deepest ballast condition, except that:

a) segregated ballast and clean ballast may be discharged below the waterline:
   - in ports or at offshore terminals, or
   - at sea by gravity,

   provided that the surface of the ballast water has been examined immediately before the discharge to ensure that no contamination with oil has taken place.

b) on every oil carrier at sea, dirty ballast water or oil contaminated water from tanks in the cargo area, other than slop tanks, may be discharged by gravity below the waterline, provided that sufficient time has elapsed in order to allow oil/water separation to have taken place and the water ballast has been examined immediately before the discharge with an oil/water interface detector, in order to ensure that the height of the interface is such that the discharge does not involve any increased risk of harm to the marine environment.

5.3.3 Discharge stopping *(1/5/2013)*

Means are to be provided for stopping the discharge into the sea of ballast water or oil contaminated water from cargo tank areas, other than those discharges below the waterline permitted under [5.3.2], from a position on the upper deck or above located so that the manifold in use referred to in [5.3.1] and the discharge to the sea from the pipelines referred to in [5.3.1] may be visually observed. Means for stopping the discharge need not be provided at the observation position if a positive communication system such as a telephone or radio system is provided between the observation position and the discharge control position.

5.3.4 Cargo piping connections to sea chests *(1/5/2013)*

Where a sea chest is permanently connected to the cargo pipeline system, it is to be equipped with both a sea chest valve and an inboard isolation valve. In addition to these valves, the sea chest is to be capable of isolation from the cargo piping system whilst the carrier is loading, transporting or discharging cargo by use of a positive means that is to the satisfaction of the Society. Such a positive means is a facility that is installed in the pipeline system in order to prevent the section of pipeline between the sea chest valve and the inboard valve being filled with cargo under all circumstances.

Examples of positive means may take the form of blanks, spectacle blanks, pipeline blinds, evacuation or vacuum systems, or air or water pressure systems. In the event that evacuation or vacuum systems, or air or water pressure

systems are used, then they are to be equipped with both a pressure gauge and alarm system to enable the continuous monitoring of the status of the pipeline section, and thereby the valve integrity, between the sea chest and inboard valves.

6 Certification, inspection and testing

6.1 Application

6.1.1 *(1/5/2013)*

The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt C, Ch 1, Sec 10, [21] for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials *(1/5/2013)*

Where required in Tab 3, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt C, Ch 1, Sec 10, [21.3.2].

6.2.2 Hydrostatic testing *(1/5/2013)*

a) Where required in Tab 3, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [20.4]

c) Where fitted, bellow pieces of gas-tight penetration glands are to be pressure tested

6.2.3 Tightness tests *(1/5/2013)*

Tightness of the following devices is to be checked:

- gas-tight penetration glands
- cargo tank P/V and high velocity valves.

Note 1: These tests may be carried out in the workshops or on board.

6.2.4 Check of the safety valves setting *(1/5/2013)*

The setting pressure of the pressure/vacuum valves is to be checked in particular with regard to Sec 4, [4.2.6].

6.2.5 Summary table *(1/5/2013)*

Inspections and tests required for cargo piping and other equipment fitted in the cargo area are summarised in Tab 3.

6.3 Shipboard tests

6.3.1 Pressure test *(1/5/2013)*

After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

6.3.2 Survey of pollution prevention equipment *(1/5/2013)*

Every oil carriers of 150 gross tonnage and above is to be subjected to an initial survey before the ship is put in service, to ensure that the equipment, systems, fittings, arrangements and materials fully comply with the relevant provisions of [4.4] and [5].

Table 3 : Inspection and testing at works *(1/5/2013)*

No.	Item	Tests for materials		Inspections and tests for the products			References
		Y/N **(1)**	Type of material certificate **(2)**	during manu-facturing **(1)**	after completion **(1) (3)**	Type of product certificate **(2)**	
1	expansion joints and cargo hoses	Y **(5)**	W	N	Y	C	[6.2.1] [6.2.2]
2	cargo pumps	Y	W	Y **(6)**	Y	C	see note **(6)** [6.2.2]
3	gas-tight penetration glands	N		N	Y	C	[6.2.1], [6.2.3]
4	cargo tank P/V and high velocity valves	Y	C	Y	Y	C	[6.2.1] [6.2.2] **(4)** [6.2.3] [6.2.4]
5	flame arresters	N		N	Y	C	see note **(3)**

(1) Y = required, N = not required.
(2) C = class certificate, W = works' certificate.
(3) includes the checking of the rule characteristics according to the approved drawings.
(4) only in the case of welded construction.
(5) if metallic.
(6) inspection during manufacturing is to be carried out according to a program approved by the Society.

SECTION 6 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/5/2013)*

The requirements in this Section apply, in addition to those contained in Part C, Chapter 2, to ships with the service notation **oil carrier**.

1.2 Documentation to be submitted

1.2.1 *(1/5/2013)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 *(1/5/2013)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

1.3.2 *(1/5/2013)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.3 *(1/5/2013)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

1.4 Electrical equipment

1.4.1 *(1/5/2013)*

Electrical equipment, cables and wiring are not to be installed in hazardous locations unless they conform with standards not inferior to those given in IEC 60092-502 Standard.

However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Society, to ensure that an equivalent level of safety is assured.

1.5 Earth detection

1.5.1 *(1/5/2013)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [1.3.1].

1.6 Precautions against inlet of gases or vapours

1.6.1 *(1/5/2013)*

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

1.7 Electrical equipment permitted in hazardous areas

1.7.1 *(1/5/2013)*

Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5], and Pt C, Ch 2, Sec 3, [10.1.6].

1.7.2 In addition to the requirements of [1.7.1], in Zone 1 and Zone 2 the installation of the following is permitted:

hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of animpressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulk-head. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

1.7.3 *(1/5/2013)*

The explosion group and temperature class of electrical equipment of a certified safe type are to be at least IIA and T3 in the case of ships arranged for the carriage of crude oil or other petroleum products.

Other characteristics may be required for dangerous products other than those above.

1.7.4 *(1/5/2013)*

Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

2 Special requirements for oil carriers carrying flammable liquids having a flash point not exceeding 60°C

2.1 Hazardous area classification

2.1.1 *(1/5/2013)*

For hazardous area classification see Tab 1.

3 Special requirements for oil carrier carrying flammable liquids having a flash point exceeding 60°C

3.1 Hazardous area classification

3.1.1 *(1/5/2013)*

For hazardous area classification see Tab 2.

3.2 Cargoes heated to a temperature above their flash point and cargoes heated to a temperature within 15°C of their flash point

3.2.1 *(1/5/2013)*

The requirements under [2] apply.

Table 1 : Classification of hazardous areas for oil carriers carrying flammable liquids having a flash point not exceeding 60°C *(1/5/2013)*

Spaces		Hazardous area
N.	Description	
1	Interior of cargo tanks, slop tanks, any pipework of pressure relief or other venting systems for cargo and slop tanks, pipes and equipment containing cargo or developing flammable gases or vapours.	Zone 0
2	Void spaces adjacent to, above or below integral cargo tanks.	Zone 1
3	Hold spaces containing independent cargo tanks.	Zone 1
4	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks.	Zone 1
5	Cargo pump rooms.	Zone 1
6	Enclosed or semi-enclosed spaces immediately above cargo tanks (e.g. 'tweendecks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the Society.	Zone 1
7	Spaces other than cofferdams, adjacent to and below the top of a cargo tank (e.g. trunks, passageways and holds) as well as double bottoms and pipe tunnels below cargo tanks.	Zone 1
8	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump room ventilation outlets and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation.	Zone 1
9	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6m radius centred upon the centre of the outlet, and within a hemisphere of 6m radius below the outlet.	Zone 1
10	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5m of cargo pump room entrances, cargo pump room ventilation inlets, openings into cofferdams or other Zone 1 spaces.	Zone 1
11	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck.	Zone 1
12	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where structures are restricting the natural ventilation and to the full breadth of the ship plus 3m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4m above the deck.	Zone 1
13	Compartments for cargo hoses.	Zone 1
14	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located.	Zone 1
15	Areas 2m beyond the area defined in item 8.	Zone 2
16	Areas of 1,5 m surrounding open or semi-enclosed spaces of Zone 1.	Zone 2
17	Areas 4m beyond the cylinder and 4m beyond the sphere defined in item 9.	Zone 2
18	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service areas and 3m beyond these up to a height of 2,4m above the deck.	Zone 2
19	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4m above the deck surrounding open or semi-enclosed spaces of Zone 1.	Zone 2
20	Spaces forward of the open deck areas to which reference is made in item 12 and item 18, below the level of the main deck, and having an opening on the main deck or at a level less than 0,5m above the main deck, unless: a) the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilation system inlets and exhausts, are situated at least 5m from the foremost cargo tank and at least 10m measured horizontally from any cargo tank outlet or gas or vapour outlet; and b) the spaces are mechanically ventilated.	Zone 2

Table 2 : Hazardous areas classification for oil carriers carrying flammable liquids having a flash point exceeding 60°C unheated or heated to a temperature below and not within 15°C of their flash point *(1/5/2013)*

Spaces		Hazardous area
No.	Description	
1	Interior of cargo tanks, slop tanks, any pipework of pressure relief or other venting systems for cargo and slop tanks, pipes and equipment containing cargo.	Zone 2

Chapter 26

PALM OIL CARRIERS - ASSISTED PROPULSION

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Service notation palm oil carrier *(1/5/2013)*

a) The requirements of this Chapter apply to ships having the service notations palm oil carrier, as defined in Pt A, Ch 1, Sec 2, [4.5.2]

As indicated in Pt A, Ch 1, Sec 2, [4.5.11] these units are to be assigned with the additional service feature **assisted propulsion**.

Note 1: As recalled in Part A, Chapter 1, Sec 1, [3.1.1], the classification of a ship does not absolve the Interested Party from compliance with any requirements issued by Administrations and any other applicable international and national regulations for the safety of life at sea and protection of the marine environment.

b) The substances the carriage in bulk of which is covered by the service notations

- **palm oil carrier**

are limited to Palm Oil, carried at a temperature below and not within 15°C of the flashpoint.

1.2 Summary tables

1.2.1 *(1/5/2013)*

Tab 1 indicates, for easy reference, the Sections or Appendixes of this Chapter dealing with requirements applicable to ships having the service notation:

- **Palm oil carrier**

Table 1 : Sections or Appendixes with requirements applicable to ships having the Service Notation Palm oil carrier *(1/5/2013)*

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery and cargo system	Sec 4
Electrical installations	Sec 5
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements are given in this Chapter.	

1.3 Definitions

1.3.1 Cargo area *(1/5/2013)*

The cargo area is that part of the ship that contains cargo tanks as well as slop tanks, cargo pump rooms including pump rooms, cofferdams, ballast or void spaces adjacent to cargo tanks or slop tanks as well as deck areas throughout the entire length and breadth of the part of the ship above these spaces.

When independent tanks are installed in hold spaces, the cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space are excluded from the cargo area.

1.3.2 Cargo pump room *(1/5/2013)*

Cargo pump room is a space containing pumps and their accessories for the handling of products covered by the service notation granted to the ship.

1.3.3 **Cargo service spaces** *(1/5/2013)*

Cargo service spaces are spaces within the cargo area used for workshops, lockers and storerooms of more than 2 m^2 in area, intended for cargo handling equipment.

1.3.4 **Clean ballast** *(1/5/2013)*

Clean ballast means the ballast in a tank which since oil was last carried therein, has been so cleaned that the effluent therefrom if it were discharged from a ship which is stationary into clean calm water on a clear day would not produce visible traces of oil on the surface of the water or on adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. If the ballast is discharged through an oil discharge monitoring and control system approved by the Society, evidence based on such a system to the effect that the oil content of the effluent did not exceed 15 parts per million is to be determinative that the ballast was clean, notwithstanding the presence of visible traces.

1.3.5 Hold space *(1/5/2013)*

Hold space is the space enclosed by the ship's structure in which an independent cargo tank is fitted

1.3.6 Fuel oil *(1/5/2013)*

Fuel oil means any oil used as fuel in connection with the propulsion and auxiliary machinery of the ship on which such oil is carried.

1.3.7 Integrated cargo and ballast system *(1/5/2013)*

Integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps (including active control and safety systems and excluding passive components, e.g. piping).

1.3.8 Pump room *(1/5/2013)*

Pump room is a space, located in the cargo area, containing pumps and their accessories for the handling of ballast and fuel oil, or cargoes other than those covered by the service notation granted to the ship.

1.3.9 Segregated ballast *(1/5/2013)*

Segregated ballast means the ballast water introduced into a tank which is completely separated from the cargo oil and fuel oil system and which is permanently allocated to the carriage of ballast or to the carriage of ballast or cargoes other than oil or noxious substances as variously defined in Chapter 8.

1.3.10 Slop tank *(1/5/2013)*

Slop tank means a tank specifically designated for the collection of tank draining, tank washings and other oily mixtures.

1.3.11 Void space *(1/5/2013)*

Void space is an enclosed space in the cargo area external to a cargo tank, except for a hold space, ballast space, fuel oil tank, cargo pump room, pump room, or any space normally used by personnel.

SECTION 2 SHIP ARRANGEMENT

1 General

1.1 Application

1.1.1 *(1/5/2013)*
The requirements in Sec 2 apply to single deck ships, integral cargo tanks with machinery aft, double bottom throughout the cargo tank area, double side skin and possible longitudinal bulkheads, or single side skin and one or more longitudinal bulkheads throughout the cargo tank area. The deck may be single or double skin, with or without a trunk.

The application of these requirements to other ship types is to be considered by the Society on a case-by-case basis.

1.1.2 Exemptions *(1/5/2013)*
The requirements in Pt B, Ch 2, Sec 2, [3], b) and [5] do not apply.

2 General arrangement design

2.1 General

***2.1.1* Cofferdams** *(1/5/2013)*
A cofferdam or similar compartment of width not less than 760 mm is to be provided at the aft end of the cargo tank area. Its bulkheads are to extend from keel to deck across the full breadth of the ship.

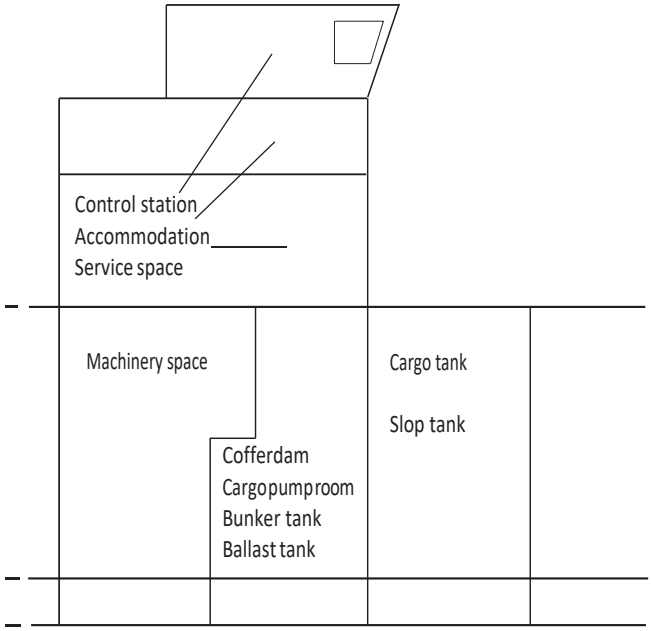
For the purpose of this requirement, the term “cofferdam” is intended to mean an isolating compartment between two adjacent steel bulkheads or decks. The minimum distance between the two bulkheads or decks is to be sufficient for safe access and inspection.

