Rules for the Classification of Offshore Units Operating in the Caspian Sea and Similar Areas

Effective from 1 January 2023

Part E

Service Notations

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GENERAL CONDITIONS

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.

"IACS" means the International Association of Classification Societies.

"*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.

"Rules" in these General Conditions means the documents below issued by the Society:

- (i) Rules for the Classification of Ships or other special units;
- (ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
- (iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
- (iv) Guides to carry out particular activities connected with Services;
- (v) Any other technical document, as for example rule variations or interpretations.

"*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*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

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. In particular, the Society:
- (i) sets forth and develops Rules;
- (ii) publishes the Register of Ships;
- (iii) issues certificates, statements and reports based on its survey activities.

1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various G overnments.

1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are 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, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules 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 reinstatemen t. 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.tasneef.ae.

2.3. The Society exercises due care and skill:
- (i) in the selection of its Surveyors
- (ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the 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 the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. 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, reflects the 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).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of th e specific scope of the Service requested by the Interested Party or on its behalf.

3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as p art 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, is governed by the Rules of the Society, which is the sole subject entitled to make such 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.

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificati on 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 seaw orthiness, 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.

3.4. 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.

3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as 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.

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 ship 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.

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.

In consideration of the above, 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.

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, 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 late payment, interest at the legal current rate increased by 1.5% may be demanded.

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.

For every termination of the contract, the fees for the activities performed until the time of the termination 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.

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 art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

Therefore, except as provided for in paragraph 5.2 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.

5.2. Notwithstanding the provisions in paragraph 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). 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 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 AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph 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 paragraph 5.1 above.

5.3. 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: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) 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. These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

6.2. However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the righ t to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

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 international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of cl ass, 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.

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.

7.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's c lients hereby accept that the Society may 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 propert y 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.

7.3. 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, certificat es, 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 t o 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.

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

RULES FOR THE CLASSIFICATION OF
OFFSHORE UNITS OPERATING IN THE CASPIAN SEA
AND SIMILAR AREAS

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Part E
Service Notations

Chapter 1
OIL TANKERS AND FLS TANKERS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 Service notation oil tanker

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, [4.2.2] and **oil tanker ESP CSR**, as defined in Pt A, Ch 1, Sec 2, [4.2.3] and **asphalt tanker**, as defined in Pt A, Ch 1, Sec 2, [4.2.5] or **asphalt tanker ESP** as defined in Pt A, Ch 1, Sec 2, [4.2.6]. 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 carrier** or **oil 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, flash point > 60°C**
- **oil tanker ESP CSR, flash point > 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, [4.2.4]. 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, [9] 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 chemical tankers.

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

Tab 1 indicates, for easy reference, the Sections of this Chapter dealing with requirements applicable to ships having the following service notations:

- **oil tanker**
- **oil tanker, flash point > 60°C**
- **oil tanker ESP**
- **oil tanker ESP, flash point > 60°C**
- **FLS tanker**
- **FLS tanker, flash point > 60°C**
- **asphalt tanker**
- **asphalt tanker ESP**.

1.2.2 Tab 2 indicates, for easy reference, the Sections 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

Main subject	Reference
Ship arrangement	Sec 2
Hull and stability	Sec 3
Machinery and cargo system	Sec 4 **(1)**
Electrical installations	Sec 5
Automation	**(2)**
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) This Section contains a table summarising the departures applicable to the different service notations.
(2) No specific requirements for **oil tanker ESP** and **FLS tanker** are given in this Chapter.

Table 2

Main subject	Reference
Ship arrangement	**(2)**
Hull	**(2)**
Stability	Sec 3, [2]
Machinery and cargo system	Sec 4 **(1)**
Electrical installations	Sec 5
Automation	**(2)**
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

(1) This Section contains a table summarising the departures applicable to the different service notations.
(2) No specific requirements for **oil tanker ESP CSR** 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 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.

1.3.5 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.

1.3.6 Crude oil tanker

Crude oil tanker means an oil tanker engaged in the trade of carrying crude oil.

1.3.7 Hold space

Hold space is the space enclosed by the ship's structure in which an independent cargo tank is fitted

1.3.8 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.

1.3.9 Integrated cargo and ballast system

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

Oil mixture means a mixture with any oil content.

1.3.11 Product carrier

Product carrier means an oil tanker engaged in the trade of carrying oil other than crude oil.

1.3.12 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.

1.3.13 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 1.

1.3.14 Slop tank

Slop tank means a tank specifically designated for the collection of tank draining, tank washings and other oily mixtures.

1.3.15 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.

SECTION 2 SHIP ARRANGEMENT

1 General

1.1 Application

1.1.1

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

The requirements in [2.1.1] to [2.1.3], apply only to ships with the service notation:

- **oil tanker ESP**
- **oil tanker ESP CSR**
- **FLS tanker**

The requirements in [2.2], [3], [4], [5]and [6] apply only to ships with the service notation:

- **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 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.

2.1.2 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.

2.1.3 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.

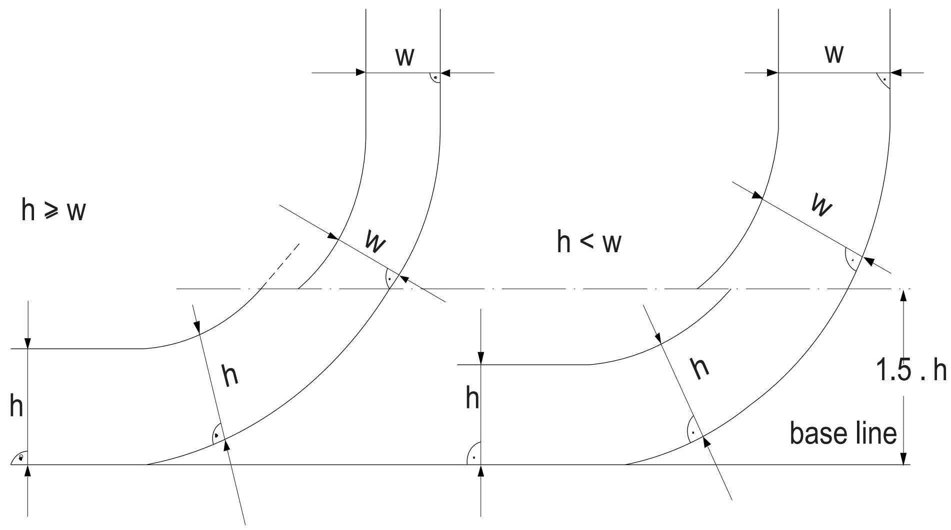
On ships without deck camber, or where the height of the installed gutter bars exceeds the camber, and for oil tankers having cargo tanks exceeding 60% of the vessel’s maximum beam amidships regardless of gutter bar height, gutter bars may not be accepted without an assessment of the initial stability (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.

2.2 Double bottom tanks or compartments

2.2.1 General

Double bottom tanks adjacent to cargo tanks may not be used as fuel oil tanks.

Figure 1 : Cargo tank boundary lines



2.2.2 Oil tankers of 5000 t deadweight and above

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:

$$f h_c \rho_c g + 1000 \Delta p \leq T_1 \rho g$$

where:

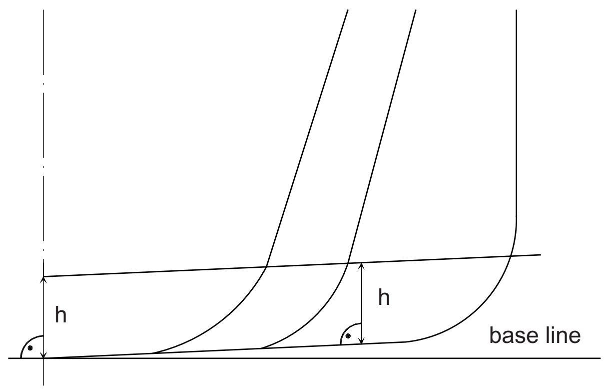
- f : Safety factor equal to 1,1
- h_c : Height, in m, of cargo in contact with the bottom plating
- ρ_c : Maximum cargo density, in t/m^3
- g : Standard acceleration of gravity equal to 9,81 m/s^2
- Δp : Maximum set pressure, in MPa, of pressure/vacuum valve provided for the cargo tank
- T_1 : Minimum operating draught, in m, under any expected loading condition
- ρ : Density of sea water, in t/m^3.

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.

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.

Figure 2 : Cargo tank boundary lines



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.

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

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

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:

$$w = 0,4 + \frac{2,4DW}{20000} \quad \text{with a minimum value of 0,76 m}$$

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

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

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

- 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

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

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

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

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

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, 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

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

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

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

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

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

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

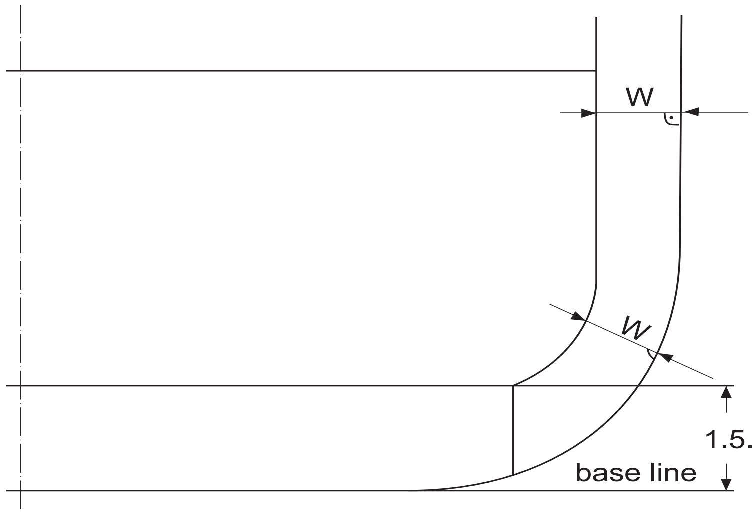
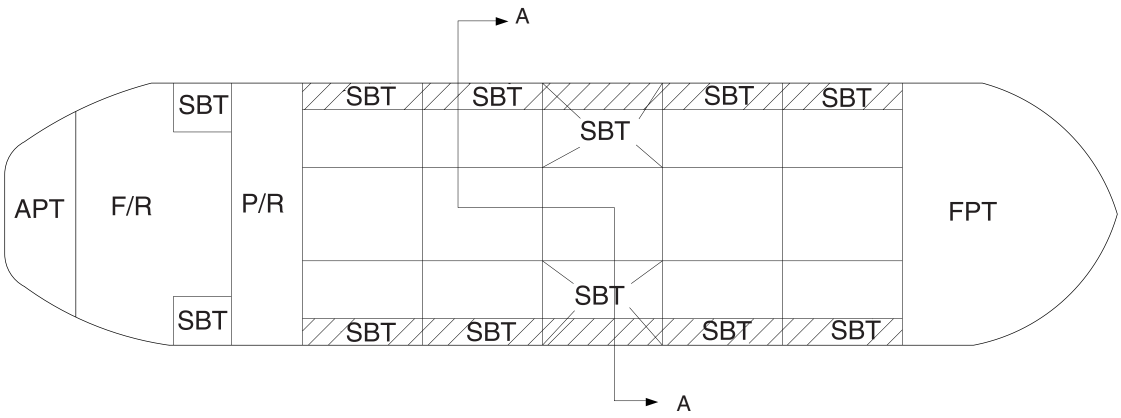
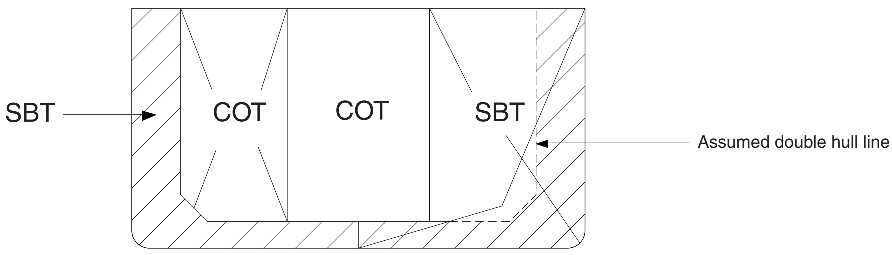


Figure 4 : Segregated ballast tanks located inboard of double hull





SECTION A-A

4.2.6 Alternative methods of design and construction

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 **FLS tanker**.

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 oil 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

The access to the fore peak tank is to be direct from the open deck.

Alternatively, indirect access from the open deck to the fore peak tank through an enclosed space may be accepted provided that:

a) if the enclosed space is separated from the cargo tanks by cofferdams, the access is through a gas-tight bolted manhole located in the enclosed space and a warning sign is provided at the manhole stating that the fore peak tank may only be opened after:
   - it has been proven to be gas-free; or
   - any electrical equipment which is not electrically certified safe in the enclosed space is isolated

b) if the enclosed space has a common boundary with the cargo tanks and is therefore a hazardous area (see Note 1), the enclosed space can be well ventilated.

Note 1: The hazardous area classification is to be defined in accordance with IEC 60092-502: Electrical installations in ships - Tankers - Special features.

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 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.

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, [1.2.3] 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

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

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 ≥ 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.

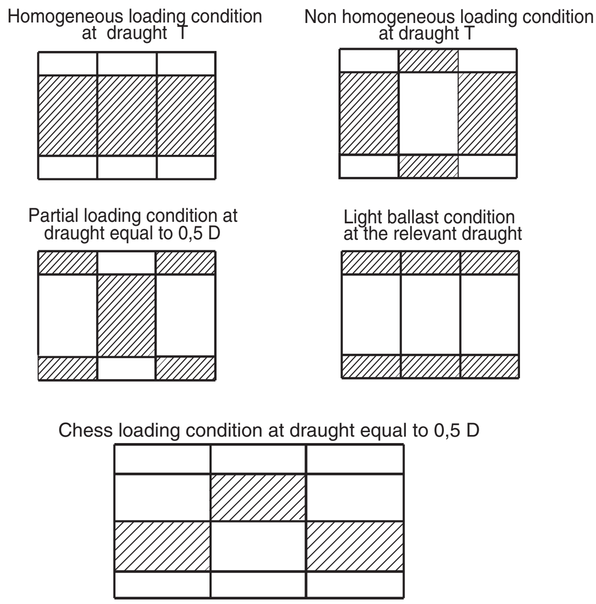
Where the loading manual is not available, the loading conditions to be considered in the analysis of primary supporting members in cargo and ballast tanks are those shown in:

