Marine Division
Marine Website: http://www.veristar.com
Email: veristarinfo@bureauveritas.com

Rules for the Classification of Inland Navigation Vessels

PART D – Additional Requirements for Notations

Chapters 1 – 2 – 3

NR 217.D1 DNI R02 E April 2009

Inland Navigation Management
Mechelsesteenweg 128/136
B-2018 Antwerpen - Belgium
Tel: + 32 (0)3 247 94 00 / + 32 (0)3 247 94 70
Email: bvnirulesbelgium@be.bureauveritas.com

MARINE DIVISON

GENERAL CONDITIONS

ARTICLE 1

1.1. - BUREAU VERITAS is a Society the purpose of whose Marine Division (the "Society") is the classification (" Classification ") of any ship or vessel or structure of any type or part of it or system therein collectively hereinafter referred to as a "Unit" whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

The Society:

- prepares and publishes Rules for classification, Guidance Notes and other documents ("Rules");
- issues Certificates, Attestations and Reports following its interventions ("Certificates");
- publishes Registers.

1.2. - The Society also participates in the application of National and International Regulations or Standards, in particular by delegation from different Governments. Those activities are hereafter collectively referred to as " Certification ".

1.3. - The Society can also provide services related to Classification and Certification such as ship and company safety management certification; ship and port security certification, training activities; all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board.

1.4. - The interventions mentioned in 1.1., 1.2. and 1.3. are referred to as " Services ". The party and/or its representative requesting the services is hereinafter referred to as the " Client ". **The Services are prepared and carried out on the assumption that the Clients are aware of the International Maritime and/or Offshore Industry (the "Industry") practices.**

1.5. - The Society is neither and may not be considered as an Underwriter, Broker in ship's sale or chartering, Expert in Unit's valuation, Consulting Engineer, Controller, Naval Architect, Manufacturer, Shipbuilder, Repair yard, Charterer or Shipowner who are not relieved of any of their expressed or implied obligations by the interventions of the Society.

ARTICLE 2

2.1. - Classification is the appraisement given by the Society for its Client, at a certain date, following surveys by its Surveyors along the lines specified in Articles 3 and 4 hereafter on the level of compliance of a Unit to its Rules or part of them. This appraisement is represented by a class entered on the Certificates and periodically transcribed in the Society's Register.

2.2. - Certification is carried out by the Society along the same lines as set out in Articles 3 and 4 hereafter and with reference to the applicable National and International Regulations or Standards.

2.3. - **It is incumbent upon the Client to maintain the condition of the Unit after surveys, to present the Unit for surveys and to inform the Society without delay of circumstances which may affect the given appraisement or cause to modify its scope.**

2.4. - The Client is to give to the Society all access and information necessary for the safe and efficient performance of the requested Services. The Client is the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out.

ARTICLE 3

3.1. - **The Rules, procedures and instructions of the Society take into account at the date of their preparation the state of currently available and proven technical knowledge of the Industry. They are not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.**

Committees consisting of personalities from the Industry contribute to the development of those documents.

3.2. - The Society only is qualified to apply its Rules and to interpret them. Any reference to them has no effect unless it involves the Society's intervention.

3.3. - The Services of the Society are carried out by professional Surveyors according to the applicable Rules and to the Code of Ethics of the Society. Surveyors have authority to decide locally on matters related to classification and certification of the Units, unless the Rules provide otherwise.

3.4. - **The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not in any circumstances involve monitoring or exhaustive verification.**

ARTICLE 4

4.1. - The Society, acting by reference to its Rules:

- reviews the construction arrangements of the Units as shown on the documents presented by the Client;
- conducts surveys at the place of their construction;
- classes Units and enters their class in its Register;
- surveys periodically the Units in service to note that the requirements for the maintenance of class are met.

The Client is to inform the Society without delay of circumstances which may cause the date or the extent of the surveys to be changed.

ARTICLE 5

5.1. - The Society acts as a provider of services. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty.

5.2. - The certificates issued by the Society pursuant to 5.1. here above are a statement on the level of compliance of the Unit to its Rules or to the documents of reference for the Services provided for.

In particular, the Society does not engage in any work relating to the design, building, production or repair checks, neither in the operation of the Units or in their trade, neither in any advisory services, and cannot be held liable on those accounts. Its certificates cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.

5.3. - The Society does not declare the acceptance or commissioning of a Unit, nor of its construction in conformity with its design, that being the exclusive responsibility of its owner or builder, respectively.

5.4. - The Services of the Society cannot create any obligation bearing on the Society or constitute any warranty of proper operation, beyond any representation set forth in the Rules, of any Unit, equipment or machinery, computer software of any sort or other comparable concepts that has been subject to any survey by the Society.

ARTICLE 6

6.1. - The Society accepts no responsibility for the use of information related to its Services which was not provided for the purpose by the Society or with its assistance.

6.2. - If the Services of the Society cause to the Client a damage which is proved to be the direct and reasonably foreseeable consequence of an error or omission of the Society, its liability towards the Client is limited to ten times the amount of fee paid for the Service having caused the damage, provided however that this limit shall be subject to a minimum of eight thousand (8,000) Euro, and to a maximum which is the greater of eight hundred thousand (800,000) Euro and one and a half times the above mentioned fee.

The Society bears no liability for indirect or consequential loss such as e.g. loss of revenue, loss of profit, loss of production, loss relative to other contracts and indemnities for termination of other agreements.

6.3. - All claims are to be presented to the Society in writing within three months of the date when the Services were supplied or (if later) the date when the events which are relied on of were first known to the Client, and any claim which is not so presented shall be deemed waived and absolutely barred. Time is to be interrupted thereafter with the same periodicity.

ARTICLE 7

7.1. - Requests for Services are to be in writing.

7.2. - **Either the Client or the Society can terminate as of right the requested Services after giving the other party thirty days' written notice, for convenience, and without prejudice to the provisions in Article 8 hereunder.**

7.3. - The class granted to the concerned Units and the previously issued certificates remain valid until the date of effect of the notice issued according to 7.2. here above subject to compliance with 2.3. here above and Article 8 hereunder.

7.4. - The contract for classification and/or certification of a Unit cannot be transferred neither assigned.

ARTICLE 8

8.1. - The Services of the Society, whether completed or not, involve, for the part carried out, the payment of fee upon receipt of the invoice and the reimbursement of the expenses incurred.

8.2. Overdue amounts are increased as of right by interest in accordance with the applicable legislation.

8.3. - The class of a Unit may be suspended in the event of non-payment of fee after a first unfruitful notification to pay.

ARTICLE 9

9.1. - The documents and data provided to or prepared by the Society for its Services, and the information available to the Society, are treated as confidential. However:

- clients have access to the data they have provided to the Society and, during the period of classification of the Unit for them, to the **classification file** consisting of survey reports and certificates which have been prepared at any time by the Society for the classification of the Unit;
- copy of the documents made available for the classification of the Unit and of available survey reports can be handed over to another Classification Society, where appropriate, in case of the Unit's transfer of class;
- the data relative to the evolution of the Register, to the class suspension and to the survey status of the Units, as well as general technical information related to hull and equipment damages, are passed on to IACS (International Association of Classification Societies) according to the association working rules;
- the certificates, documents and information relative to the Units classed with the Society may be reviewed during certificating bodies audits and are disclosed upon order of the concerned governmental or inter-governmental authorities or of a Court having jurisdiction.

The documents and data are subject to a file management plan.

ARTICLE 10

10.1. - Any delay or shortcoming in the performance of its Services by the Society arising from an event not reasonably foreseeable by or beyond the control of the Society shall be deemed not to be a breach of contract.

ARTICLE 11

11.1. - In case of diverging opinions during surveys between the Client and the Society's surveyor, the Society may designate another of its surveyors at the request of the Client.

11.2. - Disagreements of a technical nature between the Client and the Society can be submitted by the Society to the advice of its Marine Advisory Committee.

ARTICLE 12

12.1. - Disputes over the Services carried out by delegation of Governments are assessed within the framework of the applicable agreements with the States, international Conventions and national rules.

12.2. - Disputes arising out of the payment of the Society's invoices by the Client are submitted to the Court of Nanterre, France.

12.3. - **Other disputes over the present General Conditions or over the Services of the Society are exclusively submitted to arbitration, by three arbitrators, in London according to the Arbitration Act 1996 or any statutory modification or re-enactment thereof. The contract between the Society and the Client shall be governed by English law.**

ARTICLE 13

13.1. - **These General Conditions constitute the sole contractual obligations binding together the Society and the Client, to the exclusion of all other representation, statements, terms, conditions whether express or implied. They may be varied in writing by mutual agreement.**

13.2. - The invalidity of one or more stipulations of the present General Conditions does not affect the validity of the remaining provisions.

13.3. - The definitions herein take precedence over any definitions serving the same purpose which may appear in other documents issued by the Society.

RULES FOR INLAND NAVIGATION VESSELS

Part D
Additional Requirements for Notations

Chapters **1 2 3**

April 2009

These Rules apply to inland navigation vessels for which contracts for construction are signed on or after July 1st, 2009.

The English version of these Rules takes precedence over editions in other languages.

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Part D
Additional Requirements for Notations

Chapter 1
TYPE AND SERVICE NOTATIONS

SECTION 1 GENERAL CARGO VESSELS

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

B_1 : Breadth, in m, of the hold

A_{SH} : Net web sectional area, in cm^2

w : Net section modulus, in cm^3, of ordinary stiffeners or primary supporting members

S, s : Stiffener spacing, in m

ℓ : Stiffener span, in m

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4]

β_b, β_S : Bracket coefficients defined in Pt B, Ch 2, Sec 2, [5.2]

n : Navigation coefficient defined in Pt B, Ch 3, Sec 1, [5.2]

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the type and service notation **General cargo vessel**, as defined in Pt A, Ch 2, Sec 3, [3.1.1].

1.1.2 Vessels dealt with in this Section are to comply with the requirements stipulated in Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to general cargo vessels.

1.2 Stability

1.2.1 Depending on the vessel's design and operating conditions, proof of sufficient stability may be required by the Society.

1.3 Direct calculation

1.3.1 The following requirements apply for the analysis of primary supporting members.

Direct calculation is to be carried out in compliance with Pt B, Ch 2, Sec 5.

1.3.2 Loading cases

The following loading conditions are to be considered in the analysis of the hold structure supporting members:

a) Loading / unloading in two runs
   - full cargo load and vessel draught equal to 0,575T
   - vessel draught equal to 0,575T, without cargo load.

b) Loading / unloading in one run
   - full cargo load and vessel draught equal to 0,15T
   - vessel draught equal to T, without cargo load.

1.3.3 Structure checks

The following checks are to be carried out:

- level of bending stresses and shear stresses, in particular, in way of holes and passage of longitudinals
- buckling strength of unstiffened web
- for double hull vessels, continuity of double bottom in the side tank.

2 Single side general cargo vessels

2.1 General

2.1.1 Application

The requirements of this Article apply to open deck vessels of single side construction, with or without double bottom, intended primarily to carry general cargoes.

The loading/unloading may be performed in one or two runs.

2.2 Protection of cargo holds

2.2.1 Coating

All metallic structures are to be protected against corrosion according to Pt B, Ch 8, Sec 2.

Suitable coatings for the intended cargoes (in particular for the compatibility with the cargo) are to be chosen and applied in accordance with the manufacturer's requirements.

2.2.2 Cargo hold ceiling

The cargo hold bottom is to be sheathed up to the upper part of bilges by wooden or metallic ceiling of thickness depending on the cargo nature.

Where a side ceiling is provided, it is to be secured every 4 frame spacings to the side frames by an appropriate system.

2.3 Accesses

2.3.1 Access to double bottom

Manholes may be cut in the floors and side girders to provide convenient access to all parts of the double bottom.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

As a rule, the manholes height is not to be more than 0,6 times the floor height or girder height.

Manholes in the floors are to be located at half the floor height and in a region extending on 0,2B from the axis of the vessel, on both sides. When a central girder exists, its distance to the nearest side of cutting is not to be less than the double bottom height.

Manholes in the side girders are to be located at half the girder height and midway between two successive web frames.

2.3.2 Access to cargo hold

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

2.4 Bottom structure

2.4.1 Single bottom vessels are to be fitted with girders in compliance with Pt B, Ch 5, Sec 2, [6.2] or Pt B, Ch 5, Sec 2, [7.3].

2.4.2 Transversely framed single bottom

A single bottom transversely framed is to be fitted with floors at every frame.

2.4.3 Longitudinally framed single bottom

Longitudinal stiffeners are generally to be continuous when crossing primary members.

The section modulus of longitudinals located in way of the web frames of transverse bulkheads is to be increased by 10%.

Longitudinals are to be supported by transverses whose spacing is to be not greater than 8 frame spacing, nor than 4 m, which is the lesser.

2.5 Transversely framed side

2.5.1 Connection of frames with floors

The frames are to be connected to the floors in compliance with Pt B, Ch 5, Sec 3, [6.1].

2.5.2 Connection with deck structure

At the upper end of frames, connecting brackets are to be provided, in compliance with Pt B, Ch 5, Sec 3, [10]. Such brackets are to extend to the hatch coaming.

2.5.3 Web frames

Web frames are to be fitted with a spacing not exceeding 5 m.

Their scantling is to be performed according to [2.8.2].

2.5.4 Connection of frames to bottom longitudinals

In the case of a longitudinally framed single bottom, the side frames are connected to the bottom longitudinal most at side, either directly or by means of a bracket.

Similarly, at the frame upper part, connecting brackets are to be provided, extending up to the deck longitudinal most at side and even to:

- the hatch coaming, in general
- the side trunk bulkhead, in case of a trunk vessel.

2.6 Longitudinally framed side

2.6.1 Side transverses

Side transverses are to be fitted in general, with a spacing not greater than 8 frame spacings, nor than 4m.

Their scantling is to be performed according to [2.8.2] here-below.

The side transverses are generally directly welded to the shell plating.

In the case of a double bottom, the side transverses are to be bracketed to the bottom transverses.

2.6.2 Side longitudinals

Longitudinal ordinary stiffeners are generally to be continuous when crossing primary supporting members.

In the case the longitudinals are interrupted by a primary supporting member, brackets on both sides of the primary supporting member are to be fitted in perfect alignment.

2.7 Topside structure

2.7.1 Strength continuity

At the ends of the cargo hold space, the members taking part in the overall strength are to be correctly staggered.

Arrangements are to be made to ensure strength continuity of the topside structure at the end of the hatchways. As far as practicable, it is recommended to extend the part of the hatch coaming which is located above deck and to connect it to the side bulkheads of the accommodation spaces.

2.8 Hull scantlings

2.8.1 General

The hull scantlings are to be as specified in Part B, Chapter 5, unless otherwise specifies.

2.8.2 Transverse rings

Where necessary, transverse rings are to be fitted to provide additional supports of the stringer plate.

The ring component scantlings are not to be less than required in Tab 1.

2.8.3 Transverse hold bulkhead structure

The number and location of transverse bulkheads are defined in Pt B, Ch 5, Sec 5.

Where necessary, additional bulkheads are to be fitted to provide for sufficient transverse strength of the vessel.

The scantlings of transverse hold bulkheads are to be not less than required in Pt B, Ch 5, Sec 5.

a) Vertically framed plate bulkhead

   The upper end of the vertical stiffeners is to be connected either to a strong deck box beam or to a stringer located at the stringer plate level or above.

   As far as practicable, the bottom of the box beam or the bulkhead end stringer is to be located in the same plane as the stringer plate.

Where this is not the case, the bulkhead plating or the box beam sides are to be fitted with an efficient horizontal framing at that level.

b) Horizontally framed bulkhead

The upper part of horizontally framed bulkheads are to be specially considered by the Society.

c) Plate bulkhead end stringer

The net scantlings of the plate bulkhead end stringer is to be determined using the formula:

$$w = \beta_b \frac{p}{m(226/k - \sigma_A)} S \ell^2 10^3$$

where:

p : Bulkhead end stringer design load, in kN/m², to be determined using applicable formulas given in Pt B, Ch 3, Sec 4, [3]

S : Bulkhead stringer spacing, in m

σ_A : Bulkhead end stringer axial stress, in N/mm²

$$\sigma_A = \frac{10qD_1}{A}$$

A : Bulkhead end stringer sectional area, in cm², to be determined in compliance with Pt B, Ch 5, Sec 4, [9.2.2], where:

$P_S = q\ D_1$

q : Distributed transverse load acting on the stringer plate, in kN/m, to be determined as stated under Pt B, Ch 5, Sec 4, [4.4.1]

D_1 : Unsupported stringer plate length, in m, defined under Pt B, Ch 5, Sec 4, [4.4.2]

In way of hold end bulkheads D_1 is to be sustituted by $0{,}5D_1$

m : Boundary coefficient to be taken equal to 8

3 Double hull general cargo vessels

3.1 General

3.1.1 Application

The requirements of this Article apply to open deck vessels of double hull construction, intended primarily to carry general cargoes.

The loading/unloading may be performed in one or two runs.

3.1.2 Protection of cargo holds

All metallic structures are to be protected against corrosion according to Pt B, Ch 8, Sec 2.

Suitable coatings for the intended cargoes (in particular for the compatibility with the cargo) are to be chosen and applied in accordance with the manufacturer's requirements.

3.1.3 Access to double bottom

Manholes may be cut in the floors and side girders to provide convenient access to all parts of the double bottom.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

As a rule, the manholes height is not to be more than 0,6 times the floor height or girder height.

Manholes in the floors are to be located at half the floor height and in a region extending on $0{,}2B_1$ from the axis of the vessel, on both sides. When a central girder exits, its distance to the nearest side of cutting is not to be less than the double bottom height.

Manholes in the side girders are to be located at half the girder height and midway between two successive web frames. Their distance from the transverse bulkheads of the side tanks is not to be less than 1,5 m, if there is no web frame. The Society may wave this rule subject to direct calculation of the shear stresses.

3.1.4 Access to side tanks

Where openings allowing access to side tanks are cut in the stringer plate, they are to be arranged clear of the hatch corners and shall be of even-deck design, without obstacles causing stumbling. In order to assure the continuity of the strength, they are to be cut smooth along a well rounded design and are to be strengthened by thick plates, by doubling plates or by other equivalent structure.

3.1.5 Access to cargo hold

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

3.2 Welding

3.2.1 General

Welding is to comply with the requirements of Pt B, Ch 8, Sec 1.

3.2.2 Arrangements applying to the shell plating and the double hull

Transverse butts are to be butt welded. Double bottom butts may be welded in way of floor faceplate which then acts as a support.

The longitudinal joints are to be obtained either by butt welding or by overlap welding. In the second case, the outer line welding is to be continuous with a throat thickness of 0,5t, whereas the inner line of welding may be discontinuous with a ratio $p/d < 4$ and a throat thickness of 0,5t; however, for spaces which are not accessible after construction, the inner weld is to be carried out with a continuous line welding.

3.2.3 Arrangements applying to the topside plating

Butt weldings are to be carried out on the transverse butts of the sheerstrake, stringer plate and coaming.

3.2.4 Connection of inner bottom with floors

Where the floors cannot be welded to the inner bottom by means of fillet welds, the connection may be obtained by slot welds, in compliance with Pt B, Ch 8, Sec 1, [2.7]. In that case, the floors are to be fitted with flange of adequate width.

3.3 Transversely framed double side

3.3.1 Structural arrangement

Where the inner side does not extend down to the outer bottom, it is to be held in position by means of brackets or vertical stiffeners fitted to the floors.

Adequate continuity strength is to be ensured in way of changes in width of the double side. In particular, scarfing of the inner side is to be ensured beyond the cargo hold region.

3.3.2 Side and inner side frames

At their upper end, side and inner side frames are to be connected by means of a bracket. This bracket can be a section or a flanged plate with a section modulus at least equal to that of the side web frames.

Where the outer and inner side frames are connected by means of struts located at mid-span, their section modulus may be reduced by 30%.

The strut sectional area is to be not less than those of the connected frames.

At their lower end, the frames are to be adequately connected to the floors or top tank.

3.3.3 Side and inner side web frames

It is recommended to provide side web frames, fitted every 3 m and, in general, not more than 6 frame spacings apart.

At their upper end, side and inner side web frames are to be connected by means of a bracket. This bracket can be a section or a flanged plate with a section modulus at least equal to that of the side web frames. An attached plating strip, where applicable, may be taken into account.

The web frames are to be connected at their mid-span by means of struts, the cross sectional area of which is not to be less than those of the connected web frames.

At their lower end, the web frames are to be adequately connected to the floors or top tank.

3.3.4 Plate webs

Plate webs may be fitted in addition or instead of web frames.

Plate webs are to be fitted with horizontal stiffeners, the spacing of which is not to be greater than 1 m.

The scantling of plate webs with large openings is to be examined by the Society on a case by case basis.

3.4 Longitudinally framed double side

3.4.1 Inner side plating

The requirements of [3.3.1] also apply to longitudinally framed double side, with the transverses instead of web frames.

3.4.2 Side and inner side longitudinals

Where the outer and inner side longitudinals are connected by means of struts located at mid-span, their section modulus may be reduced by 30%.

The strut sectional area is to be not less than those of the connected longitudinals.

3.4.3 Side transverses

The requirements of [3.3.3] also apply to longitudinally framed double side, with the transverses instead of web frames.

3.4.4 Plate webs

The requirements of [3.3.4] also apply to longitudinally framed double side.

3.5 End structure

3.5.1 Arrangements for self-propelled vessels

At the ends of the cargo hold space, the strength continuity of members taking part in the overall strength is to be adequately ensured.

In particular, arrangements are to be made to ensure strength continuity of the top structure at the end of the hatchways. As far as practicable, it is recommended to extend the part of the hatch coaming located above deck and to connect it to the side bulkheads of the accommodation spaces.

The longitudinal boundaries of the engine room side bunkers are to be located, as far as practicable, in the extension of the double hull sides.

3.5.2 Arrangements for pushed vessels

Where the compartments outside the cargo hold space are of small size, the strength continuity is to be ensured by scarfing of strength members.

The double hull sides are to be extended, in the shape of brackets, outside the cargo hold space over a distance equal to twice the stringer plate width.

Strength continuity of the inner bottom is to be ensured by means of brackets, one of which is to be along the vessel's centreline. Where the vessel ends are built on the longitudinal system, the brackets are to be connected to the bottom longitudinals; otherwise, they are to be connected to keelsons.

Pushing transoms, if any, are to be designed in compliance with Pt B, Ch 7, Sec 6, [2.2].

3.6 Hull scantlings

3.6.1 General

The hull scantlings and arrangements are to be determined according to Part B, Chapter 5, unless otherwise specifies.

Table 1 : Net scantling of transverse rings

Primary supporting member	w (cm^3)	A_{Sh} (cm^2)
Floors Bottom transverses	$w = \beta_b \frac{p}{m(226/k)} a B^2 10^3$	$A_{sh} = 10\beta_S \frac{p}{226/k} a B$
Side webs and side transverses **(1)** if $\ell_0 \leq \ell$ if $\ell_0 > \ell$	$w = 26\beta_b \frac{\ell}{m(226/k)} S \ell_0^2 10^3$ $w = 4,4\lambda_b \beta_b \frac{p}{m(226/k)} S \ell^2 10^3$	$A_{sh} = 68\beta_S \frac{\ell}{226/k} S \ell_0$ $A_{sh} = 10\beta_S \frac{p}{226/k} S \ell$
Strong box beams	see Pt B, Ch 5, Sec 4, [4.4.4]	

p : Design load, in kN/m², defined in Pt B, Ch3, Sec 4
ℓ_0 : Span parameter, in m
$\ell_0 = p_d / 9,81$
p_d : Total pressure, in kN/m², at the lower end of the stiffener
a : Structural member spacing
a = s for floors
a = S for bottom transverses
m : Boundary coefficient to be taken equal to 8
(1) Scantlings of web frames and side transverses at the lower end are to be the same as those of floors or bottom transverses connected to them.

3.6.2 General arrangements of double bottom structure

Where the inner side plating does not extend down to the bottom plating, the floors of vessels built in the transverse system are to be stiffened, at each frame, in way of the inner side plating, by means of a section, the net sectional area of which, in cm², is not to be less than:

$A = 0,01\ b\ t_F$

where:

t_F : Net thickness of floor web, in mm

b : Section height, in mm

$b = 100H_D$

H_D : Double bottom height, in m

As a rule, manholes are not to be provided into the centreline girder.

3.6.3 Transverse hold bulkhead structure

Arrangements and scantlings of transverse hold bulkheads are to be in compliance with Pt B, Ch 5, Sec 5.

SECTION 2 BULK CARGO VESSELS

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

B_1 : Breadth, in m, of the hold

A_{SH} : Net web sectional area, in cm^2

w : Net section modulus, in cm^3, of ordinary stiffeners or primary supporting members

S, s : Stiffener spacing, in m

ℓ : Stiffener span, in m

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4]

β_b, β_S : Bracket coefficients defined in Pt B, Ch 2, Sec 2, [5.2]

n : Navigation coefficient defined in Pt B, Ch 3, Sec 1, [5.2]

p_S : Bottom or inner bottom still water design pressure, in kN/m^2, defined in Pt B, Ch 3, Sec 4, [3.2.3]

ρ_B, φ_B : Dry bulk cargo density, in t/m^3, and angle of repose, in degree

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the type and service notation **Bulk cargo vessel**, as defined in Pt A, Ch 2, Sec 3, [3.1.2].