In order to meet the single failure principle, in the particular case when a corner-to-corner situation occurs, this principle may be met by welding a diagonal plate across the corner.

The cofferdams are also to be constructed so as to enable adequate ventilation.

***2.1.2* Cargo segregation** *(1/5/2013)*
Unless expressly provided otherwise, tanks containing cargo or cargo residues are to be segregated from accommodation, service and machinery spaces, drinking water and stores for human consumption by means of a cofferdam, or any other similar compartment (see Fig 1).

Figure 1 *(1/5/2013)*



2.1.3 Deck spills *(1/5/2013)*

Means are to be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by providing a permanent continuous coaming of a suitable height extending from side to side.

2.2 Double bottom tanks or compartments

2.2.1 General *(1/5/2013)*

Double bottom tanks adjacent to cargo tanks may not be used as fuel oil tanks.

2.2.2 Palm Oil carriers of 5000 t deadweight and above *(1/5/2013)*

a) At any cross-section, the depth of each double bottom tank or compartment is to be such that the distance h between the bottom of the cargo tanks and the moulded line of the bottom shell plating measured at right angles to the bottom shell is not less than B/15, in m, with a minimum value of 0,76 m.

b) In the turn of the bilge area and at locations without a clearly defined turn of the bilge, the cargo tank boundary line is to run parallel to the line of the midship flat bottom as shown in Fig 3.

3 Size and arrangement of cargo tanks and slop tanks

3.1 Cargo tanks

3.1.1 General *(1/5/2013)*

Palm oil carriers of 600 t deadweight and above are not allowed to carry cargo in any compartment extending forward of a collision bulkhead located in accordance with Pt B, Ch 2, Sec 1, [2].

3.1.2 Size of cargo tanks *(1/5/2013)*

The length of each cargo tank is not to exceed 10 metres or one of the values of Tab 1, as applicable, whichever is the greater.

Palm oil carriers are to be provided with cargo tanks so arranged that the capacity of each cargo tank does not exceed 700 m3 unless wing tanks or compartments are arranged, extending either for the full depth of the ship side or from the top of the double bottom to the uppermost deck, disregarding a rounded gunwale where fitted. They are to be arranged such that the cargo tanks are located inboard of the moulded line of the side shell plating, nowhere less than the distance w which, as shown in Fig 2, is measured at any cross-section at right angles to the side shell, as specified below:

$$w = 0,4 + \frac{2,4DW}{20000}$$ with a minimum value of 0,76 m

DW is the deadweight, in t.

3.1.3 Piping through cargo tanks *(1/5/2013)*

Lines of piping which run through cargo tanks in a position less than 0,30 B_s from the ship's side or less than 0,30 D_s from the ship's bottom are to be fitted with valves or similar closing devices at the point at which they open into any cargo tank. These valves are to be kept closed at sea at any time when the tanks contain cargo oil, except that they may be opened only for cargo transfer needed for essential operations.

3.1.4 Suction wells in cargo tanks *(1/5/2013)*

Suction wells in cargo tanks may protrude into the double bottom below the boundary line defined by the distance h in [2.2.2], provided that such wells are as small as practicable and the distance between the well bottom and bottom shell plating is not less than 0,5 h.

Figure 2 : Cargo tank boundary lines *(1/5/2013)*

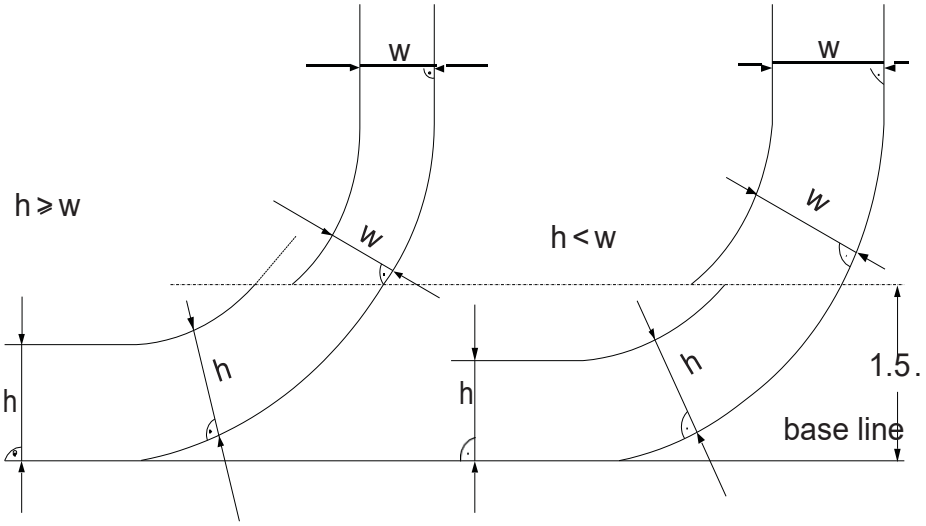
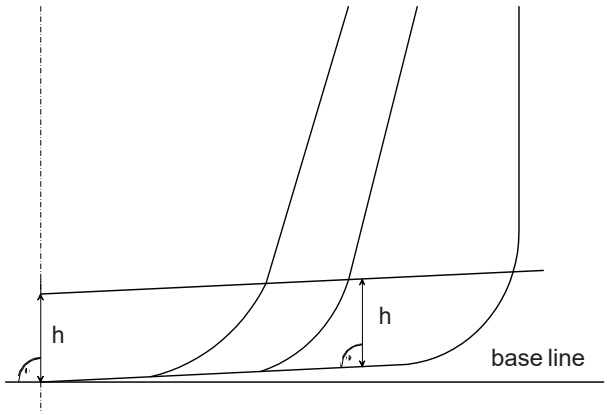


Figure 3 : Cargo tank boundary lines *(1/5/2013)*



4 Access arrangement

4.1 General

4.1.1 *(1/5/2013)*

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo tanks and ballast compartments.

4.1.2 *(1/5/2013)*

Means of access to side and centre tanks may not be provided in the same transverse section.

Table 1 : Length of cargo tanks *(1/5/2013)*

Longitudinal bulkhead arrangement	Cargo tank	Condition **(1)**	Centreline bulkhead arrangement	Length of cargo tanks, in m
No bulkhead	-	-	-	$(0,5\ b_i / B + 0,1)\ L$ **(2)**
Centreline bulkhead	-	-	-	$(0,25\ b_i / B + 0,15)\ L$
Two or more bulkheads	Wing cargo tank	-	-	0,2 L
	Centre cargo tank	$b_i / B \geq 1/5$	-	0,2 L
		$b_i / B < 1/5$	No	$(0,5\ b_i / B + 0,1)\ L$
			Yes	$(0,25\ b_i / B + 0,15)\ L$

(1) b_i is the minimum distance from the ship side to the outer longitudinal bulkhead of the i-th tank, measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.

(2) Not to exceed 0,2 L

4.2 Access to pipe tunnel and opening arrangement

4.2.1 Access to the pipe tunnel in the double bottom *(1/5/2013)*

The pipe tunnel in the double bottom is to comply with the following requirements:

- it may not communicate with the engine room
- provision is to be made for at least two exits to the open deck arranged at a maximum distance from each other. One of these exits fitted with a watertight closure may lead to the cargo pump room.

4.2.2 Doors between pipe tunnel and main pump room *(1/5/2013)*

Where there is a permanent access from a pipe tunnel to the main pump room, a watertight door is to be fitted complying with the requirements in Pt B, Ch 2, Sec 1, [6.2.1] for watertight doors open at sea and located below the freeboard deck. In addition the following is to be complied with:

- in addition to bridge operation, the watertight door is to be capable of being manually closed from outside the main pump room entrance
- the watertight door is to be kept closed during normal operations of the ship except when access to the pipe tunnel is required. A notice is to be affixed to the door to the effect that it may not be left open.

4.3 Access to compartments in the cargo area

4.3.1 General *(1/5/2013)*

Access to cofferdams, ballast tanks, cargo tanks and other compartments in the cargo area is to be direct from the open deck and such as to ensure their complete inspection. Access to double bottom compartments may be through a cargo pump room, pump room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

4.3.2 Access to the fore peak tank *(1/1/2026)*

The requirements for access to the fore peak tank in Ch 7, Sec 2, [7.2] and [7.3] are to be complied with where only the arrangements in Ch 7, Sec 2, Fig 5, 6, 9 and 10 are applicable to palm oil carriers.

4.3.3 Access through horizontal openings *(1/5/2013)*

For access through horizontal openings the dimensions are to be sufficient to allow a person wearing a self-contained, air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the compartment. The minimum clear opening is to be not less than 600 mm by 600 mm.

4.3.4 Access through vertical openings *(1/5/2013)*

For access through vertical openings the minimum clear opening is to be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

4.3.5 Palm oil carriers less than 5000 t deadweight *(1/5/2013)*

For palm oil carriers of less than 5000 t deadweight smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

SECTION 3 STABILITY

1 Stability

1.1 Intact stability

1.1.1 General *(1/5/2013)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.6] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2. In addition, the requirements in [1.1.2] are to be complied with.

1.1.2 Liquid transfer operations *(1/5/2013)*

Ships with certain internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling, the design of oil carriers of 5000 t deadweight and above is to be such that the following criteria are complied with:

a) The intact stability criteria reported in b) is to be complied with for the worst possible condition of loading and ballasting as defined in c), consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.

b) The initial metacentric height GMo, in m, corrected for free surface measured at 0° heel, is to be not less than 0,15. For the purpose of calculating GMo, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.

c) The vessel is to be loaded with:
   - all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank
   - cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value
   - full departure consumable
   - 1% of the total water ballast capacity.The maximum free surface moment is to be assumed in all ballasttanks.

SECTION 4 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Application

1.1.1 *(1/5/2013)*

The requirements of this Section apply to ships having the service notations:

- **palm oil carrier**

intended to carry palm oil at a temperature below and not within 15°C of the flashpoint.

1.2 Documents to be submitted

1.2.1 *(1/5/2013)*

The documents listed in Tab 1 are to be submitted for approval in four copies.

2 Piping systems other than cargo piping system

2.1 General

2.1.1 Materials *(1/5/2013)*

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 10.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

***2.1.2* Independence of piping systems** *(1/5/2013)*

Fuel oil systems are to:

- be independent from the cargo piping system
- have no connections with pipelines serving cargo or slop tanks.

***2.1.3* Passage through cargo tanks and slop tanks** *(1/1/2025)*

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted, ballast pipes passing through cargo tanks are to fulfil the following provisions:

- they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
- they are to be of extra-reinforced wall thickness as per Pt C, Ch 1, Sec 10, Tab5
- they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

2.2 Bilge system

***2.2.1* Draining of spaces located outside the cargo area** *(1/5/2013)*

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 10, [6].

***2.2.2* Draining of pump rooms** *(1/5/2013)*

a) Arrangements are to be provided to drain the pump rooms by means of power pumps or bilge ejectors.

Note 1: On carriers of less than 500 gross tonnage, the pump rooms may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

b) Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:

- a screw-down non-return valve is fitted on the bilge suctions, and

c) Bilge pipe internal diameter is not to be less than 50 mm.

d) High liquid level in the bilges is to activate an audible and visual alarm in the cargo control room and on the navigation bridge.

Table 1 : Documents to be submitted *(1/5/2013)*

No.	Description of the document **(1)**
1	Diagram of cargo piping system
2	Diagram of the cargo tank venting system with indication of the outlet position
3	Diagram of the cargo tank level gauging system with overfill safety arrangements
4	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
5	Diagram of the cargo heating systems
(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.	

2.2.3 Drainage of hold spaces, cofferdams and void spaces located within the cargo area *(1/5/2013)*

Hold spaces, cofferdams and void spaces located within the cargo area and not intended to be filled with water ballast are to be fitted with suitable means of drainage.

2.3 Ballast system

2.3.1 General *(1/5/2013)*

a) Every Palm oil carrier is to be provided with segregated ballast tanks

b) The capacity of the segregated ballast tanks is to be considered by the Society on a case-by-case basis. In general, the capacity of segregated ballast tanks is to be at least such that, in any ballast condition at any part of the voyage, including the conditions consisting of lightweight plus segregated ballast only, the ship's draught and trim satisfy minimum and maximum values deemed reasonable by the Society

c) Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo and fuel oil systems.

d) In palm oil carriers of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt C, Ch 1, Sec 10, [7.1.3].

2.3.2 Pumping arrangements for ballast tanks within the cargo area *(1/5/2013)*

Segregated ballast tanks located within the cargo area are to be served by two different means. At least one of these means is to be a pump or an eductor used exclusively for dealing with ballast. The ballast system serving the spaces located outside the cargo area may be used for this purpose.

2.3.3 Emergency discharge of segregated ballast *(1/5/2013)*

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of palm oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be displayed in a conspicuous position adjacent to it.

2.3.4 Carriage of ballast water in cargo tanks *(1/5/2013)*

a) Provisions may made for filling cargo tanks with sea water, where permitted. Such ballast water is to be dealt with according to [5].

b) The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

c) Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges.

d) Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

2.3.5 Ballast pipes passing through tanks *(1/1/2025)*

a) In palm oil carriers of 600 tonnes deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks. Expansion bends only are permitted (see Note 1).

Note 1: Expansion bends means expansion loops such as an omega bend (' Ω ') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

2.3.6 Integrated cargo and ballast system *(1/5/2013)*

The requirements for integrated cargo and ballast systems are given in [3.5].

2.4 Scupper pipes

2.4.1 *(1/5/2013)*

Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt C, Ch 1, Sec 10, Tab 22, column 1.

2.5 Heating systems intended for cargo

2.5.1 General *(1/5/2013)*

Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 10.

2.5.2 *(1/5/2013)*

Heating or cooling media are to be of a type approved for use with the specific cargo.

The surface temperature of heating coils or ducts is to be limited so as to avoid dangerous reactions from localized overheating or overcooling of cargo.

2.5.3 *(1/5/2013)*

In any heating or cooling system, means shall be provided to ensure that, when in any condition other than empty, a higher pressure can be maintained within the system than the maximum pressure head that could be exerted by the cargo tank contents on the system.

3 Cargo pumping and piping systems

3.1 General

3.1.1 *(1/5/2013)*

A complete system of pumps and piping is to be fitted for handling the cargo.

3.2 Cargo pumping system

3.2.1 Number and location of cargo pumps *(1/5/2013)*

Each cargo tank is to be served by at least one fixed mean of discharging. In addition, arrangements are to be adopted to make discharge by pumps in the oil terminal possible, taking into account the NPSHD at the pumps, or a second separate fixed mean of discharging is to be fitted.

3.2.2 Use of cargo pumps *(1/5/2013)*

a) Except where expressly permitted in [2.2] and [2.3], cargo pumps are to be used exclusively for handling the liquid cargo.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

3.2.3 Cargo pump drive *(1/5/2013)*

Pumps with a submerged electric motor are not permitted in cargo tanks.