- 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 ≥ 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 ≥ 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 ≥ 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 ≥ 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:

$$A_{Sh} = 2\frac{Q}{\gamma_R \gamma_m R_y}$$

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

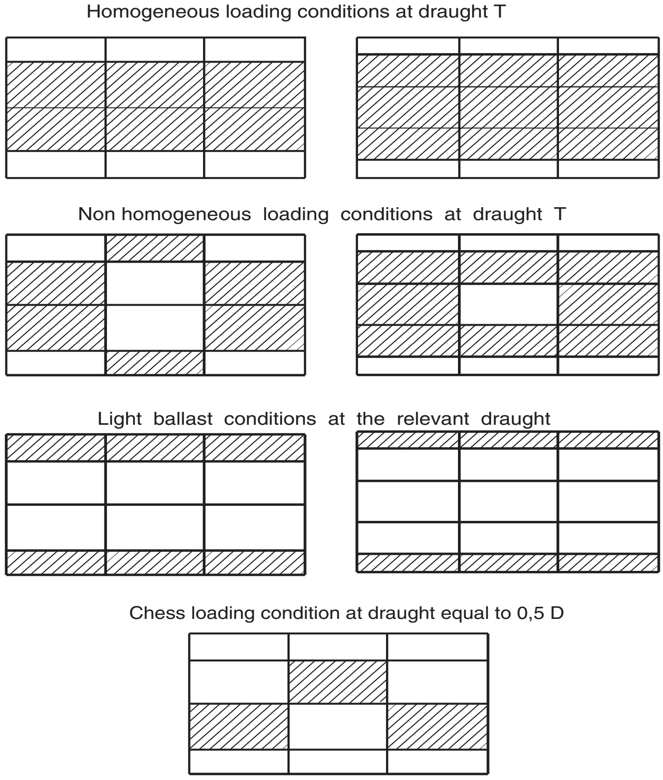
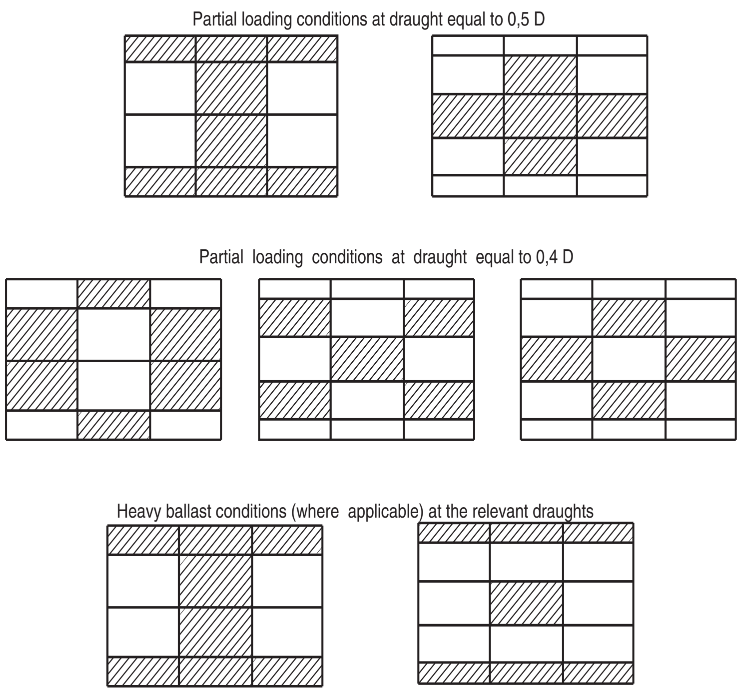


Figure 3 : Loading conditions for ships equal to or greater than 200 m in length



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:

$$10\frac{F_T}{A_{ct}} + 10^3\frac{M}{w_{yy}} \le \frac{R_y}{\gamma_R\gamma_m}$$

where:

- F_T : Axial tensile force, in kN, in the cross-ties, obtained from the structural analysis
- A_{ct} : Net sectional area, in cm², 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 cm³, 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:

$$10F_C\left(\frac{1}{A_{ct}} + \frac{\Phi e}{w_{xx}}\right) \le \frac{R_y}{\gamma_R\gamma_m}$$

$$10\frac{F_C}{A_{ct}} + 10^3\frac{M_{max}}{w_{yy}} \le \frac{R_y}{\gamma_R\gamma_m}$$

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 ($|M_0|$, $|M_1|$, $|M_2|$)

$$M_0 = \frac{\sqrt{1+t^2}(M_1 + M_2)}{2\cos(u)}$$

$$t = \frac{1}{\tan(u)}\left(\frac{M_2 - M_1}{M_2 + M_1}\right)$$

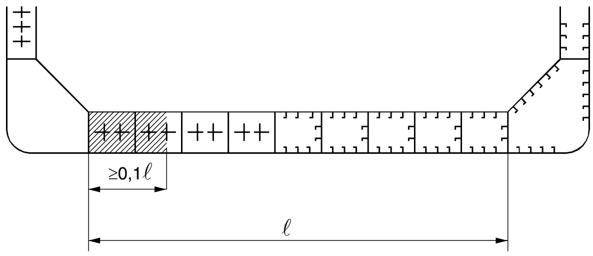
$$u = \frac{\pi}{2}\sqrt{\frac{F_C}{F_{EY}}}$$

- 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: $\gamma_R = 1{,}02$
- γ_m : Material partial safety factor: $\gamma_m = 1{,}02$

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:

$$|\sigma| \le \frac{\sigma_C}{\gamma_R\gamma_m}$$

where:

- σ : 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/mm², from the following formulae:

$$\sigma_c = \sigma_E \quad \text{for} \quad \sigma_E \le \frac{R_y}{2}$$

$$\sigma_c = R_y\left(1 - \frac{R_y}{4\sigma_E}\right) \quad \text{for} \quad \sigma_E > \frac{R_y}{2}$$

where:

$\sigma_E = \min(\sigma_{E1}, \sigma_{E2})$,

σ_{E1} : Euler flexural buckling stress, to be obtained, in N/mm², from the following formula:

$$\sigma_{E1} = \frac{\pi^2 EI}{10^4 A_{ct} \ell^2}$$

I : Min (I_{xx}, I_{yy})

I_{xx} : Net moment of inertia, in cm⁴, of the cross-tie about the x axis defined in [4.3.4] a)

I_{yy} : Net moment of inertia, in cm⁴, of the cross-tie about the y axis defined in [4.3.4] a)

A_{ct} : Net cross-sectional area, in cm², of the cross-tie

ℓ : Span, in m, of the cross-tie

σ_{E2} : Euler torsional buckling stress, to be obtained, in N/mm², from the following formula:

$$\sigma_{E2} = \frac{\pi^2 E I_w}{10^4 I_o \ell^2} + 0{,}41\, E \frac{J}{I_o}$$

I_w : Net sectorial moment of inertia, in cm⁴, of the cross-tie, specified in Tab 2 for various types of profiles

I_o : Net polar moment of inertia, in cm⁴, 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 cm⁴, 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 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 75°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.

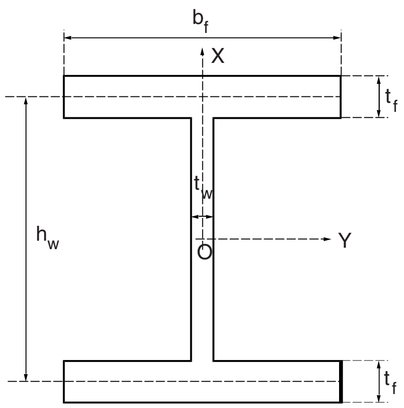
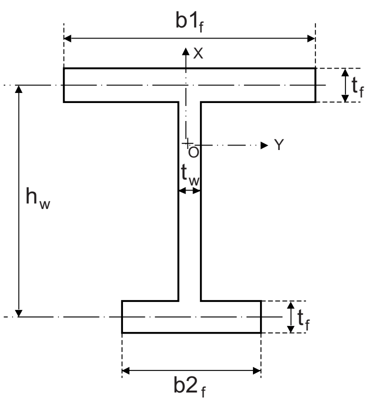
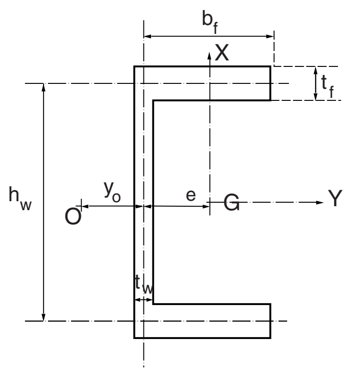
5.2 Opening arrangement

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	$\frac{1}{3}\lvert(b_{1f} + b_{2f})t_f^3 + h_w t_w^3\rvert$	$\frac{t_f h_w^2 b_{1f}^3 b_{2f}^3}{12(b_{1f}^3 + b_{2f})}$
Non-symmetrical 	$\frac{b^2 t_f}{h t_w + 2 b t_f}$	$\frac{3 b_f^2 t_f}{6 b_f t_f + h_w t_w}$	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f b_f^3 h^2}{12} \frac{3 b_f t_f + 2 h_w t_w}{6 b_f t_f + h_w t_w}$

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 The use of aluminium coatings 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

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], [2.4.2], [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.

Table 1 :

Subject	Reference to these Rules	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

1.2 Documents to be submitted

1.2.1

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

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 8.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

2.1.2 Independence of piping systems

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

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 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 8, Tab 5
   - they are to be adequately supported and protected against mechanical damage.

2.1.4 Pumps

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 2 : Documents to be submitted

Item N°	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

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

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 8, [6].

2.2.3 Draining of pump rooms

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

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

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

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

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 8, [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

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

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

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

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

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.

2.3.7 Ballast pipes passing through tanks

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.

2.3.8 Fore peak ballast system on oil tankers

The fore peak tank can be ballasted with the system serving ballast tanks within the cargo area, provided:

a) the fore peak tank is considered a hazardous area Note 1

b) the vent pipe openings are located on open deck at an appropriate distance from sources of ignition. In this respect, the separation distances for hazardous zones are to be defined in accordance with IEC 60092-502: Electrical installations in ships - Tankers - Special features;

c) means are provided, on the open deck, to allow measurement of flammable gas concentrations within the fore peak tank by a suitable portable instrument

d) the sounding arrangements to the fore peak tank are direct from the open deck..

Note 1: The hazardous area classification is to be defined in accordance with IEC 60092-502: Electrical installations in ships - Tankers - Special features.

2.3.9 Integrated cargo and ballast system

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

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

The air pipes referred to in [2.4.1] are to be arranged as per Pt C, Ch 1, Sec 8, [9]] and are to be fitted with easily removable flame screens at their outlets.

2.4.3 Passage through cargo tanks

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

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 8, Tab 23, column 1.

2.6 Heating systems intended for cargo

2.6.1 General

a) Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 8.

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

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

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 and piping systems

3.1 General

3.1.1

A complete system of pumps and piping is to be fitted for handling the cargo oil.

3.1.2 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

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

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

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

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

Cargo pumps are to be monitored as required in Tab 3.

3.2.6 Control of cargo pumps

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

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

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 8 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

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

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

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

a) Valves with remote control are to comply with Pt C, Ch 1, Sec 8, [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

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

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.

3.4.2 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.

3.4.3 Valves

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

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

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

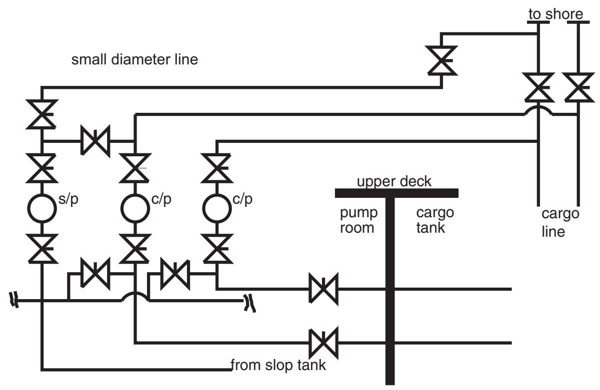
Every oil tanker required to be provided with segregated ballast tanks or fitted with a crude oil washing system is to comply with the following requirements:

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



3.4.7 Cleaning and gas-freeing

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

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

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

The provisions of Article [4] apply to cargo tanks and slop tanks.

4.2 Cargo tank venting

4.2.1 Principle

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

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

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 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

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

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

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

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

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

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 Appendix 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

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

a) Arrangements are to be made for purging and/or gas-freeing of cargo tanks. The arrangements a*re 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

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

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

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

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

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

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

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

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

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

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 Appendix 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 Appendix 2 related to safety.

4.6.2 Washing machines

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

a) Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 8, 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

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

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

Unless otherwise specified, the provisions of [5.2] and [5.3] apply only **oil tankers** of 150 gross tonnage and above.

5.1.2 Provisions for oil tankers of less than 150 gross tonnage (.....................)

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

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 subject to the provisions of Chapter 1 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 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 compliance with the applicable procedures.

5.2 Retention of oil on board

5.2.1 General

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

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

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

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

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

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

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.

5.4.2 Discharge pipelines

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 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

On every **ol 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

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

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 8, [20] for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials

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 8, [20.3.2].

6.2.2 Inspection of welded joints

Where required in Tab 4, welded joints are to be subjected to the examinations specified in Pt C, Ch 1, Sec 8, [3.6] for class II pipes.

6.2.3 Hydrostatic testing

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 8, [20.4].

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 8, [20.4].

c) Where fitted, bellow pieces of gas-tight penetration glands are to be pressure tested.

6.2.4 Tightness tests

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

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

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

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 Appendix 2, App 2, [3.2.1].

6.3.2 Survey of pollution prevention equipment

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

N°	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	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

In addition to the provisions of , Pt C, Ch 1, Sec 9 the steering gear of ships having the service notations **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 10,000 gross tonnage and above carrying flammable cargoes.

7.2 Design of the steering gear

7.2.1

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 9, [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 9, [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

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

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/mm².

7.3.3 Design

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 9, [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

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 9, [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 9, [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

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 for FLS tankers

8.1 Application

8.1.1

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

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

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

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

a) If residues from cargo tanks are removed by means of ventilation, ventilation equipment meeting the following provisions is to be provided.

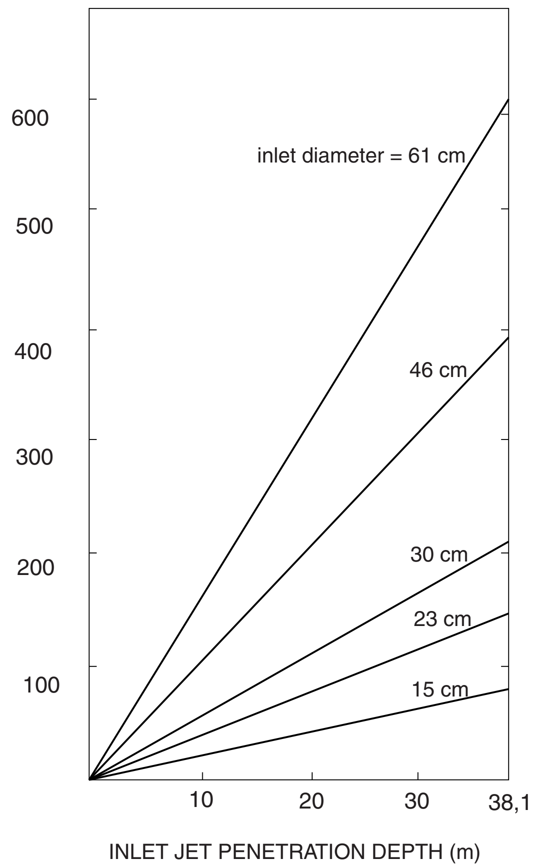
Note 1: Ventilation procedures may be applied only to those substances having a vapour pressure greater than 5×10^3 Pa at 20°C.

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



Note: Jet penetration depth is to be compared against tank height.

SECTION 5 MACHINERY AND CARGO SYSTEMS FOR OIL TANKER ESP FLASHPOINT > 60°C, OILT-TANKER ESP CSR FLASHPOINT > 60°C, ASPHALT TANKER, ASPHALT TANKER ESP, FLS TANKER FLASHPONT > 60°C

1 General

1.1 Application

1.1.1

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 ESP, 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**r 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

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

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

a) Materials are to comply with the provisions of Pt C, Ch 1, Sec 8.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping.

2.1.2 Independence of piping systems

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

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 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 8, Tab 5
   - they are to be adequately supported and protected against mechanical damage.

Table 1 : Documents to be submitted

Item N°	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 Bilge system

2.2.1 Draining of spaces located outside the cargo area

For bilge draining of spaces located outside the cargo area, refer to Pt C, Ch 1, Sec 8, [6].

2.2.2 Draining of pump rooms

a) Arrangements are to be provided to drain the pump rooms, where fitted, by means of power pumps or bilge ejectors.s.

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 (...............)

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

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 tanker**s 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 8, [7.1.3].

d) In **oil tanker**s 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

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

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

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

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.

2.3.6 Integrated cargo and ballast system

The requirements for integrated cargo and ballast systems are given in [3.5].

2.4 Scupper pipes

2.4.1

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 8, Tab 23, column 1.