1.1.2 Vessels dealt with in this Section are to comply with the requirements stipulated in Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to bulk cargo vessels.

1.2 Stability

1.2.1 Depending on the vessel's design and operating conditions, proof of sufficient stability may be required by the Society.

1.3 Estimated still water design bending moments

1.3.1 Estimated still water design bending moments are to be determined in compliance with Pt B, Ch 3, Sec 2. If parameters X_{AV} and X_{AR} are not known, they are not to be taken less than:

$$X_3 = \frac{p_S}{19,6\rho_B \tan\varphi_B}$$

where:

1.4 Direct calculation

1.4.1 The following requirements apply for the analysis of primary supporting members.

Direct calculation is to be carried out in compliance with Pt B, Ch 2, Sec 5.

1.4.2 Loading cases

The following loading conditions are to be considered in the analysis of the hold structure supporting members:

a) Loading / unloading in two runs
   - full cargo load and vessel draught equal to 0,575T
   - vessel draught equal to 0,575T, without cargo load.

b) Loading / unloading in one run
   - full cargo load and vessel draught equal to 0,15T
   - vessel draught equal to T, without cargo load.

1.4.3 Structure checks

The following checks are to be carried out:

- level of bending stresses and shear stresses, in particular, in way of holes and passage of longitudinals
- buckling strength of unstiffened web
- for double hull vessels, continuity of double bottom in the side tank.

2 Single side bulk cargo vessels

2.1 General

2.1.1 Application

The requirements of this Article apply to open deck vessels of single side construction, with or without double bottom, intended primarily to carry bulk dry cargoes.

The loading/unloading may be performed in one or two runs.

2.2 Protection of cargo holds

2.2.1 Coating

All metallic structures are to be protected against corrosion according to Pt B, Ch 8, Sec 2.

Suitable coatings for the intended cargoes (in particular for the compatibility with the cargo) are to be chosen and applied in accordance with the manufacturer's requirements.

2.2.2 Cargo hold ceiling

The cargo hold bottom is to be sheathed up to the upper part of bilges by wooden or metallic ceiling of thickness depending on the cargo nature.

Where a side ceiling is provided, it is to be secured every 4 frame spacings to the side frames by an appropriate system.

2.3 Accesses

2.3.1 Access to double bottom

Manholes may be cut in the floors and side girders to provide convenient access to all parts of the double bottom.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

As a rule, the manholes height is not to be more than 0,6 times the floor height or girder height.

Manholes in the floors are to be located at half the floor height and in a region extending on 0,2B from the axis of the vessel, on both sides. When a central girder exists, its distance to the nearest side of cutting is not to be less than the double bottom height.

Manholes in the side girders are to be located at half the girder height and midway between two successive web frames.

2.3.2 Access to cargo hold

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

2.4 Bottom structure

2.4.1 Single bottom vessels are to be fitted with girders in compliance with Pt B, Ch 5, Sec 2, [6.2] or Pt B, Ch 5, Sec 2, [7.3].

2.4.2 Transversely framed single bottom

A single bottom transversely framed is to be fitted with floors at every frame.

2.4.3 Longitudinally framed single bottom

Longitudinal stiffeners are generally to be continuous when crossing primary members.

The section modulus of longitudinals located in way of the web frames of transverse bulkheads is to be increased by 10%.

Longitudinals are to be supported by transverses whose spacing is to be not greater than 8 frame spacing, nor than 4 m, which is the lesser.

2.5 Transversely framed side

2.5.1 Connection of frames with floors

The frames are to be connected to the floors in compliance with Pt B, Ch 5, Sec 3, [6.1].

2.5.2 Connection with deck structure

At the upper end of frames, connecting brackets are to be provided, in compliance with Pt B, Ch 5, Sec 3, [10]. Such brackets are to extend to the hatch coaming.

2.5.3 Web frames

Web frames are to be fitted with a spacing not exceeding 5 m.

Their scantling is to be performed according to [2.8.2] herebelow.

2.5.4 Connection of frames to bottom longitudinals

In the case of a longitudinally framed single bottom, the side frames are connected to the bottom longitudinal most at side, either directly or by means of a bracket.

Similarly, at the frame upper part, connecting brackets are to be provided, extending up to the deck longitudinal most at side and even to:

- the hatch coaming, in general
- the side trunk bulkhead, in case of a trunk vessel.

2.6 Longitudinally framed side

2.6.1 Side transverses

Side transverses are to be fitted in general, with a spacing not greater than 8 frame spacings, nor than 4m.

Their scantling is to be performed according to [2.8.2] herebelow.

The side transverses are generally directly welded to the shell plating.

In the case of a double bottom, the side transverses are to be bracketed to the bottom transverses.

2.6.2 Side longitudinals

Longitudinal ordinary stiffeners are generally to be continuous when crossing primary supporting members.

In the case the longitudinals are interrupted by a primary supporting member, brackets on both sides of the primary supporting member are to be fitted in perfect alignment.

2.7 Topside structure

2.7.1 Strength continuity

At the ends of the cargo hold space, the members taking part in the overall strength are to be correctly staggered.

Arrangements are to be made to ensure strength continuity of the topside structure at the end of the hatchways. As far as practicable, it is recommended to extend the part of the hatch coaming which is located above deck and to connect it to the side bulkheads of the accommodation spaces.

2.8 Hull scantlings

2.8.1 General

The hull scantlings are to be as specified in Part B, Chapter 5, unless otherwise specified.

2.8.2 Transverse rings

Where necessary, transverse rings are to be fitted to provide additional supports of the stringer plate.

The ring component scantlings are not to be less than required in Tab 1.

2.8.3 Transverse hold bulkhead structure

The number and location of transverse bulkheads are defined in Pt B, Ch 5, Sec 5.

Where necessary, additional bulkheads are to be fitted to provide for sufficient transverse strength of the vessel.

The scantlings of transverse hold bulkheads are to be not less than required in Pt B, Ch 5, Sec 5.

a) Vertically framed plate bulkhead

The upper end of the vertical stiffeners is to be connected either to a strong deck box beam or to a stringer located at the stringer plate level or above.

As far as practicable, the bottom of the box beam or the bulkhead end stringer is to be located in the same plane as the stringer plate.

Where this is not the case, the bulkhead plating or the box beam sides are to be fitted with an efficient horizontal framing at that level.

b) Horizontally framed bulkhead

The upper part of horizontally framed bulkheads are to be specially considered by the Society.

c) Plate bulkhead end stringer

The net scantlings of the plate bulkhead end stringer is to be determined using the formula:

$$w = \beta_b \frac{p}{m(226/k - \sigma_A)} S\ell^2 10^3$$

where:

- p : Bulkhead end stringer design load, in kN/m², to be determined using applicable formulas given in Pt B, Ch 3, Sec 4, [3]
- S : Bulkhead stringer spacing, in m
- σ_A : Bulkhead end stringer axial stress, in N/mm²

$$\sigma_A = \frac{10qD_1}{A}$$

- A : Bulkhead end stringer sectional area, in cm², to be determined in compliance with Pt B, Ch 5, Sec 4, [9.2.2], where:

$P_S = qD_1$

- q : Distributed transverse load acting on the stringer plate, in kN/m, to be determined as stated under Pt B, Ch 5, Sec 4, [4.4.1]
- D_1 : Unsupported stringer plate length, in m, defined under Pt B, Ch 5, Sec 4, [4.4.2]

  In way of hold end bulkheads D_1 is to be substituted by $0,5D_1$
- m : Boundary coefficient to be taken equal to 8

2.8.4 Strengthening of cargo hold structures

In case of grab loading/unloading, the scantlings of structural elements within the cargo hold are to be increased according to Ch 2, Sec 10, [2].

Table 1 : Net scantling of transverse rings

Primary supporting member	w (cm³)	A_{Sh} (cm²)
Floors Bottom transverses	$w = \beta_b \frac{p}{m(226/k)} aB^2 10^3$	$A_{sh} = 10\beta_S \frac{p}{226/k} aB$
Side webs and side transverses **(1)** if $\ell_0 \le \ell$	$w = 26\beta_b \frac{\ell}{m(226/k)} S\ell_0^2 10^3$	$A_{sh} = 68\beta_S \frac{\ell}{226/k} S\ell_0$
if $\ell_0 > \ell$	$w = 4,4\lambda_b\beta_b \frac{p}{m(226/k)} S\ell^2 10^3$	$A_{sh} = 10\beta_S \frac{p}{226/k} S\ell$
Strong box beams	see Pt B, Ch 5, Sec 4, [4.4.4]	

p : Design load, in kN/m², defined in Pt B, Ch3, Sec 4
ℓ_0 : Span parameter, in m
$\ell_0 = p_d / 9,81$
p_d : Total pressure, in kN/m², at the lower end of the stiffener
a : Structural member spacing
a = s for floors
a = S for bottom transverses
m : Boundary coefficient to be taken equal to 8
(1) Scantlings of web frames and side transverses at the lower end are to be the same as those of floors or bottom transverses connected to them.

3 Double hull bulk cargo vessels

3.1 General

3.1.1 Application

The requirements of this Article apply to open deck vessels of double hull construction, intended primarily to carry bulk dry cargoes.

The loading/unloading may be performed in one or two runs.

3.1.2 Protection of cargo holds

All metallic structures are to be protected against corrosion according to Pt B, Ch 8, Sec 2.

Suitable coatings for the intended cargoes (in particular for the compatibility with the cargo) are to be chosen and applied in accordance with the manufacturer's requirements.

3.1.3 Access to double bottom

Manholes may be cut in the floors and side girders to provide convenient access to all parts of the double bottom.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

As a rule, the manholes height is not to be more than 0,6 times the floor height or girder height.

Manholes in the floors are to be located at half the floor height and in a region extending on $0,2B_1$ from the axis of the vessel, on both sides. When a central girder exits, its distance to the nearest side of cutting is not to be less than the double bottom height.

Manholes in the side girders are to be located at half the girder height and midway between two successive web frames. Their distance from the transverse bulkheads of the side tanks is not to be less than 1,5 m, if there is no web frame. The Society may wave this rule subject to direct calculation of the shear stresses.

3.1.4 Access to side tanks

Where openings allowing access to side tanks are cut in the stringer plate, they are to be arranged clear of the hatch corners and shall be of even-deck design, without obstacles causing stumbling. In order to assure the continuity of the strength, they are to be cut smooth along a well rounded design and are to be strengthened by thick plates, by doubling plates or by other equivalent structure.

3.1.5 Access to cargo hold

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

3.2 Welding

3.2.1 General

Welding is to comply with the requirements of Pt B, Ch 8, Sec 1.

3.2.2 Arrangements applying to the shell plating and the double hull

Transverse butts are to be butt welded. Double bottom butts may be welded in way of floor faceplate which then acts as a support.

The longitudinal joints are to be obtained either by butt welding or by overlap welding. In the second case, the outer line welding is to be continuous with a throat thickness of 0,5t, whereas the inner line of welding may be discontinuous with a ratio $p/d < 4$ and a throat thickness of 0,5t; however, for spaces which are not accessible after construction, the inner weld is to be carried out with a continuous line welding.

3.2.3 Arrangements applying to the topside plating

Butt weldings are to be carried out on the transverse butts of the sheerstrake, stringer plate and coaming.

3.2.4 Connection of inner bottom with floors

Where the floors cannot be welded to the inner bottom by means of fillet welds, the connection may be obtained by slot welds, in compliance with Pt B, Ch 8, Sec 1, [2.7]. In that case, the floors are to be fitted with flange of adequate width.

3.3 Transversely framed double side

3.3.1 Structural arrangement

Where the inner side does not extend down to the outer bottom, it is to be held in position by means of brackets or vertical stiffeners fitted to the floors.

Adequate continuity strength is to be ensured in way of changes in width of the double side. In particular, scarfing of the inner side is to be ensured beyond the cargo hold region.

3.3.2 Side and inner side frames

At their upper end, side and inner side frames are to be connected by means of a bracket. This bracket can be a section or a flanged plate with a section modulus at least equal to that of the side web frames.

Where the outer and inner side frames are connected by means of struts located at mid-span, their section modulus may be reduced by 30%.

The strut sectional area is to be not less than those of the connected frames.

At their lower end, the frames are to be adequately connected to the floors or top tank.

3.3.3 Side and inner side web frames

It is recommended to provide side web frames, fitted every 3 m and, in general, not more than 6 frame spacings apart.

At their upper end, side and inner side web frames are to be connected by means of a bracket. This bracket can be a section or a flanged plate with a section modulus at least equal to that of the side web frames. An attached plating strip, where applicable, may be taken into account.

The web frames are to be connected at their mid-span by means of struts, the cross sectional area of which is not to be less than those of the connected web frames.

At their lower end, the web frames are to be adequately connected to the floors or top tank.

3.3.4 Plate webs

Plate webs may be fitted in addition or instead of web frames.

Plate webs are to be fitted with horizontal stiffeners, the spacing of which is not to be greater than 1 m.

The scantling of plate webs with large openings is to be examined by the Society on a case by case basis.

3.4 Longitudinally framed double side

3.4.1 Inner side plating

The requirements of [3.3.1] also apply to longitudinally framed double side, with the transverses instead of web frames.

3.4.2 Side and inner side longitudinals

Where the outer and inner side longitudinals are connected by means of struts located at mid-span, their section modulus may be reduced by 30%.

The strut sectional area is to be not less than those of the connected longitudinals.

3.4.3 Side transverses

The requirements of [3.3.3] also apply to longitudinally framed double side, with the transverses instead of web frames.

3.4.4 Plate webs

The requirements of [3.3.4] also apply to longitudinally framed double side.

3.5 End structure

3.5.1 Arrangements for self-propelled vessels

At the ends of the cargo hold space, the strength continuity of members taking part in the overall strength is to be adequately ensured.

In particular, arrangements are to be made to ensure strength continuity of the top structure at the end of the hatchways. As far as practicable, it is recommended to extend the part of the hatch coaming located above deck and to connect it to the side bulkheads of the accommodation spaces.

The longitudinal boundaries of the engine room side bunkers are to be located, as far as practicable, in the extension of the double hull sides.

3.5.2 Arrangements for pushed vessels

Where the compartments outside the cargo hold space are of small size, the strength continuity is to be ensured by scarfing of strength members.

The double hull sides are to be extended, in the shape of brackets, outside the cargo hold space over a distance equal to twice the stringer plate width.

Strength continuity of the inner bottom is to be ensured by means of brackets, one of which is to be along the vessel's centreline. Where the vessel ends are built on the longitudinal system, the brackets are to be connected to the bottom longitudinals; otherwise, they are to be connected to keelsons.

Pushing transoms, if any, are to be designed in compliance with Pt B, Ch 7, Sec 6, [2.2].

3.6 Hull scantlings

3.6.1 General

The hull scantlings and arrangements are to be determined according to Part B, Chapter 5, unless otherwise specifies.

3.6.2 General arrangements of double bottom structure

Where the inner side plating does not extend down to the bottom plating, the floors of vessels built in the transverse system are to be stiffened, at each frame, in way of the inner side plating, by means of a section, the net sectional area of which, in cm², is not to be less than:

$A = 0{,}01\ b\ t_F$

where:

t_F : Net thickness of floor web, in mm

b : Section height, in mm

$b = 100 H_D$

H_D : Double bottom height, in m

As a rule, manholes are not to be provided into the centreline girder.

3.6.3 Transverse hold bulkhead structure

Arrangements and scantlings of transverse hold bulkheads are to be in compliance with Pt B, Ch 5, Sec 5.

3.6.4 Strengthening of cargo hold structure

In case of grab loading/unloading, the scantlings of structural elements within the cargo hold are to be increased according to Ch 2, Sec 10, [2].

SECTION 3 TANKERS

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

$B_1 = B - 2B_2$

B_2 : Breadth of the side tank, in m

s : Spacing of ordinary stiffeners, in m

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4]

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the type and service notation **Tanker**, as defined in Pt A, Ch 2, Sec 3, [4.1.1].

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to tankers.

2 Vessel arrangement

2.1 Basic structural configuration

2.1.1 Single hull tankers

In a single hull tanker, see Fig 1, the cargo tanks are bounded by the vessel's outer shell, i.e. the bottom, the sides of the shell plating and the decks simultaneously act as tank walls.

2.1.2 Double hull tankers

As in the case of the single hull tanker, the cargo tanks form part of the vessel's structure. However, the bottom and side plating does not function simultaneously as tank walls, see Fig 2. For certain products minimum distances between tank boundaries and bottom or side plating are to be observed. Accessibility must, however, be guaranteed in every case.

2.1.3 Tankers with inserted cargo tanks

In this type of vessel the cargo tanks are independent of the vessel's structure but are permanently installed, see Fig 3.

Figure 1 : Single hull tankers

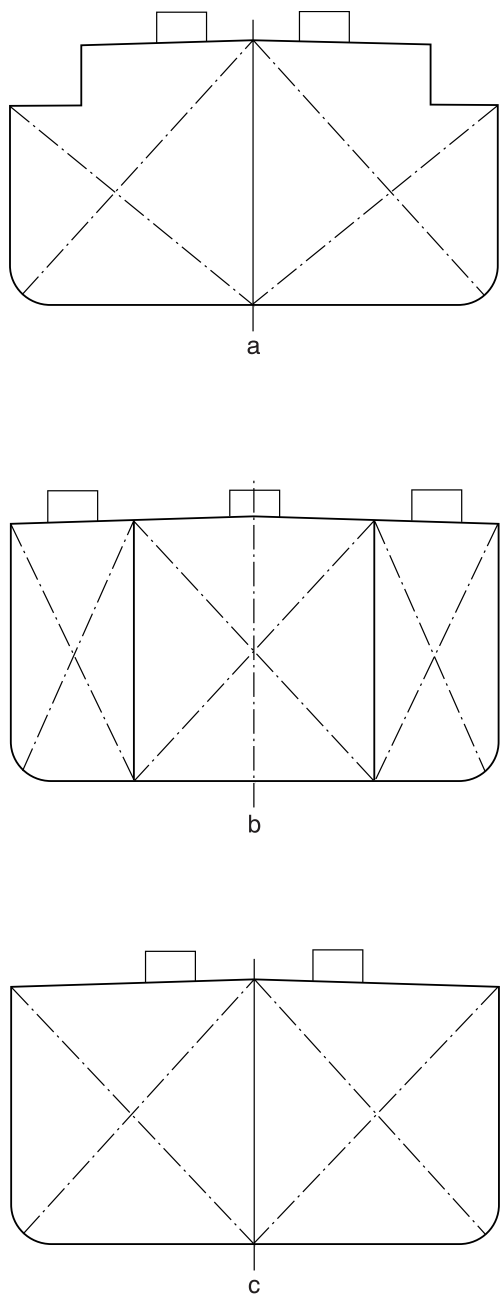


Figure 2 : Double hull tankers

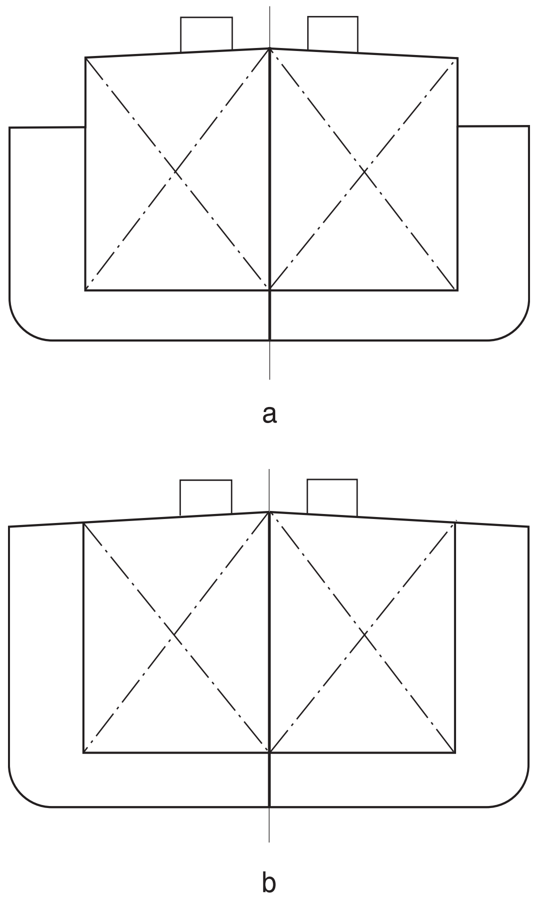
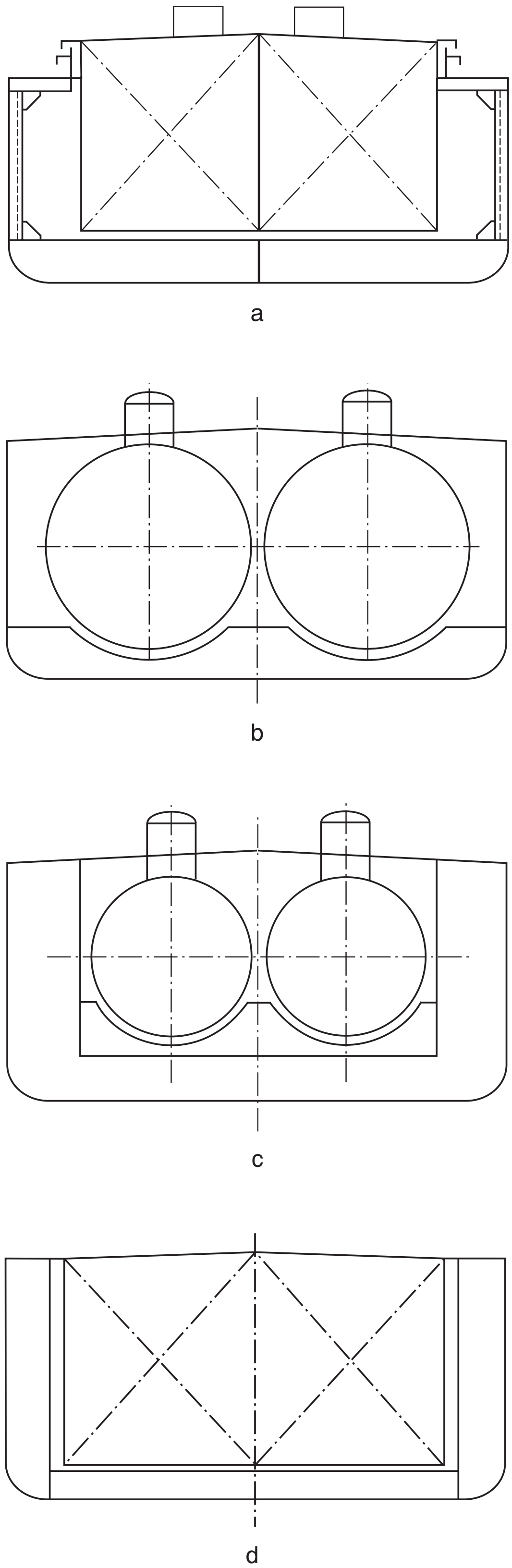


Figure 3 : Inserted cargo tank



d_H : Inside diameter of main bilge pipe, in mm

d_Z : Inside diameter of branch bilge pipe, in mm

ℓ : Length of the watertight compartment, in m.

2.2 Stability

2.2.1 Tankers carrying dangerous goods

For vessels carrying dangerous goods, see Part D, Chapter 3.

2.2.2 Other tankers

Where the tank breadth exceeds 0,7 B, cargo tanks are normally to be provided with centre longitudinal bulkheads. Where the tank breadth is greater than the figure mentioned and centre longitudinal bulkheads are not fitted, proof of sufficient stability may be required by the Society.

2.3 Piping

2.3.1 Bilge lines

The inside diameter of the bilge lines shall not be taken less than 50 mm nor than the values derived from the following formulas:

- main pipe

$$d_H = 3,0\sqrt{(B + D)\ell_1} + 35$$

- branch pipe

$$d_Z = 2,0\sqrt{(B + D)\ell} + 25$$

where:

ℓ_1 : Total length, in m, of spaces between cofferdam or cargo bulkhead and stern tube bulkhead.

3 Hull scantlings

3.1 General

3.1.1 The hull scantlings are to be determined as specified in Part B, Chapter 5, using the adequate design loads, unless otherwise specified in this Article.

3.1.2 Independent tanks

Scantlings of independent tanks are to be determined in compliance with Pt B, Ch 5, Sec 5, [4] and Pt B, Ch 5, Sec 5, [5].

3.1.3 Thermal stresses

Where heated liquids are intended to be carried in tanks, a calculation of thermal stresses is required, if the carriage temperature of the liquid exceeds 90°C.

The calculations are to be carried out for both temperatures, the actual carriage temperature and the limit temperature specified hereabove.

The calculations are to give the resultant stresses in the hull structure based on a water temperature of 0°C and an air temperature of −5°C.

Constructional measures and/or strengthenings will be required on the basis of the results of the calculation for both temperatures.