Note 1: The provisions of this requirement also apply to stripping pumps and ballast pumps.

3.2.4 Design of cargo pumps *(1/5/2013)*

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

3.2.5 Monitoring of cargo pumps *(1/5/2013)*

Cargo pumps are to be monitored as required in Tab 2.

3.2.6 Control of cargo pumps *(1/5/2013)*

Cargo pumps are to be capable of being stopped from:

- a position outside the pump room, and
- a position next to the pumps.

3.3 Cargo piping design

3.3.1 General *(1/5/2013)*

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 10 applicable to piping systems of class III.

b) For tests, refer to Ch 7, Sec 4, [6].

3.3.2 Materials *(1/5/2013)*

a) Cargo piping is, in general, to be made of steel or cast iron.

b) Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.

c) Spheroidal graphite cast iron may be used for cargo oil piping.

d) Grey cast iron may be accepted for cargo oil lines:

- within cargo tanks, and
- on the weather deck for pressure up to 1,6 Mpa.

It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.

e) Plastic pipes may be used in the conditions specified in Pt C, Ch 1, App 3. Arrangements are to be made to avoid the generation of static electricity.

3.3.3 Connection of cargo pipe lengths *(1/5/2013)*

Cargo pipe lengths may be connected either by means of welded joints or, unless otherwise specified, by means of flange connections.

3.3.4 Expansion joints *(1/5/2013)*

a) Where necessary, cargo piping is to be fitted with expansion joints or bends.

b) Expansion joints including bellows are to be of a type approved by the Society.

c) Expansion joints made of non-metallic material may be accepted only inside tanks and provided they are:

- of an approved type
- designed to withstand the maximum internal and external pressure
- electrically conductive
- sliding type couplings are not to be used for expansion purposes where lines for cargo oil pass through tanks for segregated ballast.

3.3.5 Valves with remote control *(1/5/2013)*

a) Valves with remote control are to comply with Pt C, Ch 1, Sec 10, [2.7.3].

b) Submerged valves are to be remote controlled. In the case of a hydraulic remote control system, control boxes are to be provided outside the tank, in order to permit the emergency control of valves.

c) Valve actuators located inside cargo tanks are not to be operated by means of compressed air.

Table 2 : Monitoring of cargo pumps *(1/5/2013)*

Equipment, parameter	Alarm	Indication **(1)**	Comments
pump, discharge pressure		L	• on the pump **(2)**, or • next to the unloading control station
(1) L = low **(2)** and next to the driving machine if located in a separate compartment			

3.3.6 Cargo hoses *(1/5/2013)*

a) Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

b) Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 4 times the maximum pressure under cargo transfer conditions.

c) The ohmic electrical resistance of cargo hoses is not to exceed 10^6 Ω.

3.4 Cargo piping arrangement and installation

3.4.1 Cargo pipes passing through tanks or compartments *(1/5/2013)*

a) Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with [2.1.3], item b).

b) Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of [2.1.3], item b) are complied with.

c) Piping through cargo tanks, see also Ch 25, Sec 2, [3.1.3].

3.4.2 Cargo piping passing through bulkheads *(1/5/2013)*

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead. Bolted flanges are not to be used in the bulkhead.

3.4.3 Valves *(1/5/2013)*

a) Stop valves are to be provided to isolate each tank.

b) A stop valve is to be fitted at each end of the cargo manifold.

c) When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

d) Main cargo valves located in the cargo pump room below the floor gratings are to be remote controlled from a position above the floor.

3.5 Integrated cargo and ballast systems design

3.5.1 Functional requirements *(1/5/2013)*

The operation of cargo and/or ballast systems may be necessary, under certain emergency circumstances or during the course of navigation, to enhance the safety of carriers.

As such, measures are to be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems. The same criteria apply to control systems of cargo and ballast valves.

3.5.2 Design features *(1/5/2013)*

The following design features are, inter alia, to be fitted:

a) the emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems. A single failure in the control system circuits or the emergency stop circuits is not to render the integrated cargo and ballast system inoperative;

b) manual emergency stops of the cargo pumps are to be arranged such that they do not cause the shutdown of the power pack making ballast pumps inoperable;

c) the control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

d) in the event of failure of the automatic or remote control systems, a secondary means of control is to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

4 Cargo tanks and fittings

4.1 Application

4.1.1 *(1/5/2013)*

The provisions of [4] apply to cargo tanks and slop tanks.

4.2 Cargo tank venting *(1/5/2013)*

4.2.1 *(1/5/2013)*

The relevant provisions of Pt C, Ch 1, Sec 10, [9] and Pt C, Ch 1, Sec 10, [11] are to be complied with.

Tank venting systems are to open to the atmosphere at a height of at least 760 mm above the weather deck.

Tanks may be fitted with venting systems of the open type.

4.3 Protection against tank overload

4.3.1 General *(1/5/2013)*

a) Provisions are to be made to guard against liquid rising in the venting system of cargo or slop tanks to a height which would exceed the design head of the tanks. This is to be accomplished by high level alarms or overflow control systems or other equivalent means, together with gauging devices and cargo tank filling procedures.

b) Sufficient ullage is to be left at the end of tank filling to permit free expansion of liquid during carriage.

c) High level alarms, overflow control systems and other means referred to in a) are to be independent of the gauging system.

4.3.2 High level alarms *(1/5/2013)*

a) High level alarms are to be type approved.

b) High level alarms are to give an audible and visual signal at t he control station, where provided.

4.3.3 Other protection systems *(1/5/2013)*

a) Where the tank level gauging systems, cargo and ballast pump control systems and valve control systems are centralised in a single location, the provisions of [4.3.1] may be complied with by the fitting of a level gauge for the indication of the end of loading, in addition to that required for each tank. The readings of both gauges for each tank are to be as near as possible to each other and so arranged that any discrepancy between them can be easily detected.

b) Where a tank can be filled only from other tanks, the provisions of [4.3.1] are considered as complied with.

5 Prevention of pollution by palm oil

5.1 General

5.1.1 *(1/5/2013)*

The control of discharge is to be effected by the retention of oil on board with subsequent discharge of all residues, including contaminated washings if any, to reception facilitie.

6 Certification, inspection and testing

6.1 Application

6.1.1 *(1/5/2013)*

The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt C, Ch 1, Sec 10, [21] for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials *(1/5/2013)*

Where required in Tab 3, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt C, Ch 1, Sec 10, [21.3.2].

6.2.2 Hydrostatic testing *(1/5/2013)*

a) Where required in Tab 3, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

c) Where fitted, bellow pieces of gas-tight penetration glands are to be pressure tested.

6.2.3 Tightness tests *(1/5/2013)*

Tightness of the following devices is to be checked:

- gas-tight penetration glands
- cargo tank P/V and high velocity valves.

Note 1: These tests may be carried out in the workshops or on board.

6.2.4 Check of the safety valves setting *(1/5/2013)*

The setting pressure of the pressure/vacuum valves is to be checked in particular with regard to Ch 25, Sec 4, [4.2.6].

6.2.5 Summary table *(1/5/2013)*

Inspections and tests required for cargo piping and other equipment fitted in the cargo area are summarised in Tab 3.

6.3 Shipboard tests

6.3.1 Pressure test *(1/5/2013)*

After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

Table 3 : Inspection and testing at works *(1/5/2013)*

No.	Item	Tests for materials		Inspections and tests for the products			References
		Y/N **(1)**	Type of material certificate **(2)**	during manu-facturing **(1)**	after completion **(1) (3)**	Type of product certificate **(2)**	
1	expansion joints and cargo hoses	Y **(4)**	W	N	Y	C	[6.2.1] [6.2.3]
2	cargo pumps	Y	W	Y **(5)**	Y	C	see note [6.2.3] **(5)**

(1) Y = required, N = not required.
(2) C = class certificate, W = works' certificate.
(3) includes the checking of the rule characteristics according to the approved drawings.
(4) if metallic
(5) inspection during manufacturing is to be carried out according to a program approved by the Society.

SECTION 5 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/5/2013)*

The requirements in this Section apply, in addition to those contained in Part C, Chapter 2, to ships with the service notation **palm oil carrier**.

1.2 Documentation to be submitted

1.2.1 *(1/5/2013)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, Tab 1, the following are to be submitted for approval:

a) plan of hazardous areas

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 *(1/5/2013)*

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective 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 hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions

d) intrinsically safe systems.

1.3.2 *(1/5/2013)*

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.3 *(1/5/2013)*

The additional limitations in the choice of the system of supply (type of distribution system) as per SOLAS Ch.II-1 Reg. 45.4.3 apply to ships subject to the SOLAS Convention.

1.4 Electrical equipment

1.4.1 *(1/5/2013)*

Electrical equipment, cables and wiring are not to be installed in hazardous locations unless they conform with standards not inferior to those given in IEC 60092-502 Standard.

However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Society, to ensure that an equivalent level of safety is assured.

1.5 Earth detection

1.5.1 *(1/5/2013)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

The above is not applicable to systems mentioned in [1.3.1].

1.6 Precautions against inlet of gases or vapours

1.6.1 *(1/5/2013)*
Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

1.7 Electrical equipment permitted in hazardous areas

1.7.1 *(1/5/2013)*
Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [10.1.4], Pt C, Ch 2, Sec 3, [10.1.5], and Pt C, Ch 2, Sec 3, [10.1.6].

1.7.2 *(1/5/2013)*
In addition to the requirements of [1.7.1], in Zone 1 and Zone 2 the installation of the following is permitted:

hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of animpressed current cathodic protection system, or transducers such as those for depth sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, as well as any testing to establish their gas-tightness, are to be to the satisfaction of the Society. The associated cables are to be protected by means of heavy gauge steel pipes with gas-tight joints.

1.7.3 *(1/5/2013)*
Enclosed or semi-enclosed spaces (not containing a source of hazard) having a direct opening, including those for ventilation, into any hazardous area, are to be designated as the same hazardous zone as the area in which the opening is located.

Electrical installations are to comply with the requirements for the space or area into which the opening leads.

Note 1: For openings, access and ventilation conditions affecting the extent of hazardous areas, see IEC Standard 60092-502.

1.8 Hazardous area classification

1.8.1 *(1/5/2013)*
For hazardous area classification see Tab 1.

Table 1 : Hazardous areas classification for palm oil carriers (carrying palm oil heated to a temperature below and not within 15°C of the flash point) *(1/5/2013)*

Spaces		Hazardous area
No.	Description	
1	Interior of cargo tanks, slop tanks, any pipework of pressure relief or other venting systems for cargo and slop tanks, pipes and equipment containing cargo.	Zone 2

Chapter 27

UNITS FOR TRANSHIPMENT OF DRY CARGO IN BULK

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/7/2014)*
The requirements of this Section apply to units having one of the service notations **transhipping unit** or **transhipping floating terminal**, as defined in Pt A, Ch 1, Sec 2, [4.11].

1.1.2 *(1/7/2014)*
Units dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to transhipping units or transhipping floating terminals.

1.1.3 *(1/7/2014)*
Units equipped with permanent mooring arrangements are to comply with the requirements for the assignment of the additional class notation **MOORING**, given in Pt F, Ch 13, Sec 21.

1.1.4 *(1/7/2014)*
Units provided with at least one crane, fitted with a grab or a bucket, are to comply with the requirements for the assignment of the additional class notation **CARGO HANDLING**, given in Pt A, Ch 1, Sec 2, [6.14.30].

1.2 Summary table

1.2.1 *(1/7/2014)*
Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to transhipping units or transhipping floating terminals.

Table 1 *(1/7/2014)*

Main subject	Reference
Unit arrangement	Sec 2
Hull and stability	Sec 3
Machinery and systems	**(1)**
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for transhipping units or transhipping floating terminals are given in this Chapter.	

SECTION 2 UNIT ARRANGEMENT

1 General

1.1 Application

1.1.1 *(1/7/2014)*

The requirements of this Section apply to units having one of the service notations **transhipping unit** or **transhipping floating terminal**, as defined in Pt A, Ch 1, Sec 2, [4.11].

1.2 Documents to be submitted

1.2.1 *(1/7/2014)*

Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable.

Table 1 : Documents to be submitted *(1/7/2014)*

No.	A/I **(1)**	Document
1	A	Typical loading and unloading sequences, including conditions with uneven distribution (e.g. part loading conditions with empty cargo holds, as applicable)
2	I	Data regarding properties of cargo (e.g. bulk density, angle of repose, humidity limits, etc.)
3	I	Loading and unloading systems manual
(1) A = to be submitted for approval in four copies I = to be submitted for information in duplicate		

2 Cargo handling arrangements

2.1 General

2.1.1 *(1/7/2014)*

In compliance with Pt A, Ch 1, Sec 2, [4.11.1], the additional class notation **CARGO HANDLING** is assigned.

The lifting arrangements are to comply with the "Rules for loading and unloading arrangements and for other lifting appliances on board ships or other similar units".

2.1.2 *(1/7/2014)*

The minimum cargo handling piece of equipment to be fitted on a transhipping unit or a transhipping floating terminal is a crane fitted with a grab or bucket.

2.1.3 *(1/7/2014)*

The cargo handling cranes, when loaded with the maximum volume of cargo having the maximum allowed density, are to have a minimum outreach (i.e. the extension outboard of the bumper) not greater than 10 meters and a maximum outreach not less than 20 meters; these values may be considered on a case by case basis in the case of units intended for special operations, at the discretion of the Society.

2.1.4 *(1/7/2014)*

The designer is responsible for the scantlings of specific cargo handling gears like conveyors and similar equipment.

2.1.5 *(1/7/2014)*

Cargo handling cranes and gears are to be arranged such that cargo does not normally pass over or in close proximity to accommodation and control stations of the unit; the Society may consider alternative arrangements giving an equivalent level of safety in the case of unintentional release of lifted cargo.

2.1.6 *(1/7/2014)*
Units equipped with one or more cranes fitted with a grab or bucket are assigned the additional class notation **GRAB [X]** and are to comply with the requirements in Pt F, Ch 13, Sec 2, [3].

3 Ship-to-Unit Mooring arrangements

3.1 General

3.1.1 *(1/7/2014)*
Transhipping units and Transhipping floating terminals are to be fitted with suitable arrangements for mooring; this includes winches, cables, fairleads and mooring cleats but also bumpers, fenders and hull structures.

3.1.2 *(1/7/2014)*
The mooring analysis is to be carried out considering the range of ships that, according to the design, are intended to be moored with the unit in order to carry out ship-to-unit cargo transfer operations.

3.1.3 *(1/7/2014)*
A selected sample of representative ships is to be identified, and agreed with the Society, on the basis of which the mooring analysis is to be carried out and the mooring loads are to be calculated, by means of a direct analysis.

In any case, the overall methodology for the ship-to-unit mooring analysis (sample of ships to be considered, model tests, numerical calculations and software verification) is to be agreed with the Society at the first phase of the design.