2.5 Heating systems intended for cargo

2.5.1 General

Heating systems intended for cargo are to comply with the relevant requirements of Pt C, Ch 1, Sec 8.

2.5.2 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 and piping systems

3.1 General

3.1.1

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

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.

3.2.2 Use of cargo pumps

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

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

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

Cargo pumps are to be monitored as required in Tab 2.

3.2.6 Control of cargo pumps

Cargo pumps are to be capable of being stopped from:

- a position outside the pump room, and
- a position next to the pumps.

Table 2 : Monitoring of cargo pumps

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 design

3.3.1 General

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt C, Ch 1, Sec 8 applicable to piping systems of:
- class III, in the case of **oil tanker**s 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].

3.3.2 Materials

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

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

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 tanker**s 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

a) Valves with remote control are to comply with Pt C, Ch 1, Sec 8, [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

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

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.

3.4.2 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.

3.4.3 Valves

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

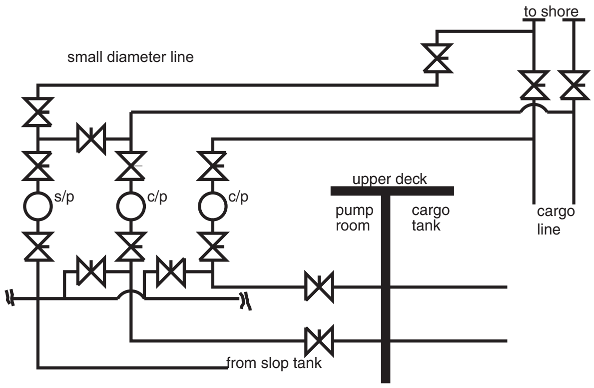
Every **oil tanker** and **asphalt carrier** required to be provided with segregated ballast tanks is to comply with the following requirements:

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



3.4.5 Cleaning and gas-freeing

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 system design

3.5.1 Functional Requirements

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

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

The provisions of Article [4] apply to cargo tanks and slop tanks.

4.2 Cargo tank venting

4.2.1

The relevant provisions of Pt C, Ch 1, Sec 8, [9] and Pt C, Ch 1, Sec 8, [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

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].

4.3.2 High level alarms

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

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.

4.4 Tank washing systems

4.4.1 General

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

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

Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 8, depending on the kind of washing fluid or water.

4.4.4 Installation of washing systems

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

Unless otherwise specified, the provisions of [5.2] and [5.3] apply only **oil tankers** of 150 gross tonnage and above.

5.1.2 Provisions for oil tankers of less than 150 gross tonnage

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

a) The provisions of [5.2] and [5.3] may be waived in the following ships:

- **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 compliance with the applicable procedures.

5.2 Retention of oil on board

5.2.1 General

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

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

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

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

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

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

In every **oil tanker** and **asphalt tanker** 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

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

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

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

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 8, [20] for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials

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 8, [20.3.2].

6.2.2 Inspection of welded joints

Where required in Tab 3, welded joints are to be subjected to the examinations specified in Pt C, Ch 1, Sec 8, [3.6] for class II pipes.

6.2.3 Hydrostatic testing

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 8, [20.4].

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 8, [20.4].

c) Where fitted, bellow pieces of gas-tight penetration glands are to be pressure tested.

6.2.4 Tightness tests

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

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

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

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 Appendix 2, App 2, [3.2.1].

6.3.2 Survey of pollution prevention equipment

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 3 : Inspection and testing at works

N°	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	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

In addition to the provisions of , Pt C, Ch 1, Sec 9 the steering gear on **oil tanker**s and **asphalt tankers** 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 10,000 gross tonnage and above carrying flammable cargoes.

7.2 Design of the steering gear

7.2.1

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 9, [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 9, [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

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

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

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 9, [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

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 9, [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 9, [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

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 for FLS tankers

8.1 Application

8.1.1

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 for asphalt tankers

8.2.1 Heating systems

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].

8.2.2 Thermometers

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

Cargo piping and associated fittings outside tanks are to be suitably insulated, where necessary.

9 Specific requirements for FSL tankers

9.1 Application

9.1.1

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-FLS, flashpoint > 60°C**, oil tanker-FLS, flashpoint > 60°C, these provisions are additional to those of [5].

9.2 Design requirements

9.2.1 General

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

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

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:

$$d = \frac{Q_d}{5 L_d}$$

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

a) If residues from cargo tanks are removed by means of ventilation, ventilation equipment meeting the following provisions is to be provided.

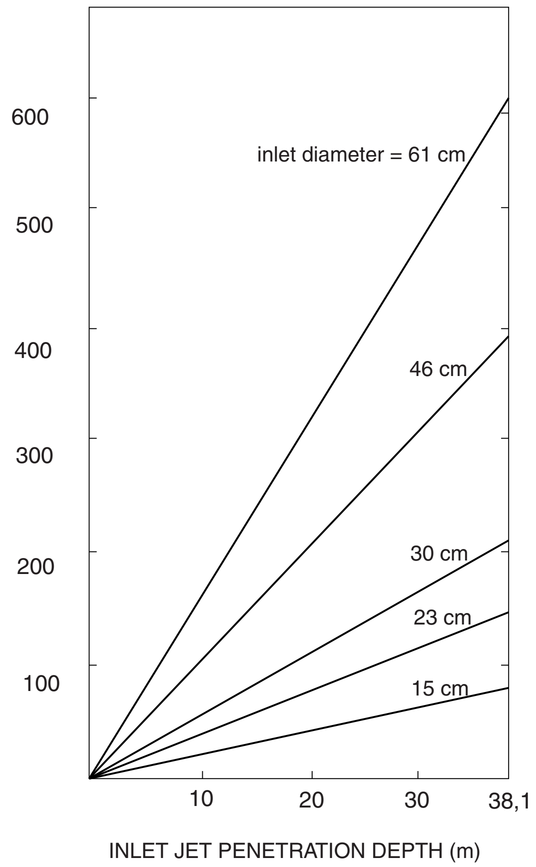
Note 1: Ventilation procedures may be applied only to those substances having a vapour pressure greater than $5x10^3$ Pa at 20°C.

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



Note: Jet penetration depth is to be compared against tank height.

APPENDIX 1 DEVICES TO PREVENT THE PASSAGE OF FLAME INTO THE CARGO TANKS

1 General

1.1 Application

1.1.1 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 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 Ships having the service notations oil tanker ESP, oil tanker ESP CSR or FLS tanker and fitted with an inert gas system in accordance with Pt C, Ch 4, Sec 1, [10] 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.

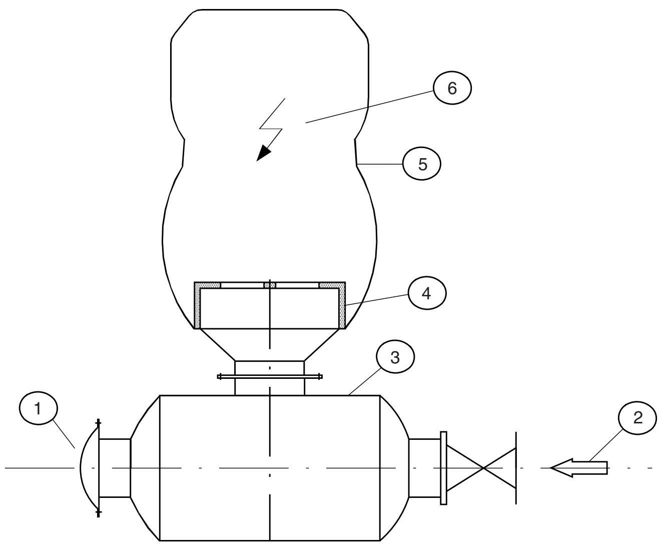
4.1.7 Flame passage is to be observed by recording, e.g. temperature, pressure, or light emission, by suitable sensors on the protected side of the device; alternatively, flame passage may be recorded on video tape.

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

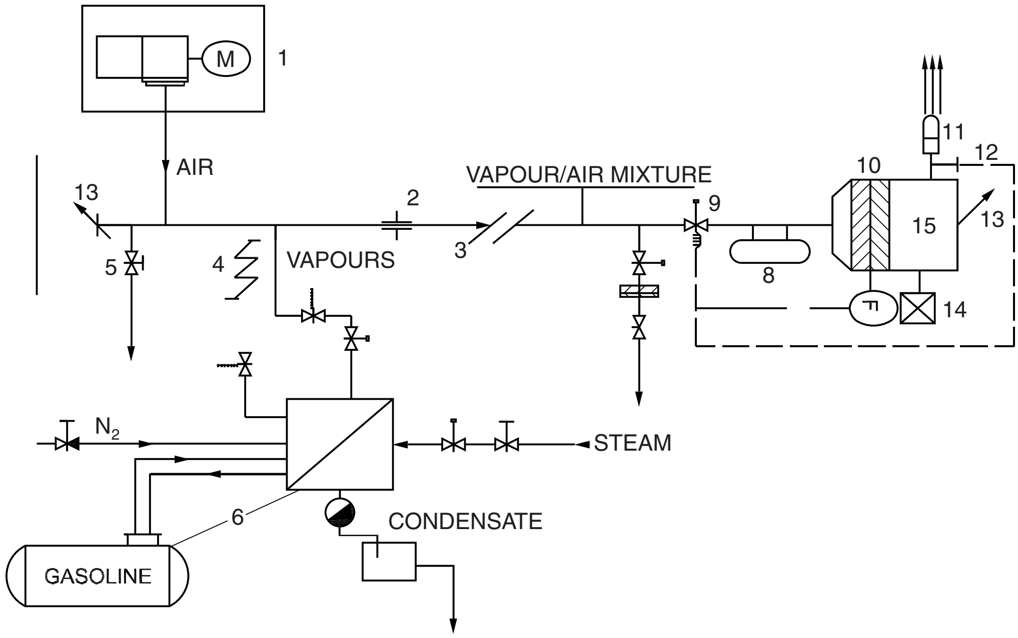
A flashback test is to be carried out as follows:

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:

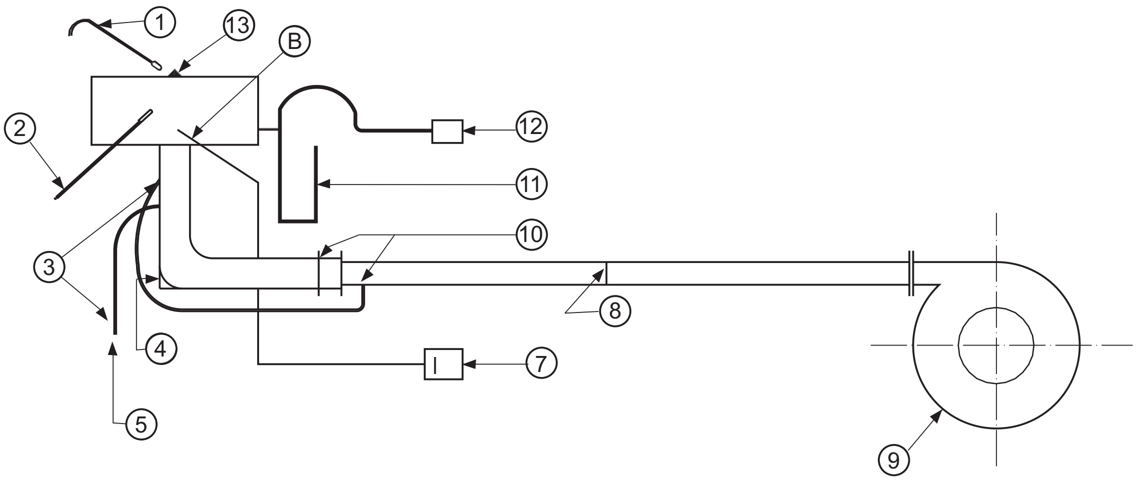
a) The test rig as referred to in [4.2.1] may be used, without the plastic bag. The flame arrester is to be so installed that the mixture emission is vertical. In this position the mixture is to be ignited. Where devices referred to in [2.3.1] Note 3, are tested, the flame arrester is to be so installed 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

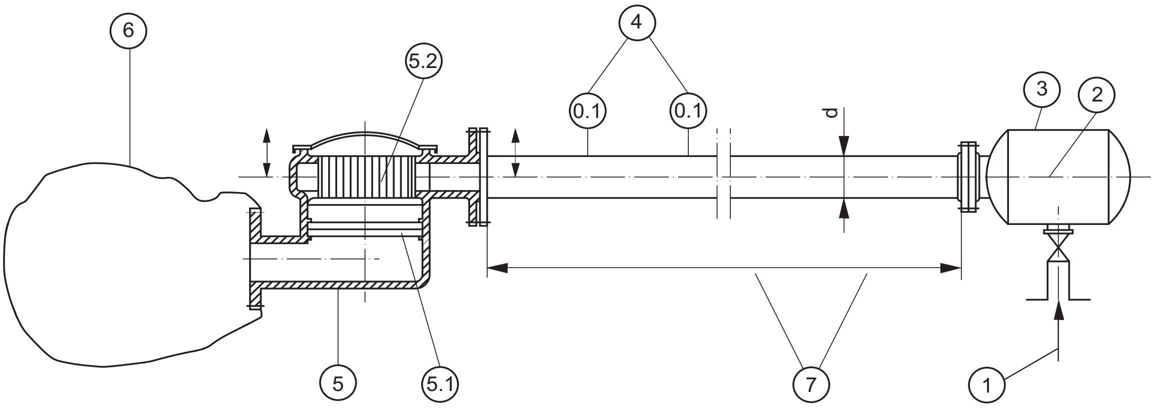
d) types of cargo for which the device is approved

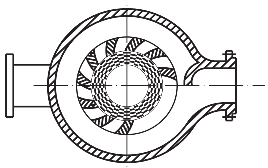
e) drawings of the test rig

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 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, [1.3.4].

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

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 the present rules does not apply, 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

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

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

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/m³)	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

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/m³)	Melting point (°C)	Service notation
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
Polyaluminium chloride solution	-	Z	Open	-	-	NF	O	-	-	N	-	1,25	-	T
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**.

Part E
Service Notations

Chapter 2
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, [4.3].

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 ships for dredging activities.

1.2 Summary table

1.2.1 Table 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	Sect 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 m³, limited to the highest weir level

g : Gravity acceleration, in m/s²:

$g = 9{,}81$ m/s²

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/mm², of the material

R_m : Minimum ultimate tensile strength, in N/mm², of the material.

1 Stability

1.1 Intact stability

1.1.1 General

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

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 m³, is to be considered equal to 1,6 **V**; for bucket dredgers the mass, in **t**, contained in each bucket of volume **V**, in m³, 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/m³.

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/m³; 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 q_R is to be assumed as a function of the angle of heel q_G and the mass density γ, in t/m³, according to the following formulas:

$$\theta_R = \theta_G \quad \text{for } \gamma \le 1$$

$$\theta_R = (3-\gamma)\cdot\theta_G/2 \quad \text{for} \quad 1<\gamma<3$$

$$\theta_R = 0 \quad \text{for } \gamma \geq 3$$

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

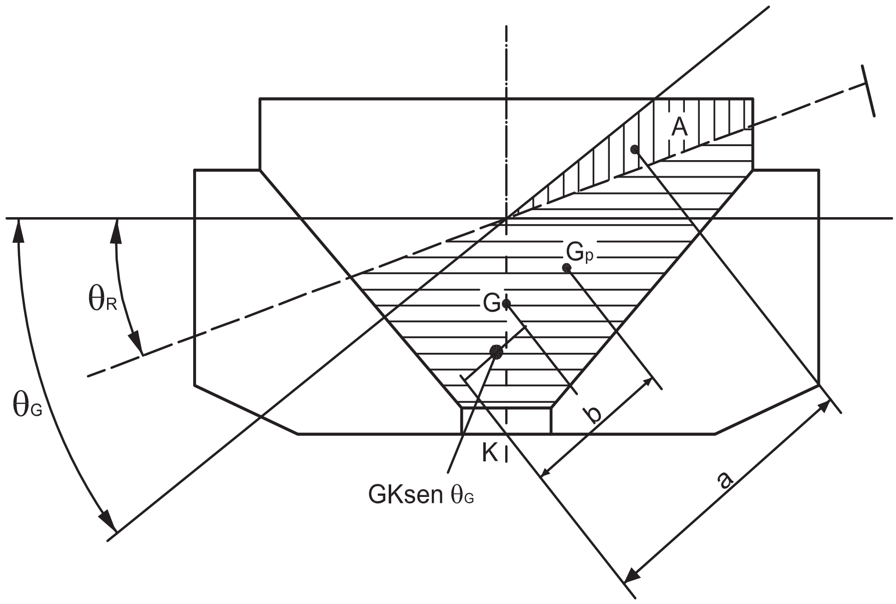
a) General

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



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.