3.2 Other requirements

3.2.1 Minimum net thickness of web plating

The net thickness, in mm, of the web plating of ordinary stiffeners is to be not less than:

- for $L < 120$ m: $t = 1{,}63 + 0{,}004\ L\ k^{0,5} + 4{,}5\ s$
- for $L \geq 120$ m: $t = 3{,}9\ k^{0,5} + s$

The net thickness, in mm, of plating which forms the web of primary supporting members is to be not less than the value obtained from the following formula:

$t = 1{,}14\ L^{1/3}\ k^{0,5}$

3.2.2 Minimum side tank width

The side tank width is to be not less than 600 mm.

4 Transverse rings

4.1 General

4.1.1 The strength check of the transverse rings is to be performed by direct calculation according to Pt B, Ch 2, Sec 5.

In particular, the requirements of [4.2] to [4.4] herebelow, are to be complied with.

4.1.2 The following loading conditions are to be considered:

a) Service condition: loading / unloading in two runs
   - full cargo load and vessel draught equal to 0,575T
   - vessel draught equal to 0,575T, without cargo load.

b) Service condition: loading / unloading in one run
   - full cargo load and vessel draught equal to 0,15T
   - vessel draught equal to T, without cargo load.

c) Testing condition
   - fully loaded tank subjected to test pressure (see Pt B, Ch 3, Sec 4, [5].

4.2 Floors and bottom transverses in way of rings

4.2.1 The following checks are to be carried out:

- level of shear stresses, in particular, in way of holes and passage of longitudinals
- buckling strength of unstiffened web
- continuity of double bottom in the side tank.

4.3 Web frames and side transverses in way of rings

4.3.1 For side primary supporting members, the level of bending stresses and shear stresses in way of holes and passage of longitudinals is to be checked.

4.4 Strong beams and deck transverses in way of rings

4.4.1 The following checks are to be carried out:

- level of bending stresses and shear stresses, in particular, in way of holes and passage of longitudinals
- buckling strength of unstiffened web
- continuity of structure and lateral support of deck transverses, notably, when the flange of the deck transverse is a round bar.

4.5 Pillars

4.5.1 Strong beams and deck transverses in way of rings are to be supported by pillars. The pillar scantlings are to be determined according to Pt B, Ch 5, Sec 4, [9], where the deck pressure is not to be taken less than 5 kN/m^2. The pillars and their attachments are also to be examined for tensile stressing resulting from the relevant test pressure related to the respective vessel type.

4.5.2 Tubular pillars are to be avoided in the cargo tanks as far as possible. On tank vessels intended to carry flammable liquids or chemicals, tubular pillars are not permitted.

4.5.3 The pillars are to be attached to the girders as well as to the floor plates located below by means of welding.

4.6 Break in the deck

4.6.1 A reinforced deck transverse, pillars or a transverse bulkhead is to be fitted in way of the deck break.

5 Vessel structural arrangements

5.1 Vessels with integrated tanks, transverse framing system

5.1.1 Beams

Beams are to be fitted at every frame. They are to be discontinuous in way of longitudinal bulkheads, to which they are connected with brackets. Deck beams are not to be discontinuous in way of expansion tanks, unless efficient compensations are provided.

5.1.2 Strong beams

As a rule, strong beams are to have the same scantlings as side web frames to which they are connected by brackets or any other equivalent arrangement, so as to ensure strength continuity.

5.1.3 Web frames

The web frames are to be spaced not more than 4m apart, considering the frames are supported at mid-span by a stringer.

5.1.4 Floors

Floors are to be fitted at every frame. They are to be discontinuous in way of bulkheads to which they are connected by means of brackets or other equivalent arrangement ensuring strength continuity.

An adequate number of limbers is to be cut out in floors, longitudinals and transverses to ensure the draining of cargo to the pump suctions.

5.2 Vessels with integrated tanks, longitudinal framing system

5.2.1 Side transverses

The side transverses are to be spaced not more than 3m apart.

The span of side shell strength transverses is to be taken equal to the vertical distance between bottom and deck.

5.2.2 Deck longitudinals

The deck longitudinals are to be continuous through expansion tanks, unless efficient compensations are fitted.

5.3 Vessels with integrated tanks, combination system

5.3.1 Web frames

It is recommended to provide side shell and longitudinal bulkhead web frames in way of bottom and deck transverses.

5.4 Vessels with independent tanks

5.4.1 General

Vessels with independent tanks are to be built on the transverse framing system. When a longitudinal framing system is applied, it is to be specially considered by the Society.

5.4.2 Floors

In way of floors not in contact with tanks, for instance floors located between tanks and floors at hold ends, at least two keelsons with intercostal plating are to be provided. The keelsons are to be fitted approximately at one-third of the width and extending at least over three frame spaces beyond tank end bulkheads.

5.5 Double hull arrangements

5.5.1 General

All parts of the cargo zone are to be well ventilated and accessible to ensure surveys and maintenance.

5.5.2 Access to double bottom

Manholes may be cut in the floors and side girders to provide convenient access to all parts of the double bottom.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

As a rule, the manholes height is not to be more than 0,6 times the floor height or girder height.

Manholes in the floors are to be located at half the floor height and in a region extending on 0,2 B_1 from the axis of the vessel, on both sides. When a central girder exists, its distance to the nearest side of cutting is not to be less than the double bottom height.

Manholes in the side girders are to be located at half the girder height and midway between two successive web frames. Their distance from the transverse bulkheads of the side tanks is not to be less than 1,5 m, if there is no web frame. The Society may waive this rule subject to direct calculation of the shear stresses.

5.5.3 Access to side tanks

Manholes are to be cut in the stringer plate and plate webs to provide convenient access to all parts of the side tanks.

Openings in the stringer plate are to be arranged clear of the hatch corners. They are to be cut smooth along a well rounded design and are to be strengthened by thick plates or by doubling plates.

5.5.4 Access to tanks

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.

5.5.5 Floor reinforcement

Where the inner side plating does not extend down to the bottom plating, the floors of vessels built in the transverse system are to be stiffened, at each frame, in way of the double hull shell plating, by means of a section, the net sectional area of which, in cm^2, is not to be less than:

$$A = 0{,}01\ b\ t_F$$

where:

b : Section height, in mm: $b = 100\ H_D$

where H_D is the double bottom height, in m

t_F : Net thickness of floor web, in mm.

5.6 Ends of cargo zone

5.6.1 The inner longitudinal side has to be extended inside the cofferdam. Moreover, when possible, it is to be extended in the fore and aft vessel by means of brackets.

6 Independent tank arrangements

6.1 Stiffening

6.1.1 The side stiffeners may be inside or outside the tank.

When tank longitudinal sides are framed vertically, stiffeners are to form continuous frames with the top and bottom stiffeners, whether the frames are connected or not by brackets.

The vertical or horizontal stiffeners of transverse sides are to be welded on to the perpendicular tank sides, either directly or by means of brackets extending up to the first stiffener of previous sides.

To ensure proper contact between tank plates and vessel bottom, the bottom structure is to be adequately stiffened.

6.2 Fastening of self-supporting tanks

6.2.1 General

Stress concentrations in the tank walls are to be avoided, and care is to be taken to ensure that the tank seatings do not impede the contraction of the tank when cooled down to transport temperature.

6.2.2 Chocking of tanks

The tank seatings are to be constructed in such a way as to make it impossible for the tanks to move in relation to the vessel structure.

The tanks are to be supported by floors or bottom longitudinals.

When the stringer plate is chocked against tanks in way of some web frames or side shell transverses, chocking may consist in a bolted assembly. In case of applying wedges in hard wood or synthetic material capable of transmitting the chocking stress, arrangements are to be provided to avoid an accidental shifting during navigation.

6.2.3 Antiflotation arrangements

Antiflotation arrangements are to be provided for independent tanks. The antiflotation arrangements are to be suitable to withstand an upward force caused by an empty tank in a hold space flooded to the damage draught of the vessel, without plastic deformation likely to endanger the hull structure.

6.2.4 Strength check of seating and stays

The strength check of the seatings and stays (gross scantling) is to be carried out in compliance with Pt B, Ch 2, Sec 5, using a partial safety factor $\gamma_R = 1,5$.

7 Expansion tanks

7.1 Expansion tanks

7.1.1 Each tank is to be provided at about mid-length with an expansion tank whose height above tank top is not to be less than 0,5 m.

7.1.2 Scantlings of expansion tank covers are to be specially examined by the Society.

8 Subdivision

8.1 General

8.1.1 Bulkheads adjacent to tanks, cofferdams and hold are to be welded or assembled by means of an equivalent approved process. They are to have no openings.

8.1.2 The bulkhead scantlings are to be determined in compliance with Pt B, Ch 5, Sec 5, [4] and Pt B, Ch 5, Sec 5, [5], taking into account additional requirements stated under [8.2] and [8.3].

8.2 Minimum thickness of bulkhead plating

8.2.1 Minimum plating thickness

The net thickness, in mm, of liquid cargo tank bulkheads is to be not less than that obtained from the following formula:

$t = 1,36 + 0,011\ L\ k^{0,5} + 3,6\ s$

In the cargo tank area, including cofferdams, the net thickness of plates and structural members in spaces containing water are to be not less than 4,4 mm.

8.3 Minimum net thickness of structural member web

8.3.1 Ordinary stiffeners

The minimum net thickness, in mm, of the web plate of ordinary stiffeners is to be obtained from the following formula:

$t = 0,61\ L^{1/3}\ k^{0,5} + 3,6\ s$

8.3.2 Primary supporting members

The minimum net thickness, in mm, of the web plate of primary supporting members is to be obtained using the following formula:

$t = 1,14 L^{1/3} k^{0,5}$

8.4 Corrugated bulkheads

8.4.1 General

In place of plane bulkheads provided with stiffeners, corrugated bulkheads, determined according to Pt B, Ch 5, Sec 5, may be built in.

8.4.2 Direct calculation

The relevant service and test pressure related to the vessel type are to be considered.

The following checks are to be carried out:

- section modulus of beam
- section modulus of welds
- buckling of face plate
- section modulus of welds when there is no continuity of web in double bottom.

For the allowable stresses, see Pt B, Ch 2, Sec 5.

SECTION 4 CONTAINER VESSELS

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

B_1 : Breadth, in m, of the hold

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4].

1 General

1.1 Application

1.1.1 The type and service notation **Container vessel** is assigned, in accordance with Pt A, Ch 2, Sec 3, [3.1.3], to vessels intended to carry dry unit cargoes.

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to container vessels.

1.2 Stability

1.2.1 Depending on the vessel's design (size) and operating conditions (number of tiers), proof of sufficient stability may be required by the Society.

2 Structure arrangements

2.1 Strength principles

2.1.1 Local reinforcements

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

The forces applying on the fixed cargo securing devices are to be indicated by the designer.

2.2 Bottom structure

2.2.1 Floor and girder spacing

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

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

2.2.2 Strength continuity

Adequate strength continuity of floors and bottom transverses is to be ensured in way of the side tank by means of brackets.

2.2.3 Reinforcements in way of cell guides

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

2.3 Fixed cell guides

2.3.1 General

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

2.3.2 Arrangement of fixed cell guides

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

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

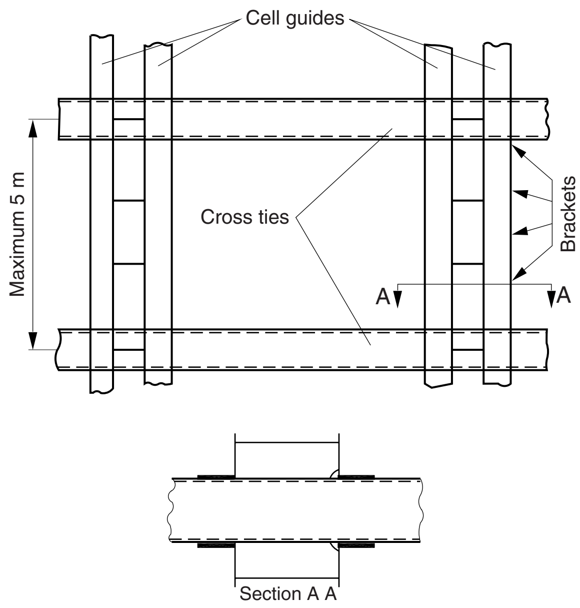
In general, the spacing between cross-ties connecting the guides may not exceed 5 metres, and their position is to coincide as nearly as possible with that of the container corners (see Fig 1).

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

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

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

Figure 1 : Typical structure of cell guides



2.4 Fixed cargo securing devices

2.4.1 Where containers are carried, in particular on the hatch covers and on deck, container supporting members of adequate scantlings are to be fitted.

2.4.2 Documentation to be submitted

A list and/or plan of all the fixed securing devices, indicating their location on board, is to be provided.

For each type of fixed securing device, the following information is to be indicated:

- type designation
- sketch of the device
- material
- breaking load
- maximum securing load.

2.5 Hatch covers carrying containers

2.5.1 Efficient retaining arrangements are to be provided to prevent translation of the hatch cover under the action of the longitudinal and transverse forces exerted by the stacks of containers on the cover. These retaining arrangements are to be located in way of the hatch coaming side brackets.

Solid fittings are to be welded on the hatch cover where the corners of the containers are resting. These parts are intended to transmit the loads of the container stacks onto the hatch cover on which they are resting and also to prevent horizontal translation of the stacks by means of special intermediate parts arranged between the supports of the corners and the container corners.

3 Single side vessels

3.1 Protection of cargo holds

3.1.1 Coating

All metallic structures are to be protected against corrosion according to Pt B, Ch 8, Sec 2.

3.2 Accesses

3.2.1 Access to double bottom

Manholes may be cut in the floors and side girders to provide convenient access to all parts of the double bottom.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

As a rule, the manholes height is not to be more than 0,6 times the floor height or girder height.

Manholes in the floors are to be located at half the floor height and in a region extending on 0,2B from the axis of the vessel, on both sides. When a central girder exists, its distance to the nearest side of cutting is not to be less than the double bottom height.

Manholes in the side girders are to be located at half the girder height and midway between two successive web frames.

3.2.2 Access to cargo hold

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

3.3 Bottom structure

3.3.1 Single bottom vessels are to be fitted with girders in compliance with Pt B, Ch 5, Sec 2, [6.2] or Pt B, Ch 5, Sec 2, [7.3].

3.3.2 Transversely framed single bottom

A single bottom transversely framed is to be fitted with floors at every frame.

3.3.3 Longitudinally framed single bottom

Longitudinal stiffeners are generally to be continuous when crossing primary members.

The section modulus of longitudinals located in way of the web frames of transverse bulkheads is to be increased by 10%.

Longitudinals are to be supported by transverses whose spacing is to be not greater than 8 frame spacing, nor than 4 m, which is the lesser.

3.4 Transversely framed side

3.4.1 Connection of frames with floors

The frames are to be connected to the floors in compliance with Pt B, Ch 5, Sec 3, [6.1].

3.4.2 Connection with deck structure

At the upper end of frames, connecting brackets are to be provided, in compliance with Pt B, Ch 5, Sec 3, [10]. Such brackets are to extend to the hatch coaming.

3.4.3 Web frames

Web frames are to be fitted with a spacing not exceeding 5 m.

Their scantling is to be performed according to [6.3.1] hereblow.

3.4.4 Connection of frames to bottom longitudinals

In the case of a longitudinally framed single bottom, the side frames are connected to the bottom longitudinal most at side, either directly or by means of a bracket.

Similarly, at the frame upper part, connecting brackets are to be provided, extending up to the deck longitudinal most at side and even to:

- the hatch coaming, in general
- the side trunk bulkhead, in case of a trunk vessel.

3.5 Longitudinally framed side

3.5.1 Side transverses

Side transverses are to be fitted in general, with a spacing not greater than 8 frame spacings, nor than 4m.

Their scantling is to be performed according to [6.3.1] herebelow.

The side transverses are generally directly welded to the shell plating.

In the case of a double bottom, the side transverses are to be bracketed to the bottom transverses.

3.5.2 Side longitudinals

Longitudinal ordinary stiffeners are generally to be continuous when crossing primary supporting members.

In the case the longitudinals are interrupted by a primary supporting member, brackets on both sides of the primary supporting member are to be fitted in perfect alignment.

3.6 Topside structure

3.6.1 Strength continuity

At the ends of the cargo hold space, the members taking part in the overall strength are to be correctly staggered.

Arrangements are to be made to ensure strength continuity of the topside structure at the end of the hatchways. As far as practicable, it is recommended to extend the part of the hatch coaming which is located above deck and to connect it to the side bulkheads of the accommodation spaces.

4 Double hull vessels

4.1 Protection of cargo holds

4.1.1 All metallic structures are to be protected against corrosion according to Pt B, Ch 8, Sec 2.

4.2 Accesses

4.2.1 Access to double bottom

Manholes may be cut in the floors and side girders to provide convenient access to all parts of the double bottom.

These manholes are to be cut smooth along a well rounded design and are not to be greater than that strictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffeners may be required.

As a rule, the manholes height is not to be more than 0,6 times the floor height or girder height.

Manholes in the floors are to be located at half the floor height and in a region extending on $0,2B_1$ from the axis of the vessel, on both sides. When a central girder exits, its distance to the nearest side of cutting is not to be less than the double bottom height.

Manholes in the side girders are to be located at half the girder height and midway between two successive web frames. Their distance from the transverse bulkheads of the side tanks is not to be less than 1,5 m, if there is no web frame. The Society may wave this rule subject to direct calculation of the shear stresses.

4.2.2 Access to side tanks

Where openings allowing access to side tanks are cut in the stringer plate, they are to be arranged clear of the hatch corners and shall be of even-deck design, without obstacles causing stumbling. In order to assure the continuity of the strength, they are to be cut smooth along a well rounded design and are to be strengthened by thick plates, by doubling plates or by other equivalent structure.

4.2.3 Access to cargo hold

As far as practicable, permanent or movable means of access stored on board are to be provided to ensure proper survey and maintenance of cargo holds.

4.3 Welding

4.3.1 General

Welding is to comply with the requirements of Pt B, Ch 8, Sec 1.

4.3.2 Arrangements applying to the shell plating and the double hull

Transverse butts are to be butt welded. Double bottom butts may be welded in way of floor faceplate which then acts as a support.

The longitudinal joints are to be obtained either by butt welding or by overlap welding. In the second case, the outer line welding is to be continuous with a throat thickness of 0,5t, whereas the inner line of welding may be discontinuous with a ratio $p/d < 4$ and a throat thickness of 0,5t; however, for spaces which are not accessible after construction, the inner weld is to be carried out with a continuous line welding.

4.3.3 Arrangements applying to the topside plating

Butt weldings are to be carried out on the transverse butts of the sheerstrake, stringer plate and coaming.

4.3.4 Connection of inner bottom with floors

Where the floors cannot be welded to the inner bottom by means of fillet welds, the connection may be obtained by slot welds, in compliance with Pt B, Ch 8, Sec 1, [2.7]. In that case, the floors are to be fitted with flange of adequate width.

4.4 Transversely framed double side

4.4.1 Structural arrangement

Where the inner side does not extend down to the outer bottom, it is to be held in position by means of brackets or vertical stiffeners fitted to the floors.

Adequate continuity strength is to be ensured in way of changes in width of the double side. In particular, scarfing of the inner side is to be ensured beyond the cargo hold region.

4.4.2 Side and inner side frames

At their upper end, side and inner side frames are to be connected by means of a bracket. This bracket can be a section or a flanged plate with a section modulus at least equal to that of the side web frames.

Where the outer and inner side frames are connected by means of struts located at mid-span, their section modulus may be reduced by 30%.

The strut sectional area is to be not less than those of the connected frames.

At their lower end, the frames are to be adequately connected to the floors or top tank.

4.4.3 Side and inner side web frames

It is recommended to provide side web frames, fitted every 3 m and, in general, not more than 6 frame spacings apart.

At their upper end, side and inner side web frames are to be connected by means of a bracket. This bracket can be a section or a flanged plate with a section modulus at least equal to that of the side web frames. An attached plating strip, where applicable, may be taken into account.

The web frames are to be connected at their mid-span by means of struts, the cross sectional area of which is not to be less than those of the connected web frames.

At their lower end, the web frames are to be adequately connected to the floors or top tank.

4.4.4 Plate webs

Plate webs may be fitted in addition or instead of web frames.

Plate webs are to be fitted with horizontal stiffeners, the spacing of which is not to be greater than 1 m.

The scantling of plate webs with large openings is to be examined by the Society on a case by case basis.

4.5 Longitudinally framed double side

4.5.1 Inner side plating

The requirements of [4.4.1] also apply to longitudinally framed double side, with the transverses instead of web frames.

4.5.2 Side and inner side longitudinals

Where the outer and inner side longitudinals are connected by means of struts located at mid-span, their section modulus may be reduced by 30%.

The strut sectional area is to be not less than those of the connected longitudinals.

4.5.3 Side transverses

The requirements of [4.4.3] also apply to longitudinally framed double side, with the transverses instead of web frames.

4.5.4 Plate webs

The requirements of [4.4.4] also apply to longitudinally framed double side.

4.6 End structure

4.6.1 Arrangements for self-propelled vessels

At the ends of the cargo hold space, the strength continuity of members taking part in the overall strength is to be adequately ensured.

In particular, arrangements are to be made to ensure strength continuity of the top structure at the end of the hatchways. As far as practicable, it is recommended to extend the part of the hatch coaming located above deck and to connect it to the side bulkheads of the accommodation spaces.

The longitudinal boundaries of the engine room side bunkers are to be located, as far as practicable, in the extension of the double hull sides.

4.6.2 Arrangements for pushed vessels

Where the compartments outside the cargo hold space are of small size, the strength continuity is to be ensured by scarfing of strength members.

The double hull sides are to be extended, in the shape of brackets, outside the cargo hold space over a distance equal to twice the stringer plate width.

Strength continuity of the inner bottom is to be ensured by means of brackets, one of which is to be along the vessel's centreline. Where the vessel ends are built on the longitudinal system, the brackets are to be connected to the bottom longitudinals; otherwise, they are to be connected to keelsons.

Pushing transoms, if any, are to be designed in compliance with Pt B, Ch 7, Sec 6, [2.2].

5 Design loads

5.1 Design torsional torque

5.1.1 Where no specific data are provided by the Designer, the design still water torsional torque induced by the non-uniform distribution of cargo, consumable liquids and ballast is to be obtained at the midship section, in kN.m, from the following formula:

$M_T = 31{,}4\ n_S\ n_T\ B$

where:

n_S : Number of container stacks over the breadth B

n_T : Number of container tiers in cargo hold amidships (including containers on hatch covers).

5.2 Force on containers

5.2.1 The force F_i applied to one container located at the level "i", as defined in Fig 2, is to be determined in compliance with Pt B, Ch 3, Sec 4, [3.4].

The mass of the containers is to be defined by the Designer.

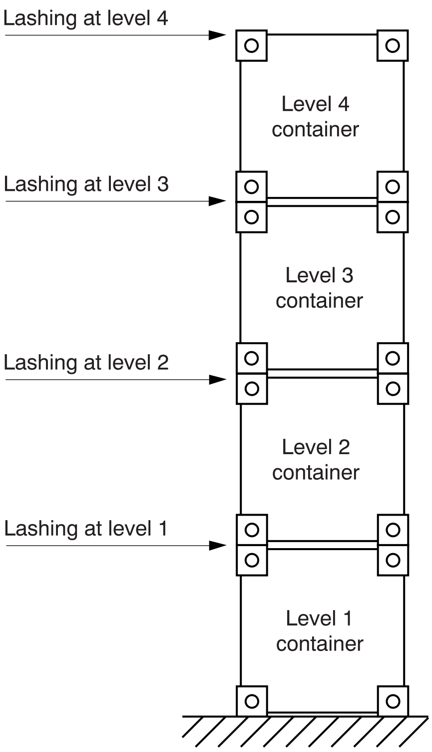
Where the mass of loaded containers is not known, the following values may be used:

- for 40 feet containers: $m_i = 27$ t
- for 20 feet containers: $m_i = 17$ t

Where empty containers are stowed at the top of a stack, the following values may be used:

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

Figure 2 : Containers level in a stack



5.2.2 Stacks of containers

The force transmitted at the corners of such stack is to be obtained, in kN, using the following formula:

P = F / 4

where:

$$F = \sum_{i=1}^{N} F_i$$

where

N : Number of containers in a stack.

5.2.3 Securing load

The scantling load of securing devices is to be determined assuming an angle of list of 12°.

6 Hull scantlings

6.1 General

6.1.1 In general, the hull scantlings and arrangements are to be in compliance with Part B, Chapter 5.

6.1.2 Scantlings of structural members subjected to concentrated loads are to be determined by direct calculation according to Pt B, Ch 2, Sec 5. In particular, the requirements of [7] are to be complied with.

6.1.3 Where the operating conditions (loading/unloading sequence as well as consumable and ballast distribution) are likely to induce excessive torsional torque, the torsional strength is to be checked, using the design torsional torque derived from [5.1.1].