3.2 Mooring analysis

3.2.1 *(1/7/2014)*
The following information is to be provided, as a minimum, in order to assess the ship-to-unit mooring analysis:

a) description of the mooring system of the unit with the seabed,

b) ship-to-unit mooring system:
   - mooring arrangements,
   - detailed description of mooring fittings, mooring lines, fenders (mechanical characteristics and geometrical description),

c) unit:
   - loading conditions during ship-to-unit transfer operations,
   - characteristics of weight distribution (moments of inertia) in the various loading conditions,

d) for each ship considered in the analysis:
   - general characteristics,
   - lines plans,
   - loading conditions during ship-to-unit transfer operations,
   - characteristics of weight distribution (moments of inertia) in the various loading conditions,
   - mooring fitting arrangement.

3.2.2 *(1/7/2014)*
The design limit environmental conditions for ship-to-unit mooring operations are to be specified. The following information on the design marine weather conditions is to be provided for the specific location:

- wave height,
- wave period (range or maximum),
- wave spectrum,
- wind speed,
- current speed,
- directionality information for wind, wave and current.

The data assumed for the mooring analysis are to be consistent with the data provided in the marine weather analysis report. The design performance, in terms of allowable failures of the mooring system, is to be specified by the designer.

3.2.3 *(1/7/2014)*
The loads on the system caused by the following primary factors are to be taken into account for the mooring analysis:

- static loads (e.g. pretension in mooring lines),

- wind,
- current,
- waves (slow frequency and wave frequency motions).

The analysis is to cover all the most critical cases envisaged, according to the design marine weather conditions for ship-to-unit operations. The effects of wind, current and waves, considered as acting simultaneously, are to be considered, according to [3.2.2].

3.2.4 *(1/7/2014)*
The analysis is to reproduce, as closely as possible, the actual behaviour of the system during its operative life, considering mechanical and hydrodynamic issues. In general, fully coupled, nonlinear, time domain simulations are required. Simplifications may be accepted by the Society, on a case by case basis.

Assumptions and simplifications are to be clearly indicated and explained.

A sensitivity analysis is to be performed in order to check the validity of the calculations.

Assessments and calculations considering the allowable failure of mooring fittings and mooring lines are to be carried out, when operations in such conditions are envisaged in the design conditions.

Additional analyses may be required by the Society, when deemed necessary on the basis of the system and unit characteristics.

3.2.5 *(1/7/2014)*
The Ship-to-unit Mooring Analysis report is to include, at least:

- a detailed description of the software for the calculation and the associated theory,
- a description of the hydrodynamic and mechanical models,
- a calibration and comparison with model tests (or with previous experience, when acceptable),
- RAO's of the vessels motions, with input parameters specification in the case of non-linear/linearized analysis, and Quadratic Transfer Function of the unit,
- environmental data and wind/current combination matrix,
- assumptions and simplifications,
- a description of additional viscous damping, if applicable,
- statistics of the results (motions, velocities, accelerations, tensions on the lines and loads on the fenders),
- spectral analyses of the results,
- time histories of the results.

4 Access on board arrangement

4.1 Means of access when moored alongside in between of two other ships

4.1.1 *(1/7/2014)*
Transhipping units and Transhipping floating terminals which are intended to be moored alongside, in between of two other ships (e.g. a barge being discharged and a bulk carrier being loaded), are to be fitted with means of access arranged so that they remain available in all operational conditions.

SECTION 3 HULL AND STABILITY

1 Application

1.1

1.1.1 *(1/7/2014)*

The requirements of this Section apply to units having one of the service notations transhipping unit or transhipping floating terminal, as defined in Pt A, Ch 1, Sec 2, [4.11].

2 Stability

2.1 Intact stability under navigating conditions

2.1.1 **Application** *(1/7/2014)*

The requirements of this item apply to units with the service notations **transhipping unit** or **transhipping floating terminal**, provided with the following characteristics:

a) a navigation notation not exceeding the Coastal Area, and

b) having a block coefficient not less than 0,9

c) having a breadth/depth ratio greater than 3,0

The intact stability of units not complying with either one of the above characteristics is to comply with Pt B, Ch 3, Sec 2, unless otherwise decided by the Society, on a case by case basis, taking into account the unit's characteristics.

In this case, an appropriate entry is made in the classification files of the unit.

Items [2.1.2] and [2.1.3] do not apply to "Transhipping unit" or "Transhipping floating terminal" having no buffering capacity or having buffering capacity only within holds.

2.1.2 **Trim and stability booklet** *(1/7/2014)*

In addition to the information to be included in the trim and stability booklet specified in Pt B, Ch 3, App 2, [1.1], simplified stability guidance, such as a loading diagram, is to be submitted to the Society for approval, so that pontoons may be loaded in compliance with the stability criteria.

2.1.3 **Stability calculations** *(1/7/2014)*

Stability calculations may be carried out according to the following criteria:

- no account is to be taken of the buoyancy of deck cargo
- consideration is to be given to such factors as water absorption (e.g. timber), trapped water in cargo (e.g. pipes) and ice accretion
- in carrying out wind heel calculations:
  - the wind pressure is to be constant and for general operations considered to act on a solid mass extending over the length of the deck and to an assumed height above the deck
  - the centre of gravity of the cargo is to be assumed at a point mid-height of the cargo
  - the wind lever arm is to be taken from the centre of the deck cargo to a point at one half the draught
- calculations are to be carried out covering the full range of operating draughts
- the downflooding angle is to be taken as the angle at which an opening through which progressive flooding may take place is immersed. This would not be an opening closed by a watertight manhole cover or a vent fitted with an automatic closure.

2.1.4 **Intact stability criteria** *(1/7/2014)*

The following intact stability criteria are to be complied with, for the loading conditions specified in Pt B, Ch 3, App 2, [1.2.1] and Pt B, Ch 3, App 2, [1.2.2]:

- the area under the righting lever curve up to the angle of maximum righting lever is to be not less than 0,08 m.rad

- the static angle of heel due to a uniformly distributed wind load of 0,54 kPa (wind speed 30 m/s) may not exceed a heeling angle corresponding to half the freeboard for the relevant loading condition, where the lever of wind heeling moment is measured from the centroid of the windage area to half the draught
- the minimum range of stability is to be:
  - 20° for L < 100 m
  - 20° - 0,1° (L - 100) for 100 < L < 150 m
  - 15° for L > 150 m.

2.2 Intact stability under operation

2.2.1 Application *(1/7/2014)*

The requirements of this item apply to units with the service notation "**transhipping unit**" or "**transhipping floating terminal**" and specify the criteria these units are to satisfy in addition to those in [2.1], during operation involving use of cargo lifting appliances.

2.2.2 Intact stability criteria during cargo lifting *(1/7/2014)*

The following intact stability criteria are to be complied with:

- $\theta_C \leq 15°$
- $GZ_C \leq 0,6\ GZ_{MAX}$
- $A_1 \geq 0,4\ A_{TOT}$

where:

θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms (see Fig 1)

GZ_C, GZ_{MAX}: Defined in Fig 1

A_1 : Area, in m.rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle C to the heeling angle equal to the lesser of:

- heeling angle θ_R of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 1)
- heeling angle θ_F, corresponding to flooding of unprotected openings as defined in Pt F, Ch 13, Sec 11, [2.1.4] (see Fig 1)

A_{TOT} : Total area, in m.rad, below the righting lever curve.

In the above formula, the heeling arm, corresponding to the cargo lifting, is to be obtained, in m, from the following formula:

$B_d = P_d - Z_z / \Delta$

where:

P : Cargo lifting mass, in t

d : Transversal distance, in m, of cargo lifting to the longitudinal plane (see Fig 1)

Z : Mass, in t, of ballast used to right the pontoon, if applicable (see Fig 1)

z : Transversal distance, in m, of the centre of gravity of Z to the longitudinal plane (see Fig 1)

Δ : Displacement, in t, at the loading condition considered.

The above check is to be carried out considering the most unfavourable situations of cargo lifting combined with the lesser initial metacentric height GM, corrected according to the requirements in Pt B, Ch 3, Sec 2, [4].

The residual freeboard of the unit during lifting operations in the most unfavourable stability condition is to be not less than 0,30 m. However, the heeling of the unit is not to produce higher loads in the lifting devices than those envisaged by the rmanufacturer, generally expected to be 5° in the boom plane and 2° transversally in the case of a crane.

The vertical position of the centre of gravity of cargo lifting is to be assumed in correspondence of the suspension point.

2.3 Intact stability for units carrying grain, cement and similar, IMSBC-A cargoes, nitrates, non-cohesive or other special cargo

2.3.1 Application *(1/7/2014)*

Units with the service notation "**transhipping unit**" or "**transhipping floating terminal**" having a buffer capacity in holds which are to be loaded with grain, cement and similar, IMSBC-A cargoes, nitrates, non-cohesive or other special cargo which may shift and affect the stability, are to comply with the specific additional criteria as indicated in Tab 1.

3 Design loads

3.1 Unit motions and accelerations

3.1.1 *(1/7/2014)*

In general, the values of unit motions and accelerations are to be derived from direct calculations, and justified on the basis of the unit's characteristics and intended areas of operation.

The values of unit motions and accelerations to be calculated are those which can be reached with a probability of 10-5 per cycle. In any case, the calculations, including the assumed sea scatter diagrams and spectra, are to be submitted to the Society for approval.

3.2 Additional requirements on local loads for units with the additional service feature heavycargo

3.2.1 *(1/7/2014)*

For units with a service notation completed by the additional service features **buffer** [x T, deck/holds] and **heavycargo** [HOLDi, Xi kN/m^2, ρi kN/m^3 - DECK, Yi kN/m^2] (see Pt A, Ch 1, Sec 2, [4.11.1]), the values Xi and i, relevant to bulk cargoes carried in holds, and Yi, relevant to uniform cargoes carried on deck, are to be taken according to [3.3.1].

3.3 Characteristics of bulk cargoes carried in holds

3.3.1 *(1/7/2014)*

ρi is, for each hold, the mass density of the cargo which fills the hold up to the upper deck level at centreline for the maximum mass which may be carried in that hold; ρi is to be defined by the designer and is to be greater than 1,0 t/m^3.

Xi is the maximum allowable local pressure on the inner bottom of each hold and is to be specified by the designer. In any case, it is to be not less than the value obtained, for each hold, from the formula for p_S on the inner bottom in Pt B, Ch 5, Sec 6, [3.1.1], where the hold is to be considered as being completely filled and ρ_B is to be taken equal to i defined above.

4 Hull scantlings

4.1 General

4.1.1 *(1/7/2014)*

Foundations of cranes and conveyors are to be checked through direct calculations on the basis of:

- inertial loads in load cases "b" and "d" as defined in Pt B, Ch 5, Sec 4
- allowable stress as per Pt B, Ch 7, Sec 3.

Figure 1 : Cargo lifting *(1/7/2014)*

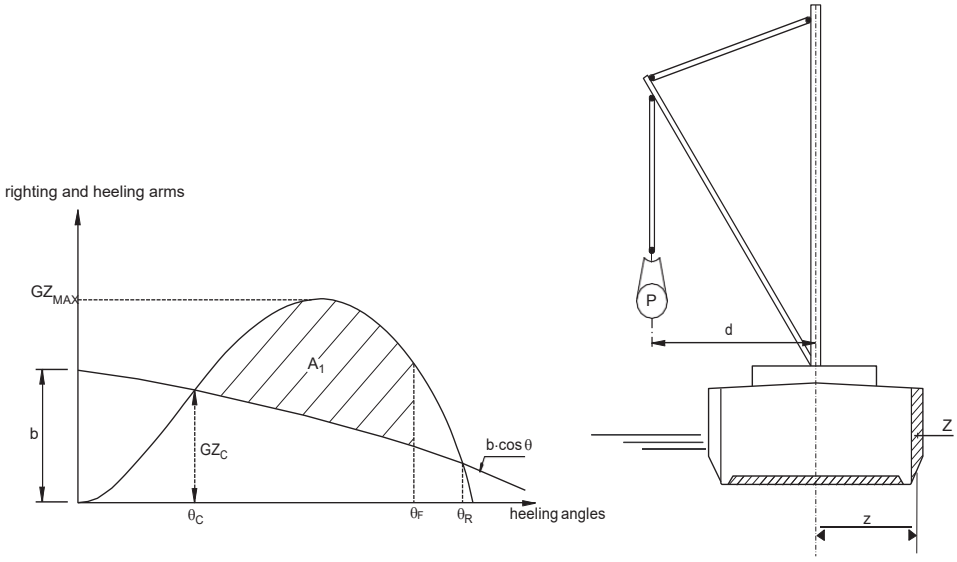


Table 1 : Documents to be submitted *(1/7/2014)*

No.	Cargo	Applicable criteria	Notes
1	Grain	Ch 4, Sec 3, [2]	
2	Cement and similar	Sec 2, [4]	
3	IMSBC-A cargoes	Pt F, Ch 13, Sec 18, [2]	The additional class notation "**IMSBC-A**" may be assigned
4	Nitrates	Pt F, Ch 13, Sec 18, [3]	The additional class notation "**IMSBC-nitrate**" may be assigned
5	Non-cohesive cargo	Pt F, Ch 13, Sec 18, [4]	The additional class notation "**IMSBC-non cohesive**" may be assigned
6	Other special cargo	The applicable criteria are to be established on a case by case basis, taking into account the properties of the proposed cargo	

Chapter 28
CHEMICAL RECOVERY SHIPS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(15/2/2016)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **chemical recovery ship**, as defined in Pt A, Ch 1, Sec 2, [4.8.6].

Ships with this service notation are designed to:

- operate in hazardous atmosphere in case of an accident involving chemical products
- remove from the sea surface, retain, carry on board and unload chemical products.

1.1.2 *(15/2/2016)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific to chemical recovery ships for operations in hazardous atmosphere.

In addition, Ships dealt with in this Chapter are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), with the exception indicated in [1.1.3].

1.1.3 *(15/2/2016)*

For ships intended to collect and carry only the bulk liquids identified in Chapter 1, [1.2.2] of the IMO Resolution A.673(16) and for which the aggregate quantity of cargo does not exceed the lesser of the following values:

- 800 m^3
- 40% of ship DWT, in m^3, calculated considering a cargo density of 1,0 t/m^3

IMO Resolution A.673(16) applies in lieu of the IBC code.

1.2 Summary table

1.2.1 *(15/2/2016)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to chemical recovery ships.

Table 1 *(15/2/2016)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	Sec 4
Automation	**(1)**
Fire protection, detection and extinction	Sec 5
(1) No specific requirements for chemical recovery ships are given in this Chapter.	

SECTION 2 HULL AND STABILITY

1 General

1.1

1.1.1 *(15/2/2016)*
The requirements given in the IBC code or IMO Resolution A.673(16), as applicable according to Sec 1, [1.1], are to be considered for cargo tanks location, cargo segregation and any other relevant aspects.

2 Documentation to be submitted

2.1

2.1.1 *(15/2/2016)*
The following documentation is to be submitted:

a) details of air locks

b) details of accesses and openings which are to be closed gas-tight during operations in hazardous atmosphere

c) windows plan drawings with information about materials used

d) general arrangement, capacities and drawings of the cargo tanks/holds.

3 Operations in hazardous atmosphere

3.1 Citadel

3.1.1 *(15/2/2016)*
A citadel area protected against penetration by hazardous atmosphere is to comprise any enclosed space in the ship in continuous use during service. In this area, an overpressure is to be maintained in order to avoid entrance of hazardous substances from outside.