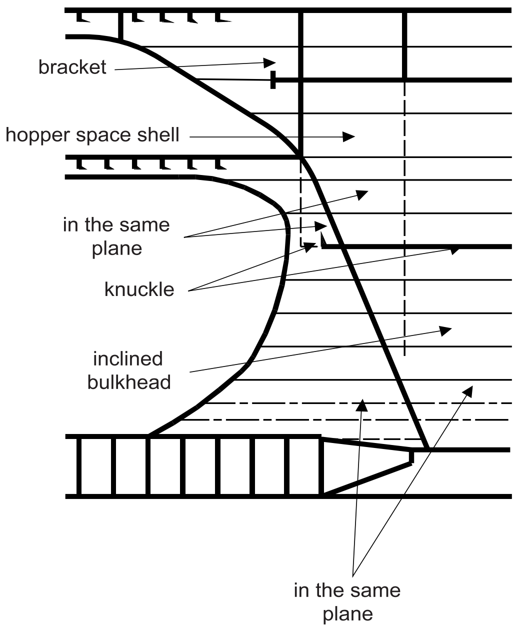
2.2.2 Attention is to be paid to the structural continuity of longitudinal members, especially coaming and hopper well bulkheads.

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

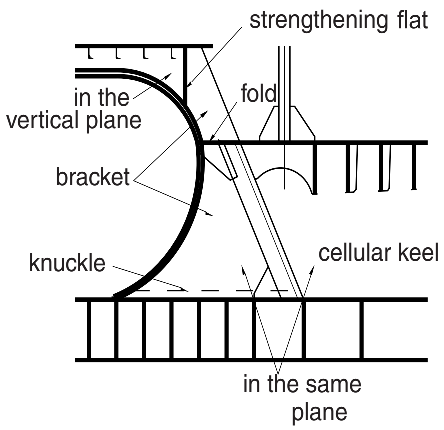


The lower bracket, which is generally oblique, is to be welded to the bottom or to the tank top. In the latter case, the lower bracket is to be extended inside the double bottom by means of a solid keelson extending at least over three frame spaces beyond the end of the bracket.

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].

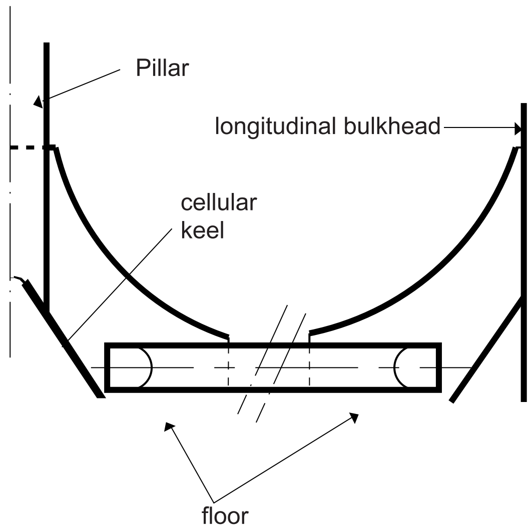
2.3.3 The upper part of the cellular keel may be connected to the deck or trunk structure by means of axial or inclined pillars in association with strong beams, or by a centreline wash bulkhead.

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

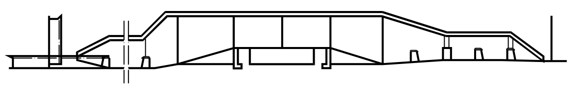
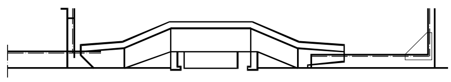


Figure 6 : Longitudinally framed side - Cut-out reinforced by means of knuckled plate



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 1, 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, [4.3.3]).

Table 1 : Operating area coefficients in dredging situation

H_S , in m	Operating area coefficient n_D
$H_S < 2,5$	1/3
$2,5 \le H_S < 4$	2/3
$H_S \ge 4$	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

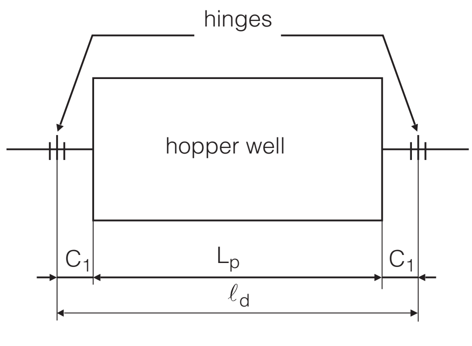


Table 4 : Load per metre applied along the hopper well

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:
α_2,α_3,α_4,α_5,α_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.

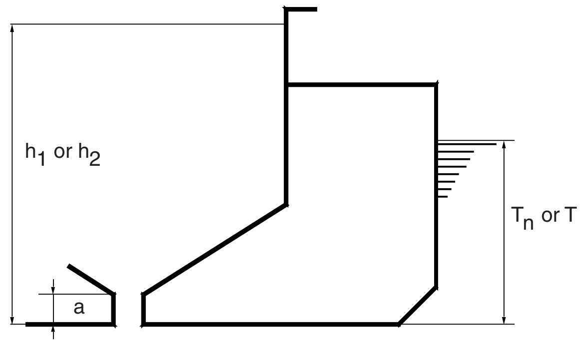
3.4.5 Combined still water and wave vertical bending moment

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 1, 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/m², 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	$\dfrac{M_{SW,H} + M_{WV,H}}{2}$	$\dfrac{M_{SW,H,D} + M_{WV,H,D}}{2}$
Sagging	$\dfrac{M_{SW,S} + M_{WV,S}}{2}$	$\dfrac{M_{SW,S,D} + M_{WV,S,D}}{2}$

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:

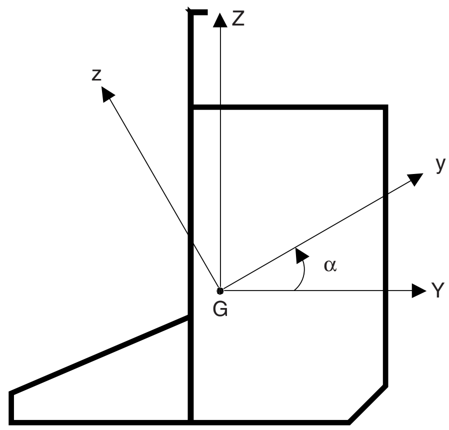
G : Centre of gravity of the transverse section

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:

$$\alpha = \frac{1}{2}\operatorname{atan}\left(\frac{2I_{YZ}}{I_Z - I_Y}\right)$$

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/mm², 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:

$$\sigma_{1,ALL} = 200/k \ \text{N/mm}^2$$

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	$4,3 + 0,036\ L\ k^{1/2} + 4,5\ s$
• longitudinal framing	$3,4 + 0,036\ L\ k^{1/2} + 4,5\ s$
Inner bottom outside hopper spaces	$2,0 + 0,025\ L\ k^{1/2} + 4,5\ s$
Side	
• below freeboard deck	$2,5 + 0,031\ L\ k^{1/2} + 4,5\ s$
• between freeboard deck and strength deck	$2,5 + 0,013\ L\ k^{1/2} + 4,5\ s$
Strength deck within 0,4L amidships	
• transverse framing	$2,5 + 0,040\ L\ k^{1/2} + 4,5\ s$
• longitudinal framing	$2,5 + 0,032\ L\ k^{1/2} + 4,5\ s$
Hopper well	
• transverse and longitudinal bulkheads	$2,7 + 0,034\ L\ k^{1/2} + 4,5\ s$
• cellular keel plating	$2,7 + 0,034\ L\ k^{1/2} + 4,5\ s$

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

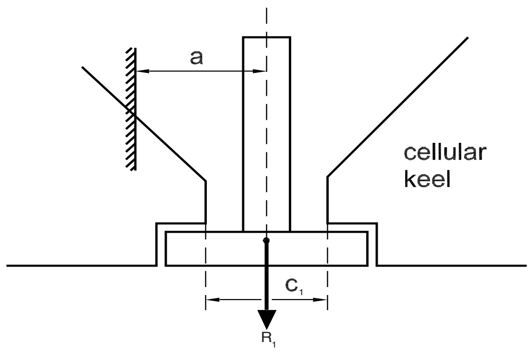
7.2.1 The scantlings of floors of ships with open wells fitted with bottom doors are to be obtained from a direct calculation, according to Pt B, Ch 7, App 1 as applicable, and taking into account the following assumptions:

- 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:

$P_r = \delta(D + h_D) - (T_D - 0{,}5\,h_0)$

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)

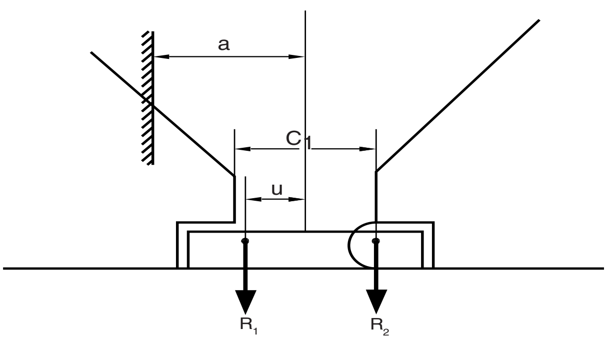


Figure 12 : Double bottom doors, with hinges at both sides and operated by one central vertical shaft connected to the doors by means of two rods (Type 3)

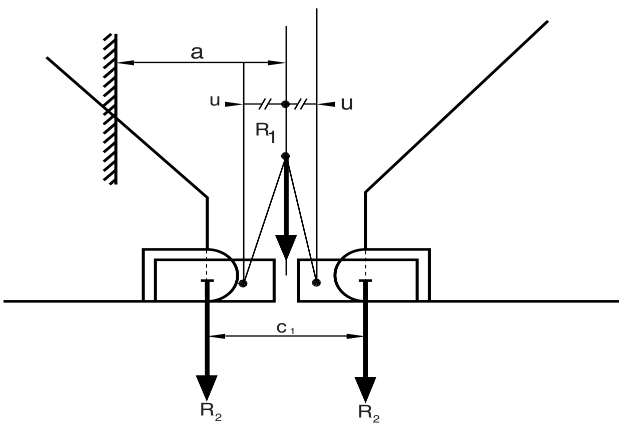


Figure 13 : Longitudinal sliding bottom doors (Type 4)

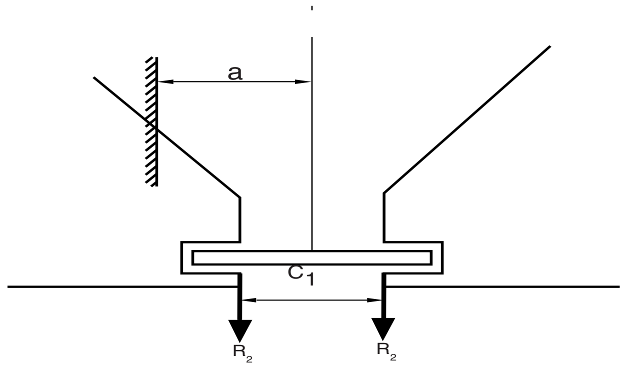


Figure 14 : Transverse sliding bottom doors, guides being supported by floors (Type 5)

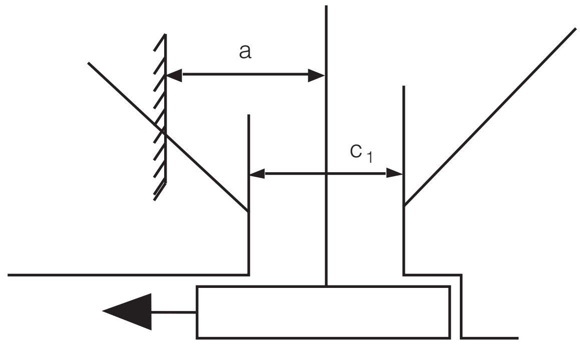


Table 10 : Reactions R_1 and R_2 for elementary load [d]

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.

[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.

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

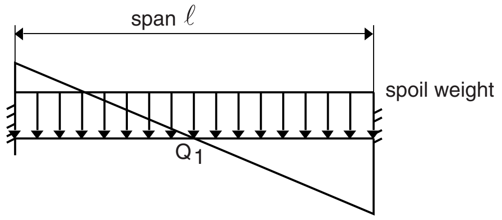


Figure 16 : Shear force diagram for elementary load [b] - Load Q_2

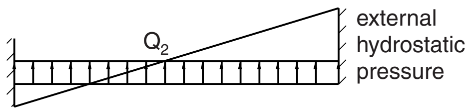


Figure 17 : Shear force diagram for elementary load [c] - Load q

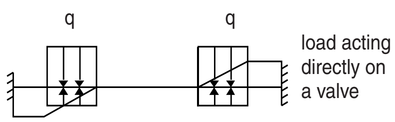


Figure 18 : Shear force diagram for elementary load [d] - Reactions R_2

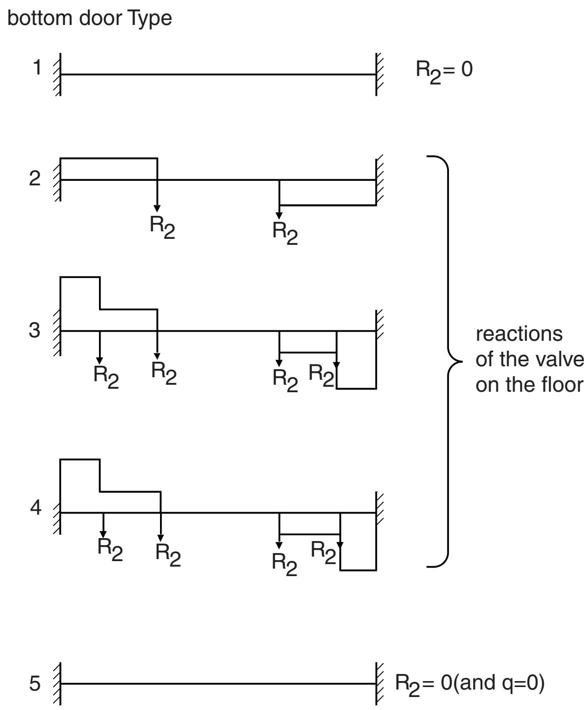


Figure 19 : Shear force diagram for elementary load [e] - Force F_1

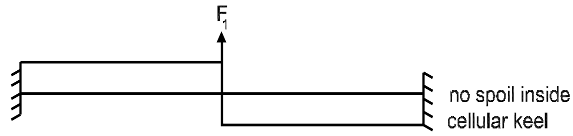


Figure 20 : Shear force diagram for elementary load [f] - Force F_2

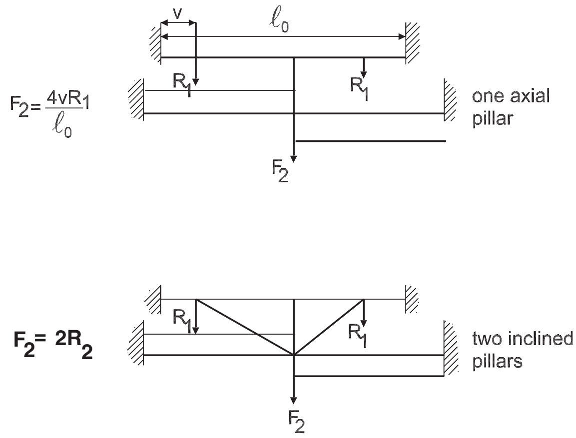


Table 11 : Shear force values

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:

$$M_S = 0{,}05\delta h_V^2[3\ell_S^2 - (\ell_S - c_1)^2]$$

- 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]	$\frac{qa(\ell - a)}{\ell}$	$-\frac{qa^2}{\ell}$
[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 cm², 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:

$$M_P = 1{,}64\delta s h_T^3$$

$$T_P = 4{,}9\delta s h_T^2$$

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/mm², and the shear stress are respectively in compliance with the following formulae:

$$\sigma \le 0{,}65\frac{R_{eH}}{k}$$

$$\tau \le 0{,}45\frac{R_{eH}}{k}$$

Table 13 : Sectional area of strong beams

Condition	Sectional area A_T, in cm²
$F_R \ge 0$	$0{,}08\ F_R$
$F_R < 0$	• when $\ell_F/r \le 1{,}15$: $\left[0{,}085 + 0{,}064\left(\frac{\ell_F}{r}\right)^2\right]F_R$ • 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 ℓ_0

r : Minimum gyration radius, in cm, to be taken equal to:

$$r = \sqrt{\frac{I}{A_T}}$$

I : Moment of inertia, in cm⁴, equal to the minimum of I_{XX} and I_{YY}

I_{XX} : Moment of inertia, in cm⁴, with respect to the axis perpendicular to the plane of the web