6.2 Container seating

6.2.1 The net thickness, in mm, of container seating, if fitted, is to be not less than that of the adjacent inner bottom plating nor than the thickness obtained from the following formula:

$$t_{CS} = 0,8C_{CS}\sqrt{kn_CP}$$

where:

C_{CS} : Coefficient to be taken equal to:

$$C_{CS} = 2,15 - \frac{0,05\ell}{s} + 0,02\left(4 - \frac{\ell}{s}\right)\alpha^{0,5} - 1,75\alpha^{0,25}$$

where ℓ/s is to be taken not greater than 3

$$\alpha = \frac{n_C A_C}{\ell s}$$

A_C : Area of a stack of container corner, in m²

In the case of several container corners on the same plate panel, the area is that corresponding to the group of corners

n_C : Number of stacks of container corners on the seating

ℓ = MAX (a,b)

s = MIN (a,b)

a, b : Spacings, in m, of container supporting members.

6.3 Additional requirements for single side vessels

6.3.1 Transverse rings

Where necessary, transverse rings are to be fitted to provide additional supports of the stringer plate.

The ring component scantlings are not to be less than required in Tab 1.

6.3.2 Transverse hold bulkhead structure

The number and location of transverse bulkheads are defined in Pt B, Ch 5, Sec 5.

Where necessary, additional bulkheads are to be fitted to provide for sufficient transverse strength of the vessel.

The scantlings of transverse hold bulkheads are to be not less than required in Pt B, Ch 5, Sec 5.

a) Vertically framed plate bulkhead

The upper end of the vertical stiffeners is to be connected either to a strong deck box beam or to a stringer located at the stringer plate level or above.

As far as practicable, the bottom of the box beam or the bulkhead end stringer is to be located in the same plane as the stringer plate.

Where this is not the case, the bulkhead plating or the box beam sides are to be fitted with an efficient horizontal framing at that level.

b) Horizontally framed bulkhead

The upper part of horizontally framed bulkheads are to be specially considered by the Society.

c) Plate bulkhead end stringer

The net scantlings of the plate bulkhead end stringer is to be determined using the formula:

$$w = \beta_b \frac{p}{m(226/k - \sigma_A)} S \ell^2 10^3$$

where:

p : Bulkhead end stringer design load, in kN/m², to be determined using applicable formulas given in Pt B, Ch 3, Sec 4, [3]

S : Bulkhead stringer spacing, in m

σ_A : Bulkhead end stringer axial stress, in N/mm²

$$\sigma_A = \frac{10 q D_1}{A}$$

A : Bulkhead end stringer sectional area, in cm², to be determined in compliance with Pt B, Ch 5, Sec 4, [9.2.2], where:

$P_S = qD_1$

q : Distributed transverse load acting on the stringer plate, in kN/m, to be determined as stated under Pt B, Ch 5, Sec 4, [4.4.1]

D_1 : Unsupported stringer plate length, in m, defined under Pt B, Ch 5, Sec 4, [4.4.2]

In way of hold end bulkheads D_1 is to be sustituted by $0,5D_1$

m : Boundary coefficient to be taken equal to 8

6.4 Additional requirements for double hull vessels

6.4.1 Double bottom arrangement

Where the inner side plating does not extend down to the bottom plating, the floors of vessels built in the transverse system are to be stiffened, at each frame, in way of the inner side plating, by means of a section, the net sectional area of which, in cm², is not to be less than:

$A = 0,01\ b\ t_F$

where:

t_F : Net thickness of floor web, in mm

b : Section height, in mm

$b = 100H_D$

H_D : Double bottom height, in m

As a rule, manholes are not to be provided into the centreline girder.

7 Direct calculation

7.1 General

7.1.1 The following requirements apply for the grillage analysis of primary supporting members subjected to concentrated loads.

Direct calculation is to be carried out in compliance with Pt B, Ch 2, Sec 5.

7.2 Loading cases

7.2.1 Bottom structure

The following loading conditions are to be considered in the analysis of the bottom primary supporting members:

a) Loading / unloading in two runs

- full cargo load and vessel draught equal to 0,575T
- vessel draught equal to 0,575T, without cargo load.

b) Loading / unloading in one run

- full cargo load and vessel draught equal to 0,15T
- vessel draught equal to T, without cargo load.

7.2.2 Deck structure

Where containers are loaded on the deck, the analysis of the deck structure is to be carried out taking into account a full container load.

7.3 Structure checks

7.3.1 The following checks are to be carried out:

- level of bending stresses and shear stresses, in particular, in way of holes and passage of longitudinals
- buckling strength of unstiffened web
- continuity of double bottom in the side tank, for bottom structure.

Table 1 : Net scantling of transverse rings

Primary supporting member	w (cm^3)	A_{Sh} (cm^2)
Floors Bottom transverses	$w = \beta_b \frac{p}{m(226/k)} aB^2 10^3$	$A_{sh} = 10\beta_S \frac{p}{226/k} aB$
Side webs and side transverses **(1)** if $\ell_0 \le \ell$ if $\ell_0 > \ell$	$w = 26\beta_b \frac{\ell}{m(226/k)} S\ell_0^2 10^3$ $w = 4,4\lambda_b\beta_b \frac{p}{m(226/k)} S\ell^2 10^3$	$A_{sh} = 68\beta_S \frac{\ell}{226/k} S\ell_0$ $A_{sh} = 10\beta_S \frac{p}{226/k} S\ell$
Strong box beams	see Pt B, Ch 5, Sec 4, [4.4.4]	

p : Design load, in kN/m², defined in Pt B, Ch3, Sec 4
ℓ_0 : Span parameter, in m
$\ell_0 = p_d / 9,81$
p_d : Total pressure, in kN/m², at the lower end of the stiffener
a : Structural member spacing
a = s for floors
a = S for bottom transverses
m : Boundary coefficient to be taken equal to 8
(1) Scantlings of web frames and side transverses at the lower end are to be the same as those of floors or bottom transverses connected to them.

SECTION 5 RoRo Cargo Vessels

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

s : Spacing, in m, of ordinary stiffeners

S : Spacing, in m, of primary supporting members

ℓ : Span, in m, of ordinary stiffeners or primary supporting members

w : Net section modulus, in cm^3, of ordinary stiffeners or primary supporting members

A_{sh} : Net web shear sectional area, in cm^2

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4]

z : Z co-ordinate, in m, of the calculation point

I_Y : Net moment of inertia, in cm^4, of the hull transverse section around its horizontal neutral axis, to be calculated according to Pt B, Ch 4, Sec 1

M_{TH} : Total vertical bending moment in hogging condition, in kN.m, to be determined according to Ch 3, Sec 2, [4]

M_{TS} : Total vertical bending moment in sagging condition, in kN.m, to be determined according to Ch 3, Sec 2, [4]

N : Z co-ordinate, in m, of the centre of gravity of the hull transverse section

F : Wheeled force, in kN, defined in Pt B, Ch 3, Sec 4, [3.5].

α_W : Coefficient taking into account the number of wheels and wheels per axle considered as acting on the stiffener, defined in Tab 4

K_S, K_T : Coefficients taking into account the number of axles considered as acting on the stiffener, defined in Tab 5.

1 General

1.1 Application

1.1.1 The type and service notation **RoRo cargo vessel** is assigned, in accordance with Pt A, Ch 2, Sec 3, [3.1.4], to vessels intended to carry wheeled vehicles.

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to RoRo cargo vessels.

1.2 Stability

1.2.1 Depending on the vessel's design and operating conditions, proof of sufficient stability may be required by the Society.

1.3 Direct calculation

1.3.1 The following requirements apply for the analysis of primary supporting members.

Direct calculation is to be carried out in compliance with Pt B, Ch 2, Sec 5.

1.3.2 Loading cases

The following loading conditions are to be considered in the analysis of the hold structure supporting members:

a) Loading / unloading in two runs
   - full cargo load and vessel draught equal to 0,575T
   - vessel draught equal to 0,575T, without cargo load.

b) Loading / unloading in one run
   - full cargo load and vessel draught equal to 0,15T
   - maximum vessel draught T, without cargo load.

1.3.3 Structure checks

The following checks are to be carried out:

- level of bending stresses and shear stresses, in particular, in way of holes and passage of longitudinals
- buckling strength of unstiffened web
- for double hull vessels, continuity of double bottom in the side tank.

2 Vessel arrangements

2.1 Sheathing

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

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

2.2 Drainage of cargo spaces, other than RoRo spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion

2.2.1 Scupper draining

Scuppers from cargo spaces, other than RoRo spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion are not to be led to machinery or other places where sources of ignition may be present.

2.3 Hull structure

2.3.1 Framing

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

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

3 Hull scantlings

3.1 General

3.1.1 The hull scantlings and arrangements are to be in compliance with Part B, Chapter 5.

3.1.2 In addition, scantlings of plating and structural members subjected to wheeled loads are to be in compliance with [3.3] to [3.5].

3.1.3 Tyre print area

Tyre print area A_T, in m² is to be defined by the designer. In the case of double or triple wheels, the area is that corresponding to the group of wheels

When the tyre print area is not known, it may be taken equal to:

$$A_T = 9,81\frac{n_P Q_A}{n_W p_T}$$

where:

Q_A : Axle load, in t

n_W : Number of wheels for the axle considered

p_T : Tyre pressure, in kN/m². When the tyre pressure is not indicated by the Designer, it may be taken as defined in Tab 1.

Table 1 : Tyre pressure p_T for vehicles

Vehicle	Tyre pressure p_T, in kN/m²	
	pneumatic tyres	solid rubber tyres
Private cars	250	NA
Vans and fork lift trucks	600	NA
Trucks and trailers	800	NA
Handling machines	1100	1600
Note 1: NA = not applicable.		

3.2 Hull girder normal stresses

3.2.1 The hull girder normal stresses to be considered for the yielding check of ordinary stiffeners subjected to wheeled loads and contributing to hull girder strength are given in Tab 2.

Table 2 : Hull girder normal stresses Ordinary stiffeners subjected to wheeled loads

Condition	σ_{X1}, in N/mm²
• Hogging	$1000\left\|\frac{M_{TH}}{I_Y}(z-N)\right\|$
• Sagging	$1000\left\|\frac{M_{TS}}{I_Y}(z-N)\right\|$

3.2.2 The hull girder normal stresses to be considered for the yielding check of primary supporting members subjected to wheeled loads and contributing to hull girder strength are given in Tab 3.

Table 3 : Hull girder normal stresses Primary supporting members subjected to wheeled loads

Condition	σ_{X1}, in N/mm²
• $z \geq N$	$1000\left\|\frac{M_{TH}}{I_Y}(z-N)\right\|$
• $z < N$	$1000\left\|\frac{M_{TS}}{I_Y}(z-N)\right\|$

3.3 Plating

3.3.1 The net thickness t_{WL}, in mm, of plate panels subjected to wheeled loads is to be obtained from the formula:

$$t_{WL} = 0,8C_{WL}\sqrt{kn_pF}$$

where:

C_{WL} : Coefficient to be taken equal to:

$$C_{WL} = 2,15 - \frac{0,05\ell}{s} + 0,02\left(4 - \frac{\ell}{s}\right)\alpha^{0,5} - 1,75\alpha^{0,25}$$

where ℓ/s is to be taken not greater than 3

$$\alpha = \frac{A_T}{\ell s}$$

n_p : Number of wheels on the plate panel, taken equal to:

- 1 in case of a single wheel
- the number of wheels in a group of wheels, in the case of double or triple wheels.

A_T : Tyre print area, in m², defined in [3.1.3]

3.3.2 For vehicles with the four wheels of the axle located on a plate panel as shown in Fig 1, the net thickness of the plating is to be not less than the greater of the values obtained, in mm, from the following formulae:

$t_{WL} = t_1$

$t_{WL} = t_2\,[k\,(1 + \beta_2 + \beta_3 + \beta_4)]^{0,5}$

where:

t_1 : Net thickness obtained, in mm, from [3.3.1] for $n_p = 2$, considering one group of two wheels located on the plate panel

t_2 : Net thickness obtained, in mm, from [3.3.1] for $n_P = 1$, considering one wheel located on the plate panel

β_2, β_3, β_4: Coefficients obtained from the following formula, by replacing i by 2, 3 and 4, respectively (see Fig 1):

- for $x_i / b < 2$:

  $\beta_i = 0{,}8\,(1{,}2 - 2{,}02\,\alpha_i + 1{,}17\,\alpha_i^2 - 0{,}23\,\alpha_i^3)$

- for $x_i / b \geq 2$:

  $\beta_i = 0$

x_i : Distance, in m, from the wheel considered to the reference wheel (see Fig 1)

b : Dimension, in m, of the plate panel side perpendicular to the axle

$$\alpha_i = \frac{x_i}{b}$$

Figure 1 : Four wheel axle located on a plate panel

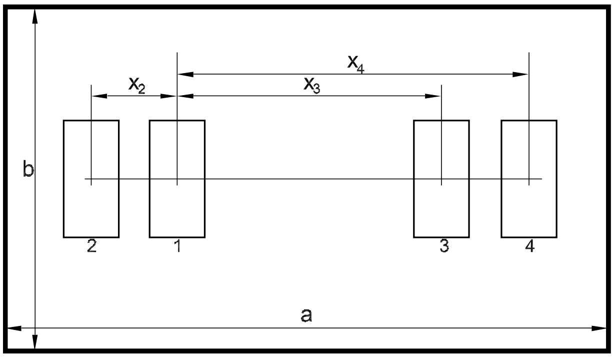
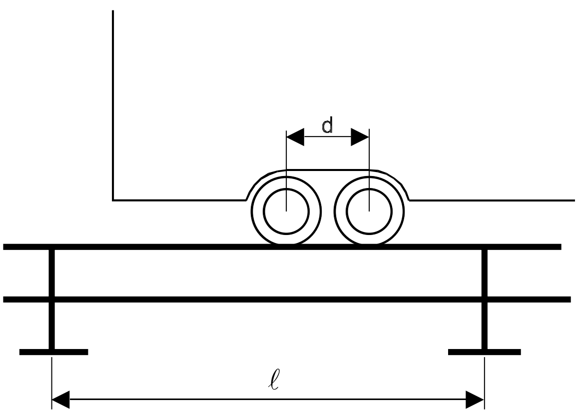


Figure 2 : Wheeled load on stiffeners - Double axles



3.4 Ordinary stiffeners subjected to wheeled loads

3.4.1 Net section modulus

The net section modulus w, cm³ of ordinary stiffeners subjected to wheeled loads are to be obtained from the following formulas:

- $L \geq 40$ m

$$w = \alpha_W K_S \frac{F}{m(226/k - \sigma_{X1})} \ell 10^3$$

- $L < 40$

$$w = \alpha_W K_S \frac{F}{m(226/k)(1 - 0{,}18 K_{MZ})} \ell 10^3$$

where:

σ_{X1} : Hull girder normal stress, in N/mm², to be determined according to [3.2.1]

m : Boundary coefficient to be taken equal to 6

K_{MZ} : Coefficient defined in Pt B, Ch 5, Sec 6

Table 4 : Wheeled loads - Coefficients α_W

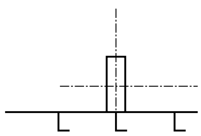
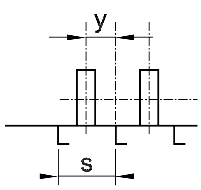
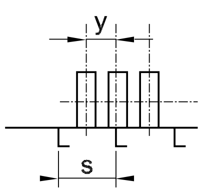
Configuration	α_W
Single wheel 	1
Double wheels 	$2\left(1 - \frac{y}{s}\right)$
Triple wheels 	$3 - 2\frac{y}{s}$
y : Distance, in m, from the external wheel of a group of wheels to the stiffener under consideration, to be taken equal to the distance from the external wheel to the centre of the group of wheels.	

Table 5 : Wheeled loads - Coefficients K_S and K_T

Coefficients	Single axle	Double axle
K_S	1	• if $d < 0,58\ \ell$ $\frac{173}{81} - \frac{4d}{3\ell} - \frac{d^2}{\ell^2} + \frac{d^4}{\ell^4}$ • if $d \geq 0,58\ \ell$ $\frac{4}{3} - \frac{4d}{3\ell} + 3\frac{d^2}{\ell^2} - \frac{8d^3}{3\ell^3}$
K_T	1	$2 - \frac{d}{2\ell} - \frac{3d^2}{2\ell^2} + \frac{d^3}{\ell^3}$
d : Distance, in m, between two axles (see Fig 2)		

3.4.2 Net shear sectional area

The net shear sectional area A_{Sh}, in cm², of ordinary stiffeners subjected to wheeled loads are to be obtained from following formula:

$$A_{sh} = 20\frac{\alpha_W K_T F}{226/k}$$

3.5 Primary supporting members

3.5.1 Wheeled loads

The scantlings of primary supporting members subjected to wheeled loads are to be determined according to Tab 6 considering uniform pressures equivalent to the distribution of vertical concentrated forces, when such forces are closely located.

For the determination of the equivalent uniform pressures, the most unfavorable case, i.e. where the maximum number of axles is located on the same primary supporting member according to Fig 3 to Fig 5, is to be considered.

The equivalent pressure may be determined using the formula:

$$p_{eq} = 10\frac{n_V Q_A}{\ell S}\left(3 - \frac{X_1 + X_2}{S}\right)$$

where:

- n_V : Maximum number of vehicles possible located on the primary supporting member
- Q_A : Maximum axle load, in t
- X_1 : Minimum distance, in m, between two consecutive axles (see Fig 4 and Fig 5)
- X_2 : Minimum distance, in m, between axles of two consecutive vehicles (see Fig 5).

3.5.2 For arrangements different from those shown in Fig 3 to Fig 5, the scantlings of primary supporting members are to be determined by direct calculation, in compliance with Pt B, Ch 2, Sec 5.

Figure 3 : Wheeled loads - Distribution of vehicles on a primary supporting member

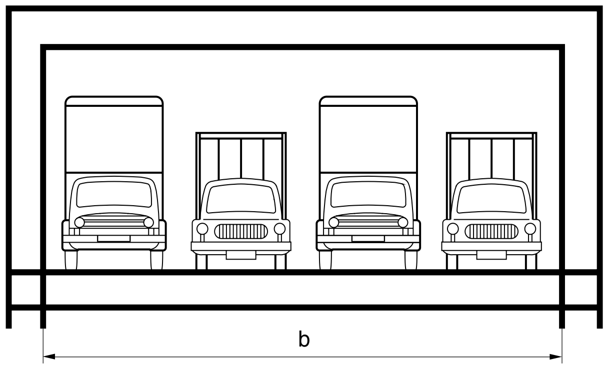


Figure 4 : Wheeled loads
Distance between two consecutive axles

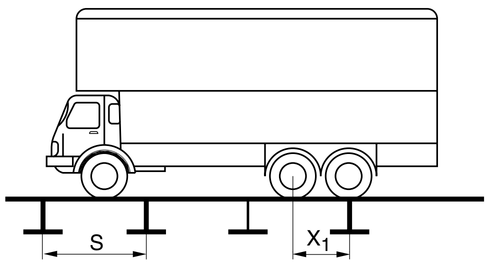
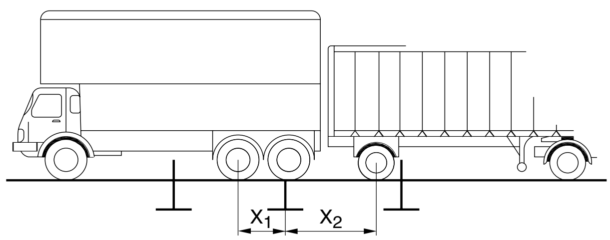


Figure 5 : Wheeled loads
Distance between axles of two consecutive vehicles



4 Other structures

4.1 Movable decks and inner ramps

4.1.1 The requirements applicable to movable decks and inner ramps are defined in Pt B, Ch 6, Sec 6, [1].

4.2 External ramps

4.2.1 The requirements applicable to external ramps are defined in Pt B, Ch 6, Sec 6, [2].

Table 6 : Net scantlings of primary supporting members

Item	w (cm³)	A_{Sh} (cm²)
Transverse primary supporting members	$w = \beta_b \dfrac{p}{m(226/k)} S\ell^2 10^3$	$A_{sh} = 10\beta_S \dfrac{p}{226/k} S\ell$
Deck girders	$w = \beta_b \dfrac{p}{m(226/k - \sigma_{X1})} S\ell^2 10^3$	
Double bottom girders	$w = \beta_b \dfrac{p}{m(200/k - \sigma_{X1})} S\ell^2 10^3$	$A_{sh} = 10\beta_S \dfrac{p}{200/k} S\ell$
Vertical primary supporting members	$w = \lambda_b \beta_b \dfrac{p}{m(226/k - \sigma_A)} S\ell^2 10^3$	$A_{sh} = 10\lambda_S \beta_S \dfrac{p}{226/k} S\ell$

p : Design load, in kN/m²
$p = p_S + p_W$

p_S : Still water pressure, in kN/m²
$p_S = p_{eq}$

p_W : Inertial pressure, in kN/m²

$$p_W = p_{eq} \frac{a_{Z1}}{9,81}$$

where a_{Z1} is the reference value of the vertical acceleration to be determined in compliance with Pt B, Ch 3, Sec 3, [2.3.3]

σ_{X1} : Hull girder normal stress, in N/mm², to be determined according to [3.2.2]

σ_A : Axial stress, to be obtained, in N/mm², from the following formula:

$$\sigma_A = 10 \frac{F_A}{A}$$

F_A : Axial load transmitted to the vertical primary supporting members by the structures above (see calculation of P_S in Pt B, Ch 5, Sec 4, [9.2.1]).

A : Net sectional area, in cm², of the vertical primary supporting members with attached plating of width b_P.

m : Boundary coefficient to be taken equal to 8

SECTION 6 PASSENGER VESSELS

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

L_{WL} : Length of the hull, in m, measured at the maximum draught

Δ : Displacement, in tons, at draught T

C_B : Block coefficient:

$$C_B = \frac{\Delta}{L \cdot B \cdot T}$$

v : Maximum speed of the vessel in relation to the water, in km/h

KG : Height, in m, of the centre of gravity above base line

S : Spacing, in m, of primary supporting members

n : Navigation coefficient defined in Pt B, Ch 3, Sec 1, [5.2]

z : Z co-ordinate, in m, of the calculation point.

ψ : Superstructure efficiency defined in Pt B, Ch 4, Sec 1, [3.2]

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the type and service notation **Passenger vessel**, as defined in Pt A, Ch 2, Sec 3, [5.1.1].

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to passenger vessels.

1.1.3 Various requirements of these Rules are to be applied for safety of passengers and crew according to Tab 1.

Where available, statutory Regulations in the operating area of the vessel (e.g. Rhine Rules, European directive) are to take precedence over these requirements.

Table 1 : Requirements applicable for safety of passengers and crew

Item	Applicable requirements
Subdivision, transverse bulkheads	[2.1]
Passenger rooms and areas	[2.2]
Propulsion system	[2.3]
Fire protection, detection and extinguishing	[3]
Electrical installations	[4]
Buoyancy and stability	[5]

1.2 Definitions

1.2.1 Day trip vessel

A day trip vessel is a passenger vessel without overnight passenger cabins.

1.2.2 Cabin vessel

A cabin vessel is a passenger vessel with overnight passenger cabins.

1.2.3 Margin line

Margin line is an imaginary line drawn on the side plating not less than 10 cm below the bulkhead deck and not less than 10 cm below the lowest non watertight point of the vessel's side. If there is no bulkhead deck, a line drawn not less than 10 cm below the lowest line up to which the outer plating is watertight shall be used.

1.2.4 Non combustible material

"Non-combustible material" is defined under Pt C, Ch 1, Sec 14, [1.4.2].

1.2.5 A-class divisions

A-class divisions are defined under Pt C, Ch 1, Sec 14, [1.4.5]

1.2.6 B-class divisions

B-class divisions are defined under Pt C, Ch 1, Sec 14, [1.4.6].

1.2.7 Main fire zones

Main fire zones are those sections into which the hull, superstructures and deckhouses are divided by A-class divisions, the mean length and width of which on any deck does not, in general, exceed 40 m.

2 Vessel arrangement

2.1 Subdivision, transverse bulkheads

2.1.1 In addition to the bulkheads called for in Pt B, Ch 5, Sec 5, the vessel is to be subdivided by further watertight transverse bulkheads in such a way that the requirements of [5] are met. All these bulkheads are to be extended upwards to the bulkhead deck.

The stepping of bulkheads is permitted only if this is located outside the penetration depths stated in [5.3.3].

2.1.2 The first compartment aft of the collision bulkhead may be shorter than the length of damage stated in [5.3.3] if the total length of the two foremost compartments measured in the plane of maximum draught is not less than this value.

The distance of the collision bulkhead from the forward perpendicular shall be between 0,04 L_{WL} and (0,04 L_{WL} + 2) m.

2.1.3 Passenger spaces are to be separated by watertight bulkheads from cargo, machinery and boiler spaces. Bulkhead doors are not permitted in the bulkheads between passenger and machinery spaces.The number of openings in watertight bulkheads shall be as small as is compatible with the construction and proper operation of the vessel.

2.1.4 Bulkhead doors which are normally in the OPEN position must be locally operable from both sides of the bulkhead, must be capable of being closed from an accessible location above the bulkhead deck and must meet the following conditions:

- the closing time is not to be less than 20 s nor more than 60 s
- at the remote control position, indicator lights are to be mounted showing whether the door is open or closed
- during the closing operation, a local audible alarm must sound automatically
- the door drive and signalling systems must also be able to operate independently of the vessel's mains.