Accesses and openings into the citadel area are to be capable to be closed gas-tight.

3.1.2 Air locks *(15/2/2016)*
Air locks with two self-closing doors are to be fitted for the entrance into the citadel area in order to maintain the overpressure inside. Forced ventilation is to be fitted in order to avoid the entrance of hazardous substances and an alarm is to be provided to indicate if both doors are open.

3.2 Windows

3.2.1 *(15/2/2016)*
Design pressure, arrangement and composition of the windows are to be considered by the Society on a case by case basis.

SECTION 3 MACHINERY AND SYSTEMS

1 Machinery and systems installations

1.1 Applicability of requirements

1.1.1 *(15/2/2016)*

The requirements given in the IBC code or IMO Resolution A.673(16), as applicable according to Sec 1, [1.1], are to be considered for recovered chemical products pumping and piping systems, cargo area equipment, ventilation and any other issue relevant to machinery and systems.

2 Documentation to be submitted

2.1 Standard list of additional documents

2.1.1 *(15/2/2016)*

The following documentation is to be submitted:

a) general plan of the system for chemical products recovery and specification of all relevant apparatuses

b) schematic arrangement of recovered chemical products pumping and piping systems

c) tank venting arrangement

d) plans, drawings and design calculation of the citadel ventilation system

e) proof of suitability of the air filters material

f) plan of closing appliance for operations in hazardous atmosphere

g) details of the design of the gas detection equipment with proof of suitability

h) operations and equipment manual for operations in hazardous atmosphere.

3 Operations in hazardous atmosphere

3.1 Citadel ventilation system

3.1.1 *(15/2/2016)*

For the ventilation of the citadel area during operation in hazardous atmosphere, specific systems such as filtration plant for cleaning the outside air or circulating-air regeneration plant is to be fitted.

The design parameters for the mentioned plants, the values of which are to be considered by the Society on a case by case basis, are:

- maximum CO_2 concentration of the air inside the citadel
- minimum value of the overpressure during service in hazardous atmosphere.

The overpressure and the CO_2 concentration are to be monitored and, in case of anomalous values, an alarm is to be activated.

3.1.2 **Regeneration plant** *(15/2/2016)*

The regeneration plant is to maintain the CO_2 concentrations and the overpressure in the citadel by means of a compressed air reservoir. Its pressure and the oxygen content in the air fed into the citadel are to be monitored and an alarm is to be activated in case of anomalous values.

3.1.3 **Filtration plant** *(15/2/2016)*

The filtration plant is to clean the outside air to be fed into the citadel area by means of filters. A monitoring system is to be fitted with an alarm to be activated in case of any penetration of hazardous substances. A redundancy of the system is to be provided. The air flow rate of the plant and the location of the intake of the plant are to be considered by the Society on a case by case basis.

3.2 Gas detection and alarm

3.2.1 *(15/2/2016)*
A gas detection and an alarm system are to be provided on board for the detection of flammable and toxic gases and vapours in the atmosphere. Measuring points are to be considered by the Society on a case by case basis.

3.3 Machinery intake air system

3.3.1 *(15/2/2016)*
The combustion air for engines, gas turbines, boilers and incinerators is to be monitored for the presence of flammable gases and vapours near the intakes. The location of the intake openings are to be considered by the Society on a case by case basis.

The air ducts are to be explosion-resistant and provided with flame arrestors.

The engines are to be either totally encased or totally gastight.

3.4 Machinery exhaust gas system

3.4.1 *(15/2/2016)*
Exhaust lines from engines, gas turbines, boilers and incinerators are to be led to a gas-safe position as high as practicable above the deck and are to be fitted with a spark and flame arrester.

The maximum exhaust gas temperature at the outlets is to be considered by the Society on a case by case basis and is to be monitored with an alarm system which is to be activated if the maximum permissible temperature is exceeded.

An air cooler is to be fitted in the machinery space to remove the heat.

3.5 Operations and Equipment Manual

3.5.1 *(15/2/2016)*
An Operations and Equipment Manual, approved by the Society, is to be carried on board.

It is to contain:

- safety measures to be adopted before starting the operations in hazardous atmosphere
- safety measures to be adopted during the operations in hazardous atmosphere
- documentation and descriptions of the technical installations present on board
- appropriate measures in case of alarms
- plans of spaces with overpressure, closing appliances, arrangement of equipment and appliances for operations in hazardous atmosphere.

SECTION 4 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(15/2/2016)*
The electrical plants on board are to comply with the requirements in the IBC code or IMO Resolution A.673(16), as applicable according to Sec 1, [1.1].

2 Documentation to be submitted

2.1 Standard list of additional documents

2.1.1 *(15/2/2016)*
The following documentation is to be submitted:

a) plan of dangerous areas subjected to explosion hazard during operations in hazardous atmosphere and of the areas with overpressure

b) document giving details of types of cables and safety characteristics of the equipment installed in hazardous areas

c) electric power balance for service in hazardous atmosphere.

SECTION 5 FIRE PROTECTION, DETECTION AND EXTINCTION

1 General

1.1 Application

1.1.1 *(15/2/2016)*
The requirements given in the IBC code or IMO Resolution A.673(16), as applicable according to Sec 1, [1.1], are to be considered for fire protection, detection and extinction.

2 Operations in hazardous atmosphere

2.1 General

2.1.1 *(15/2/2016)*
Machinery spaces which are not permanently manned or which are not accessible during service in hazardous atmosphere are to be provided with fire detection and alarm system.

Chapter 29
WELL STIMULATION SHIPS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/4/2016)*

OSVs complying with the requirements of this Chapter are eligible for the assignment of the service notation **well stimulation**, as defined in Pt A, Ch 1, Sec 2, [4.8.10].

If the ship carries only product with flashpoint exceeding 60°C, this restriction will be reported on the ship operation manual and the additional service feature flash point > 60°C is assigned.

In the case of ships provided with tanks dedicated to the containment of product with flashpoint 60°C and others dedicated to the containment of product having flashpoint > 60°C, in the ship operation manual and in the ship documents it is to be clearly indicated for each tank which is the allowed flashpoint of the product contained therein.

1.1.2 *(1/4/2016)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D, as applicable, and with the requirements of this Chapter, which are specific for the assignment of the service notation **well stimulation**.

1.2 Summary table

1.2.1 *(1/4/2016)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to well stimulation ships.

Table 1 *(1/4/2016)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	Sec 4
Automation	**(1)**
Fire protection, detection and extinction	Sec 5
Personnel protection	Sec 6
(1) No specific requirements for the assignment of the service **well stimulation** are given in this Chapter	

SECTION 2 HULL AND STABILITY

1 General

1.1 Tanks for storage of stimulating liquids

1.1.1 *(1/4/2016)*

Where it is intended to carry acids in bulk on well stimulation vessels, the arrangement is to comply with the requirements of Chapter 15 of the IBC Code.

Where it is intended to carry liquid nitrogen in bulk on well stimulation vessels, the arrangement is to comply with the applicable requirements of Chapter 17 of the IGC Code.

1.1.2 *(1/4/2016)*

Tanks for storage of stimulating liquid such as acids and nitrogen, are to be design and constructed in accordance with pertinent requirements for pressure vessel, IBC Code, LHNS Guidelines (Res. A.673(16) as amended) and ICG Code, as applicable.

1.2 Tanks material

1.2.1 *(1/4/2016)*

Material used for the construction of tanks intended for stimulating liquids is to be tested and certified according to Part D.

1.3 Documents to be submitted

1.3.1 *(1/4/2016)*

Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable.

Table 1 : Documents to be submitted *(1/4/2016)*

No.	A/I **(1)**	Document
1	A	Operation manual for well stimulation procedures
2	I	Arrangement of tanks
3	I	Documentation for liquid nitrogen tanks as required by Chapter 9 for liquefied gas carriers
4	I	Drawing of support and staying of independent tanks
5	I	Drawing of acid tanks including information of non-destructive testing of welds, strength and tightness
6	I	Testing of tanks and specification of lining

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

1.4 Operational Manual

1.4.1 *(1/4/2016)*

An approved Operational Manual is to be readily available on board. The manual has to provide instructions and information on the safety aspects related to well stimulating processing.

1.4.2 *(1/4/2016)*

The approved Operational Manual has to cover particulars on:

- protective equipment
- storage and handling of fluids and dry additives
- transfer operations
- emergency shutdown and disconnection.

2 General arrangement design

2.1 Tank location and segregation of spaces

2.1.1 Tanks location *(1/4/2016)*

Tanks are to be located at a minimum distance from the side shell and bottom, i.e 760 mm measured inboard from the side of the vessel perpendicular to the centerline at the level of the summer load waterline.

2.1.2 Segregation *(1/4/2016)*

Tanks and pumping arrangements for the well stimulation plants are to be segregated from machinery spaces, propeller shaft tunnels (if provided), dry cargo spaces, accommodation and service spaces, as well as from drinking water tanks and provision stores by means of cofferdam, void space, cargo pump room, empty tank, oil fuel tank or other similar spaces.

2.2 Protection from liquid spill

2.2.1 *(1/4/2016)*

The following protections from acid spills are to be provided:

a) Floors or decks protection: floors or decks under storage tanks, pumps and piping for acid are to have a lining or coating of corrosion-resistant materials extending up to a minimum height of 500 mm on the bounding bulkheads or coamings; hatches or similar openings in such floors or decks are to be raised to a minimum height of 500 mm and the coamings are to be protected by a lining or an acid resistant coating

b) Spray shields and drip trays: spray shields are to be provided to cover flanges and other detachable pipe connections (portable shield covers are to be provided for connecting the flanges of the loading manifold) and drip trays of corrosion-resistant material are to be provided under loading manifolds.

c) Drainage arrangement: spaces for storage tanks, pumps and piping for acid are to be provided with drainage arrangement of corrosion-resistant materials separated from draining system of the other areas.

2.2.2 *(1/4/2016)*

Adequate protection from nitrogen spill is to be provided to prevent cold cracking of structure: for this purpose drip trays resistant to cryogenic temperatures are to be provided at manifolds transferring liquefied gases and at other flanged connections in the system.

2.2.3 *(1/4/2016)*

A permanent spill coaming of 150 mm in height is to be provided on deck to keep deck spill away from accommodation and service areas

2.3 Hazardous area

2.3.1 *(1/4/2016)*

Hazardous areas are to be defined in relation with the liquids and additives used for stimulation operation and the layout of relevant systems. Due consideration is to be given to the location of air intakes and openings into accommodation, service and machinery spaces and control station in relation to cargo piping and cargo vent system.

2.4 Accesses, Air intakes, windows and other openings to accommodation spaces

2.4.1 *(1/4/2016)*

Accommodation, service spaces and control stations are not to be located within the cargo area.

2.4.2 *(1/4/2016)*

Unless they are spaced at least 7 m away from the hazardous area, entrances, air intakes and openings to accommodation, service and machinery spaces and control stations are not to face the cargo area.

2.4.3 *(1/4/2016)*

When arranged within the 7 m zone specified in [2.4.2], windows and sidescuttles facing the cargo area are to be of a fixed type ensuring an efficient gas-tight closure; such sidescuttles in the first tier on the main deck are to be fitted with inside covers of steel or equivalent material.

2.4.4 *(1/4/2016)*
Doors to spaces not having access to accommodation, service and machinery space and control stations, such as cargo control station and store-rooms, may be accepted within the 7 m specified in [2.4.2] provided that the boundaries of the spaces are insulated to A-60 standard.

2.5 Access to spaces in the cargo area

2.5.1 *(1/4/2016)*
Access to spaces within the cargo area is to meet the requirements of Paragraph 3.4 of the IBC Code.

3 Stability

3.1 Intact stability

3.1.1 *(1/4/2016)*
The stability of the ship for the loading conditions reported in the trim and stability booklet is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

3.2 Damage stability

3.2.1 *(1/4/2016)*
Damage stability is to be suitable to cope with damage to be assumed to occur anywhere in the ship's length at any transverse watertight bulkhead whenever the ship carries hazardous and noxious liquid substances more than the lesser between 800 m^3 or a volume in cubic m equal to 40% of ship's deadweight calculated at a cargo density of 1.0.

4 Hull scantlings

4.1 Local loads

4.1.1 *(1/4/2016)*
Stress analysis is to be carried out for supporting structure in way of flexible hose storage well(s) and possible other pieces of equipment of significant weight.

4.2 Movable tanks

4.2.1 *(1/4/2016)*
The net scantlings of movable tanks are considered by the Society on a case-by-case basis.

5 Seakeeping

5.1 General

5.1.1 *(1/4/2016)*
The ship is to be capable, within given environmental limit conditions, of maintaining the position during stimulation operation either by means of anchoring arrangement or dynamic positioning system.

5.2 Dynamic positioning

5.2.1 *(1/4/2016)*
Dynamic positioning system, when used to maintain the vessel's position during well stimulation operations, is to comply with the requirements for the additional class notation **DYNAPOS** (see Pt F, Ch 12, Sec 3).

5.3 Station keeping with anchors and cables

5.3.1 *(1/4/2016)*
Position mooring with anchors, cable and mooring winches are to fulfill the requirements for position mooring system of Part B, Chapter 9 of Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units. Safety precautions are to be considered to prevent damaging seabed equipment and installation by deployment, recovery and station keeping.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Application

1.1.1 *(1/4/2016)*

This Section provides, for OSVs having the service **well stimulation**, specific requirements for:

- machinery systems
- tanks
- pumping and piping systems.

The requirements of this Section apply, in addition to those contained in Part C, Chapter 1, and:

- when acids are intended to be carried in bulk on well stimulation vessels, the arrangement is to comply with the requirements of Chapter 15 of the IBC Code;
- when liquid nitrogen in bulk is intended to be carried on well stimulation vessels, the arrangement is to comply with the applicable requirements of Chapter 17 of the IGC Code.

1.2 Documents to be submitted

1.2.1 *(1/4/2016)*

The documents listed in Tab 1 are to be submitted.

1.3 Calculations

1.3.1 *(1/4/2016)*

The following calculations are to be submitted and documented:

- propulsion power required for the vessel to maintain position during well stimulation operations
- stress analysis of liquid nitrogen piping
- stress analysis of liquid nitrogen heat exchangers
- stress analysis of high pressure piping.

Table 1 : Documents to be submitted *(1/4/2016)*

No.	A/I **(1)**	Document
1	A	Cargo tank level measurement system
2	A	Cargo tank overflow protection system
3	A	Emergency shut-down system
4	A	Hydrogen indication equipment
5	A	Hydrogen chloride indication equipment
6	A	Oxygen indication equipment
7	I	Pumping arrangements
8	I	Arrangement of ventilation pipes from acid tanks
9	I	Mechanical ventilation arrangement of closed and semi-enclosed spaces containing acid tanks, pipes
10	I	Pumps and mixing units

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

(2) Diagrams are also to include, where applicable, the local and remote control, the monitoring and automation systems.

No.	A/I **(1)**	Document
11	I	Diagrams of piping for acid, nitrogen and liquid additives including details such as flange connections and securing of pipes
12	I	Drawings of pumps and mixers
13	I	Specification and information on high pressure flexible hoses with end connections
14	I	Drawings and particulars for nitrogen vaporiser
15	I	Drawings and particulars of nitrogen heat exchangers

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

(2) Diagrams are also to include, where applicable, the local and remote control, the monitoring and automation systems.