I_{YY} : Moment of inertia, in cm⁴, 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/mm², may be obtained, respectively, from the following formulae:

$$\sigma_{LX} = \frac{125 F \ell}{w}$$

$$\tau_{XY} = \frac{5F}{A_a}$$

where:

F : Maximum value, in kN, of R_1 and F_M defined in [7.2.3]

w : Girder web modulus, in cm³

A_a : Girder web sectional area, in cm², possible cut-outs deducted.

7.5.2 It is to be checked that the normal stress, in N/mm², and the shear stress are respectively in compliance with the following formulae:

$$\sigma \le 0{,}65 \frac{R_{eH}}{k}$$

$$\tau \le 0{,}45 \frac{R_{eH}}{k}$$

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 ≤ 20	A	AH
20 < t ≤ 25	D	DH
25 < t ≤ 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

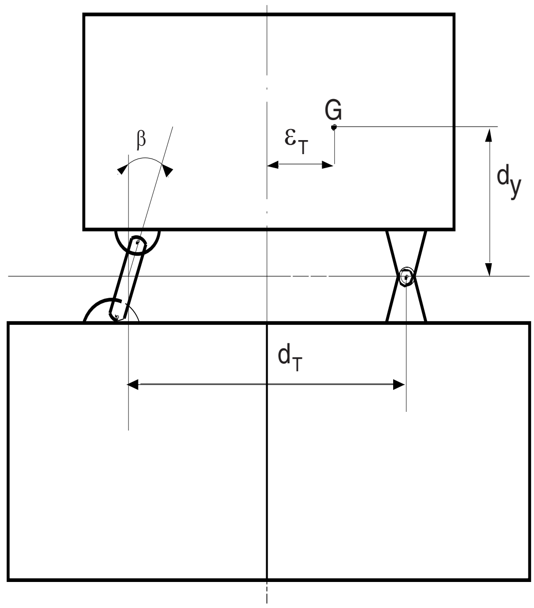
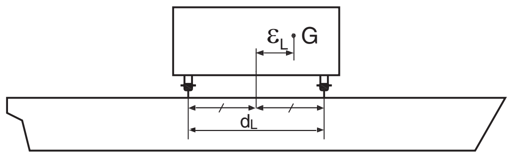


Figure 22 : Connection between superstructure and ship - Longitudinal direction



8.4.4 The force F to be considered for the check of the hinge scantlings is to be taken equal to:

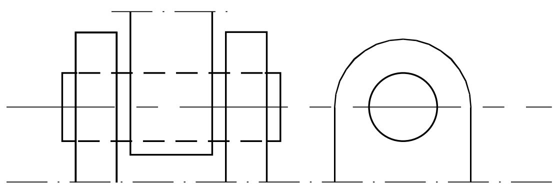
- for a simple hinge: the resultant of the horizontal and vertical forces
- for a hinge with tie-rod: the force in the tie-rod centreline

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

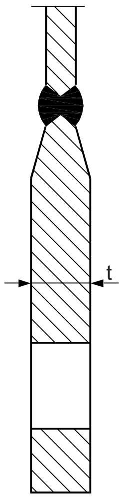


Figure 25 : Type II superstructure hinges

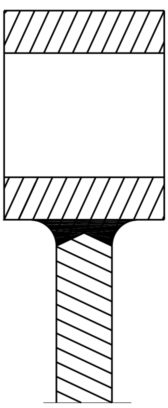


Figure 26 : Superstructure hinges: case of direct bearing

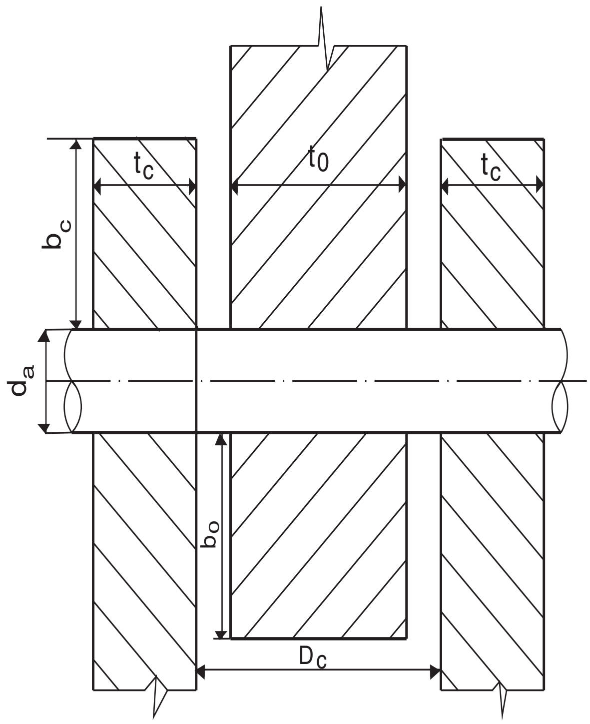


Figure 27 : Superstructure hinges: case of load transfer by bearings

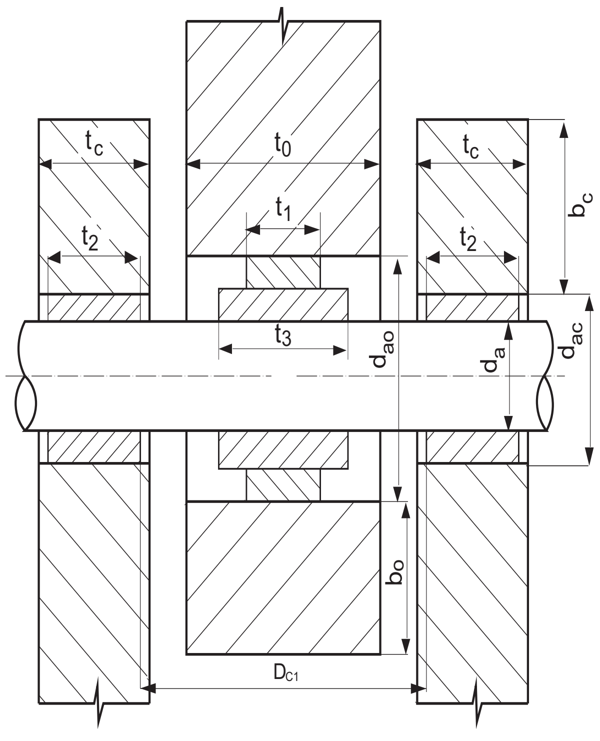


Table 15 : Scantling check of superstructures hinges

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/mm².

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 m³, 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:

$$F_{CH} = 0{,}5\left[F_h - F_d + n_1\left(1 - \frac{a_3}{a_4}\right)F_{CY} + \frac{M}{a_4}\right]$$

- 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:

$F_{MC} = M/n_1a_3$

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

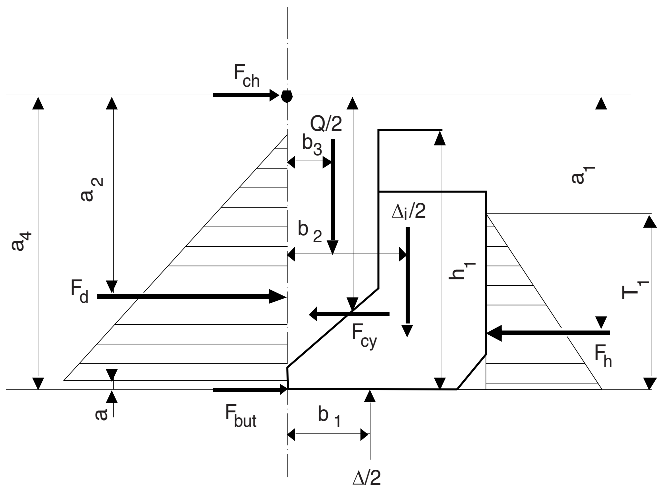
$\Delta_1\ell$: Total displacement of the ship without spoil, including superstructures

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.

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.

9.4.3 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.

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.

9.5 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/mm², 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 9, [2], while associated piping systems are generally to fulfil the relevant requirements of Pt C, Ch 1, Sec 8.

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.

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
45	60	2	120	110,0	16,0
60	80	2	140	110,0	17,5
80	92	2	220	110,0	19,0
92	102	2	260	137,5	20,5
102	112	2	290	137,5	22
112	130	2	320	165,0	24
130	155	2	350	165,0	24
155	185	2	430	165,0	26
185	210	2	500	165,0	28
210	250	2	600	165,0	30
250	285	2	700	165,0	32
285	315	2	800	220,0	34
315	350	2	900	220,0	36
350	385	2	1000	220,0	38
385	415	2	1100	220,0	38
415	450	2	1200	220,0	40
450	485	2	1300	220,0	40
485	515	2	1400	220,0	42
515	550	2	1500	220,0	44
550	585	2	1600	220,0	46
585	635	2	1700	220,0	48
635	685	2	1800	275,0	48
685	715	2	2000	275,0	50
715	750	2	2100	275,0	52
750	795	2	2200	275,0	54

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

Equipment number EN A< EN ≤ B		Towline (1)		Mooring lines		
A	B	Minimum length, in m	Breaking load, in kN	N	Length of each line, in m	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
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 8.

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 7 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 9, [3.3.1] or Pt C, Ch 1, Sec 9, [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 9, [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 8, 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 13, 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.

Part E
Service Notations

Chapter 3
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, [4.5.2].

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

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery	**(1)**
Electrical installations	**(1)**
Automation	**(1)**
Fire protection, detection and extinction	**(1)**
Integrated tug/barge combination	Sec 3

(1) No specific requirements for tugs 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 with one of the following service notations:

- **tug**, mainly intended for towing services, which are to comply with the requirements in [2]
- **salvage tug**, having specific equipment for salvage services, which are to comply with the requirements in [2] and [3]
- **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 [2] and [4].

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 [2.10].

2 Tugs, salvage tugs and escort tugs

2.1 General

2.1.1 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.

2.2 Stability

2.2.1 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.

2.2.2 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

2.2.3 Intact stability *(1/1/2021)*

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.

2.2.4 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 [2.2.5]), and induced by the hydrodynamic resistance of the hull (tow-tripping, see [2.2.6]).

2.2.5 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 1):

$A \geq B$

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 1, [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

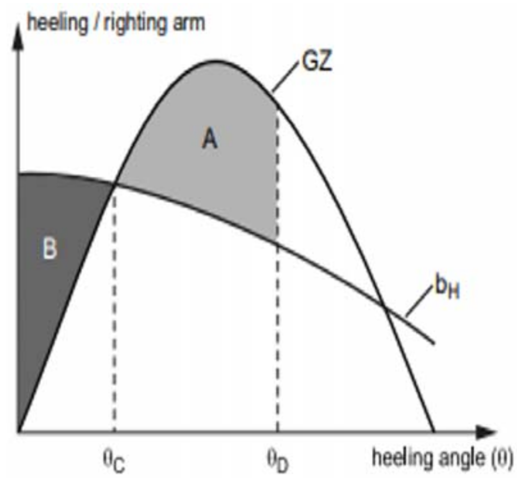
Δ : Loading condition displacement, in tons.

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 1 : Heeling and righting arms curves *(1/1/2021)*



2.2.6 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:

$$\theta_d = \operatorname{atan}\left(\frac{2 \cdot f}{B}\right)$$

f : 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

2.2.7 Exemption *(1/1/2021)*

Tugs of any length with the navigation notation **sheltered area** may be exempted from complying with the requirement specified in [2.2.5] and [2.2.6], 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:

$$GM = \frac{66 \cdot T \cdot H \cdot B}{f \cdot \Delta}$$

where:

B : Ship's maximum breadth, in m

f : Ship's freeboard, in mm, to be assumed not greater than 650 mm

T, H, Δ : Defined in [2.2.6].

2.3 Structure design principles

2.3.1 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.

2.3.2 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.

2.3.3 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.

2.3.4 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.

2.4 Hull scantlings

2.4.1 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.

2.4.2 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.

2.5 Other structures

2.5.1 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.

2.5.2 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.

2.5.3 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.

2.6 Rudder and bulwarks

2.6.1 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].

2.6.2 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.

2.7 Equipment

2.7.1 Equipment number for tugs with the navigation notation "unrestricted navigation"

For tugs with the navigation notation **unrestricted navigation**, the equipment number EN is to be obtained from the following formula:

$EN = \Delta^{2/3} + 2\,(a\,B + \Sigma h_n b_n) + 0{,}1\,A$

where:

- Δ : Moulded displacement of the tug, in t, to the summer load waterline
- a : Freeboard amidships from the summer load waterline to the upper deck, in m
- h_n : Height, in m, at the centreline of tier "n" of superstructure or deckhouse having a breadth greater then B/4. Where a house having a breadth greater than B/4 is above a house with a breadth of B/4 or less, the upper house is to be included and the lower ignored.
- b_n : Breadth, in m, of the widest superstructure or deckhouse of each tier having a breadth greater than B/4
- A : Area, in m^2, in profile view, of the parts of the hull, superstructures and houses above the summer load waterline which are within the length L_E and also have a breadth greater than B/4
- L_E : Equipment length, in m, equal to L without being taken less than 96% or greater than 97% of the total length of the summer load waterline.

Fixed screens or bulwarks 1,5 m or more in height are to be regarded as parts of houses when determining h and A. In particular, the hatched area shown in Fig 2 is to be included.

The height of hatch coamings and that of any deck cargo may be disregarded when determining h and A.

For tugs where the vertical extent of the superstructure is much greater than usual, the Society may require an increased equipment number EN.

2.7.2 Anchors, chain cables and ropes

Tugs are to be provided with equipment in stockless anchors, chain cables and ropes to be obtained as a function of the Equipment Number EN (see [2.7.1] to [2.7.3]) from:

- Pt B, Ch 10, Sec 4 for tugs

2.7.3 Additional equipment

Tugs are to be fitted with the additional equipment specified in Tab 1.