Bulkhead doors without remote control are permitted only outside the passenger area. They are to be kept closed and may only be briefly opened to allow passageway.

Bulkhead doors and their systems must be situated outside the penetration depth stated in [5.3.3].

Open piping systems and ventilation ducts are to be routed in such a way that no further flooding can take place in any considered damaged condition.

Pipelines lying outside the penetration depth stated in [5.3.3] and more than 0,5 m above the base line are to be regarded as undamaged.

Bulkhead openings below the margin line are to be made watertight.

2.2 Passenger rooms and areas

2.2.1 Means of escape

Spaces or group of spaces which are provided for 30 or more passengers or are equipped as such or which have beds for 12 or more passengers shall be provided with at least two widely separated and ready means of escape. On board of day trip vessels one of the means of escape may be replaced by two emergency exits.

For spaces below the bulkhead deck one of the required means of escape may be a watertight door to the adjacent watertight compartment from which the uppermost deck can be reached. The second means of escape shall lead directly to a safe area above the bulkhead deck or open deck. This does not apply to single cabins.

Means of escape are to be arranged in a practical way and shall have a clear width of at least 0,8 m and a clear height of at least 2,00 m. The width of doors to cabins may be reduced to 0,7 m.

Spaces and group of spaces provided for more than 80 passengers shall have escape ways with a clear width of at least 0,01 m per passenger. This does also apply to doors within the means of escape.

Doors shall always open in the direction of means of escape and shall be clearly marked as such.

2.2.2 Doors of passenger rooms

Doors of passenger rooms shall comply with the following requirements:

a) with the exception of doors leading to connecting corridors, they shall be capable of opening outwards or be constructed as sliding doors

b) Cabin doors shall be made in such a way that they can also be unlocked from the outside at any time.

2.2.3 Stairs

Stairs and their landings in the passenger areas shall comply with the following requirements:

a) they shall be constructed in accordance with recognized standards

b) they shall have a clear width of at least 0,80 m or, if they lead to connecting corridors or areas used by more than 80 passengers, at least 0,01 m per passenger

c) they shall have a clear width of at least 1,00 m if they provide the only means of access to a room intended for passengers

d) they shall not lie in the damage area, unless there is at least one staircase on each side of the vessel in the same zone.

2.2.4 Escape routes

Escape routes shall comply with the following requirements:

a) stairways, exits and emergency exits shall be so disposed that, in the event of a fire in any given area, the other areas may be evacuated safely

b) the escape routes shall lead by the shortest route to evacuation areas

c) escape routes shall not lead through engine rooms or galleys

d) there shall be no rungs, ladders or the like installed at any point along the escape routes

e) doors to escape routes shall be constructed in such a way as not to reduce the minimum width of the escape route

f) escape routes and emergency exits shall be clearly signed. The signs shall be lit by the emergency lighting system.

2.2.5 Bulwark and railing

Parts of the deck intended for passengers, and which are not enclosed, shall comply with the following requirements:

a) they shall be surrounded by a fixed bulwark or guard rail in compliance with Pt B, Ch 7, Sec 2

b) openings and equipment for embarking or disembarking and also openings for loading or unloading shall be such that they can be secured.

2.3 Propulsion system

2.3.1 In addition to the main propulsion system, vessels shall be equipped with a second independent propulsion system so as to ensure that, in the event of a breakdown affecting the main propulsion system, the vessel can continue to make steerageway under its own power.

2.3.2 The second independent propulsion system shall be placed in a separate engine room. If both engine rooms have common partitions, these shall be built according to Ch 2, Sec 7, [2].

2.4 Bilge pumps

2.4.1 Number of bilge pumps

The number of bilge pumps is to be in compliance with Pt C, Ch 1, Sec 10, [11.4.3].

Further bilge pumps may be required according to size and propulsion power.

3 Fire protection, detection and extinction

3.1 General

3.1.1 The requirements of this Article apply in addition to general requirements for fire protection, detection and extinction developed under Pt C, Ch 1, Sec 14.

3.1.2 Passenger vessels assigned additional class notation **Fire** are to comply also with additional rule requirements of Ch 2, Sec 7.

3.1.3 Documents for review/approval

The following drawings and documents are to be submitted where applicable, at least in triplicate for review/ approval:

- fire division/ insulation plan showing designation of each space, including information to applied materials and constructions
- ventilation plan
- escape way plan
- sprinkler system.

3.2 Fire detection and alarm system

3.2.1 All day rooms normaly accessible to passengers and crew as well as galleys and machinery spaces are to be monitored by a type tested, automatic fire detection and alarm system.

3.2.2 Detectors are to be grouped into separate sections, each of which shall not comprise more than one main fire zone or one watertight division and not more than two vertically adjacent decks.

If the fire detection system is designed for remote and individual identification of detectors, several decks in one main fire zone respectively one watertight division may be monitored by the same detector loop. The detector loop shall be so arranged, that in the event of a damage (wire break, short circuit, etc.) only a part of the loop becomes faulty.

Smoke detectors shall be used in passage ways, stairways and escape routes. Heat detectors shall be used in cabins in the accommodation area. Flame detectors shall only be used in addition to the other detectors.

3.2.3 The blowout of a fire and the area concerned are to be signalled automatically to a permanently manned station.

3.2.4 The requirements [3.2.2] and [3.2.3] are deemed to be met in the case of spaces protected by an automatic pressure water-spraying system designed in accordance with Pt C, Ch 1, Sec 14, [5.3].

3.2.5 Manually operated call points are to be provided in addition to the automatic system:

- in passageways, enclosed stairways and at lifts
  - in saloons, day rooms and dining rooms
  - in machinery spaces, galleys and spaces with a similar fire hazard.

The manually operated call points shall be spaced not more than 10 m apart, however at least one call point shall be available in every watertight compartment.

3.2.6 The alarm set off by a manual call point shall be transmitted only to the rooms of the vessel's officers and crew and must be capable of being cancelled by the vessel's officers. Manual call points are to be safeguarded against unintended operation.

3.3 Fire protection in accommodation areas

3.3.1 General

All insulation materials, bulkheads, linings, ceilings and draught stops shall be of at least approved non-combustible material.

Primary deck coverings and surface materials shall be of an approved type.

3.3.2 Integrity of bulkheads and decks

Bulkheads between cabins shall be of approved type B-0 and to corridors of approved type B-15.

Where a sprinkler system is fitted, the corridor bulkheads may be reduced to approved type B-0.

Corridor bulkheads shall extend from deck to deck unless a continuous B-class ceiling is fitted on both sides of the bulkhead in which case the corridor bulkhead may terminate at the continuous ceiling.

All stairways are to be of steel frame or other non-combustible construction.

Stairways connecting more than two decks are to be enclosed by at leat class B bulkheads. Stairways connecting only two decks need to be protected at least at one deck level by class B bulkheads. Doors shall have the same fire resistance as the bulkheads in which they are fitted.

Where class A and B divisions are penetrated for the passage of cables, pipes, trunks, ducts etc. or for the fitting of ventilation terminals, lighting fixtures and similar devices, arrangements shall be made to ensure that the fire resistance is not impaired.

3.3.3 Internal subdivision

The vessel shall be subdivided into sections of not more than 40 m length by class A divisions. The doors shall be of self-closing type or shall be capable of remote release from the bridge and individually from both sides of the door. Status of each fire door (open/ closed position) shall be indicated on the bridge.

Galleys and control stations shall be separated from adjacent spaces by class A divisions. Machinery spaces are to be separated from accommodation areas by class A divisions. Doors fitted therein shall have the same fire resistance and shall be self-closing and reasonable gastight.

Air spaces enclosed behind ceilings, panelling or linings shall be divided by close-fitting draught stops spaced not more than 14 m apart. In the vertical direction, such enclosed air spaces, including those behind linings of stairways, trunks, etc., shall be closed at each deck level.

3.3.4 Means of escape

One of the means of escape required by [2.2.1] shall give direct access to a stairway from where the embarkation deck or the open deck can be reached.

Stairways shall have a clear width of at least 0,80 m. Clear width means between bulkheads and/or handrails.

Emergency exits shall have a clear dimension of not less than (0,70 x 0,70) m^2 or diameter of at least 0,7 m. They shall open in the direction of escape and be marked on both sides.

3.3.5 Ventilation system

All parts of the system shall be made of non-combustible material, except that short ducts applied at the end of the ventilation device may be made of a material which has low-flame spread characterisitics (see [3.3.6], Note 1).

Ventilation ducts are to be subdivided by approved fire dampers analogously to the requirements of [3.3.3] (first-paragraph). Penetrations through stairway boundaries are also to be provided with approved fire dampers.

Fire dampers are to be so designed that they can be operated locally from both sides of the division.

Note 1: Reference is made to the Fire Test Procedure Code, Annex 1, Part 5, adopted by IMO by Resolution MSC.61(67).

3.3.6 Sounding pipes

Sounding pipes of fuel tanks may not terminate in accommodation or passenger spaces.

3.4 General water fire extinguishing system

3.4.1 Passenger vessels over 40 m L_{WL} and passenger vessels with cabins for passengers over 25 m L_{WL} are subject to the additional requirements of [3.4.2] to [3.4.5].

3.4.2 It must be possible to project at least two jets of water simultaneously on any part of the vessel from two different hydrants using for each a single length of hose not more than 20 m long. The length of throw must be at least 12 m with a nozzle diameter of 12 mm.

3.4.3 The minimum capacity of the fire pump is to be 20 m^3/h.

3.4.4 If the fire pump is located in the engine room, a second power-driven fire pump must be provided outside the engine room. The pump drive must be independent of the engine room, and the pump capacity must conform to the preceding requirements [3.4.2] and [3.4.3].

Connections in the piping system with the engine room must be capable of being shut off from outside at the point of entry into the engine room.

A portable pump may be accepted, provided that a permanently installed pump is available in the engine room.

3.4.5 Two fire hoses with dual-purpose nozzles are to be located in hose boxes in both fore ship and aft ship. Further fire hoses may be required depending on the size and structural features of the vessel.

3.5 Portable fire extinguisher

3.5.1 One additional fire extinguisher is to be provided for:

- each unit of 120 m^2, or part thereof, of the gross floor area of public rooms, dining rooms and day rooms
- each group of 10 cabins, or part thereof.

3.5.2 Galleys and shops shall depending on their size and contents be provided with additional fire extinguishers.

3.5.3 These additional fire extinguishers are to be located in such a way that a fire extinguisher is at all times accessible in the immediate vicinity of any position.

3.6 Fixed fire extinguishing systems

3.6.1 Machinery spaces containing internal combustion engines used for propulsion and oil fired boilers shall be provided with a fixed fire extinguishing system in compliance with Pt C, Ch 1, Sec 14, [5.3] or Pt C, Ch 1, Sec 14, [5.4], as applicable.

Where installed, automatic pressure water spraying systems for the passenger area must be ready for operation at all times when passengers are on board. No additional measures on the part of the crew must be needed to actuate the system.

4 Electrical installations

4.1 General

4.1.1 Application

Cabin vessels and day trip vessels ($L_{WL} \geq 25$ m) are required to comply with this Article in addition to the requirements stated under Part C, Chapter 2.

Relaxations of these rules may be allowed for ferries and day trip vessels.

4.2 Generator plant

4.2.1 At least two separate independent main generator plants are to be provided for the supply to the electrical equipment. The prime mover system and the generator output shall be such that, if any generator set fails or is taken out of service, the remaining capacity is sufficient to meet the requirements of running service and manoeuvring.

4.3 Emergency power supply

4.3.1 General

An emergency source of electrical power independent of the main power supply is to be provided which is capable of feeding the electrical systems and consumers essential to the safety of passengers and crew. The feeding time depends on the purpose of the vessel and should be agreed with the national Authority, but shall not be less than half an hour. The power supply to the following systems is in special relevant to the safety of passengers and crew:

a) navigation and signalling lights
b) sound devices such as tyfon
c) emergency lighting
d) radio installations
e) alarm systems for vessel's safety
f) public address system (general alarm)
g) telecommunication systems essential to safety and the operation of the vessel
h) emergency searchlights
i) fire detection system
j) sprinkler systems and other safety installations.

4.3.2 Emergency source of electrical power

a) A generator set with both fuel supply and cooling system independent of the main engine which starts automatically in the event of a network failure and can automatically take over the power supply within 30 s.
b) A storage battery which automatically assumes the power supply in the event of a network failure and is capable of supplying the aforementioned consumers for the specified period without recharging and without an inadmissible voltage drop.

4.3.3 Installation

Emergency generator sets, emergency storage batteries and the relevant switchgear are to be installed outside the machinery space, the machinery casings and the main generator room. They are to be separated from these spaces by fire retardant and watertight bulkheads so that the emergency power supply will not be impaired in the event of a fire or other accident in the machinery space.

The emergency power supply must remain fully serviceable with a permanent list of 22,5° and/or a trim of 10°.

Facilities are to be provided for the periodical operational testing of all items of equipment serving the emergency power supply system including especially the automatic switchgear and starting equipment. Such tests must be possible without interference with other aspects of the vessel's operation.

4.4 Alarm and communication systems

4.4.1 Passenger alarm system

Passenger vessels with cabins must be equipped with a passenger alarm system. This must be capable of being actuated from the wheelhouse and a permanently manned station. The alarm must be clearly perciptible in all rooms accessible to passengers. The alarm actuator has to be safeguarded against unintended operation.

4.4.2 Crew alarm system

Passenger vessels with cabins must be equipped with a crew alarm system in each cabin, in alleyways, lifts and stairwells, such that the distance to the next actuator is not more than 10 m, but at least one actuator every watertight compartment; in crew mess rooms, engine rooms, kitchens and similar fire hazard rooms.

4.4.3 Engineer's alarm

An engineer's alarm is to be provided enabling the machinery personnel to be summoned in their quarters from the engine room should this be rendered necessary by the arrangement of the machinery space in relation to the engineers' accommodation.

4.5 Intercommunications

4.5.1 Intercommunications from the bridge

Where no direct means of communication exist between the bridge and the:

- crew's day rooms
- service spaces
- engine room (control platform)
- foreship and aftship,

a suitable intercommunications system is to be provided.

The general telephone system can be approved for this purpose provided it is guaranteed that the bridge/engine link always has priority and that existing calls on this line between other parties can be interrupted.

Where a telephone system is used, the engineer's alarm may be dispensed with provided that two-way communication is possible between the machinery space and the engineers' accommodation.

4.5.2 Public address systems

Vessels with a length L_{WL} of 40 m and over and vessels intended for more than 75 passengers must be equipped with loudspeakers capable of reaching all the passengers.

4.6 Fire door and watertight door closure indicators

4.6.1 The door release panel on the bridge or in the permanently manned safety station shall be equipped with indicators signalling the closure and the opening of fire doors or watertight doors.

4.7 Lighting sytems

4.7.1 Construction and extent of the main lighting system

There is to be a main lighting system supplied by the main source of electrical power and illuminating all parts of the vessel normally accessible to the passengers and crew. This system is to be installed in accordance with Pt C, Ch 2, Sec 10.

4.7.2 Construction and extent of the emergency lighting system

a) Construction

An emergency lighting system is to be installed, the extent of which shall conform to b).

The power supply and the duration of the supply shall conform to [4.3].

As far as practicable the emergency lighting system shall be installed in a manner, that it will not be rendered unserviceable by a fire or other incident in rooms in which the main source of electrical power, any associated transformers, the main switchboard and the main lighting distribution panel are installed.

The emergency lighting system shall be cut in automatically following a failure of the main power supply. Local switches are to be provided only where it may be necessary to switch off the emergency lighting (e.g. in the wheelhouse).

Emergency lights must be marked as such for ease of identification.

b) Extent

Adequate emergency lighting must be provided in the following areas:

- positions at which collective life-saving appliances are stored and at which they are normally prepared for use
- escapes, exits, connecting passageways, lifts and stairways in the accommodation area
- marking indicating escapes and exits
- machinery spaces and their exits
- wheelhouse
- space of the emergency power source
- locations of fire extinguishers and fire pumps
- rooms in which passengers and crew assemble in an emergency.

c) If a vessel is divided into main fire zones, at least two circuits are to be provided for the lighting of each main fire zone, and each of these must have its own power supply line. One circuit shall be supplied from the emergency power source. The supply lines are to be so located that, in the event of a fire in one main fire zone, the lighting in the other zones is as far as practicable maintained.

4.7.3 Final subcircuits

In the important spaces mentioned below the lighting shall be supplied by at least two different circuits:

- passageways
- stairways leading to the boat deck, and public spaces and day rooms for passengers and crew
- large galleys.

The lamps are to be so arranged that adequate lighting is maintained even if one of the circuits fails.

5 Buoyancy and stability

5.1 General

5.1.1 General requirements of Pt B, Ch 2, Sec 6 are to be complied with.

5.2 Intact stability

5.2.1 General

Proof of appropriate intact stability of the vessel shall be furnished. All calculations shall be carried out free to trim and sinkage.

5.2.2 Standard load conditions

The intact stability shall be proven for the following standard load conditions:

a) at the start of the voyage:

100% passengers, 98% fuel and fresh water, 10% waste water

b) during the voyage:

100% passengers, 50% fuel and fresh water, 50% waste water

c) at the end of the voyage:

100% passengers, 10% fuel and fresh water, 98% waste water;

d) unladen vessel:

no passengers, 10% fuel and fresh water, no waste water.

For all standard load conditions, the ballast tanks shall be considered as either empty or full in accordance with normal operational conditions.

As a precondition for changing the ballast whilst under way, the requirement of [5.2.3], item d), shall be proved for the following load condition:

- 100% passengers, 50% fuel and fresh water, 50% waste water, all other liquid (including ballast) tanks are considered filled to 50%.

5.2.3 Intact stability criteria

The proof of adequate intact stability by means of a calculation shall be produced using the following intact stability criteria, for the standard load conditions mentioned in [5.2.2], items a) to d):

a) the maximum righting lever arm h_{max} shall occur at a list angle of $\varphi_{max} \geq (\varphi_{mom} + 3°)$ and must not be less than 0,20 m. However, in case $\varphi_f < \varphi_{max}$ the righting lever arm at the downflooding angle φ_f must not be less than 0,20 m

b) the downflooding angle φ_f must not be less than $\varphi_{mom} + 3°$

c) the area A under the curve of the righting lever arm shall, depending on the position of φ_f and φ_{max} , reach at least the values given in Tab 3, where:

   - φ : List angle
   - φ_f : List angle, at which openings in the hull, in the superstructure or deck houses which cannot be closed so as to be weathertight, submerge
   - φ_{max} : List angle at which the maximum righting lever arm occurs
   - φ_{mom} : Maximum list angle defined under item e)
   - A : Area beneath the curve of the righting lever arms

d) the metacentric height at the start, GM_0, corrected by the effect of the free surfaces in liquid tanks, shall not be less than 0,15 m

e) in each of the following two cases the list angle φ_{mom} shall not be in excess of the value of 12°:

   - in application of the heeling moment due to passengers and wind according to [5.2.4] and [5.2.5]
   - in application of the heeling moment due to passengers and turning according to [5.2.4] and [5.2.6]

f) for a heeling moment resulting from moments due to passengers, wind and turning according to [5.2.4], [5.2.5] and [5.2.6], the residual freeboard shall be not less than 200 mm

g) for vessels with windows or other openings in the hull located below the bulkhead decks and not closed watertight, the residual safety clearance shall be at least 100 mm on the application of the heeling moments resulting from item e).

5.2.4 Moment due to crowding of passengers

The heeling moment M_P, in t.m, due to one-sided accumulation of persons is to be calculated according to the following formula:

$$M_P = Py = \sum P_i y_i$$

where:

- P : Total weight of persons on board, in t, calculated by adding up the maximum permitted number of passengers and the maximum number of shipboard personnel and crew under normal operating conditions, assuming an average weight per person of 0,075 t
- y : Lateral distance, in m, of center of gravity of total weight of persons P from center line
- P_i : Weight of persons accumulated on area A_i, in t:

  $P_i = 0,075\ n_i\ A_i$

  where:

  - A_i : Area, in m², occupied by persons
  - n_i : Number of persons per square meter

    for free deck areas and deck areas with movable furniture: $n_i = 4$

    for deck areas with fixed seating furniture such as benches, n_i shall be calculated by assuming an area of 0,45 m in width and 0,75 m in seat depth per person
- y_i : Lateral distance, in m, of geometrical center of area A_i from center line.

The calculation shall be carried out for an accumulation of persons both to starboard and to port.

The distribution of persons shall correspond to the most unfavorable one from the point of view of stability. Cabins shall be assumed unoccupied for the calculation of the person moment.

For the calculation of the loading cases, the centre of gravity of a person should be taken as 1 m above the lowest point of the deck at 1/2 L_{WL}, ignoring any deck curvature and assuming a weight of 0,075 t per person.

A detailed calculation of deck areas which are occupied by persons may be dispensed with if the following values are used:

- $y = B / 2$
- for day trip vessels: $P = 1,1 \cdot n_{max} \cdot 0,075$

  for cabin vessels: $P = 1,5 \cdot n_{max} \cdot 0,075$

  where:

  n_{max} : Maximum permitted number of passengers.

5.2.5 Moment due to lateral wind pressure

The moment M_W, in t.m, due to lateral wind pressure is to be determined by the following formula:

$$M_W = 0,1\ P_{WD}\ A_W\ (\ell_W + T / 2)$$

where:

- P_{WD} : Specific wind pressure, in kN/m², defined in Tab 2
- A_W : Lateral area above water, in m²
- ℓ_W : Distance, in m, of the centre of gravity of area A_W, from the draught mark.

Table 2 : Specific wind pressure P_{WD}

Range of navigation	P_{WD}, in kN/m²
IN(1,2 ≤ x ≤ 2)	0,4 n
IN(0), **IN(0,6)**	0,25

Table 3 : Values of area A under the curve of righting lever arm

Case			A, in m.rad
1	$\varphi_{max} \le 15°$ or $\varphi_f \le 15°$		0,05 to angle $\varphi = \varphi_{max}$ or $\varphi = \varphi_f$
2	$15° < \varphi_{max} < 30°$	$\varphi_{max} \le \varphi_f$	0,035 + 0,001 (30 − φ_{max}) to angle φ_{max}
3	$15° < \varphi_f < 30°$	$\varphi_{max} > \varphi_f$	0,035 + 0,001 (30 − φ_{max}) to angle φ_{max}
4	$\varphi_{max} \ge 30°$ and $\varphi_f \ge 30°$		0,035 to angle $\varphi = 30°$

Table 4 : Extent of damage, in m

Dimension of the damage		1-compartment status	2-compartment status
Side damage	longitudinal ℓ	0,1 $L_{WL} \ge 4$	0,05 $L_{WL} \ge 2,25$
	transverse b	B / 5	0,59
	vertical h	from vessel bottom to top without delimitation	
Bottom damage	longitudinal ℓ	0,1 $L_{WL} \ge 4$	0,05 $L_{WL} \ge 2,25$
	transverse b	B / 5	
	vertical h	0,59; pipework shall be deemed intact **(1)**	

(1) Where a pipework system has no open outlet in a compartment, the pipework shall be regarded as intact in the event of this compartment being damaged, if it runs within the safe area and is more than 0,50 m off the bottom of the vessel.

5.2.6 Turning circle moment

The moment M_{dr}, in t.m, due to centrifugal force caused by the turning circle, is to be determined by the following formula:

$$M_{dr} = \frac{0,00347 C_B v^2 \Delta}{L_{WL}}\left(KG - \frac{T}{2}\right)$$

If not known, the block coefficient C_B is to be taken as 1,0.

For passenger vessels with special propulsion systems (rudder-propeller, water-jet, cycloidal-propeller and bow-thruster), M_{dr} shall be derived from full-scale or model tests or else from corresponding calculations.

5.3 Damage stability

5.3.1 Proof of appropriate damage stability of the vessel shall be furnished by means of a calculation based on the method of lost buoyancy. All calculations shall be carried out free to trim and sinkage.

5.3.2 Buoyancy of the vessel in the event of flooding shall be proven for the standard load conditions specified in [5.2.2]. Accordingly, mathematical proof of sufficient stability shall be determined for the three intermediate stages of flooding (25%, 50% and 75% of flood build-up) and for the final stage of flooding.

5.3.3 Assumptions

In the event of flooding, assumptions concerning the extent of damage given in Tab 4 shall be taken into account.

a) For 1-compartment status the bulkheads can be assumed to be intact if the distance between two adjacent bulkheads is greater than the damage length. Longitudinal bulkheads at a distance of less than B / 3 measured rectangular to centre line from the shell plating at the maximum draught plane shall not be taken into account for calculation purposes.

b) For 2-compartment status each bulkhead within the extent of damage will be assumed to be damaged. This means that the position of the bulkheads shall be selected in such a way as to ensure that the passenger vessel remains buoyant after flooding of two or more adjacent compartments in the longitudinal direction.

c) The lowest point of every non-watertight opening (e.g. doors, windows, access hatchways) shall lie at least 0,10 m above the damage waterline. The bulkhead deck shall not be immersed in the final stage of flooding.

d) Permeability is assumed to be 95%. If it is proven by a calculation that the average permeability of any compartment is less than 95%, the calculated value can be used instead.