2 Machinery installations and piping systems not intended for well stimulation

2.1 Bilge system

2.1.1 *(1/4/2016)*

Bilge arrangements for pump rooms, void spaces, any slop tank, double bottom tanks and similar spaces related to the well stimulation process are to be situated entirely within the well stimulation processing area. The same applies to spaces directly adjacent to such spaces.

2.2 Exhaust gas systems

2.2.1 *(1/4/2016)*

Exhaust lines from engines, gas turbines, boilers and incinerators are to be led to a gas-safe position as high as practicable above the deck and are to be fitted with a spark arrester.

2.2.2 *(1/4/2016)*

Where the distance between the exhaust lines of engines and the gas-dangerous area is less than 3 m, the ducts are to be fitted in a position:

- near the waterline if cooled by water injection, or
- below the waterline in other cases.

2.3 Additional requirements for machinery installations in hazardous area

2.3.1 *(1/4/2016)*

Attention is drawn to the risk of ignition in hazardous area from sparking due to:

- formation of static electricity, or
- friction between moving parts.

2.3.2 *(1/4/2016)*

Surface temperature of equipment in hazardous area is not to exceed the allowable temperature depending on the type of hazard.

2.3.3 *(1/4/2016)*

The installation of certified safe type internal combustion engines may be permitted in zone 2 open gas-dangerous areas, subject to special consideration by the Society.

3 Pumping system, piping system and pump rooms intended for well stimulation

3.1 Design of piping systems

3.1.1 General *(1/4/2016)*

Piping is to be designed and constructed in accordance with pertinent requirement for pressure vessel, Chapter 5 of the IBC Code, Chapter 3 of the LHNS Guidelines (Res. A.673(16) as amended) and Chapter 5 of the ICG Code, as applicable.

Materials to be used in piping systems is to be tested and certified according to Pt C, Ch 1, Sec 9.

3.2 Arrangement

3.2.1 *(1/4/2016)*

Piping systems for the well stimulation plant is to be separated from other piping systems; they are not to pass through any accommodation, service or machinery space other than cargo pump rooms or pump rooms.

3.2.2 *(1/4/2016)*

Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks are to be independent of similar equipment serving cargo tanks.

3.2.3 *(1/4/2016)*

Piping for acids shall be in corrosion resistant material or coated by an approved lining.

3.2.4 *(1/4/2016)*

Piping for the handling of flammable or hazardous and noxious liquid substances for well stimulation is to comply with the pertinent provisions given in Chapter 7 or Chapter 8 or Chapter 9, as applicable for the intended liquid.

3.2.5 *(1/4/2016)*

Piping is to be permanently installed; however, the use of portable pumps may be permitted subject to special consideration by the Society.

3.3 Pump rooms

3.3.1 *(1/4/2016)*

Pump rooms containing the pumps for handling the liquids intended for well stimulation are to comply with the pertinent provisions given in Chapter 7 or Chapter 8 or Chapter 9, as applicable for the intended liquid.

3.4 Venting systems

3.4.1 *(1/4/2016)*

Tank venting systems are to be designed and fitted taking in account both safety and health hazard; due consideration is to be given to the location of safety valves and pressure/vacuum valves outlets with regard to source of ignition, source of heat, accommodation and service spaces.

Relevant provision of Chapter 8 of the IBC Code, Chapter 3 of the LHNS Guidelines (Res. A.673(16) as amended)and Chapter 8 of IGC Codeare to be dealt with, as applicable.

3.5 Mechanical ventilation of spaces in the cargo area

3.5.1 *(1/4/2016)*

Mechanical ventilation for:

- spaces housing acid tanks has to ensure a capacity of 30 air changes per hour
- spaces containing installations for nitrogen have to ensure a capacity of 20 air changes per hour
- spaces for storage and handling of dry and liquid additives is to be case by case considered based on flammability, toxicity and reactivity criteria of the additives concerned
- mechanical ventilation of spaces in the cargo area classified as an hazardous area is to comply with the requirements in IBC Code Chapter 12.

3.6 Control and Monitoring

3.6.1 **Vapour detection** *(1/4/2016)*

Enclosed and semi-enclosed spaces containing installations for acids are to be provided with fixed vapour detection and alarm systems capable of giving an audible and visual alarm. The vapour detection system is to be capable of detecting hydrogen and hydrogen chloride gases.

3.6.2 **Oxygen deficiency monitoring** *(1/4/2016)*

Enclosed spaces containing tanks and piping for liquid nitrogen are to be equipped with a sensor continuously monitoring the oxygen content of the space; an alarm is to be provided in case of low oxygen concentration. For semi-enclosed spaces portable equipment may be accepted.

3.6.3 Tank level gauging and alarm system *(1/4/2016)*

Nitrogen tanks for liquefied nitrogen are to have gauging and level detection arrangements in accordance with Chapter 13 of IGC Code.

Tanks for hydrochloric acid are to have a closed gauging system. A high level alarm is to be provided to be activated by a level sensing device independent of the gauging system.

3.6.4 Emergency control *(1/4/2016)*

Emergency control is to be provided for:

a) Stopping the cargo pumps and similar equipment and shutoff valves in nitrogen outlet lines from each tank; these emergency controls are to be capable of being activated from a dedicated cargo control location which is manned at the time of the cargo transfer and from at least one other location outside the cargo area and at a safe distance from

b) Emergency depressurizing and disconnection of the transfer hose; these control for activating emergency depressurization and disconnection are to be located in a dedicated cargo control location which is manned at the time of the cargo transfer and in another location outside the cargo area and at a safe distance from it

Where auxiliary electrical energy is required for functionality of emergency controls, a reliable power supply is to be provided as indicated in Sec 4, [2.1.1]; where hydraulic and/or pneumatic power is used for actuation of emergency control and shutdown, pumps or compressors are to be duplicated. Where hydraulic pumps and/or compressors used for emergency control are driven by an electric motor, one motor is to be supplied from the main source of electrical power and the other from the emergency sources of electrical power.

3.6.5 *(1/4/2016)*

Where applicable, well blowout preventer closing system and disconnection from the blowout preventer is to be provided from a position located at a safe and readily accessible location.

SECTION 4 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/4/2016)*

The requirements in this Section apply, in addition to those contained in Part C, Chapter 2.

Pertinent provisions of IBC Code and IGC Code are to be dealt with, as far as applicable.

1.2 Documents to be submitted

1.2.1 *(1/4/2016)*

In addition to the documentation requested in Pt C, Ch 2, Sec 1, [2.1.1], the following is to be submitted:

a) single line diagrams of the power supply to well stimulation equipment

b) plan of hazardous area,

c) drawing showing location of all electrical equipment installed in hazardous areas,

d) list of electrical equipment installed in hazardous area, including type, manufacturer, safety characteristics and type of protection, together with the relevant safety certificates,

e) single line diagram for intrinsically safe circuits.

2 Design requirements

2.1 Power supply for emergency controls

2.1.1 *(1/4/2016)*

Electrical power supply for emergency controls is to be taken from the ship's main supply and from an uninterruptible power supply (UPS) capable of continuously operating the systems for at least 30 minutes upon loss of the normal power supply. The UPS is to be powered by means of two circuits, one from the main source of electrical power and the other from the emergency source of electrical power.

2.2 Earth detection

2.2.1 *(1/4/2016)*

For both insulated and earthed distribution systems a device, or devices, are to be installed to continuously monitor the insulation to earth and to give an audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance and/or high level of leakage current.

3 Hazardous area

3.1 Hazardous area classification

3.1.1 *(1/4/2016)*

Hazardous area classification is to be defined in relation with the liquids and additives used for stimulation operation and the layout of relevant systems. Reference is made also to pertinent requirement of Pt E, Ch 4, Sec 5 of Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

3.2 Electrical equipment permitted in hazardous area

3.2.1 *(1/4/2016)*

For the type of electrical equipment permitted in hazardous areas reference is to be made to Pt C, Ch 2, Sec 3, [10].

3.2.2 *(1/4/2016)*

The following control and monitoring systems shall be certified for the intended use.

- Cargo tank level measurement system
- Cargo tank overflow protection system
- Emergency shutdown system.

SECTION 5 FIRE PROTECTION, DETECTION AND EXTINCTION

1 General

1.1 Application

1.1.1 *(1/4/2016)*
The following provisions regarding fire protection, detection and extinction are not mandatory for the purpose of classification, except where the Society carries out surveys relevant to fire protection statutory requirements on behalf of the flag Administration. In such cases, fire protection statutory requirements are considered a matter of class and therefore compliance with these requirements is also verified by the Society for classification purposes at class surveys.

1.2 Fire Protection, Fire Fighting system and appliances

1.2.1 *(1/4/2016)*
In general pertinent requirement foreseen by:

a) Rules for Fire Protection, Detection and Extinction for the Issue and Maintenance of the SOLAS Certificates

b) Chapter 11 of IBC Code

c) Chapter 3 of the LHNS Guidelines (Res. A.673(16) as amended)

d) Chapter 11 of IGC Code

are enforced, as far as applicable, in consideration of the well stimulation system and relevant outfitting.

SECTION 6 PERSONNEL PROTECTION

1 General

1.1 Personnel protection

1.1.1 *(1/4/2016)*

The following personnel protective equipment is to be provided as appropriate decontamination showers and eyewashes: a suitably marked decontamination shower and eyewashes are to be available on deck in a convenient location. The shower and eyewash are to be operable in all ambient conditions.

Protective and safety equipment is to be kept on board in suitable locations as required by Chapter 14 of the IBC Code or Chapter 14 of the IGC Code.

Chapter 30

MARINE MOBILE DESALINATION UNIT

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(9/12/2019)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **marine mobile desalination unit**, as defined in Pt A, Ch 1, Sec 2, [4.5.13].

Ships with the service notation are:

- provided with a desalination plant capable of producing drinking water by removing salt and minerals from sea water adopting different recognized methods (e.g. electrodialysis, reverse osmosis, distillation, etc.); and
- intended to carry the produced drinking water in their own cargo tanks.

1.1.2 *(9/12/2019)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of Chapter 10, which are specific to tankers.

1.1.3 *(9/12/2019)*

Service notation **marine mobile desalination unit**, is assigned to tankers carrying water, only.

1.2 Summary table

1.2.1 *(9/12/2019)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to desalination tanker ships.

Table 1 *(9/12/2019)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for marine mobile desalination unit are given in this Chapter.	

1.3 Definitions

1.3.1 Cargo area *(9/12/2019)*

The cargo area is that part of the ship that contains cargo tanks as well as slop tanks, cargo pump rooms including pump rooms, cofferdams, ballast or void spaces adjacent to cargo tanks or slop tanks as well as deck areas throughout the entire length and breadth of the part of the ship above these spaces.

When independent tanks are installed in hold spaces, the cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forward-most hold space are excluded from the cargo area.

1.3.2 Cargo pump room *(9/12/2019)*

Cargo pump room is a space containing pumps and their accessories for the handling of products covered by the service notation granted to the ship.

1.3.3 **Cargo service spaces** *(9/12/2019)*

Cargo service spaces are spaces within the cargo area used for workshops, lockers and storerooms of more than 2 m^2 in area, intended for cargo management equipment.

1.3.4 Slop tank *(9/12/2019)*

Slop tank means a tank specifically designated for the collection of tank draining, tank washings and other treatment mixtures.

1.3.5 Redundancy *(9/12/2019)*

Ability of a component or system to maintain or restore its function, when a single failure has occurred. Redundancy can be achieved, for instance, by installation of multiple components, systems or alternative means of performing a function. Different arrangement, may be permitted subject to special consideration by the Society. Lost of complete treatment capability, involves the loss of **marine mobile desalination unit** notation.

SECTION 2 HULL AND STABILITY

1 General arrangement design

1.1 Cargo Tanks

1.1.1 *(9/12/2019)*

Marine mobile desalination unit may be built with independent or integral cargo tanks. For carriage of drinking water it is assumed that cargo tanks are not used for any other purposes, except under emergency conditions. Specification of tank coating with certificate of acceptance for toxicity and tainting testing by recognized laboratory and health authority is to be submitted.

1.1.2 *(9/12/2019)*

Cargo tanks are not to be used for ballasting the ship; when it is not possible to do otherwise, a procedure is to be provided. Such procedure shall include that the cargo tanks and piping are washed using drinkable water.

1.1.3 *(9/12/2019)*

In case the ship is provided with integral cargo tanks, cofferdams are to be fitted between tanks and compartments intended for liquids likely to alter drinking water carried. Cargo tanks are to be separated from any compartment containing heat sources by cofferdams or duly heat-insulated bulkheads.

1.1.4 *(9/12/2019)*

In general, each cargo tank is to be fitted with:

- a graduated metal gauge rod or any other equivalent sounding device,
- an inspection door of adequate size fitted with a watertight metal cover secured by wing bolts or any other device offering equivalent safety,
- sealing gaskets for all hatches providing access to cargo tanks, certified as having harmless properties to edible liquid.

1.2 Segregation of spaces intended for the water treatment system

1.2.1 *(9/12/2019)*

Spaces intended for the water treatment system are to be considered as machinery spaces and are to be separated from service and accommodation spaces.

1.3 Storage and handling of chemical products used for treatment

1.3.1 *(9/12/2019)*

Due consideration is to be given to the safety implications due to the storage and use of chemical products for the treatment system. Such implications are to be documented in the operation and maintenance manual taking into account the properties of each product and relevant safety warning reported in its own safety datasheet. In addition suitable warning notices placed in the storage and handling areas are to be provided accordingly.

1.3.2 *(9/12/2019)*

Chemical products, in general, are to be stored in an ad hoc space. The storage area of chemical products can be allowed also within a machinery space others than machinery spaces of category A. In any case, the following requirements are to be complied with:

- the area identified for the storage is to be well ventilated;
- monitoring is to be frequently carried out by the crew to ascertain the absence of leaks, ruptures, etc.;
- in case of toxic products, storage is to be made at a safe distance from ventilation or access openings to other enclosed spaces;
- corrosive products are to be stored outside areas where equipment for navigation and safety are located;
- the storage area is to be at a safe distance from heat sources or in a position not easily exposed to open flames in case of fire;

- compliance with Sec 3, [4.2] is required;
- the products are properly stowed and secured so as to minimize the hazards to the marine environment without impairing the safety of the ship and persons on board;
- the tanks are to be made of materials resistant to the product intended to be stowed;
- the storage is always to be carried out in compliance with segregation criteria (see Fig 1).

2 Stability

2.1 Intact stability

2.1.1 General *(9/12/2019)*

The stability of the ship for the loading conditions in Pt B, Ch 3, App 2, [1.2.3] is to be in compliance with the requirements in Pt B, Ch 3, Sec 2.

In particular, a sufficient number of loading conditions representing the initial, intermediate and final stages of the filling or discharge operation using the free surface correction at the filling level in each tank at the considered stage shall be included in the stability booklet.