2.8 Towing arrangements

2.8.1 General

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.

2.8.2 Hooks and winches

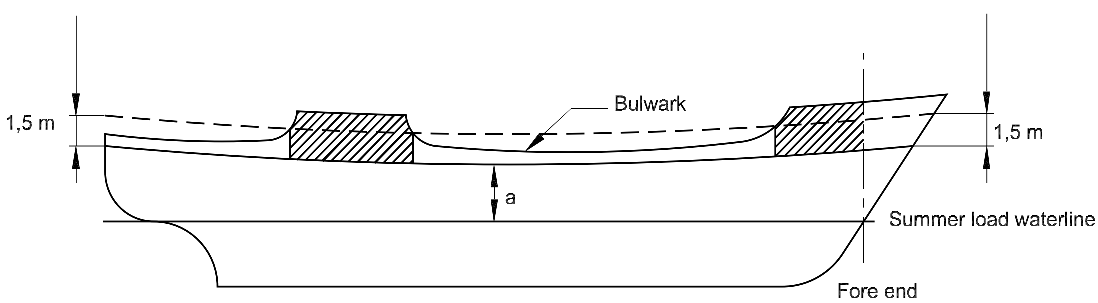
The hook and the winch materials are to comply with the applicable requirements of Part D.

The maximum towing force T, in kN, defined in [2.2.2], is to be specified in the structural arrangement plans of the hook and the winch.

The hooks and the winches are to be subjected to a static test, where the testing force C_T is to be not less than that obtained from Tab 2 as a function of T.

Winches may be equipped with a device for automatic adjustment of the tow.

Figure 2 : Effective area of bulwarks or fixed screens to be included in the Equipment Number



2.8.3 Hook quick-release device

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.

The quick-release device is to be tested both at maximum towing pull T and testing force C_T, 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 maximum towing pull T.

2.8.4 Winch slip device

Winches are to be equipped with a suitable slip device, operable by remote control, allowing the rope to unwind when necessary.

2.8.5 Winch quick-release device

The unhooking of the rope from the winch drum is to be enabled by means of a suitable device or by using a rope whose terminal is not fixed to the drum.

2.8.6 Connection with the hull structures

The scantlings of the structures intended to connect the towing arrangements to the hull are to be in accordance with Part B, Chapter 7 or Part B, Chapter 8, as applicable, where the load to be considered is the maximum towing pull T defined in [2.2.2].

Table 1 : Additional equipment for tugs

Arrangement or equipment	Navigation notation		
	Unrestricted navigation	**Coastal area**	**Sheltered area**
Fender	Requested	Requested	Requested
Towing hook or winch	Requested	Requested	Requested
Tow 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 tow 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.

Table 2 : Testing force C_T

Towing pull T, in kN	Testing force C_T, in kN
$T < 400$	2 T
$400 \le T \le 1200$	T + 400
$T > 1200$	1,33 T

2.9 Construction and testing

2.9.1 Bollard pull test

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 declaration enclosed with the Certificate of Classification.

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.

2.10 Additional arrangements and equipment for tugs with additional service feature "rescue"

2.10.1 Tugs with additional service feature "rescue" are to be provided with at least the arrangements and equipment indicated in [2.10.2].

2.10.2

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 100% 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.

2.10.3 Relaxation from the requirements of [2.10.2] may be granted by the Society case-by-case on the basis of the ship operational area.

2.10.4 The maximum number of shipwrecked persons for which the ship is designed as well as the ship operational area, where [2.10.3] applies, are recorded in the Certificate of Classification of the ship.

The relevant arrangements and equipment are recorded in the ship's status.

3 Additional requirements for salvage tugs

3.1 General

3.1.1 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 [2].

3.2 Equipment

3.2.1 Additional equipment

Ships with the service notation **salvage tug** are to be fitted with the additional equipment specified in Tab 3 in addition to that specified in Tab 1.

4 Additional requirements for escort tugs

4.1 General

4.1.1 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 [2].

4.1.2 Characteristics of escort tugs

For classification purposes, the following characteristic is to be specified by the Designer:

- the maximum steering force T_Y, in kN, applied by the tug on the stern of the escorted ship, which is the transverse component of the maximum dynamic towing pull T with respect to the longitudinal axis of the escorted ship. This maximum force is generated at some value of the angle α between the line of pull and the direction of the escorted ship, see Fig 3. This force is to be calculated at speeds V, to be defined by the Designer and in general to be comprised between 8 and 10 knots.

  If the tug escort service is carried out within a certain speed range, the maximum steering forces T_Y at the minimum and maximum service speeds V_{MIN} e V_{MAX}, respectively, are to be calculated by the Designer.

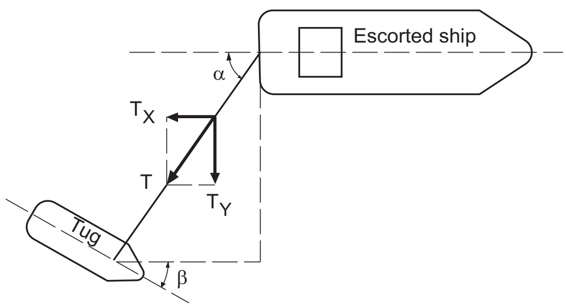
T_Y is to be obtained on the basis of the results of full-scale tests (see [4.5]), to be carried out at speed V or, as applicable, at speeds V_{MIN} and V_{MAX}, defined above or alternatively may be evaluated by computer model simulation as indicated in [4.6.1].

Table 3 : 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 1	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.

Figure 3 : Typical escort configuration



4.1.3 Documentation

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 towline components with relevant minimum breaking loads
- preliminary calculation of maximum steering forces T_Y at speeds V or V_{MAX}, as applicable according to [4.1.2], including the propulsion force which is needed for equilibrating hydrodynamic forces acting on the tug and the towline pull
- preliminary stability calculation.

4.1.4 Propulsion forces

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 3.

4.1.5 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.

4.2 Stability

4.2.1 Intact stability

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)

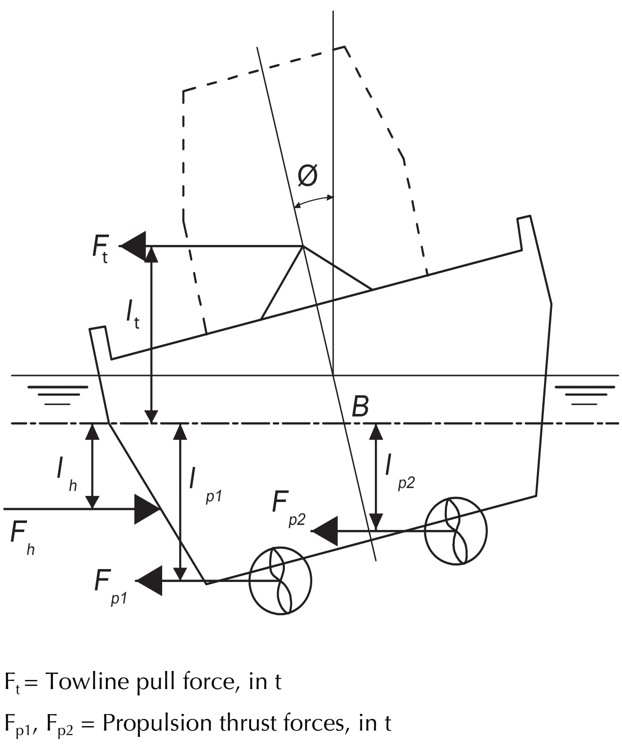
θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms, to be obtained when the maximum steering force T_Y, defined in [4.1.2], is applied from the tug

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 [4.5]), 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



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

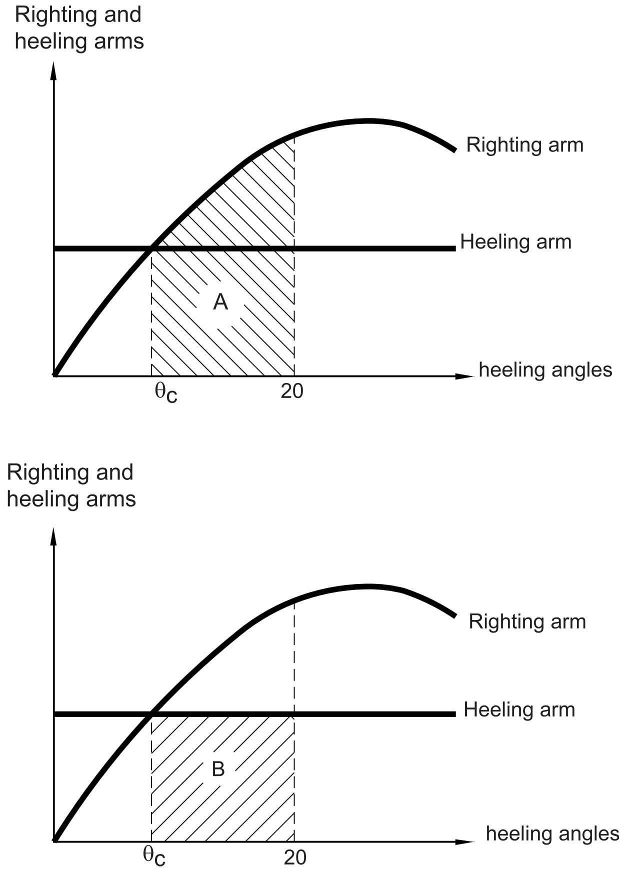
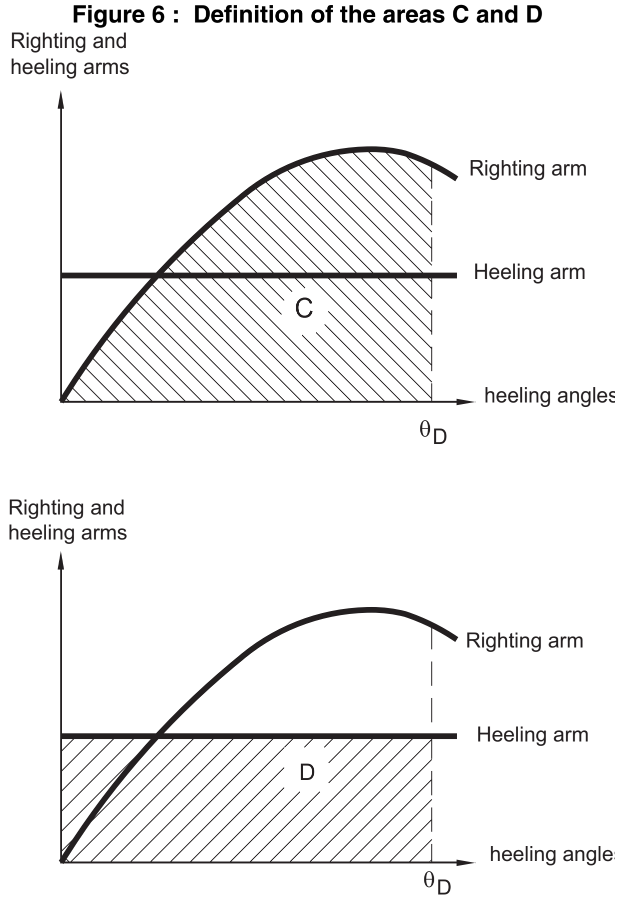


Figure 6 : Definition of the areas C and D



4.3 Structural design principles

4.3.1 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.

4.3.2 Bulwark

A bulwark is to be fitted all around the weather deck.

4.4 Equipment

4.4.1 Towline breaking stenght

The towline breaking strength is to be not less than 2,2 times the greater of the static bollard pull load and the maximum line pull.

4.4.2 Towing winches *(1/1/2021)*

The towing 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. As a minimum, the winch brake holding load is to be equal to or greater than two times the maximum steady towline force, T.

4.5 Full-scale tests

4.5.1 Testing

The following requirements apply to full scale tests to be carried out in order to obtain the values of the main characteristics of the tug defined in [4.1.2].

4.5.2 Documentation to be submitted prior to testing

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 maximum steering force T_Y 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 [2.9.1]).

4.5.3 Data to be collected during tests

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 3), the maximum towing pull T, the ship rudder position, the heeling angle of the tug and any other parameter used in the preliminary calculation.

4.6 Alternative to full-scale tests

4.6.1 Maximum steering force

The maximum 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.

4.7 Inclinometer

4.7.1 *(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/mm², of the material, to be taken equal to 235/k N/mm², unless otherwise specified

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

R_{eH} : Yield stress, in N/mm², of the steel used, and not exceeding the lower of 0,7 R_m and 450 N/mm²

R_m : Minimum ultimate tensile stress, in N/mm², 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, [2], 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:

$$\tau_E \le \tau_{ALL}$$

$$\tau \le 0,5\frac{R_Y}{\gamma_R\gamma_m}$$

where:

τ : Shear stress, in N/mm², to be obtained as a result of direct calculations

τ_{ALL} : Allowable shear stress, in N/mm², 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:

$$\sigma_E \le \sigma_{ALL}$$

where:

σ_E : Von Mises equivalent stress, in N/mm², to be obtained as a result of direct calculations

σ_{ALL} : Allowable stress, in N/mm², 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 9, 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].

Part E
Service Notations

Chapter 4
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, [4.5.3].

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

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.

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

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"

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"

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.

1.1.7 Additional service feature "anchor handling stab"

The additional service notation of supply vessels is completed by the additional service feature **anchor handling stab** when they are specially equipped and designed for anchor handling operation and also fulfil specific stability requirements related to this service.

1.1.8 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.

1.1.9 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.

Figure 1

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 product"

2.2.1 Cargo tank capacity

The total capacity of cargo tanks designed to carry oil product having any flashpoint is to be less than 1000 m^3 and not exceed 40% of the total underdeck volume of the ship.

2.2.2 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.

2.2.3 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

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

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.
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

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 [1.1.7].

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 product”

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

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

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 Supply vessels with additional service feature "rescue" are to be provided with at least the following arrangements and equipment:

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 (bathrooms and showers for at least 1/6 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.

2.10 Additional requirements for supply vessels with additional service feature "anchor handling" and "anchor handling stab"

2.10.1 Visibility from the bridge deck

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

Figure 3

2.10.2 Marking on the aft end of working bridge (only supply vessels with additional service feature "anchor handling stab")

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

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

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, [1.2.6] 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, [1.2.6] 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_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.

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

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.

Figure 4

3.4.2 Stability criteria to be fulfilled during anchor handling operations

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.

3.4.3 Information to be provided to the Master

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 accord-

ing 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.

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 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)

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

Sidescuttles and windows, with the relevant hinged and portable deadlight arrangement, are to be fitted according to Fig 5 and Pt B, Ch 9, Sec 9.

The strength of sidescuttles is to comply with Standard ISO 1751 as follows:

- "Type A: in the shell plating, in the sides of superstructures and in the forward facing bulkhead of superstructures and deckhouses on weather deck as indicated in Fig 5
- "Type B: in the after end of superstructures and in the sides and ends of deckhouses as indicated in Fig 5.

Portable deadlights and storm covers, where allowed according to Fig 5, are to be stowed adjacent to the windows for quick mounting.

Where portable deadlights are fitted externally, easy and safe access is to be provided for their mounting (e.g. gangway with rails).

At least two deadlights of wheelhouse windows are to be provided with means to provide a clear view.

The deadlights and storm covers are to comply with recognised national or international standards taking into account the glass thickness of the windows and sidescuttles to which they are attached.

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 : sadimensional factor

p : α p_2 for exposed decks and bulkheads, to be assumed not less than

- 20 kN/m² for front bulkheads
- 13 kN/m² for sides and aft end bulkheads

α : 2 for front bulkheads

α : 13 kN/m2 for sides and aft end bulkheads

P_2 : design sea pressure as given in Pt B, Ch 9, Sec 4, [2.2]

$$\beta = 0,54A_r - 0,078A_r^2 - 0,17 \text{ for } A_r < 3$$

$$\beta = 0,75 \text{ for } A_r \geq 3$$

$$A_r = \frac{a}{b}$$

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 the calculated glass thickness according to the formula above is to be multiplied by 1,4.