   The values to be adopted shall not be less than those given in Tab 5.

e) If damage of a smaller dimension than specified above produces more detrimental effects with respect to listing or loss of metacentric height, such damage shall be taken into account for calculation purposes.

Table 5 : Permeability values, in %

Spaces	μ
Lounges	95
Engine and boiler rooms	85
Luggage and store rooms	75
Double bottoms, fuel bunkers and other tanks, depending on whether, according to their intended purpose, they are to be assumed to be full or empty for the vessel floating at the plane of maximum draught	0 or 95 %

5.3.4 Damage stability criteria

a) For all intermediate stages of flooding referred to in [5.3.2], the following criteria shall be met:

- the angle of heel φ at the equilibrium position of the intermediate stage in question shall not exceed 15°
- Beyond the inclination in the equilibrium position of the intermediate stage in question, the positive part of the righting lever arm curve shall display a righting lever arm value of GZ ≥ 0,02 m before the first unprotected opening becomes immersed or an angle of heel φ of 25° is reached
- non-watertight openings shall not be immersed before the inclination in the equilibrium position of the intermediate stage in question has been reached.

b) During the final stage of flooding, the following criteria shall be met (see Fig 1) taking into account the heeling moment due to passengers in accordance with [5.2.4]:

- the angle of heel φ_E shall not exceed 10°
- beyond the equilibrium position the positive part of the righting lever arm curve shall display a righting lever arm value of $GZ_R \geq 0,02$ m with an area $A \geq 0,0025$ m·rad. These minimum values for stability shall be met until the immersion of the first unprotected opening or in any case before reaching an angle of heel $\varphi_m \leq 25°$
- non-watertight openings shall not be immersed before the trimmed position has been reached; if such openings are immersed before this point, the rooms affording access are deemed to be flooded for damage stability calculation purposes.

5.3.5 The shut-off devices which shall be able to be closed watertight shall be marked accordingly.

5.3.6 If cross-flood openings to reduce asymmetrical flooding are provided, they shall meet the following conditions:

a) for the calculation of cross-flooding, IMO Resolution A.266 (VIII) shall be applied

b) they shall be self-acting

c) they shall not be equipped with shut-off devices

d) the total time allowed for compensation shall not exceed 15 minutes.

5.4 Safety clearance and freeboard

5.4.1 Safety clearance

The safety clearance shall be at least equal to the sum of:

a) the additional lateral immersion, which, measured on the outside plating, is produced by the permissible angle of heel according to [5.2.3] e) , and

b) the residual safety clearance according to [5.2.3] g).

For vessels without a bulkhead deck, the safety clearance shall be at least 500 mm.

5.4.2 Freeboard

The freeboard shall correspond to at least the sum of:

a) the additional lateral immersion, which, measured on the outside plating, is produced by the angle of heel according to [5.2.3] e), and

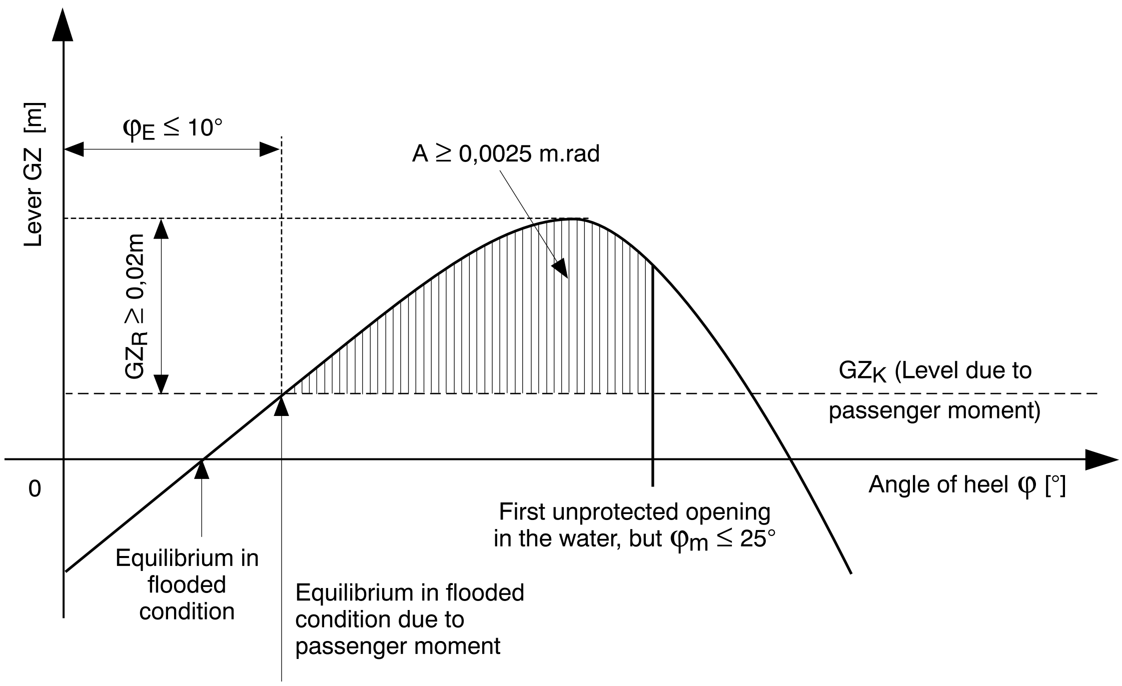
b) the residual freeboard according to [5.2.3] f).

The freeboard shall be at least 300 mm.

5.4.3 The plane of maximum draught is to be set so as to ensure compliance with the safety clearance according to [5.4.1], and the freeboard according to [5.4.2].

5.4.4 For safety reasons, the Society may stipulate a greater safety clearance or a greater freeboard.

Figure 1 : Proof of damage stability (final stage of flooding)



6 Design loads

6.1 Pressure on bottom and sides

6.1.1 The design lateral pressure at any point of the hull bottom and sides is to be determined in compliance with Pt B, Ch 3, Sec 4, [2], taking into account adequate load case.

6.2 Pressure on sides and bulkheads of superstructures and deckhouses

6.2.1 The lateral pressure to be used for the determination of scantlings of structure of sides and bulkheads of superstructures and deckhouses is to be obtained, in kN/m², from the following formula:

$p = 2 + p_{WD}$

where, p_{WD} is the specific wind pressure, in kN/m², defined in Tab 2.

6.3 Pressure on decks

6.3.1 The pressure due to load carried on decks is to be defined by the designer and, in general, it may not be taken less than the values given in Tab 6.

Table 6 : Pressure on decks

Item	p, in kN/m²
Weather deck	3,75 (n + 0,8)
Exposed deck of superstructure or deckhouse:	
• first tier (non public)	2,0
• upper tiers (non public)	1,5
• public	4,0
Accommodation compartments:	
• large spaces, such as: restaurants, halls, cinemas, lounges, kitchen, service spaces, games and hobbies rooms, hospitals	4,0
• cabins	3,0
• other compartments	2,5

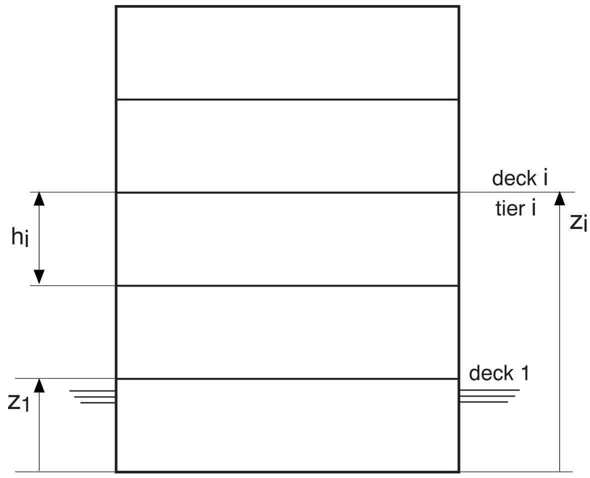
6.4 Loads due to list and wind action

6.4.1 General

The loads inducing the racking in vessel superstructures above deck 1 (see Fig 2) are as follows:

- structural horizontal load P_S
- non structural horizontal load P_C
- wind load P_W.

Figure 2 : Height and location of tier i



6.4.2 Definitions

The following parameters are used for the determination of loads inducing racking:

φ : Angle of list up to which no non-watertight opening to a non-flooded compartment reaches the water level, to be derived from damaged stability calculation

Where this value is not known, φ is to be taken equal to 12°

p_{WD} : Specific wind pressure, in kN/m², defined in Tab 2

h_i : Height, in m, of tier i of superstructure (see Fig 2)

b_i : Width, in m, of tier i of superstructure.

6.4.3 Structural horizontal load

The structural horizontal load, in kN, between successive gantries or transverse bulkheads, acting on deck i is given by the formula:

$P_{Si} = 9,81\ m_{Si} \sin \varphi$

where:

m_{Si} : Structural mass, in t, of tier i of superstructure, between successive gantries or bulkheads.

The following indicated value may be adopted:

$m_{Si} = 0,08\ S\ h_i\ b_i$

6.4.4 Non structural horizontal load

The non structural horizontal load, in kN, between successive gantries or transverse bulkheads, acting on deck i is given by the formula:

$P_{Ci} = p_i\ S\ b_i \sin \varphi$

where:

p_i : Design pressure on deck i, in kN/m², defined in Tab 6.

6.4.5 Wind load

The wind load, in kN, between successive gantries or transverse bulkheads, acting on deck i is given by the formula:

$P_W = p_{WD}\ S\ (h_i + h_{i+1}) / 2$

6.5 Inertial loads

6.5.1 General

The following inertial loads inducing racking in vessel superstructures above deck 1 (see Fig 2) are to be taken into account:

- structural horizontal load, P_{SR}, induced by roll acceleration
- non structural horizontal load, P_{CR}, induced by roll acceleration.

6.5.2 Definitions

Following parameters are used for the determination of inertial loads inducing racking:

h_i : Height, in m, of tier i of superstructure (see Fig 2)

b_i : Width, in m, of tier i of superstructure

z_i : Height, in m, of deck i above base line (see Fig 2)

z_G : Height, in m, of rolling centre above base line

z_G may be considered as the vertical centre of gravity when no information is available

T_R : Motion period, in s:

$$T_R = \frac{0,77B}{\sqrt{GM}}$$

GM : Distance, in m, from the vessel's centre of gravity to the transverse metacentre, for the loading considered; when GM is not known, its value may be determined using the following formula:

GM = 0,07 B

a_R : Motion acceleration, in m/s²:

$$a_R = \frac{40\varphi(z_i - z_G)}{T^2_R}$$

φ : Angle of list, in radian, defined in [6.4.2]

6.5.3 Structural horizontal inertial load

The structural horizontal inertial load, in kN, between successive gantries or transverse bulkheads, acting on deck i is given by the formula:

$P_{SRi} = m_{Si}\ a_R$

where:

m_{Si} : Structural mass, in t, defined in [6.4.3].

6.5.4 Non structural horizontal inertial load

The non structural horizontal inertial load, in kN, between successive gantries or transverse bulkheads, acting on deck i is given by the formula:

$$P_{CRi} = \frac{p_i S b_i a_R}{9,81}$$

where:

p_i : Design pressure on deck i, in kN/m², defined in Tab 6.

See also Pt B, Ch 3, Sec 4, [3.5.4].

6.6 Loads induced by collision

6.6.1 In the case of sensitive superstructures, the Society may require the structure to be checked against collision induced loads.The values of the longitudinal and transverse accelerations, in m/s², are to be taken not less than:

- longitudinal acceleration: a = 3,0 m/s²
- transverse acceleration: a = 1,5 m/s²

6.7 Hull girder loads

6.7.1 The design bending moments in hogging and sagging conditions and the vertical design shear force are to be determined according to Part B, Chapter 4.

7 Scantlings

7.1 General

7.1.1 The hull scantlings are to be as specified in Part B, Chapter 5.

7.2 Additional requirements

7.2.1 Hull girder section modulus

The hull girder section modulus to be used for the scantling of hull and contributing superstructures / deckhouses, is to be determined in compliance with Pt B, Ch 4, Sec 1, taking into account the strength deck or the contributing deck up to which extends the considered superstructure / deckhouse.

7.2.2 Primary supporting members

The design pressure of bottom primary supporting members is to be determined using $\gamma = 1$ for the draught coefficient.

7.2.3 Catamarans

Scantlings of primary structural members contributing to the transverse bending strength and torsional strength are to be supported by direct calculations carried out according to Pt B, Ch 2, Sec 5.

Special attention is to be paid to the staggering of resistant members in the two hulls.

A method for the determination of scantlings of deck beams connecting the hulls of a catamaran subject to torsional moment is given in Pt B, Ch 2, App 4.

Any other agreed method of calculation may be accepted by the Society.

7.3 Superstructures and deckhouses

7.3.1 The arrangement and scantlings of superstructures and deckhouses are to be in compliance with Pt B, Ch 6, Sec 4.

Contributing superstructures and deckhouses are also to be in compliance with applicable requirements of Part B, Chapter 5.

7.3.2 Transverse strength

The existing constructive dispositions must ensure an effective transverse strength of the superstructures and deckhouses notably the end bulkheads, the partial or complete intermediate bulkheads and the greatest possible number of continuous and complete gantries.

Scantlings of primary structural members contributing to the transverse strength of superstructures are to be supported by direct calculation, according to guidance defined in [7.4].

7.4 Racking analysis

7.4.1 General

The racking analysis is performed for checking strength of structure against lateral horizontal loads due to list and wind action defined in [6.4] and, eventually, to inertial loads induced by vessel motion.

7.4.2 Analysis methodology

The following methodology is to be followed for checking strength of structure above the lowest deck (so called deck 1 in Fig 2):

a) Calculation of transverse forces
   - determination of structural horizontal load on each deck, above deck 1, according to [6.4.3] and, eventually, [6.5.3]
   - determination of non structural horizontal load on each deck, above deck 1, according to [6.4.4] and, eventually, [6.5.4]
   - determination of wind load on each deck above deck 1 according to [6.4.5]

b) Distribution of transverse forces
   - distribution of these loads on vertical structural members efficiently acting against racking

c) Analysis of transverse structures.

7.4.3 Checking criteria

It is to be checked that the normal stress σ, the shear stress τ and the equivalent stress σ_{VM} are in compliance with the following formulae:

$$\frac{0,98R_{eH}}{\gamma_R} \geq \sigma$$

$$\frac{0,49R_{eH}}{\gamma_R} \geq \tau$$

$$\frac{0,98R_{eH}}{\gamma_R} \geq \sigma_{VM}$$

where:

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

γ_R : Partial safety factor covering uncertainties regarding resistance, to be taken equal to 1,20.

7.5 Scantling of window stiles

7.5.1 General

The geometric characteristics of the hull girder to be used for the scantling of window stiles are to be determined in compliance with Pt B, Ch 4, Sec 1, assuming that the hull girder extends up to the uppermost contributing superstructure / deckhouse deck.

7.5.2 Forces in the window stile

a) Local shear force, in kN
   - In general:

$$F = \frac{100 \cdot \psi \cdot T_S \cdot \mu}{2 \cdot I} \cdot \ell$$

   - In way of highest contributing superstructure / deckhouse deck:

$$F = \frac{100 \cdot \psi \cdot T_S \cdot A}{2 \cdot w_1} \cdot \ell$$

b) Maximum local bending moment, in kN.m

$$M_B = \frac{F \cdot h}{2}$$

where:

T_S : Shear force, in kN, to be determined according to Pt B, Ch 3, Sec 2, [5.3.1]

I : Net hull girder moment of inertia, in cm^4, with respect to the hull girder neutral axis

μ : Net static moment, in cm^3, with respect to the hull girder neutral axis, of the part including lateral strip of plate and all contributing tiers of superstructure or deckhouse located above the window considered

w_1 : Net hull girder section modulus in way of the superstructure deck considered, in cm^3, with respect to the hull girder neutral axis

A : Net sectional area of the superstructure / deckhouse deck considered, in cm^2, including lateral strip of plating above windows

h : Window height, in m

ℓ : Distance, in m, between centres of two successive windows.

7.5.3 Checking criteria

It is to be checked that the stresses in the window stile are in compliance with [7.4.3].

SECTION 7 TUGS AND PUSHERS

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4].

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the type and service notation **Tug** or **Pusher**, as defined in Pt A, Ch 2, Sec 3, [7.1.1] or Pt A, Ch 2, Sec 3, [7.1.2].

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C, as applicable, and with the requirements of this Section, which are specific to tugs and pushers.

In particular, when pushed convoy or side-by-side formation comprises a vessel carrying dangerous goods, vessels used for propulsion shall meet the requirements of Ch 3, Sec 8, [2] and Ch 3, Sec 9, [2], as applicable.

1.2 Documents to be submitted

1.2.1 In addition to the documentation requested in Pt B, Ch 1, Sec 2, a drawing showing the towing devices and their installation is to be submitted for review/approval to the Society. The maximum towing force contemplated is to be mentioned on that drawing.

2 Arrangement

2.1 Towing devices

2.1.1 Connection with hull structures

On tugs towing astern, the connection of the towing hook to the hull structure is to be strengthened by means of sufficient framing.

On tugs using a broadside tow, the towing bitts are to be secured to stools adequately supported by web frames or bulkheads, the latter being located on either side of the bitts.

2.2 Pushing devices

2.2.1 Transom plate

Pushers are to be arranged with an efficient flat transom plate or any other equivalent device at the fore end of the vessel the structure of which is to be in compliance with Pt B, Ch 7, Sec 6.

2.3 Hull protection

2.3.1 Fenders

A strong fender for the protection of the tug's sides is to be fitted at deck level.

Alternatively, loose side fenders may be fitted, provided that they are supported by vertical ordinary stiffeners extending from the lightship waterline to the fenders themselves.

3 Hull scantlings

3.1 General

3.1.1 The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 5, taking into account additional requirements defined in [3.2].

3.2 Additional requirements

3.2.1 Minimum net thickness of plating

The minimum thickness of the shell plating and deck plating are to be obtained from Tab 1.

Table 1 : Minimum net thickness t of plating

Plating	t, in mm
Decks, sides, bottom, bulkheads, web of primary supporting members, web of ordinary stiffeners and other structures	$t = 3,3 + 0,048\ L\ k^{0,5}$
Keel plate	t = thickness of adjacent bottom plating

3.2.2 Topside structure

The topside structure scantlings are to be determined according to Pt B, Ch 5, Sec 4, [5], where the minimum thickness is to be taken equal to 5 mm.

3.2.3 Primary supporting members

The design pressure of bottom primary supporting members is to be determined using $\gamma = 1$ for the draught coefficient.

4 Other structures

4.1 Sternpost

4.1.1 Irrespective of the range of navigation assigned to the vessel, the scantlings of the sternpost are not to be less than those determined according to requirements applicable to range of navigation **IN(1,2)**.

5 Hull outfitting

5.1 Rudder

5.1.1 Irrespective of the range of navigation assigned to the vessel, the rudder scantlings are not to be less than those determined according to the requirements applicable to range of navigation **IN(1,2)**.

6 Machinery

6.1 Propelling machinery

6.1.1 Propulsion systems under the bottom of the vessel are to be protected against damage by an effective structure around the propulsion system.

SECTION 8 PONTOONS

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4].

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of one of the type and service notations **Pontoon** and **Pontoon - crane** as defined in Pt A, Ch 2, Sec 3, [7.1.4].

Specific requirements which apply only to vessels with the type and service notation **Pontoon** or vessels with the type and service notation **Pontoon - crane** are indicated.

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to type and service notations **Pontoon** and **Pontoon - crane**.

1.1.3 Main characteristics of considered units

The requirements of this Section are based on the following assumptions:

- considered units are of normal structural configuration and proportions
- cargo is homogeneously distributed.

The scantlings of 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 2, Sec 5.

1.2 Documents to be submitted

1.2.1 In addition to the documentation requested in Pt B, Ch 1, Sec 2, the following documents are to be submitted to the Society:

- cargo weight distribution on the deck
- equipment weight and distribution.

2 Structure design principles

2.1 Hull structure

2.1.1 Framing

In general, vessels with one of the service notations Pontoon and Pontoon - crane are to be longitudinally framed. Longitudinal stiffening members are to be supported by transverses arranged to form ring systems.

2.1.2 Supports for docking

Adequate supports are to be fitted on the longitudinal centreline in order to carry loads acting on the structure when the pontoons are in dry dock.

2.1.3 Truss arrangement supporting deck loads

Where truss arrangements may be 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.

2.2 Lifting appliances

2.2.1 Crane or derrick position during navigation

For vessels with the type and service notation Pontoon - crane, it is to be possible to lower the crane boom or the derrick structure and to secure them to the pontoon during the voyage.

3 Hull girder strength

3.1 Yielding check

3.1.1 Vessels less than 40 m lifted by crane

For units less than 40 m in length intended to be lifted on board ships by crane, the hull girder strength is to be checked, in the condition of fully-loaded vessel lifted by crane, through criteria to be agreed with the Society on a case-by-case basis.

3.1.2 Vessels with type and service notation pontoon carrying special cargoes

For vessels with the type and service notation pontoon intended for the carriage of special cargoes, such as containers or heavy loads concentrated in limited areas, the hull girder strength is to be checked through criteria to be agreed with the Society on a case-by-case basis.

3.1.3 Vessels with type and service notation pontoon - crane

For vessels with the type and service notation pontoon - crane having length greater than or equal to 40 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.

4 Hull scantlings

4.1 General

4.1.1 The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 5, taking into account the following additional requirements.

4.1.2 Minimum net thickness of plating

The minimum thickness of the shell plating and deck plating are to be obtained from Tab 1.

Table 1 : Minimum net thickness t of plating

Plating	t, in mm
Decks, sides, bottom, bulkheads, web of primary supporting members, web of ordinary stiffeners and other structures	• For $L \leq 40$ m: $t = 3,3 + 0,048\ L\ k^{0,5}$ • For $L > 40$ m: $t = 4,8 + 0,019\ L\ k^{0,5}$
Keel plate	t = thickness of adjacent bottom plating

4.1.3 Plating and stiffeners subjected to wheeled loads are to comply with Ch 1, Sec 5.

4.1.4 Primary supporting members

In the case of primary supporting members forming a grillage, the scantlings are to be determined by direct calculation as specified in Ch 1, Sec 4, [7].

4.2 Hull scantlings of units with type and service notation pontoon - crane

4.2.1 Loads transmitted by the lifting appliances

The forces and moments transmitted by the lifting appliances to the vessel'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.

4.2.2 Vessel's structures

The vessel's structures, subjected to the forces transmitted by the lifting appliances, are to be reinforced to the Society's satisfaction.

4.2.3 Lifting appliances

The check of the behaviour of the lifting appliances during operation is outside the scope of the classification and is under the responsibility of the Designer. However, where the requirements in [2.2.1] 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.

4.3 Reinforcements

4.3.1 Reinforcements are to be provided at places where the hull is heavily stressed, as the securing points of the towing ropes.

SECTION 9 VESSELS FOR DREDGING ACTIVITIES

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

ρ : Density of the water and spoil mixture; as a general rule, the value of ρ may be taken not greater than 1,8 t/m³.

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of one of the following type and service notations, as defined in Pt A, Ch 2, Sec 3, [6.1.1] to Pt A, Ch 2, Sec 3, [6.1.4]:

- **Dredger**
- **Hopper dredger**
- **Hopper barge**
- **Split hopper barge**.

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to vessels for dredging activities.

1.1.3 Dredging equipment and installations are not covered by these Rules.

1.2 Dredger types

1.2.1 Hopper dredger and hopper barge

Hopper dredger and hopper barge are vessels intended to carry out dredging operations and having one or several hopper spaces in the midship region, or a suction pipe well.

1.2.2 Dredger

A dredger is a vessel intended to carry out dredging operations and that does not carry spoil, such as bucket dredger.

1.2.3 Split hopper barge

A split hopper barge is an hopper barge which opens longitudinally around hinges.

1.3 Documents to be submitted

1.3.1 In addition to the documentation requested in Pt B, Ch 1, Sec 2, the following documents are to be submitted to the Society:

- calculation of the maximum still water bending moments
- dredging equipment weight and distribution
- other equipment weight and distribution.

2 Arrangement

2.1 Transverse rings

2.1.1 General

Transverse rings are to be provided abreast the hopper spaces, spaced not more than (1,1 + 0,025 L) apart.

Rings located in the same cross section are to be connected by means of a deep floor.

Strong beams may be fitted at deck level, if deemed necessary for the hopper transverse strength.

2.1.2 Gusset stays for coamings

Gusset stays for coamings are to be fitted in way of the transverse rings to which they are to be securely fixed.

2.2 Transverse and longitudinal bulkheads

2.2.1 It is recommended to provide a chafing allowance for plates subjected to rapid wear (hopper space bulkheads, weir, ...).

2.3 Suction pipe well

2.3.1 As far as the operation of the vessels permits it, the side compartments are to be firmly connected together unless adequate arrangements are made and approved by the Society.

Longitudinal strength continuity is to be ensured. The top and bottom of the side compartments are to be correctly connected to elements beyond the transverse bulkheads of the well by means of large horizontal brackets.