Figure 1 : Segregation Chart *(9/12/2019)*

DANGEROUS CLASS ID		2.1	2.2	2.3	3	4.1	4.2	4.3	5.1	5.2	6	7	8	9	Foods	Substances having risk of fire
	2.1	Y	Y	Y	Y	N	N	N	N	N	Y	N	Y	Y	Y	Y
	2.2	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y
	2.3	Y	Y	Y	N	Y	N	Y	N	N	Y	Y	Y	Y	N	Y
	3	Y	Y	N	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	Y
	4.1	N	Y	Y	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	Y
	4.2	N	N	N	N	N	Y	Y	N	N	Y	N	Y	Y	Y	Y
	4.3	N	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	Y	Y
	5.1	N	Y	N	N	N	N	N	Y	N	Y	N	N	Y	Y	N
	5.2	N	N	N	N	N	N	N	N	Y	Y	N	N	Y	Y	N
	6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	$N_{(6)}$	Y
	7	N	Y	Y	N	N	N	N	N	N	Y	Y	N	Y	$N_{(6)}$	Y
	8	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	$N_{(6)}$	Y
	9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

SECTION 3 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Application

1.1.1 *(9/12/2019)*

This Section provides, for ships having the service notation **marine mobile desalination unit**, specific requirements for the desalination system.

1.2 Documents to be submitted

1.2.1 *(9/12/2019)*

The documents listed in Tab 1 are to be submitted.

2 Piping systems

2.1 General

2.1.1 Materials *(9/12/2019)*

a) Materials used for piping systems are to comply with the provisions of Pt C, Ch 1, Sec 10, [2.1].

b) Attention is drawn to any national standards or regulations which might restrict the use of materials in contact with edible substances.

c) Valves and associated gasket of desalination piping system are to be suitable for use in contact with edible substances.

3 Desalination system: pumping and piping systems

3.1 Design of pumping and piping systems

3.1.1 General *(9/12/2019)*

a) The relevant provisions of Pt C, Ch 1, Sec 10 are to be complied with.

b) The pumping and piping systems intended for desalination system are to be independent from other pumping and piping systems of the ship from the operational and functional point of view. Exception can be done for the seachests with associated inlet pipes that can be common with other systems requiring sea water from seachest.

c) Piping is to be permanently installed. However, the use of portable pumps may be permitted, subject to special consideration by the Society.

d) Arrangements are to be made to avoid any inadvertent contamination of the cargo. In particular, the filling and discharge connections serving the cargo tanks are to be located remote from those serving the machinery piping system.

e) Inlet seachest is to be located as far away as possible from any eventual desalination system outlets.

3.1.2 Passage of pipes through tanks *(1/1/2025)*

a) Apart pipes used for conveying treated water, cargo tanks are not to be passed through by pipes conveying other liquids. See also [3.2.1].

b) When, for technical reasons, it is necessary that pipes pass through cargo tanks, they must be made in stainless steel and fulfil the following provisions:

- they are to have welded or heavy flanged joints (see Note 1) the number of which is kept to a minimum
- they are to be of extra-reinforced wall thickness
- they are to be adequately supported and protected against mechanical damage.

Note 1: Heavy flanged joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

3.2 Pumping System

3.2.1 Cargo pumps *(9/12/2019)*

At least two cargo pumps are to be provided for transferring the cargo.

Submerged cargo pumps may be used provided that they are fitted with a double barrier between the driving oil and cargo; oil or cargo leakages into the double barrier are to be detectable. As alternative to double barrier, hydraulic oil harmless to the edible liquid can be used.

Hydraulically operated valves are not to be located inside cargo tanks unless the hydraulic fluid used is harmless to the edible liquid quality in case of a leakage of hydraulic fluid.

Pumps used for the treatment of water are to be made in stainless steel, or in other material suitable for edible water.

3.2.2 Desalination system pumps *(9/12/2019)*

All pumps asserving the desalination system are to be redundant.

3.2.3 Level gauging systems *(9/12/2019)*

Level gauging systems of tanks containing edible substances are to be so designed as to avoid any contamination of the cargo.

4 Bilge system

4.1 Draining of spaces located inside the cargo area

4.1.1 *(9/12/2019)*

Connection between the bilge system of engine room and the cargo area, are not permitted. This requirement is in addition to those given in Pt C, Ch 1, Sec 10, [6] for bilge systems.

4.2 Drip trays in the spaces containing chemical products

4.2.1 *(9/12/2019)*

Drip trays with adequate drainage to contain possible leakages from chemical products are to be fitted.

Where drain pipes are provided for collecting leakages, they are to be led to an appropriate drain tank.

5 Air pipes

5.1 Installation requirements

5.1.1 *(9/12/2019)*

a) Air pipes of cargo tanks are to be fitted with automatic closing appliances. Refer to Pt C, Ch 1, Sec 10, [9.1].

b) Air pipes of tanks containing edible substances are to be located as far away as possible from:
   - air pipes of sewage or flammable oil tanks
   - machinery ventilation outlets.

c) Air pipes of tanks containing edible substances are to be arranged with mosquito net.

6 Refrigerating installations

6.1 Prevention of contamination and general requirements

6.1.1 *(9/12/2019)*

a) Where the cargo needs to be kept refrigerated for conservation purposes, the refrigerating installation is to comply with the applicable provisions of Part F, Chapter 8.

b) Provisions are to be made to avoid any contamination of the cargo by the refrigeration fluid.

7 Cargo tanks

7.1 Cargo tank cleaning systems

7.1.1 *(9/12/2019)*

Adequate means are to be provided for cleaning and sanitization the cargo tanks. In particular when tanks are filled with sea water before being used for storage of edible substances, procedure are to be provided.

7.1.2 *(9/12/2019)*

Adequate means are to be provided for preventing stagnation of the cleaning water.

7.2 Cargo tank coating

7.2.1 *(9/12/2019)*

Cargo tanks coating is to be certified non toxic and suitable for drinking water, according to International Sanitary Rules.

Drip trays with adequate drainage to contain possible leakage from flammable fluid systems are to be fitted.

Where drain pipes are provided for collecting leakages, they are to be led to an appropriate drain tank.

8 Certification, inspection and testing

8.1 Application

8.1.1 *(9/12/2019)*

The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They are additional to those given in Pt C, Ch 1, Sec 10, [21] for piping systems.

8.2 Workshop tests

8.2.1 **Tests for materials** *(9/12/2019)*

Where required in Tab 2, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt C, Ch 1, Sec 10, [21.3.2].

8.2.2 **Hydrostatic testing** *(9/12/2019)*

a) Where required in Tab 2, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt C, Ch 1, Sec 10, [21.4].

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions off Pt C, Ch 1, Sec 10, [21.4].

8.3 Shipboard tests

8.3.1 **Pressure test** *(9/12/2019)*

After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

Table 1 : Documents to be submitted *(9/12/2019)*

Item No.	A/I	Description of the document **(1)**
1	I	General plan of the desalination system and specification of all relevant apparatuses
2	A	Schematic arrangement of cargo and desalination system
3	I	Procedure and limiting conditions for desalination treatment, cargo transfer, tank cleaning, gas freeing and ballasting (operation and maintenance manual)
4	A	Diagram of the cargo tank venting system with indication of the outlet position

Note 1: A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

(1) Documents are also to include, where applicable:
- the (local and remote) control and monitoring systems and automation systems
- the instructions for the operation and maintenance of the piping system concerned (for information).

Item No.	A/I	Description of the document **(1)**
5	A	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
6	A	Diagram of the cargo refrigerating systems (if any)

Note 1: A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

(1) Documents are also to include, where applicable:
- the (local and remote) control and monitoring systems and automation systems
- the instructions for the operation and maintenance of the piping system concerned (for information).

Table 2 : Inspection and testing at works *(9/12/2019)*

No.	Item	Tests for materials		Inspections and tests for the products			References
		Y/N **(1)**	Type of material certificate **(2)**	during manufacturing **(1)**	after completion **(1) (3)**	Type of product certificate **(2)**	
1	expansion joints and cargo hoses	Y **(5)**	W	N	Y	C	[8.2.1] [8.2.2]
2	cargo pumps	Y	W	Y	Y **(6)**	C	[8.2.1] [8.2.2]

(1) Y = required, N = not required.
(2) C = class certificate, W = works' certificate.
(3) includes the checking of the rule characteristics according to the approved drawings.
(4) if metallic.
(5) inspection during manufacturing is to be carried out according to a program approved by the Society.

Chapter 31

CHEMICAL TANKER - ASSISTED PROPULSION

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2021)*

For the assignment of the service notation "chemical tanker - assisted propulsion", as defined in Pt A, Ch 1, Sec 2, [4.5.14], the requirements in Chapter 8 are to be applied, reading "chemical tanker" as "chemical tanker assisted propulsion", with the following differences due to the limited navigation and propulsion capabilities:

a) the following requirements are not applicable:
- Ch 8, Sec 1, [2]
- Ch 8, Sec 3, [8]
- Ch 8, Sec 4, [2]
- Ch 8, Sec 4, [3.3.2]
- Ch 8, Sec 4, [4.3.1]

b) the following additional requirements to be added to Ch 8, Sec 10, [1.4.1] are applicable:
- However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Society, to ensure that an equivalent level of safety is assured.

Chapter 32

OFFSHORE SUPPORT VESSEL (OSV)

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **offshore support vessel**, as defined in Pt A, Ch 1, Sec 2, [4.8.11].

1.1.2 *(1/1/2022)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of Chapter 15, which are specific to supply vessels.

1.2 Summary table

1.2.1 *(1/1/2022)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to offshore support vessel.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	(1)
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	Sec 4
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for offshore support vessel are given in this Chapter.	

2 Offshore support vessel with additional service feature W2W

2.1 General

2.1.1 *(1/1/2022)*

This service feature covers the OSVs equipped with a Walk-to-work (W2W) system such as a motion compensated gangway used for personnel transfer from a mobile unit to an offshore facility (e.g. a wind farm) or to another mobile unit.

The selection of the W2W system depends on several factors, such as the OSV characteristics, the envisaged utlization of the W2W, the expected worst environmental conditions, the design technology, etc.

IMCA Marine Renewable Energy Walk to Work (W2W) Decision Support Tool (IMCA Information Note M01/18) is an example of the decisional process that should be followed when undertaking a new W2W project. It shows that the OSVs and W2W systems may be of various nature, thus in the following some basic requirements are provided, leaving the more specific issues to the ad-hoc process of Technology Qualification (TQ) according to the TASNEEF "Guide for Technology Qualification Processes".

This process is to cover the W2W system in the context of the specific OSV, with special attention to the interfaces between OSV and W2W and to the type of service the W2W is designed for, in the operating conditions that are to be specified up front.

Guidance for the operational aspects of personnel transfer , which can be taken into account during the design phase, can be found in publications like the "Guidance on the Transfer of Personnel to and from OffshoreVessels and Structures" (IMCA HSSE 025, IMCA LR 012, IMCA M 202 - Rev. 2.1).

2.2 Application

2.2.1 *(1/1/2022)*

OSVs complying with the requirement of this Chapter and equipped with a W2W system certified by the Society according to the "Guide for Technology Qualification Processes" (see App 1) are eligible for the assignment of the service feature **W2W**, as defined in Pt A, Ch 1, Sec 2, [4.8.11].

Note 1: QSCS Classification Society means a Classification Society which is subject to verification of compliance with the IACS Quality System Certification Scheme (QSCS).

2.2.2 *(1/1/2022)*

Ships dealt with in this Article are to comply with the requirements stipulated in Parts A, B, C and D, as appli- cable and with the specific requirements in this Chapter for the assignment of the service feature **W2W**.

2.2.3 *(1/1/2022)*

The W2W system is intended as the whole system and equipment.

The service feature covers the following issues:

a) the ship's ability to maintain its position during W2W operations,

b) the ship's stability during W2W,

c) the hull structural arrangements related to the W2W system and relevant lifting appliances,

d) the electrical system, the auxiliary systems (pneumatic, hydraulic etc., as applicable) and control system to operate the W2W system.

2.3 Position keeping

2.3.1 *(1/1/2022)*

The ship is to be able to maintain its position safely during W2W, whatever the means for position keeping (Dynamic Positioning, anchor mooring etc.).

2.4 General safety criteria

2.4.1 *(1/1/2022)*

The following criteria are additional to those set forth by the TASNEEF rules for the classification of ships and take into account the specific arrangement of the W2W gangway.

2.4.2 *(1/1/2022)*

Any single failure on a critical structural, mechanical (active and passive), electrical, hydraulic, pneumatic, control, hardware or software item of the W2W and on any of its auxiliary systems, including the interfaces with the OSV, is not to lead to a hazardous situation for the personnel, the OSV or the facility connected to it.

Any incipient failure is to rise a timely alarm at the W2W control station. Control systems are to be self-monitoring with relevant timely alarms in case of detected failures.

W2W is not to lose control of its motions in case of loss of any kind of power of the W2W or any of its auxiliaries. Before emergency disconnection (e.g. in case of worsening environmental conditions) an alarm is to alert personnel in time to allow for the safe evacuation from the gangway to a safe position.

The fulfilment of such safety criteria is to be demonstrated through a FMEA or equivalent method, which also constitutes a part of the risk assessment required by the TQ. Additional availability criteria may be set forth by stakeholders in the TQ process.

2.5 Documents to be submitted

2.5.1 *(1/1/2022)*

The documents listed in Tab 2 are to be submitted in addition to the documentation requested for the assignment of the additional class notation **DP2** or **DP3**, if applicable (see Pt F, Ch 13, Sec 6).

3 Offshore support vessel with additional service feature WIND TURBINE MAINTENANCE

3.1 Offshore transfer system

3.1.1 *(1/1/2022)*

Offshore support vessels with additional service feature **WIND TURBINE MAINTENANCE** equipped with an offshore transfer system to transfer technicians from the ship to the wind turbine are to be assigned with the additional service feature **W2W**.

Table 2 : Documents to be submitted *(1/1/2022)*

No.	A/I **(1)**	Document
1	I	General arrangement of the W2W system
2	A	Hull structures related to the arrangement of the W2W system, showing the interfaces with the ship
3	A	Electrical load analysis of main and emergency source, showing W2W system related loads
4	A	Drawings of electrical equipment arrangement, including single line diagram and its interface with the ship
5	A	Drawings of auxiliary systems necessary for the W2W system operations, as applicable (hydraulic, pneumatic, etc.)
6	A	General philosophy, technical specification and drawings of the control, monitoring and alarm system and of the relevant control stations
7	A	Communication systems

(1) A = to be submitted for approval in four copies
I = to be submitted for information in duplicate

SECTION 2 HULL AND STABILITY

1 Offshore support vessel with additional service feature Walk-to-Work (W2W)

1.1 Intact stability criteria during lifting of W2W equipment

1.1.1 *(1/1/2022)*

The following intact stability criteria are to be complied with:

- $\theta_c \leq 15°$
- $GZ_C \leq 0,6\ GZ_{MAX}$
- $A_1 \geq 0,4\ A_{TOT}$

where:

θ_c : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms (see Fig 1)

GZ_C, GZ_{MAX} : Defined in Fig 1

A_1 : Area, in m·rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_c to the heeling angle equal to the lesser of:

- heeling angle θ_R of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 1)
- heeling angle θ_F, corresponding to flooding of unprotected openings which may lead to progressive flooding if they are situated within the range of the positive righting lever curve. Unprotected openings are openings which are not fitted with at least weathertight means of closure (see Fig 1)

A_{TOT} : Total area, in m rad, below the righting lever curve.