Table 7 : Safety factor S

Window and sidescuttle location	2nd tier	3rd tier	4th tier	5th and higher tiers
Front or side	70	75	100	125
Aft	90	95	145	145

Figure 5 : Location windows and sidescuttles

7.3.2 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.

7.3.3 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.

7.3.4 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.

7.3.5 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

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 Strength of rollers and their supporting structures for ships with additional service feature "anchor handling" and "anchor handling stab"

8.3.1 Strength of rollers used for anchor handling operations and of their hull supporting structures

Stern rollers and all the rollers used for anchor handling operations, as well as their hull supporting structures, are to be designed to have a factor of safety of 3 with respect to the minimum yield strength of the material under a working load that is to be assumed not less than the greater of the maximum pull of the winch and the maximum brake holding capacity of the winch.

8.4 Equipment

8.4.1 Chain cables for anchors

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 [1.1.7].

8.4.4 Towline breaking load for ships with additional service feature standby vessel

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.

8.5 Arrangement of winches used for anchor handling operations for ships with additional service feature "anchor handling"

8.5.1 Winch design and testing

The winch materials are to be in compliance with the applicable requirements of Part D.

The maximum handling capacity of the anchor handling winch is to be specified in the structural arrangement of the winch.

The winches are to be subjected to a static test corresponding to their maximum handling capacity and to a static test considering the maximum brake winch holding capacity (with the brake in force).

8.5.2 Winch slip design

Anchor handling winches are to be equipped with a suitable slip device, operable by local and remote control (if possible located on the bridge), allowing the rope to unwind when necessary.

8.5.3 Winch quick-release device

The unhooking of the rope from the winch drum is to be possible by means of a suitable device or by using a rope whose terminal is not fixed to the drum.

8.5.4 Connection with hull structures

The scantlings of the hull structures intended to connect the anchor handling winch to the hull are to be in accordance with Part B, Chapter 7, or Part B, Chapter 8, as applicable, where the load to be considered is the greater of the maximum pull of the winch and the maximum brake holding capacity of the winch.

8.6 Arrangement of winches used for anchor handling operations for ships with additional service feature "anchor handling stab"

8.6.1 Winch design

The anchor handling winches are to be in accordance with the requirements from [8.5.1] to [8.5.4] and, in addition, they are to be fitted with a system suitable to adjust and keep constant the pull (the maximum pull for a precise loading condition is to be fixed by the Master according to the information provided in the operational loading manual).

This system is to be able to release the steel wire rope when the pull is greater than the adjusted one.

8.6.2 Winch monitoring systems

The ship is to be fitted with a monitoring system on the bridge deck showing the following information:

- winch operation data (tension of steel wire rope, wire rope length, wire speed)
- winch control system status.

SECTION 3 MACHINERY AND CARGO SYSTEMS

1 General

1.1 Application

1.1.1 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.

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 1, 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

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 1, Sec 4.

b) For the construction, installation and operation of cargo pumps, the applicable requirements for oil tankers are to be complied with. Refer to Ch 1, Sec 4.

4.1.2 Piping system

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.

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.

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 3, 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 1, 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

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].

4.3 Prevention of pollution

4.3.1 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].

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

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

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.

Part E
Service Notations

Chapter 5
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, [4.5.4].

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, [1.2.5] 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:

$$b_h = \frac{\Sigma \cdot R_i \cdot h_i + S \cdot (T/2 - e)}{9{,}81 \cdot \Delta} \cdot \cos\theta$$

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

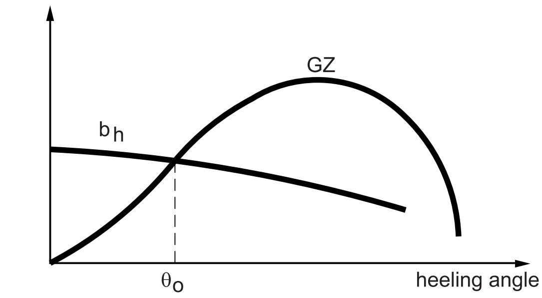
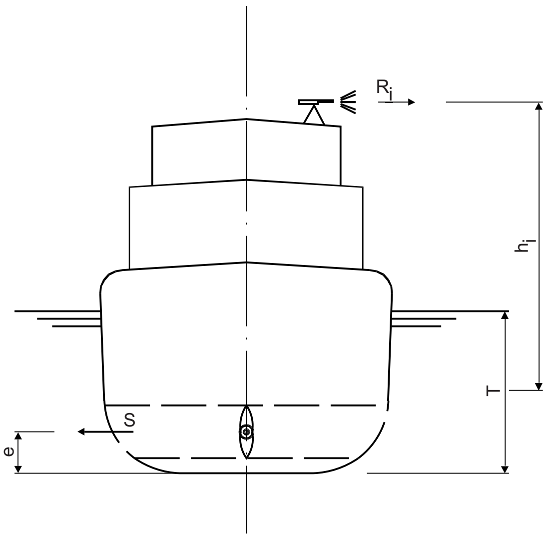


Figure 2 : Reaction force of water jet in the beam direction due to monitors



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)**
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

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

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 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 8, [20.3].

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 8, [20.4].

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 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

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 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

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 8.

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.

Part E
Service Notations

Chapter 6
OIL RECOVERY 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 **oil recovery ship**, as defined in Pt A, Ch 1, Sec 2, [4.5.5].

If the ship collects only oil with flashpoint exceeding 60°C, this restriction will be reported on the ship operation manual and on the ship documents.

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) 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

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

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

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 Dangerous spaces are those indicated in Sec 4, [3] and Sec 4, Tab 1.

2.3 Access to safe spaces

2.3.1 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 This Section provides, for ships having the service notation **oil recovery ship**, specific requirements for:

- machinery systems
- recovered oil pumping and piping systems
- tanks.

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 8, [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 1, Sec 4, [3] and Pt C, Ch 1, Sec 8 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

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

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 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 8, [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 8, [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 1, Sec 4, [2.6].

Table 1 : Documents to be submitted

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 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 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 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 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 Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [9.1.4], Pt C, Ch 2, Sec 3, [9.1.5], and Pt C, Ch 2, Sec 3, [9.1.6].

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 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

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

1.3 Definitions

1.3.1

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 Gas-dangerous spaces are to have a ventilation system independent from that serving gas-safe spaces.

2.1.2 Ventilation systems are to be so arranged as to avoid the formation of gas pockets.

2.1.3 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 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 Ventilation intakes are to be so arranged as to minimise the possibility of recycling hazardous vapours from ventilation discharge openings.

2.2.3 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 Protection screens of not more than 13 mm square mesh are to be fitted on ventilation duct intakes and outlets.

2.2.5 Ventilation fans are to be of non-sparking construction as per Pt C, Ch 4, Sec 1, [5.3].

2.2.6 The ventilation system is to be capable of being controlled from outside the pump room.

Table 1 : Documents to be submitted

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 Ventilation of enclosed normally entered dangerous spaces other than cargo pump rooms

2.3.1 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.

2.3.2 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 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 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 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 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
- the oil flashpoint.

3.2.2 Gas measurement system

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

The equipment for oil flashpoint measurement may be portable.

3.3 Structural fire protection

3.3.1 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 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.eads will not be accepted in these boundaries.

3.3.3 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/m2. The system is to be fully activated by opening of one valve on the bridge.

3.4 Fire fighting

3.4.1 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 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 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 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.

Part E
Service Notations

Chapter 7
CABLE-LAYING 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 **cable laying ship**, as defined in Pt A, Ch 1, Sec 2, [4.5.6].

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 cable laying ships.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to cable laying 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, detection and extinction	**(1)**

(1) No specific requirements for cable laying 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 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 ships

2.1.1 Cable laying ships, 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

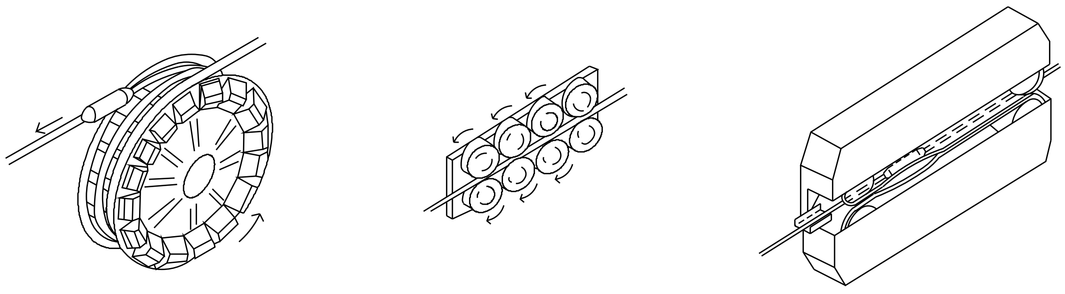
2.3.1 The requirements of this Chapter are based on the assumption that during cable handling all necessary safety measures are taken, due consideration being given to risks connected with the use of machinery and equipment dealt with in [2.1], and that such machinery and equipment are properly used 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.

Part E
Service Notations

Chapter 8
NON-PROPELLED UNITS

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 notations applicable to non propelled units, as defined in Pt A, Ch 1, Sec 2, [4.6.1], [4.6.2]:

- service notations :
  - **barge**
  - **pontoon**
  - **pontoon-crane**
- additional service feature :
  - **non propelled**

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 non-propelled units.

1.2 Summary table

1.2.1 Table 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to non-propelled units.

Table 1

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery systems	Sec 3
Electrical installations	**(1)**
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

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.

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

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.

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 ≤ L ≤ 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

The following intact stability criteria are to be complied with:

- $\theta_C \le 15°$
- $GZ_C \le 0,6\ GZ_{MAX}$
- $A_1 \ge 0,4\ A_{TOT}$

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 10, Sec 9, [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)

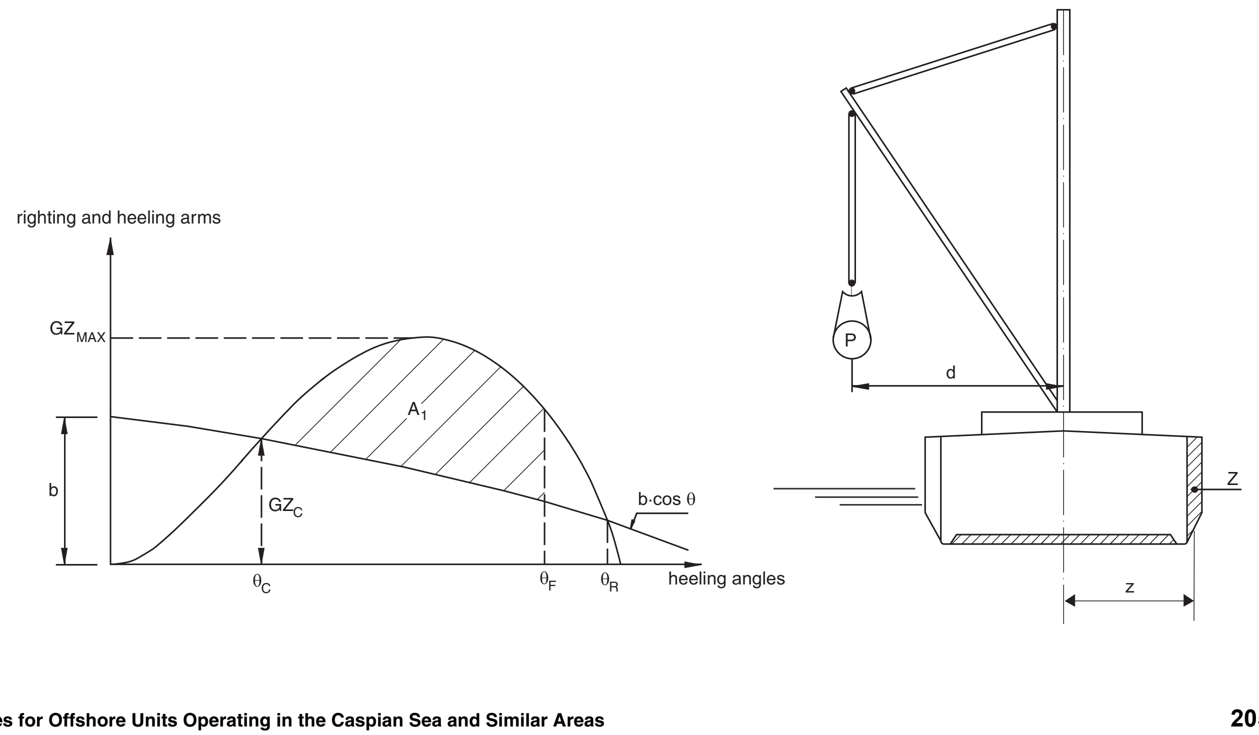
Δ : Displacement, in t, at the loading condition considered.

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

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 2),

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 2)

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 2)

θ_1 : Heeling angle of equilibrium during lifting (see Fig 2)

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 2)

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 2)

θ_R : Heeling angle of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 2).

θ_F : Heeling angle at which progressive flooding may occur (see Fig 2)

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].

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.

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

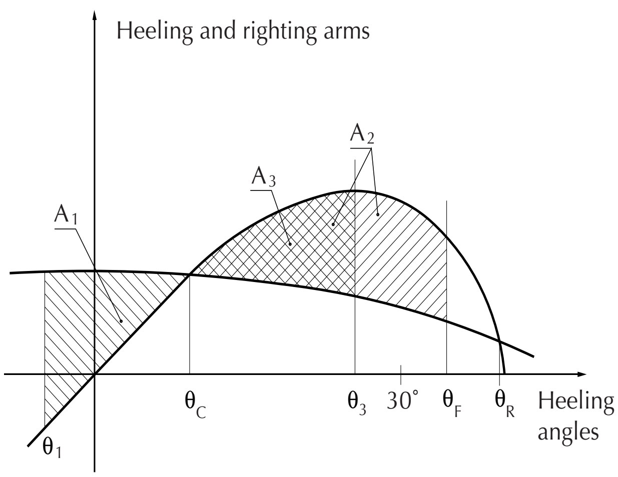
For small non-propelled units intended to be lifted on board ship by crane, the hull girder strength is to be checked, in the condition of fully-loaded barge lifted by crane, through criteria to be agreed with the Society on a case-by-case basis.

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/mm²

$\tau \leq 100/k$ N/mm².

Figure 2 : Cargo loss



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 1.

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 1.

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 1.

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.

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

In addition to the documentation specified in Pt B, Ch 1, Sec 3, the following information is to be submitted to the Society:

- maximum draught of the ship during the different stages of the launching operations
- operating loads and their distribution
- launching cradle location.

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.

Table 1 : 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].	

5.2.3 Deck scantlings

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.

The net thickness of deck plating in way of launch ground ways is to be suitably increased if the cradle may be placed in different positions.

The scantlings of decks in way of pivoting and end areas of the cradle 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

The launching cradles 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 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.

6.1.2 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.

Table 2 : 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

6.1.3 Partial safety factors

The partial safety factors to be considered for checking the reinforcements of the flat bottom forward area are specified in Tab 2.

6.1.4 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 [6.1.1], are to be not less than those obtained according to Pt B, Ch 9, Sec 1, [2] and those obtained from Tab 3.

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 3.

6.1.5 Tapering

Outside the flat bottom forward area, scantlings are to be gradually tapered so as to reach the values required for the areas considered.

6.1.6 Floor spacing

In the area to be reinforced, defined in [6.1.1], the floor spacing is to be not greater than 0,68 $L^{1/4}$.