2.4 Hopper space structure

2.4.1 At the ends of the hopper space, the transverse bulkheads are to extend from one side to the other of the vessel. Where this is not the case, web rings with special scantlings are to be provided.

2.5 Particular arrangements

2.5.1 Dredgers

Where dredgers are likely to work in association with hopper barges, the sheerstrake is to be protected. This can be accomplished slightly below the deck by a fender efficiently secured to the shell plating and extending at least over two-thirds of the vessel length.

Strength continuity is to be ensured in way of deck breaks as required in Pt B, Ch 5, Sec 4, [1.2.1].

2.5.2 Bucket dredgers

Dangerous flooding in case of damage to shell plating by metal debris (f.ex. anchors) is to be avoided. A watertight compartment is to be provided at the lower part of the caissons on either side of the suction pipe well in the area of the buckets. The compartment is to be of sufficient size to allow surveys to be carried out.

2.6 Shifting of the structures at ends of the hopper spaces

2.6.1 Continuity of the longitudinal members is to be ensured at the ends of the hopper spaces.

The ends of the longitudinal bulkheads are to be extended upwards and downwards by large brackets each having, a rule length and width equal to about 0,25 D.

Under the lower brackets, the bottom is to be stiffened by means of a solid keelson extending beyond the bracket end over three frame spaces at least.

As a general rule, the coaming sides are to extend beyond the hopper space ends over 1,5 times their height approximately.

3 Design loads

3.1 External pressure

3.1.1 Still water pressure

The river still water pressure to be used in connection with the wave pressure is to be determined in compliance with Pt B, Ch 3, Sec 4, [2.1.3], using values of coefficient γ given in Tab 1.

Table 1 : Values of coefficient γ

Load case	Loading condition	γ	
		River contrepressure	River design pressure
Working	**1R** and **Nonhomload**	0,150	1,000
	2R	0,575	0,575
Navigation	Full load		1,000
	Lightship	0,150	

3.1.2 River wave pressure

The river wave pressure is to be obtained from Pt B, Ch 3, Sec 4, [2.1.4].

3.2 Internal pressure for hopper well

3.2.1 Still water pressure for hopper well

The still water pressure to be used in connection with the inertial pressure is to be obtained, in kN/m², from the following formula:

$$P_S = \max(11;\ 9{,}81\rho\ (z_W - z))$$

where:

z_W : Z co-ordinate of the highest point of the eir, in m

z : Z co-ordinate of the calculation point, in m.

3.2.2 Inertial pressure for hopper well

The inertial pressure is to be obtained, in kN/m², from the following formula:

$$P_W = \frac{a_{Z1}\gamma_{W2}p_S}{9,81}$$

where:

a_{Z1} : Reference value of the acceleration in Z direction, defined in Pt B, Ch 3, Sec 3, [2.2]

γ_{W2} : Partial safety factor covering uncertainties regarding wave pressure

$\gamma_{W2} = 1$ for $n < 1,02$

$\gamma_{W2} = 1,2$ for $n \geq 1,02$

3.2.3 Hull girder loads

The total vetical bending moments M_{TH} and M_{TS} are to be determined as specified inTab 2, where M_H, M_S, M_W and γ_W are defined in Pt B, Ch 3, Sec 2.

4 Hull scantlings

4.1 Split hopper barge

4.1.1 Scantlings and arrangements of vessels with type and service notation **Split hopper barge** will be considered on a case by case basis, considering the applicable requirements of the Society's Rules.

4.2 Shell plating and topside plating

4.2.1 The net scantlings of the shell plating and the topside plating are to be determined in compliance with the applicable requirements stated under Ch 1, Sec 2 or Ch 1, Sec 8.

4.3 Framing structure

4.3.1 The net scantlings of the hull structure are to be determined in compliance with the applicable requirements stated under Ch 1, Sec 2 or Ch 1, Sec 8.

4.3.2 Transverse rings

The ring component scantlings are to be considered by the Society on a case by case basis.

The gusset stays for coamings are to have a section modulus at the lower end level not less than that of the web frames or the side transverses.

4.3.3 Transverse web plates in the side tanks abreast the hopper spaces

The scantlings of these web plates are to be considered by the Society on a case by case basis.

4.4 Rudders

4.4.1 The rudder stock diameter obtained from Pt B, Ch 7, Sec 1 is to be increased by 5%.

Table 2 : Total vertical bending moments

Load case	Limit state	Hogging	Sagging
Navigation	Hull girder yielding	$M_{TH} = M_H + M_W$	$M_{TS} = M_S + M_W$
	Other limit states	$M_{TH} = M_H + \gamma_W M_W$	$M_{TS} = M_S + \gamma_W M_W$
Working	Hull girder yielding	$M_{TH} = M_H + M_W$	$M_{TS} = M_S + M_W$
	Other limit states	$M_{TH} = M_H + \gamma_W M_W$	$M_{TS} = M_S + \gamma_W M_W$

SECTION 10 LAUNCHES

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4].

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the type and service notation **Launch**, as defined in Pt A, Ch 2, Sec 3, [7.1.3].

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C of the Rules, as applicable, and with the requirements of this Section, which are specific to launches.

2 Hull scantlings

2.1 General

2.1.1 The scantlings of the hull structure are to be determined in compliance with Part B, Chapter 5, taking into account additional requirements defined in [2.2].

2.2 Additional requirements

2.2.1 Minimum net thickness of plating

The minimum thickness of the shell plating and deck plating are to be obtained from Tab 1.

Table 1 : Minimum net thickness t of plating

Plating	t, in mm
Decks, sides, bottom, bulkheads, web of primary supporting members, web of ordinary stiffeners and other structures	$t = 3,3 + 0,048\ L\ k^{0,5}$
Keel plate	t = thickness of adjacent bottom plating

2.2.2 Topside structure

The topside structure scantlings are to be determined according to Pt B, Ch 5, Sec 4, [5], where the minimum thickness is to be taken equal to 5 mm.

2.2.3 Primary supporting members

The design pressure of bottom primary supporting members is to be determined using $\gamma = 1$ for the loading coefficient.

Part D
Additional Requirements for Notations

Chapter 2
ADDITIONAL CLASS NOTATIONS

SECTION 1 ICE

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Thickness, in mm

A : Sectional area, in cm^2

N : Rotational speed, in rev/min

P_w : Power transmitted by shaft, in kW

D : Diameter of propeller, in mm

C_{EW} : Strengthening factor for shafts:

$C_{EW} = 1,10$

C_{EP} : Strengthening factor for propeller blades:

$C_{EP} = 1,15$

K_E : Strengthening factor for gears and couplings:

$K_E = 1,08$

T_{ice} : Calculated/estimated ice torque, in kN/m, generated by the propeller working in ice

m : Coefficient for calculation of ice torque:

$m = 11300$

K_A : Calculation factor for gear, defined in Pt C, Ch 1, Sec 6, [1]

T_{MCR} : Nominal mean torque, in Nm, delivered by the engine (referred to installed MCR of engine)

$T_{Nom, cpl}$: Proven nominal torque for coupling, in Nm, for continuous operation including an allowance of at least 30% for dynamical superimposed torques (catalogue's nominal torque)

$T_{ice, cpl}$: Assumed peak torque, in Nm, which the elastic coupling must transmit safely, including the influence of ice operation

$T_{max1, cpl}$: Maximal permissible peak torque for elastic coupling, in Nm, excluding reduction due to thermal loading (catalogue's permissible repetitive peak torque)

σ_H : Calculated tooth flank contact (Hertzian) stress, in N/mm^2, without ice load as referred to in Pt C, Ch 1, Sec 6, [1]

$\sigma_{H, ice}$: Increased actual tooth contact (Hertzian) stress for ice load, in N/mm^2

$\sigma_{H, lim}$: Maximal permissible contact (Hertzian) stress, in N/mm^2, depending on material's properties (see Society's machinery Rules for sea going vessels).

$s_{H, lim} = 1050$ N/mm^2 for alloyed case-hardened steels

σ_{FB} : Calculated tooth root bending stress without ice load, in N/mm^2, as referred to in Pt C, Ch 1, Sec 6, [1]

$\sigma_{FB, ice}$: Increased actual tooth root bending stress for ice load, in N/mm^2

$\sigma_{FB, lim}$: Maximal permissible tooth root bending stress, in N/mm^2, depending on material's properties (see Society's machinery Rules for sea going vessels).

$\sigma_{FB, lim} = 440$ N/mm^2 for alloyed case-hardened steels

t_{bl} : Thickness of the propeller blade, in mm, determined in compliance with Pt C, Ch 1, Sec 8, [3.1] for unstrengthened machinery installations

$t_{bl, ice}$: Strengthened blade thickness of the propeller, in mm

$t_{0, ice}$: Strengthened thickness of blade's tip, in mm

$R_{m, pr}$: Tensile strength of the propeller's material, in N/mm^2

p : Required mean pressure, in N/mm^2, in the shrink fit between propeller hub and propeller shaft in accordance with Pt C, Ch 1, Sec 8, [6.2.1]

p_{ice} : Required increased mean pressure, in N/mm^2, in the shrink fit between propeller hub and propeller shaft

d : Minimum diameter of shaft, in mm, determined in compliance with Pt C, Ch 1, Sec 7, [3.1], for unstrengthened machinery installations

d_{ice} : Strengthened minimum diameter of shaft, in mm

d_S : Minimum required diameter, in mm, of fitting pin of propeller connection in accordance with Pt C, Ch 1, Sec 8, [1], for unstrengthened machinery installations

$d_{S, ice}$: Strengthened minimum diameter of fitting pin, in mm.

1 General

1.1 Application

1.1.1 The additional class notation **Ice** is assigned, in accordance with Pt A, Ch 2, Sec 3, [9.3.1] to vessels strengthened for navigation in ice and complying with the requirements of this Section.

1.2 Ice level

1.2.1 Ice strengthened vessels dealt with in these Rules are assumed to operate in inland navigation conditions corresponding to a low ice level, i.e. brash ice with a thickness not exceeding 0,20 m.

These conditions are lighter than the minimal ice class in accordance to the Finnish-Swedish ice Rules, 1985, as amended, (IC, where h is defined to 0,22).

For vessels intended to operate under more severe ice conditions, the Society's Rules for navigation in ice for sea going vessels must be applied for the corresponding/required ice class.

The reinforcements as described hereafter are neither compatible nor equivalent to national requirements and ice or polar ice classes as defined and introduced by specific administrations, such as Finnish-Swedish, Canadian or Russian ice Rules.

These Rules are not applicable to vessels intended for ice breaking.

1.3 Ice belt

1.3.1 The ice belt is that portion of the side shell which is to be strengthened. Its depth extends between 300 mm below the light waterline and 300 mm above the load waterline.

The side shell is to be strengthened fore, over a length equal to the vessel breadth B, or up to the cross-section with the breadth B that is closest to the fore end if this cross-section is aft of a length equal to B.

2 Hull scantlings

2.1 Strengthened plating

2.1.1 Thickness

The strengthened plating net thickness is not to be less than 1,5 times the rule value for the shell plating thickness amidships.

The gross thickness is to be obtained using an abrasion and corrosion addition taken equal to 2 mm. Where a special surface coating, shown by experience to be capable of withstanding the abrasion of ice, is applied, a lower value may be accepted by the Society on a case by case basis.

2.2 Strengthened framing

2.2.1 General

These requirements apply to transversely framed shell. Strengthening of longitudinally framed shell will be considered on a case by case basis.

2.2.2 Intermediate framing

Over the length of the strengthened plating, intermediate frames are to be fitted extending from the deck down to the bilge turn.

The net section modulus of intermediate frames is not to be less than 0,75 times the rule value for ordinary frames.

In way of these frames, intermediate floors are to be fitted. Their scantlings are to be determined assuming a span equal to the bottom girder spacing.

2.2.3 Side stringer

A stringer is to be fitted on the frames in the strengthened area, about half-way of the light and load waterlines.

The net section modulus of the side stringer is to be not less than twice the rule section modulus of side frames.

3 Other structures

3.1 Fore part

3.1.1 General

A sharp edged stem improves the manoeuvrability of the vessel in ice.

3.1.2 Plate stem

The gross thickness, in mm, of the plate stem, where fitted, is to be not less than 1,30 times that derived from Pt B, Ch 6, Sec 1, [6.2].

The horizontal diaphragms foreseen in Pt B, Ch 6, Sec 1, [6.2.3] are to have a reduced spacing not exceeding 0,5m. Their thickness is not to be less than 2/3 of the stem plate thickness.

A centreline web is to be provided from the forefoot to a horizontal diaphragm located at least 0,5m above the load waterline. Its thickness and depth are not to be respectively less than 0,67 t and 10 t, t being the stem plate thickness.

3.1.3 Bar stem

The gross sectional area, in cm^2, of the bar stem, where fitted, is to be not less than:

$$A = 1,6\ f\ (0,006\ L^2 + 12)$$

where:

- f = 1 for **IN(1,2 ≤ x ≤ 2)**
- f = 0,9 for **IN(0,6)**
- f = 0,8 for **IN(0)**

The gross thickness, in mm, is not to be less than:

$$t = 1,25\ (0,33\ L + 10)$$

3.2 Aft part

3.2.1 Stern frame

The section modulus of the stern sole piece is not to be less than 1,25 times the rule value laid down in Pt B, Ch 7, Sec 1, [7.2].

4 Hull outfitting

4.1 Rudder stock

4.1.1 Diameter

The rudder stock diameters are not to be less than 1,08 times the rule value laid down in Pt B, Ch 7, Sec 1, [3].

4.2 Pintles

4.2.1 Pintle diameter

The pintle diameter is not to be less than 1,125 times the rule value laid down in Pt B, Ch 7, Sec 1, [5.4.1].

4.3 Rudder blade

4.3.1 Thickness

The plate thickness of the streamlined rudder blade and of the single plating rudder blade is not to be less than 1,125 times the values derived from the formulae laid down in Pt B, Ch 7, Sec 1, [6].

4.3.2 Section modulus of rudder arms

The section modulus of the arms of single plating rudder blade is to be not less than 1,25 times the value given in Pt B, Ch 7, Sec 1, [6.5.3].

5 Machinery

5.1 Gears and couplings

5.1.1 Gears

a) Bending strength of tooth root

For adequate bending strength of the tooth root $\sigma_{FB,\ ice}$, the following condition must be satisfied:

$\sigma_{FB,\ ice} = K_E\ \sigma_{FB} \leq \sigma_{FB,\ lim}$

b) Contact stress of tooth flanks

For adequate contact stress of the tooth flanks or Hertzian pressure $\sigma_{H,\ ice}$, the following condition must be satisfied:

$\sigma_{H,\ ice} = K_E^{0,5}\ \sigma_H \leq \sigma_{H,\ lim}$

5.1.2 Gear shafts

The diameter of gear shafts in accordance with Pt C, Ch 1, Sec 6, [4.1] is to be increased as required by the relevant design considerations.

5.1.3 Flexible couplings

Flexible couplings in main propulsion installation are to be designed for a torque capacity in accordance to the following condition:

$T_{MCR} \leq T_{Nom,\ cpl}$

Further the coupling must be designed to withstand torque shocks $T_{ice,\ cpl}$ of magnitude, in N.m:

$T_{ice,\ cpl} = K_E\ K_A\ T_{MCR} \leq T_{max1,\ cpl}$

5.2 Main shafting

5.2.1 General

For the purpose of these Rules, the additional torque due to ice impacts is defined with m = 1,15, in reference to the Finnish-Swedish ice Rules, 1985, as amended, and minimal requirements for power are not set out.

The ice torque, originating from the propeller working in ice may be calculated using the formula:

$T_{ice} = m\ (0{,}001\ D)^2$

5.2.2 Diameter of propeller shafts, intermediate shafts and thrust shafts

The minimum diameters d_E of the main shafting strengthened for navigation in ice, are to be obtained using the following formula:

$d_E = C_{EW}\ d$

The part of the propeller shaft forward the fore end of the aftermost propeller shaft Load-carrying length may be reduced by 5 % in diameter, but not less than the diameter d.

In the case that the propeller is running in a nozzle, the value of C_{EW} can be reduced to the value 1.

5.2.3 Connecting bolts

The diameter of fitted and plain bolts determined by applying formulae of Pt C, Ch 1, Sec 7, [5.1.2] to Pt C, Ch 1, Sec 7, [5.1.4] are to be increased proportionally.

5.3 Propellers

5.3.1 Thickness of propeller blade sections

The minimum thickness $t_{bl,\ ice}$ of the propeller blade strengthened for navigation in ice, is to be obtained using the following formula:

$t_{bl,\ ice} = C_{EP}\ t_{bl}$

5.3.2 Thickness of blade tips

The thickness, in mm, of blade tips at 95% radius is to be determined in accordance with the following formula:

$$t_{0,\ ice} = \sqrt{\frac{500}{R_{m,\ pr}}}(0,002D + 12)$$

5.3.3 Propeller mounting

Where the propeller is mounted on the propeller shaft by the oil shrink fit method, the necessary pressure, in N/mm², in the area of the mean taper diameter is to be determined using the formula:

$p_{ice} = C_{EW}\ p$

In the case of flanged propellers, the required diameter of the fitting pin(s) is to be determined by applying the following formula:

$d_{S,\ ice} = C_{EW}^{1,5}\ d_S$

6 Miscellaneous

6.1 River inlets and cooling water systems of machinery

6.1.1 The cooling water system is to be designed to ensure the supply of cooling water also when navigating in ice.

6.2 Steering gear

6.2.1 The dimensional design of steering gear components is to take account of the rudderstock diameter specified in [4.1].

SECTION 2 TRANSPORT OF HEAVY CARGOES

Symbols

L	:	Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]
t	:	Net thickness, in mm, of plating
s	:	Spacing, in m, of ordinary stiffeners
ℓ	:	Span, in m, of ordinary stiffeners or primary supporting members
k	:	Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4]

1 General cargo vessels

1.1 Application

1.1.1 The additional class notation **Heavycargo (AREAi, x_i kN/m²)**, is assigned, in accordance with Pt A, Ch 2, Sec 3, [3.2.4] to vessels with type and service notation **General cargo vessel** intended to carry heavy unit cargoes.

1.1.2 Unless otherwise mentioned, these vessels are to comply, as applicable, with the requirements stated under Part A, Part B, Part C and Ch 1, Sec 1.

1.2 Design load

1.2.1 The value of design pressure p_S, in kN/m², is to be specified by the designer for each $area_i$, according to [1.1.1], and introduced as x_i values.

1.3 Hull scantlings

1.3.1 General

In general, the hull scantlings are to be not less than required in Part B, Chapter 5.

1.3.2 Primary supporting members

Strength check of primary supporting members is to be carried out by direct calculation, in compliance with Ch 1, Sec 4, [7].

2 Bulk cargo vessels

2.1 Application

2.1.1 The additional class notation **Heavycargo**, is assigned, in accordance with Pt A, Ch 2, Sec 3, [3.2.4] to vessels with type and service notation **Bulk cargo vessel** intended to carry heavy bulk dry cargoes.

2.1.2 Unless otherwise mentioned, these vessels are to comply, as applicable, with the requirements stated under Part A, Part B, Part C and Ch 1, Sec 2.

2.2 Design loads

2.2.1 The still water bending moment and internal local loads are to be determined according to Pt B, Ch 3, Sec 2, [2.4] and Pt B, Ch 3, Sec 4, [3.2], respectively, where the cargo properties are not to be taken less than:

- Cargo density, in t/m³

  $\rho_B \geq 2,5$

- Angle of repose of the bulk cargo

  $\varphi_B \geq 35°$

2.3 Bottom or inner bottom plating thickness

2.3.1 The net thickness of bottom or inner bottom plating subjected to heavy bulk dry cargo, is to be determined according to Pt D, Ch 1, Sec 2, taking into account the additional requirement stated under [2.2.1].

This thickness, in mm, is not to be less than the value derived from the following formula:

$$t = 2L^{1/3}k^{0,5} + 3,6s$$

SECTION 3 EQUIPPED FOR TRANSPORT OF CONTAINERS

1 General

1.1 Application

1.1.1 General cargo vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **Equipped for transport of containers**, as defined in Pt A, Ch 2, Sec 3, [3.2.1].

1.1.2 These vessels are to comply with the requirements stated under Part A, Part B, Part C and Ch 1, Sec 1, as far as applicable.

2 Structure arrangements

2.1 Strength principles

2.1.1 Local reinforcements

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

The forces applying on the fixed cargo securing devices are to be indicated by the designer.

2.1.2 Structural continuity

In double hull vessels, the inner side is to extend as far aft as possible and be tapered at the ends.

2.2 Bottom structure

2.2.1 Floor and girder spacing

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

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

2.2.2 Strength continuity

Adequate strength continuity of floors and bottom transverses is to be ensured in way of the side tank by means of brackets.

2.2.3 Reinforcements in way of cell guides

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

2.3 Hatch covers carrying containers

2.3.1 Efficient retaining arrangements are to be provided to prevent translation of the hatch cover under the action of the longitudinal and transverse forces exerted by the stacks of containers on the cover. These retaining arrangements are to be located in way of the hatch coaming side brackets.

Solid fittings are to be welded on the hatch cover where the corners of the containers are resting. These parts are intended to transmit the loads of the container stacks onto the hatch cover on which they are resting and also to prevent horizontal translation of the stacks by means of special intermediate parts arranged between the supports of the corners and the container corners.

3 Design loads

3.1 Design torsional torque

3.1.1 Where no specific data are provided by the Designer, the design still water torsional torque induced by the non-uniform distribution of cargo, consumable liquids and ballast is to be obtained at the midship section, in kN.m, from the following formula:

$$M_T = 31{,}4\ n_S\ n_T\ B$$

where:

n_S : Number of container stacks over the breadth B

n_T : Number of container tiers in cargo hold amidships (including containers on hatch covers).

3.2 Force on containers

3.2.1 The force applied to one container located at the level "i", as defined in Fig 1, is to be determined in compliance with Pt B, Ch 3, Sec 4, [3.4].

The mass of the containers is to be defined by the Designer.

Where the mass of loaded containers is not known, the following values may be used:

- for 40 feet containers: $m_i = 27$ t
- for 20 feet containers: $m_i = 17$ t.

Where empty containers are stowed at the top of a stack, the following values may be used:

- in the case of empty steel containers:

  0,14 times the weight of a loaded container
- in the case of empty aluminium containers:

  0,08 times the weight of a loaded container.

3.2.2 Stacks of containers

The force transmitted at the corners of such stack is to be obtained, in kN, using the following formula:

P = F / 4

where:

$$F = \sum_{i}^{N} F_i$$

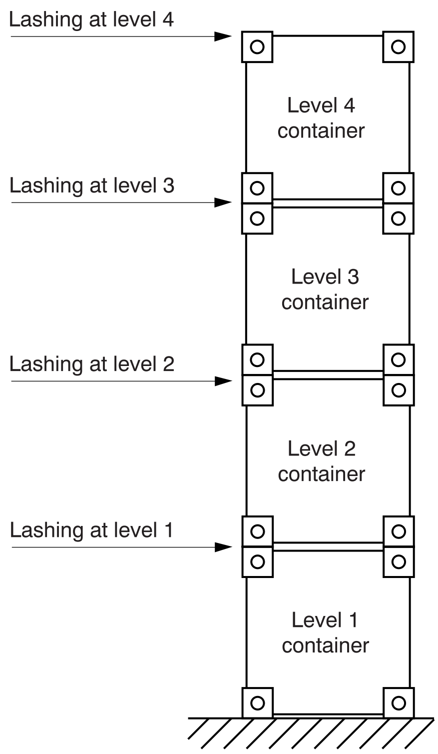
with:

N : Number of containers in a stack.

3.2.3 Securing load

The scantling load of securing devices is to be determined assuming an angle of list of 12°.

Figure 1 : Containers level in a stack



4 Hull scantlings

4.1 General

4.1.1 In general, the hull scantlings are to be not less than required in Part B, Chapter 5.

4.1.2 Scantlings of structural members subjected to concentrated loads are to be determined by direct calculation according to Pt B, Ch 2, Sec 5. In particular, the requirements of [5] are to be complied with.

4.1.3 Where the operating conditions (loading / unloading sequence as well as consumable and ballast distribution) are likely to induce excessive torsional torque, the torsional strength is to be checked, using the design torsional torque derived from [3.1.1].

5 Direct calculation

5.1 General

5.1.1 These requirements apply for the grillage analysis of primary supporting members subjected to concentrated loads.

Direct calculation is to be carried out in compliance with Pt B, Ch 2, Sec 5.

SECTION 4 EQUIPPED FOR TRANSPORT OF WHEELED VEHICLES

1 General

1.1 Application

1.1.1 General cargo vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **Equipped for transport of wheeled vehicles**, as defined in Pt A, Ch 2, Sec 3, [3.2.2].

1.1.2 These vessels are to comply with the requirements stated under Part A, Part B, Part C and Ch 1, Sec 1, as far as applicable.

2 Vessel arrangements

2.1 Sheathing

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

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

2.2 Hull structure

2.2.1 Framing

In general, RoRo cargo decks or platforms are to be longitudinally framed.

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

2.3 Drainage of cargo spaces, other than RoRo spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion

2.3.1 Scupper draining

Scuppers from cargo spaces, other than RoRo spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion are not to be led to machinery or other places where sources of ignition may be present.