In the above formula, the heeling arm, corresponding to equipment lifting, is to be obtained, in m, from the following formula:

$b = (P_d - Z_z) / \Delta$

where:

P : Equipment lifting mass, in t

d : Transverse distance, in m, from W2W equipment to the longitudinal plane (see Fig 1)

Z : Mass, in t, of ballast used to right the ship, if applicable (see Fig 1)

z : Transverse distance, in m, of the centre of gravity of Z to the longitudinal plane (see Fig 1)

Δ : Displacement, in t, in the loading condition considered.

The above check is to be carried out considering the most unfavourable situations of equipment lifting combined with the lesser initial metacentric height GM, corrected according to the requirements in Pt B, Ch 3, Sec 2, [4].

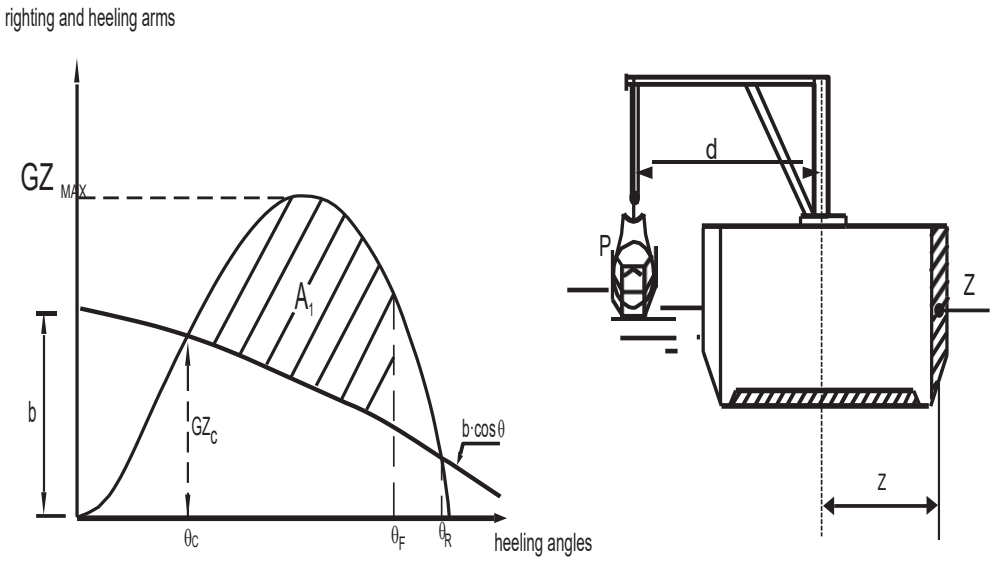
The heeling of the unit is not to produce in the lifting devices higher loads than those envisaged by the Manufacturer, generally expected to be 5° in the boom plane and 2° transversally in the case of a crane.

Table 1 : Documents to be submitted *(1/1/2022)*

No.	I/A **(1)**	Document
1	I	General arrangement of the W2W system
2	A	Hull structures related to the arrangement of the W2W system, showing the interfaces with the ship
3	A	Electrical load analysis of main and emergency source, showing W2W system related loads
4	I	Plans showing electrical equipment arrangement
5	A	Single line diagrams of communication systems

(1) A = to be submitted for approval, in quadruplicate
I = to be submitted for information, in duplicate

Figure 1 : W2W system stability equipment lifting *(1/1/2022)*



1.2 Hull structural arrangements related to the W2W system

1.2.1 General *(1/1/2022)*

The hull structures related to the arrangement of the W2W system on the ship are to be designed with adequate strength and stiffness to sustain the loads induced by the system during rest and operation, in accordance with the general load criteria in Part B, Chapter 5 and the strength criteria in Part B, Chapter 8 (or, for ships of L > 90 m, Part B, Chapter 7).

Pedestals and foundations also concern the ship's hull and are to comply with the above structural strength requirements.

1.3 Arrangement and installation of the W2W system

1.3.1 Location *(1/1/2022)*

The W2W is not to be located in spaces containing other machinery or in spaces where explosive gas-air mixtures may be present.

2 Offshore support vessel with additional service feature WIND TURBINE MAINTENANCE

2.1

2.1.1 *(1/1/2022)*

The hull structural strength is to be as required for the main class taking into account necessary strengthening of supporting structures for equipment applied during the maintenance and service of offshore wind farms.

2.1.2 *(1/1/2022)*

All load effects caused by deck cargo and heavy equipment are to be accounted for in the design calculations for all operational phases.

SECTION 3 MACHINERY AND SYSTEMS

1 Offshore support vessel with additional service feature WIND TURBINE MAINTENANCE

1.1 Seakeeping

1.1.1 General *(1/1/2022)*

The ship is to be capable, within given environmental limit conditions, of maintaining the position during operation, either by means of anchoring arrangement or dynamic positioning system.

1.1.2 Dynamic positioning *(1/1/2022)*

Dynamic positioning system, when used to maintain the vessel's position during operations, is to comply with the requirements for the additional class notation **DYNAPOS** (see Pt F, Ch 13, Sec 6).

1.1.3 Station keeping with anchors and cables *(1/1/2022)*

Position mooring with anchors, cable and mooring winches are to fulfill the requirements for position mooring system of Part B, Chapter 9 of Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units. Safety precautions are to be considered to prevent damaging seabed equipment and installation by deployment, recovery and station keeping.

SECTION 4 ELECTRICAL INSTALLATIONS

1 Offshore support vessel with additional service feature Walk-to-Work (W2W)

1.1 General

1.1.1 *(1/1/2022)*

For the purpose of W2W, the essential electrical services that need to be in continuous operation to ensure the safe operation of the system at all times are to be taken into account.

A non-exhaustive list of such services is as follows, as applicable.

- Power driven motion compensation system (e.g. dynamic ballast)
- lighting along the W2W system (gangway, platform etc.)
- control, monitoring and alarms
- control stations
- systems that support the W2W motions (hydraulic, pneumatic etc.)
- power driven connection/disconnection systems.

1.2 Main source and emergency source

1.2.1 *(1/1/2022)*

The essential services mentioned above for the period required to the safe completion of the mission both in normal and emergency conditions are to be supplied from both main and emergency sources of electrical power.

1.3 Distribution systems

1.3.1 *(1/1/2022)*

Only insulated (IT) electrical distribution systems are permitted to supply a W2W system. Being insulated, they are to be provided with a device capable of automatic insulation monitoring and, in the case of insulation failure, actuating switch-off and giving an alarm.

Alarm only may be used if a sudden switch-off of the equipment may cause danger to the divers.

Systems using double insulated apparatus or earth fault circuit-breakers will be considered on a case-by-case basis.

When the main power to the W2W system is supplied via a distribution board, this board is to be supplied by two separate feeders from different sections of the main switchboard.

When the emergency power to the W2W system is supplied by the ship, the supply is to be from the ship's emergency switchboard.

1.4 Installation

1.4.1 *(1/1/2022)*

Tensile loads are not to be applied to electrical cables or wiring.

1.5 Communication systems

1.5.1 *(1/1/2022)*

A communication system is to be arranged for direct two-way communication between the bridge and/or control stations and the W2W system.

APPENDIX 1 CERTIFICATION OF THE W2W SYSTEM

1 General

1.1 Technology qualification processes and general guidelines

1.1.1 *(1/1/2022)*

As explained in Sec 1, the W2W system is to be certified for fitness of service according to the TASNEEF "Guide for Technology Qualification Processes", which is to be applied to the system. Salient points of TQ are the establishment of a team with stakeholders, the agreed definition of qualification basis for the fitness of service, the normative gap analysis, the risk assessment and the engineering activities (analysis and tests) to demonstrate the qualification criteria have been fulfilled.

Some generic guidance is provided in the following, but the actual process is to be developed in full according to the aforesaid Guide for TQ Processes.

a) To define the qualification basis, first of all the actual design, mission and safety criteria of the W2W need to be appraised, bearing in mind that the first and foremost goal is the safety of the personnel in all operating conditions.

   In this regulation, the W2W is assumed to be a gangway to transfer personnel from the OSV to offshore facilities such as wind farms, offshore platforms and the like, built using steel and/or aluminum alloys. It may be fitted on an OSV during her construction, or on an existing vessel, which obviously poses different problems.

   Other systems than a gangway may be employed, and this is to be appraised up front.

b) The OSV, gangway and facility are to be viewed as closely interrelated aspects and particular care is to be given to the physical and operational interfaces; the TQ of a gangway is valid on a specific combinations of such aspects (unless it is demonstrated that the same qualified gangway is used in more benign conditions). The aspects of integration onboard of the supporting OSV are to be appraised, e.g.:

   - physical layout of the W2W and its supporting structures and foundations;
   - the OSV motions and accelerations in the most severe environmental conditions;
   - stability issues during W2W operations in the most severe environmental conditions;
   - the station keeping system;
   - the power supply, which is at least to be sized to feed simultaneously the station keeping system, the W2W and its auxiliaries in the worst defined environmental conditions
   - the W2W auxiliaries fitted onboard
   - the actions on the W2W, in its various operating phases, initiated by the control and automation system in case of emergency scenarios affecting the OSV, the facility, or both.
   - the actions on the W2W in a transit loading condition, when W2W is stowed but subject to the most severe wind and ship motion loads.

   The studies need to include aspects like the OSV motion response characteristics in the operational sea area, the location of the gangway system on the OSV structures, the W2W system's ability to compensate for motions imposed on it by the OSV, the means of connection to the facility, the OSV station keeping system, the facility motions if it is not a fixed structures, etc.

c) The gangway scantlings are to consider the maximum number of personnel onboard expected to be involved in the gangway operation for their work, and whether their work includes the transfer of loads through it. Of course, this personnel will be additional to the OSV crew and this number will have to be consistent with the regulatory framework of the OSV.

d) Careful consideration is to be given to the combination of environmental forces affecting the OSV, the W2W and the facility, to find out the worst case and the maximum operational envelope that still allows safety of operations through the gangway.

e) Power supply, auxiliary systems, control/monitoring/ alarm and communication system is to be designed taking into account all the scenarios that may affect safety in relation to the W2W mission, e.g. the environmental conditions, single failures, contingency scenarios among OSV, W2W and facility, transfer of stretched personnel etc. according to the basic philosophy of the applicable sections of Part C, Chapter 3.

f) Particular care needs to be applied to the means of connection to the facility and to the failure modes of its active components or to structural problems e.g. due to excessive motions of the W2W. This latter characteristic is to be taken into account when setting the alarms and the emergency disconnection.

g) Control stations are to be designed so as to avoid that a single realistic operator error causes the loss of control of the W2W or the unwanted disconnection of the gangway.

h) Since the W2W system and the OSV are to be seen as a whole, the risk assessment studies required for the TQ, among others, are to cover power supply and auxiliary systems; in this framework, particular care is to be taken to cover:

- Command systems (mechanical - electromechanical - electrohydraulic - electrical)
- Control systems (electrical/electronic/hydraulic)
- Safety systems (passive and active)
- Interfaces with other OSV systems (ESD - position reference system…)
- emergency scenarios (blackout, fire, flooding etc.)

The results of the risk assessment will then be used to complete the commissioning phase, to set up onboard verification tests to demonstrate that the W2W system is safe in the envisaged normal and abnormal operating conditions.

Chapter 33

WIND TURBINE INSTALLATION VESSEL

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/1/2022)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **wind turbine installation vessel**, as defined in Pt A, Ch 1, Sec 2, [4.8.12].

Wind turbine installation vessel are specially intended for installation and/or maintenance of fixed and floating wind power equipment such as:

- foundations
- columns
- generator house
- blades.

1.1.2 *(1/1/2022)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable, and with the requirements of this Chapter, which are specific for the assignment of the service feature **wind turbine installation vessel**.

1.2 Summary table

1.2.1 *(1/1/2022)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to wind turbine Installation vessel.

Table 1 *(1/1/2022)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
(1) No specific requirements for wind turbine Installation vessel are given in this Chapter.	

2 Wind turbine installation vessel with additional service feature W2W

2.1 General

2.1.1 *(1/1/2022)*

Wind turbine installation vessels with the additional service feature **W2W** are to comply with applicable requirements in Chapter 32.

SECTION 2 HULL AND STABILITY

1 Special design principles applied to self-elevating units

1.1

1.1.1 *(1/1/2022)*
For **wind turbine installation vessel** equipped with a self-elevating system, the special design principles of Pt E, Ch 4, Sec 2, [1] and [7] of TASNEEF Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units are to be applied.

2 Intact stability criteria

2.1

2.1.1 *(1/1/2022)*
Intact stability criteria are to be in compliance with Pt E, Ch 4, Sec 3, [4] of TASNEEF Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

3 Subdivision and damage stability

3.1

3.1.1 *(1/1/2022)*
Subdivision and damage stability are to be in compliance with Pt E, Ch 4, Sec 3, [5.1] of TASNEEF Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

4 Stability and watertight integrity

4.1

4.1.1 *(1/1/2022)*
Stability and watertight integrity are to be in compliance with Pt E, Ch 4, Sec 3, [6.2] and [7.1.6] of TASNEEF Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

5 Freeboard

5.1

5.1.1 *(1/1/2022)*
Freeboard is to be in compliance with Pt E, Ch 4, Sec 3, [9.3] of TASNEEF Rules for the Classification of Floating Offshore Units at Fixed Locations and Mobile Offshore Drilling Units.

SECTION 3 MACHINERY AND SYSTEMS

1 Machinery installations for self-elevating units

1.1 General

1.1.1 *(1/1/2022)*

The requirements of this item apply in lieu of those in Pt C, Ch 1, Sec 1, [2.4].

All machinery, components and systems essential to the safe operation of a unit are to be designed to operate under the following static condition of inclination: when self-elevating units are upright and inclined to an angle up to 10° in any direction.

The Society may permit or require deviations from these angles, taking into consideration the type, size and service conditions of the unit.

1.1.2 *(1/1/2022)*

Jacking mechanisms for self-elevating units are in general to be arranged with redundancy so that a single failure of any component does not cause an uncontrolled descent of the unit.

1.1.3 *(1/1/2022)*

Means are to be provided whereby normal operation of vital systems. such as ballast systems in semisubmersible units, jacking systems in self-elevating units or control of blow-out preventers, can be sustained or restored even though one of the essential auxiliaries becomes inoperable.

2 Cranes

2.1 Service notation lifting unit

2.1.1 *(1/1/2022)*

For **wind turbine installation vessel** equipped with cranes intended to be operated offshore, the service notation **lifting unit** is to be complied with, as defined in Pt A, Ch 1, Sec 2.

3 Seakeeping

3.1 General

3.1.1 *(1/1/2022)*

The ship is to be capable, within given environmental limit conditions, of maintaining the position during operation, either by means of anchoring arrangement or dynamic positioning system.

3.2 Dynamic positioning

3.2.1 *(1/1/2022)*

Dynamic positioning system, when used to maintain the vessel's position during operations, is to comply with the requirements for the additional class notation **DYNAPOS** (see Pt F, Ch 13, Sec 6).