Table 3 : 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 cm³, 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: • $t = 1{,}5 L_2^{1/3}$ • the thickness of the attached plating.
	Net shear sectional area, in cm²: $A_{Sh} = 10 \gamma_R \gamma_m \beta_s \frac{\gamma_{W2} p_{BI}}{R_y}\left(1 - \frac{s}{2\ell}\right) s \ell$	

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 2

p_{BI} : Bottom dynamic impact pressure, defined in Pt B, Ch 9, Sec 1, [3.2].

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 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.

7.1.3 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.

SECTION 3 MACHINERY SYSTEMS

1 General

1.1 Application

1.1.1 This Section provides requirements for bilge systems of non propelled units.

1.2 Documents to be submitted

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

2 Bilge system

2.1 Bilge system in ships having no source of electrical power

2.1.1 General

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

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 8, [9.1]. In any event they are anyway to be provided with sounding means according to Pt C, Ch 1, Sec 8, [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.

2.2.2 Arrangement of the bilge system

The bilge system is to comply with the provisions of Pt C, Ch 1, Sec 8, [6.3] to Pt C, Ch 1, Sec 8, [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 8, [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 8, [6.8].

Table 1 : Documents to be submitted

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.

Part E
Service Notations

Chapter 9
RESEARCH SHIPS

SECTION 1 GENERAL

SECTION 1 GENERAL

1 Application

1.1

1.1.1 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, [4.5.7]

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 specific requirements given in [2].

2 Specific requirements

2.1

2.1.1 Ships are to comply with the specific requirements for supply vessels given in Chapter 4, 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.

Part E
Service Notations

Chapter 10
PIPE LAYING 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 **pipe laying ship**, as defined in Pt A, Ch 1, Sec 2, [4.5.8].

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 pipe laying ships.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to pipe laying 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, detection and extinction	**(1)**

(1) No specific requirements for pipe laying 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 the hull structures, support structures and connecting structures related to pipe laying operations.

1.2 Documents to be submitted

1.2.1 Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable.

Table 1 : Documents to be submitted

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

2 Foundation structures, supporting structures and fastening

2.1

2.1.1 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 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.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Application

1.1.1 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 Tab 1 lists the plans or documents that are to be submitted to the Society, as applicable.

2 Pipe laying equipment

2.1

2.1.1 The equipment and installation is considered on a case-by-case basis.

3 Anchoring equipment

3.1

3.1.1 The equipment and installation is considered on a case-by-case basis.

4 Dynamic positioning equipment during pipe laying

4.1

4.1.1 In general, the requirements in Pt F, Ch 10, Sec 4 of the Rules apply.

5 Testing of pipe laying, anchoring and positioning equipment

5.1 Testing of materials

5.1.1 In general testing of materials is required according to the applicable requirements of the Rules.

5.2 Hydraulic tests

5.2.1 Pressure parts are to be subjected to hydraulic tests in accordance with Pt C, Ch 1, Sec 3 and Pt C, Ch 1, Sec 8, as applicable.

5.3 Tests of mechanical components

5.3.1 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 The tests required in Part C, Chapter 2 are to be carried out as applicable.

6 Equipment trials on board

6.1

6.1.1 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

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

Part E
Service Notations

Chapter 11
ICE BREAKING EMERGENCY EVACUATION VESSEL (IBEEV)

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 following service notation:

- **IBEEV (Ice Breaking Emergency Evacuation Vessel)**

as defined in Pt A, Ch 1, Sec 2, [4.4.1].

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 IBEEVs.

1.2 Summary table

1.2.1 Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to IBEEV.

Table 1

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Section 2
Machinery and systems	Section 3
Electrical installations	Section 4
Automation	Section 5
Fire protection, detection and extinction	
(1) No specific requirements for IBEEVs are given in this Chapter.	

1.3 Documents to be submitted

1.3.1 In order to verify the actual performance in **Ice Going**, **Ice Breaking**, the capability and structural and machinery response in level and deformed ice of thickness up to (M) meters, the results of ice trials or alternative methods are to be submitted to Tasneef for information and reference.

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 The requirements of this Section apply to Emergency Evacuation Vessels designed to evacuate personnel from off-shore installations in an emergency response situations in a hydrocarbon/ toxic environment, in ice.

2 General arrangement

2.1 General

2.1.1 An IBEEV is required to:

- safely evacuate a number of personnel during emergency situations
- operate in a hydrocarbon/toxic environment
- transit through floating oil pool fires and withstand explosive overpressures, for enough time to navigate outside the highest concentration area of a gas cloud.

2.2 Stability

2.2.1 Intact Stability

The intact stability criteria specified in Tasneef Rules Pt B Ch 3 Sec 2 are to be complied with, as applicable.

2.2.2 Damage Extent

The damage extent specified in Sec. 3.2.2 of IMO MSC/Circ.1056 is to be adopted, as applicable.

2.2.3 Damage Criteria at the Final Stage of Flooding

The following criteria are to be complied with:

- No progressive flooding or down flooding (all non-watertight openings above final damaged waterline)
- Equilibrium heel angle less than 15 degrees (17 degrees if deck edge not submerged)
- Positive range of stability from equilibrium greater than 20 degrees
- Maximum GZ greater than 0.10 m in range 20 degrees from equilibrium position.

2.2.4 Damage Criteria at the Intermediate Stage of Flooding

The following criteria are to be complied with:

- No progressive flooding or down flooding (all non-watertight openings above final damaged waterline)
- Equilibrium heel angle less than 25 degrees (30 degrees if deck edge not submerged)
- Positive range of stability from equilibrium greater than 10 degrees
- Maximum GZ greater than 0.05 m in range 10 degrees from equilibrium position.

2.3 General Arrangement Design

2.3.1 General

Systems and material selection of the exposed areas of the vessel are to take into account the extent of the heat and overpressure loads obtained from the risk analysis of the evacuation scenarios.

2.3.2 Airlocks

Airlock gastight A-60 doors are to be provided to prevent ingress of flammable or toxic gases in the spaces for crew and evacuees or where non-explosion-proof equipment is present.

2.3.3 Wheelhouses

The wheelhouses are to allow 360° range of sight and provide a line of sight to all the release hooks or any equivalent system fitted onboard.

SECTION 3 MACHINERY

1 General

1.1

1.1.1 The IBEEV is required to operate for enough time, obtained from the risk analysis of the evacuation scenarios, to navigate outside the highest concentration area of gas cloud.

Equipment situated in hazardous areas (open deck or upstream of gastight dampers) is to be suitably certified.

2 Documentation to be submitted

2.1

2.1.1 A FMEA or equivalent analysis covering onboard systems is to be submitted to Tasneef for approval.

3 Propulsion

3.1

3.1.1 Diesel engines

Diesel engines are to be automatically stopped in case of overspeed due to suction of hydrocarbon gases where necessary.

3.1.2 Emergency combustion air

A dedicated compressed air system is to be provided to meet the maximum demand from the essential internal combustion engines and for the airlocks when the vessel's ventilation system is shut down due to the presence of flammable or toxic gases. The capacity is to be defined on the basis of the risk analysis of the evacuation scenarios.

The system is to be designed with sufficient redundancy such that a single failure will not result in the immediate exposure of the evacuees to the emergency environment.

4 Ventilation

4.1

4.1.1 General

Fans and dampers are to be shut down in case of gas detection.

Fans are to be rated for operation in explosive atmosphere.

At least five air changes per hour are to be provided in wheelhouses and evacuees' spaces.

The vessel's accommodation and control spaces, machinery spaces, and evacuees' spaces are to be over-pressurised to avoid the ingress of flammable and toxic gases.

4.1.2 Emergency breathing air

The emergency breathing air is to be sized on the number of evacuees, assuming an average CO_2 production rate of 0.6 liters/min per person and an average O_2 consumption of 0.67 liters/min per person.

5 Operation in inclined position

5.1

5.1.1 The main and auxiliary machinery essential to propulsion and the safety of the ship are, as fitted in the ship, be designed to operate when the ship is upright and when inclined at any angle of list up to 22.5° or when inclined up to 10° either in the fore or aft direction or in any combination of angles within those limits.

SECTION 4 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 The requirements of Part C, Chapter 2 apply with the exception of the requirements relevant to emergency electrical system.

In addition to the above, the requirements in this section apply.

1.2 Documentation to be submitted

1.2.1 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 hazardous areas

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

2 Design requirements

2.1 System of supply

2.1.1 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 unfavorable 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 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 Hazardous area classification

3.1.1 For hazardous area classification in case of oil spill see Tab 1.

3.1.2 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.

3.1.3 As a general rule, access doors or other openings are not permitted between an area intended to be considered as non hazardous and a hazardous area, or between a space intended to be considered as zone 2 and a zone 1 space, except where required for operational reasons. Where access doors or other openings are provided for operational reasons, IEC 60092-502 clause 4.1.5 applies.

Table 1 : Classification of hazardous areas

No.	Spaces Description	Hazardous area
1	Areas extending up to a height of 1 m above the surface of the water or deepest load waterline	Zone 0
2	Areas extending above a height of 1 m above the surface of the water or deepest load waterline	Zone 1
3	Airlocks	Zone 2

3.2 Electrical equipment permitted in hazardous areas

3.2.1 Electrical equipment permitted in hazardous areas is that indicated in Pt C, Ch 2, Sec 3, [9.1.4], Pt C, Ch 2, Sec 3, [9.1.5] and Pt C, Ch 2, Sec 3, [9.1.6].

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

3.2.2 The explosion group and temperature class of electrical equipment of a certified safe type are to be at least IIB and T3.:

3.2.3 Non-certified safe-type equipment may be permitted, provided that they are:

- located in non hazardous areas for the duration of the service in a hazardous atmosphere only, and
- disconnected and safeguarded against unauthorized reconnection at a control position located in non-hazardous area (e.g. by means of disconnectors lockable in open position), for the duration of service in a hazardous atmosphere, until gas freeing is carried out.

Warning plates are to be provided at the above mentioned control position and suitable written instructions are to be given.

4 Heating

4.1

4.1.1 Assuming external air temperature of -35°C, the heating system is to achieve the following minimum temperature conditions:.

- Wheelhouse 20°C
- Machinery spaces 5°C

5 Emergency electrical system

5.1 Emergency sources and users

5.1.1 An emergency source of electrical power is to be provided, of sufficient capacity 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.

5.1.2 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:

a) for a period of 3 hours, the emergency lighting

b) for a period of 12 hours:

   1) the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force

   2) the radio installation

   3) all internal communication equipment as required in an emergency unless other communication means are proved efficient

   4) fire & gas detection and alarm systems.

c) for a period of half a hour, the ship's control systems.

5.1.3 Low location lighting is to be provided at least in evacuees' spaces, airlocks, watertight door areas, wheelhouses, switchboards and machinery spaces.

5.1.4 External lighting, certified for hazardous areas, is to be provided at least at the external doors, LSA launch area and routes to LSA.

SECTION 5 AUTOMATION

1 Propulsion

1.1

1.1.1 The propulsion is to be fully controllable from any control position/ wheelhouses.

2 Alarms and Indications

2.1

2.1.1 Visual alarms and indicating units, powered by the emergency supply and fail-safe or self-monitoring type, are to be fitted throughout the unit alerting occupants of concentrations of hazardous gas outside the safe thresholds. As a minimum, the following locations are to be monitored:

- Wheelhouses, to be equipped with O_2, flammable gases, H_2S, CO_2 and smoke detectors.
- Airlocks, to be equipped with O_2, flammable gases, H_2S, and CO_2 detectors
- Evacuees' spaces, to be equipped with O_2, flammable gases, H_2S, CO_2 and smoke detectors.
- Machinery spaces, to be equipped with H_2S detectors.
- Switchboard spaces, to be equipped with H_2S detectors
- Ventilation intakes/exhausts, to be equipped with H_2S detectors, with the addition of flammable gas detectors for intake/exhaust trunks of machinery spaces
- Ventilation/breathing air equipment space to be equipped with smoke detectors.

3 Monitoring in emergency

3.1

3.1.1 In case the unit is gastight closed in hazardous gas cloud operation, a 24 V DC system is to be fitted to monitor the status of the following system :

- Ventilation damper control/status
- Ventilation fan control/status
- Combustion air status
- Concentration of CO_2 and O_2 in evacuees' spaces
- Concentration of CO_2 and O_2 in breathing air system
- Electrically operated valves status

Part E
Service Notations

Chapter 12
AIR CUSCHION BARGE (ACB)

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 *(1/3/2017)*

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation **ACB (Air Cushion Barge)** as defined in Pt A, Ch 1, Sec 2, [4.7.1].

1.1.2 *(1/3/2017)*

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 ACBs.

1.1.3 *(1/3/2017)*

Exemptions from the requirements in [1.1.2] and /or the application of alternative are considered by Tasneef on a case-by-case basis, depending on the characteristics of the unit concerned.

1.2 Summary table

1.2.1 *(1/3/2017)*

Tab 1 indicates, for ready reference, the Sections of this Chapter containing specific requirements applicable to **ACB**.

Table 1 *(1/3/2017)*

Main subject	Reference
Ship arrangement	**(1)**
Hull and stability	Sec 2
Machinery and systems	Sec 3
Electrical installations	Sec 4
Automation	Sec 5
Automation	Sec 6
Handling, controllability and performance	**(1)**

(1) No specific requirements for pipe laying ships are given in this Chapter

SECTION 2 HULL AND STABILITY

1 General

1.1 Application

1.1.1 *(1/3/2017)*

This Section provides requirements for hull and stability of ACBs.

2 Hull

2.1 Structures

2.1.1 *(1/3/2017)*

Chapter 3 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

2.2 Anchoring, towing and berthing

2.2.1 *(1/3/2017)*

Chapter 3 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.Chapter 6 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

2.3 Buoyancy, Stability and Subdivision

2.3.1 *(1/3/2017)*

Chapter 2 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

SECTION 3 MACHINERY AND SYSTEMS

1 General

1.1 Application

1.1.1 *(1/3/2017)*

This Section provides requirements for machinery and systems of ACBs.

1.2 Machinery and systems

1.2.1 Machinery *(1/3/2017)*

Chapter 9 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

For lift fans and propulsion propellers certification the standards of the manufacturer apply.

1.2.2 Auxiliary systems *(1/3/2017)*

Chapter 10 of the Rules for the of Rules for Special Ships and Units Res.21/ E apply.

1.2.3 Stabilization systems *(1/3/2017)*

Chapter 16 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

1.2.4 Directional Control systems *(1/3/2017)*

Chapter 10 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

SECTION 4 ELECTRICAL INSTALLATIONS

1 General

1.1 Application

1.1.1 *(1/3/2017)*

This Section provides requirements for main, auxiliary and emergency source of power, steering and stabilization, precautions against shock electrical installations of ACBs.

1.1.2 Electrical installations *(1/3/2017)*

Chapter 12 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

SECTION 5 AUTOMATION

1 General

1.1

1.1.1 *(1/3/2017)*

This Section provides requirements for automation of ACBs.

1.1.2 Remote control, alarm and systems *(1/3/2017)*

Chapter 11 of the Rules for the application of Rules for Special Ships and Units RES.21/E apply.

SECTION 6 HANDLING, CONTROLLABILITY AND PERFORMANCE

1 General

1.1

1.1.1 *(1/3/2017)*

This Section provides requirements for handling, controllability and performance of ACBs.

1.1.2 Handling, controllability and performance *(1/3/2017)*

Chapter 17 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.

SECTION 7 INSPECTION AND MAINTENANCE REQUIREMENTS

1 General

1.1

1.1.1 *(1/3/2017)*

This Section provides requirements for inspection and maintenance requirements of ACBs.

1.1.2 Inspection and maintenance requirements *(1/3/2017)*

Chapter 19 of the Rules for the application of Rules for Special Ships and Units Res.21/ E apply.