3 Scantlings

3.1 RoRo cargo spaces

3.1.1 Design loads

The wheeled loads induced by vehicles are defined in Pt B, Ch 3, Sec 4, [3.5].

3.1.2 The scantlings of RoRo cargo spaces are to be in compliance with Ch 1, Sec 5, [3].

3.2 Movable decks and inner ramps

3.2.1 The requirements applicable to movable decks and inner ramps are defined in Pt B, Ch 6, Sec 6, [1].

3.3 External ramps

3.3.1 The requirements applicable to external ramps are defined in Pt B, Ch 6, Sec 6, [2].

SECTION 5 FERRY

1 General

1.1 Application

1.1.1 Passenger vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **Ferry**, as defined in Pt A, Ch 2, Sec 3, [5.2.1].

1.1.2 These vessels are to comply with the requirements stated under Part A, Part B, Part C and Ch 1, Sec 6, as far as applicable.

2 Vessel arrangements

2.1 Sheathing

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

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

2.2 Hull structure

2.2.1 Framing

In general, car decks or platforms are to be longitudinally framed.

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

2.3 Drainage of RoRo cargo spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion

2.3.1 Scupper draining

Scuppers from cargo spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion are not to be led to machinery or other places where sources of ignition may be present.

3 Scantlings

3.1 RoRo cargo spaces

3.1.1 Design loads

The wheeled loads induced by vehicles are defined in Pt B, Ch 3, Sec 4, [3.5].

3.1.2 The scantlings of RoRo cargo spaces are to be in compliance with Ch 1, Sec 5, [3].

3.2 Movable decks and inner ramps

3.2.1 The requirements applicable to movable decks and inner ramps are defined in Pt B, Ch 6, Sec 6, [1].

3.3 External ramps

3.3.1 The requirements applicable to external ramps are defined in Pt B, Ch 6, Sec 6, [2].

4 Electrical installations

4.1 Protective measures on car decks

4.1.1 Special category spaces: definition

Special category spaces are those enclosed vehicle spaces above and below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be accommodated on more than one deck.

4.1.2 Installations in special category spaces situated above the bulkhead deck

On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment and cables are to be installed at least 450 mm above the deck or platform.

Where the installation of electrical equipment and cables at least 450 mm above the deck or platform is deemed necessary for the safe operation of the vessel, the electrical equipment is to be of a certified safe type as stated in Pt C, Ch 2, Sec 1, [1.4.6] and to have minimum explosion group IIA and temperature class T3.

Electrical equipment is to be as stated in Pt C, Ch 2, Sec 1, [1.4.7].

4.1.3 Installations in special category spaces situated below the bulkhead deck

An electrical equipment installed is to be as stated in Pt C, Ch 2, Sec 1, [1.4.6] and to have minimum explosion group IIA and temperature class T3.

4.1.4 Ventilation

Electrical equipment and cables in exhaust ventilation ducts are to be as stated in Pt C, Ch 2, Sec 1, [1.4.6] and to have minimum explosion group IIA and temperature class T3.

SECTION 6 STABILITY

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

L_{WL} : Length of the hull, in m, measured at the maximum draught

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

Δ : Displacement of the laden vessel, in t

v : Maximum speed of the vessel in relation to the water, in km/h

KG : Height, in m, of the centre of gravity above base line

n : Navigation coefficient defined in Pt B, Ch 3, Sec 1, [5.2]

C_B : Block coefficient.

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of one of the following additional class notations, as defined in Pt A, Ch 2, Sec 3, [9.4]:

- **Intact stability**
- **Damage stability**.

1.2 Documents to be submitted

1.2.1 List of documents

The documents to be submitted are listed in Pt B, Ch 2, Sec 6, [2.1].

The Society may require any other necessary guidance for the safe operation of the vessel.

2 Cargo vessels

2.1 General

2.1.1 Application

The following requirements apply to vessels with type and service notation General cargo vessel, Bulk cargo vessel and RoRo cargo vessel which have been requested to receive the additional class notation Intact stability.

For vessels with type and service notation Container vessel, see [4].

2.2 Intact stability

2.2.1 Proof of sufficient intact stability is to be provided for all loading / unloading stages and for the final loading stage.

2.2.2 The intact stability characteristics of cargo vessels are to comply at least with the following criteria, taking into account eventual heeling moment (see Fig 1):

- a minimum righting lever GZ value of 0,10 m is to be reached within the range of positive stability, limited by the angle at which unprotected openings become submerged
- the area below the GZ curve within the range of positive stability, limited by the angle φ_2 at which unprotected openings become submerged or 27 degrees whichever is the lesser, is to be not less than 0,024 m.radians
- the initial metacentric height GM_0 value is to be at least 0,10 m.

2.3 Additional requirements for bulk cargo vessels

2.3.1 For bulk dry cargo likely to redistribute itself if the vessel lists to an inclination greater than its angle of repose, such as grain or cement, requirements [2.3.2] to [2.3.5] are to be additionally complied with.

2.3.2 Cargo shift induced moment

For bulk cargo vessels, the cargo shift induced moment is to be taken into account.

This heeling moment is to be determined in relation with the hold or compartment geometry, assuming an angle to the horizontal of the resulting cargo surface after shifting of 12°.

2.3.3 Trimming

All necessary and reasonable trimming is to be performed to level all free cargo surfaces and minimise the effect of cargo shifting.

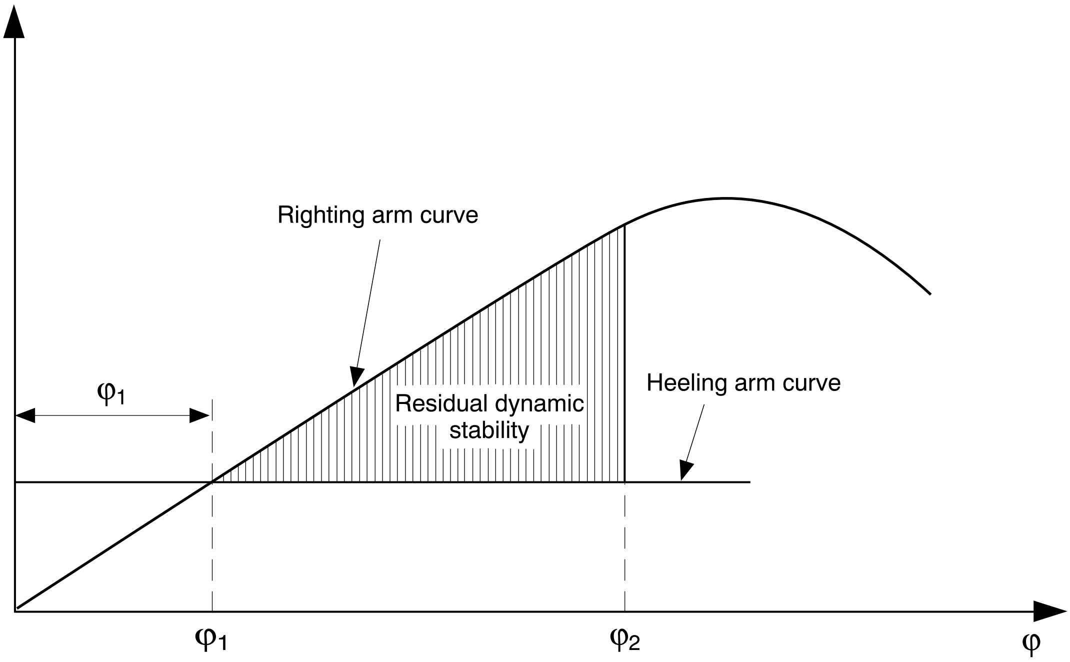
2.3.4 Cargo securing

Unless account is taken of the adverse heeling effect due to cargo shift according to these Rules, the surface of the bulk cargo in any partially filled compartment is to be secured so as to prevent a cargo shift by overstowing.

2.3.5 Longitudinal subdivisions

The proper precaution is to fit one or more temporary longitudinal subdivisions in the holds or compartments to minimise the possibility of shift of cargo.

Figure 1 : Stability curve



3 Tankers

3.1 General

3.1.1 Application

The following requirements apply to tankers which have been requested to receive the additional class notation Intact stability.

3.1.2 The centre longitudinal bulkhead may be dispensed with only if sufficient stability is guaranted.

3.2 Intact stability

3.2.1 Proof of sufficient intact stability is to be provided for all loading / unloading stages and for the final loading stage.

3.2.2 For vessels with cargo tanks of more than 0,70 B in width, the following intact stability requirements are to be complied with:

- a minimum righting lever GZ value of 0,10 m is to be reached within the range of positive stability, limited by the angle at which unprotected openings become submerged
- the area below the GZ curve within the range of positive stability, limited by the angle at which unprotected openings become submerged or 27 degrees whichever is the lesser, is to be not less than 0,024 m.radians
- the initial metacentric height GM_0 value is to be at least 0,10 m.

The stability reducing free surface effect shall be taken into account according to Pt B, Ch 2, Sec 6, [2.3].

4 Container vessels

4.1 General

4.1.1 Application

The following requirements apply to container vessels which have been requested to receive the additional class notation Intact stability or Damage stability.

4.1.2 Secured containers

A cargo of containers shall be considered to be secured if each individual container is firmly secured to the hull of the vessel by means of rails or turnbuckles and its position cannot alter during the voyage.

4.1.3 In case of vessels likely to carry either secured or non-secured containers, separate documents concerning stability are required for the carriage of each type of container.

4.2 Stability in case of non-secured containers

4.2.1 All methods of calculating a vessel's stability in the case of non-secured containers shall meet the following limit conditions:

a) metacentric height, GM, shall not be less than 1,00 m.

b) under the joint action of the wind thrust, centrifugal force resulting from the vessel's turning and the effect of free surfaces induced by the hold or double bottom fillings, the angle of heel shall not exceed 5° and the edge of the deck shall not be immersed.

4.2.2 The heeling lever, in m, resulting from the centrifugal force caused by the vessel turning shall be determined in accordance with the following formula:

$$h_{KZ} = 0,00347 \frac{v^2}{L_{WL}} \left(KG - \frac{T}{2} \right)$$

4.2.3 The heeling lever, in m, resulting from the wind thrust is to be determined in accordance with the following formula:

$$h_{KW} = 0,1 p_{WD} \frac{A_W}{\Delta}\left(\ell_W - \frac{T}{2}\right)$$

where:

p_{WD} : Specific wind pressure, in kN/m^2:
- for **IN(0)** and **IN(0,6)**: P_{WD} = 0,25
- for **IN(1,2 ≤ x ≤2)**: P_{WD} = 0,4 n

A_W : Side surface above the water of the loaded vessel, in m^2

ℓ_W : Height, in m, of the centre of gravity of the side surface A_W above the water related to the waterline.

4.2.4 The heeling lever, in m, resulting from the free surfaces of rainwater and residual water within the hold or the double bottom shall be determined in accordance with the following formula:

$$h_{KFO} = \frac{0,015}{\Delta}\sum[b\ell(b - 0,55\sqrt{b})]$$

where:

β : Width of hold or section of the hold in question, in m

λ : Length of hold or section of the hold in question, in m.

4.2.5 Half of the fuel and fresh water supply shall be taken into account for each load condition.

4.2.6 The stability of a vessel carrying non-secured containers shall be considered to be sufficient if the effective KG does not exceed the KG_Z resulting from the formula below mentioned.

The KG_Z shall be calculated for various displacements covering all of the possible draught variations.

$KG \le KG_Z$

where:

KG_Z : Maximum permissible height, in m, of the loaded vessel's centre of gravity above its base, given by the formula:

$$KG_Z = \frac{KM + \frac{B_{WL}}{2F}\left(Z_Z \frac{T_m}{2} - h_{KW} - h_{KFO}\right)}{\frac{B_{WL}}{2F} Z_Z + 1}$$

or

$KG_Z = KM - 1$

whichever is the lesser,

with:

$B_{WL} / 2F > 11,5$

KM : Height of the metacentre above the base, in m.

If no curve diagram is available the value of KM may be determined, for example, via the following approximation formulae:

- vessels in the form of a pontoon

$$KM = \frac{B_{WL}^2}{\left(12,5 - \frac{T_m}{D}\right)T_m} + \frac{T_m}{2}$$

- other vessels

$$KM = \frac{B_{WL}^2}{\left(12,7 - 1,2\frac{T_m}{D}\right)T_m} + \frac{T_m}{2}$$

F : Effective freeboard at 0,5 L

B_{WL} : Vessel waterline breadth, in m

T_m : Average draught, in m

Z_Z : Parameter for the centrifugal force resulting from turning:

$$Z_Z = 0,00347\frac{v^2}{L_{WL}}$$

4.3 Stability in the case of secured containers

4.3.1 In the case of secured containers, all means of calculation used in order to determine vessel stability shall meet the following limit conditions:

- metacentric height GM shall be not to be less than 0,50 m
- no hull opening shall be immersed by the combined action of the centrifugal force resulting from the turning of the vessel, wind thrust and free surfaces of water.

4.3.2 The heeling moments resulting from the wind thrust, centrifugal force due to vessel's turning and free surfaces of water, are to be determined in accordance with [4.2].

Half of the supply of fuel and fresh water for each load condition shall be taken into account.

4.3.3 The stability of a vessel carrying secured containers shall be considered to be adequate if the effective KG does not exceed the KG_Z resulting from the formula that has been calculated for the different displacements resulting from the possible height variations.

$KG \le KG_Z$

where:

KG_Z : Maximum admissible height, in m, of vessel centre of gravity above its base line, given by:

$$KG_Z = \frac{KM - KM_1 + KM_2}{0,75\frac{B_{WL}}{F^*}Z_Z + 1}$$

or

$KG_Z = KM - 0,5$

whichever is the lesser,

with:

$$KM_1 = \frac{I - i}{2\nabla}\left(1 - 1,5\frac{F}{F^*}\right) \ge 0$$

$$KM_2 = 0,75\frac{B_{WL}}{F^*}\left(Z_Z\frac{T_m}{2} - h_{KW} - h_{KFO}\right)$$

$B_{WL} / F^* \ge 6,6$

F* : Ideal freeboard, in m:

$F^* = MIN (F_1^*, F_2^*)$

$F_1^* = D^* - T_m$

$$F_2^* = \frac{a B_{WL}}{2b}$$

a : Vertical distance between the lower edge of the opening that is first immersed in the event of heeling and the water line in the vessel's normal position, in m

b : Distance of the same opening as above from the centre of the vessel, in m

D* : Ideal depth, in m:

$$D^* = D + \frac{q}{0,9 L B_{WL}}$$

q : Sum of the volumes, in m^3, of the deckhouses, hatchways, trunk decks and other superstructures up to a height of 1,0 m above D or up to the lowest opening in the space under consideration, the lowest value shall be taken.

Parts of spaces located within the area of 0,05 L from the extremities of the vessel shall not be taken into account

∇ : Displacement of the vessel at T_m , in m^3

i : Transverse moment of inertia, in m^4, of waterline parallel to the base, at height, in m, equal to:

$h = T_m + 2 F^* / 3$

I : Transverse moment of inertia, in m^4, of waterline T_m

If there is no curve diagram the value needed for calculating lateral moment of inertia I of the water line may be obtained from the following approximation formulae:

- vessels in the form of a pontoon:

$$I = \frac{\nabla B_{WL}^2}{\left(12,5 - \frac{T_m}{D}\right) T_m}$$

- other vessels:

$$I = \frac{\nabla B_{WL}^2}{\left(12,7 - 1,2\frac{T_m}{D}\right) T_m}$$

T_m : Average draught, in m

4.4 Damage stability

4.4.1 Application

In addition to the rules stated under [4.2] and [4.3], the requirements of this subarticle apply to vessels exceeding 110 m in length and to vessels intended for the carriage of dangerous goods according to Ch 3, Sec 7.

4.4.2 The proof of sufficient stability after damage is to be produced for the most unfavourable loading condition.

The basic values for the stability calculation - the vessel's lightweight and location of the centre of gravity - shall be determined:

- either by means of an heeling experiment, or
- by detailed mass and moment calculation, in which case the lightweight of the vessel shall be verified by checking the draught, with a tolerance limit of ± 5% between the mass determined by calculation and the displacement determined by the draught readings.

4.4.3 The proof of floatability after damage shall be produced for the fully loaded vessel.

For this purpose, calculated proof of sufficient stability shall be established for the critical intermediate stages of flooding and for the final stage of flooding. For critical intermediate stages of flooding, the righting lever curve has to show, beyond the equilibrium stage, a righting lever ≥ 0,03 m and a positive range ≥ 5°.

4.4.4 The following assumptions shall be taken into account for the damaged condition:

a) Extent of side damage:
   - longitudinal extent: at least 0,10 L
   - transverse extent: 0,59 m
   - vertical extent: from base line upwards without limit

b) Extent of bottom damage:
   - longitudinal extent: at least 0,10 L
   - transverse extent: 3,00 m
   - vertical extent: from base line to 0,49 m upwards, the sump excepted

c) Any bulkhead within the damaged area shall be assumed damaged, which means that the location of the bulkheads shall be chosen that the vessel remains afloat after flooding two or more adjacent compartments in the longitudinal direction.

   For the main engine room only a one-compartment status needs to be taken into account, i.e. the end bulkheads of the engine room shall be assumed not damaged.

   For bottom damage, adjacent athwartship compartments shall also be assumed flooded.

d) Permeability

   Permeability shall be assumed to be 95%.

   Differing from the above documented assumption, the values of permeability stated in Tab 1 may be assumed.

   If a calculation proves that the average permeability of any compartment is lower, the calculated value may be used.

e) At the final stage of flooding, the lower edge of any non-watertight opening (e.g. doors, windows, access hatches) shall, at the final stage of flooding, be not less than 100 mm above the damaged waterline.

Table 1 : Permeability values, in %

Spaces	μ
Engine and sevice rooms	85
Accommodation spaces	95
Double bottoms, fuel tanks, ballast tanks, etc. depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught	0 or 95

4.4.5 The stability after damage shall be sufficient if, on the basis of the assumptions in [4.4.4]:

a) at the final stage of flooding a safety clearance of not less than 100 mm remains and the angle of heel of the vessel does not exceed 5°

b) the postive range of the righting lever curve beyond the stage of equilibrium shall have an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability shall be satisfied up to immersion of the first non-weathertight openings and in any event up to an angle of heel equal to 10° (see Fig 2). If non-weathertight openings are immersed before that stage, the corresponding spaces shall be considered as flooded for the purpose of stability calculation

   If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly; or

c) for vessels carrying dangerous goods, calculations in accordance with the procedure for damage calculations specified in ADNR part 9 produce a positive result.

4.4.6 When cross- or down-flooding openings are provided for reduction of unsymmetrical flooding, the time for equalisation shall not exceed 15 minutes, if during the intermediate stages of flooding sufficient damaged stability has been demonstrated.

4.4.7 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked according to their operating instructions.

4.4.8 Where necessary in order to meet the requirements in [4.4.2] or [4.4.3], the plane of maximum draught shall be re-established.

5 Dredgers and pontoons

5.1 General

5.1.1 Application

The following requirements apply to dredgers and pontoons which have been requested to receive the additional class notation Intact stability.

5.1.2 Documentation to be submitted

Stability confirmation shall include the following data and documents:

a) scale drawings of the floating equipment and working gear and the detailed data relating to these that are needed to confirm stability, such as content of the tanks, openings providing access to the inside of the vessel, etc.

b) hydrostatic data or curves

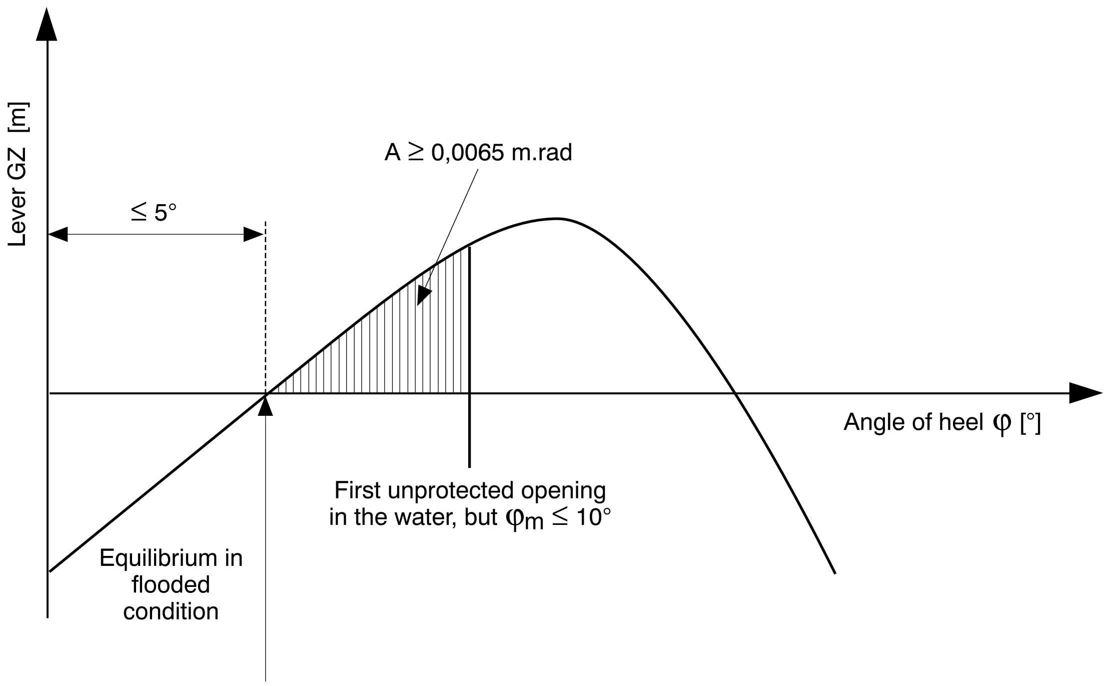
c) curves for the static stability lever arm effects

d) description of the situations of use together with the corresponding data concerning weight and centre of gravity, including its unladen state and the equipment situation as regards transport

e) calculation of the list, trim and righting moments, with statement of the list and trim angles and the corresponding residual freeboard and residual safety clearances

f) all of the results of the calculation with a statement of the use and load limits.

Figure 2 : Container vessels: proof of damage stability



5.2 Load assumptions

5.2.1 Stability assessment is to be based at least on the following load assumptions:

a) Density of dredged material for dredgers:
   - sands and gravels: 1,5 t/m^3
   - very wet sands: 2,0 t/m^3
   - soil, on average: 1,8 t/m^3
   - mixture of sand and water in the ducts: 1,3 t/m^3

b) Clamshell dredgers:
   the values given in a) are to be increased by 15 %

c) Hydraulic dredgers:
   the maximum lifting power shall be considered.

5.3 Intact stability

5.3.1 It shall be confirmed that, when account has been taken of the loads applied during the use and operation of the working gear, the residual freeboard and the residual safety clearance are adequate, i.e.:

- the residual safety clearance value is, at least:
  - 0,30 m for watertight and weathertight aperture
  - 0,40 m for non-weathertight openings
- the residual freeboard value is at least 0,30 m.

For that purpose the sum of the list and trim angles shall not exceed 10° and the base of the hull shall not emerge.

5.3.2 Stability checking shall take into account the heeling moments defined in [5.3.3] to [5.3.10].

The moments which may act simultaneously shall be added up.

5.3.3 Load induced moment

The load induced moment is to be defined by the Designer.

5.3.4 Asymmetric structure induced moment

The asymmetric structure induced moment is to be defined by the Designer.

5.3.5 Moment due to wind pressure

The moment caused by the wind pressure, in t.m, shall be calculated in accordance with the following formula:

$M_W = 0,1c\ P_{WD}\ A_W\ (\ell_W + T / 2)$

where:

c : Shape-dependent coefficient of resistance taking account of gusts:
- for frameworks: c = 1,2
- for solid section beam: c = 1,6

P_{WD} : Specific wind pressure, in kN/m^2:
- for **IN(0)** and **IN(0,6)** : P_{WD}= 0,25
- for **IN(1,2 ≤ x ≤ 2)** : P_{WD} = 0,4 n

A_W : Side surface area of the floating installation, in m^2

ℓ_W : Distance, in m, of centre of gravity of area A_W, from draught mark.

5.3.6 Turning circle induced moment

For self-propelled vessels, the moment resulting from the turning of the vessel in t.m, is to be determined by the following formula:

$$M_T = \frac{0,00647 C_B v^2 \Delta}{L_{WL}}\left(KG - \frac{T}{2}\right)$$

5.3.7 Cross current induced moment

The moment resulting from the cross current must only be taken into account for floating equipment which is anchored or moored across the current while operating.

5.3.8 Ballast and supplies induced moment

The least favourable extent of tank filling on stability shall be determined and the corresponding moment introduced into the calculation when calculating the moments resulting from the liquid ballast and the liquid provisions.

5.3.9 Moment due to inertia forces

The moment resulting from the inertia forces must be taken into account if the movements of the load and the working gear are likely to affect its stability.

5.3.10 Moment due to other mechanical equipment

The moment due to other mechanical equipment is to be defined by the Designer.

5.3.11 The righting moments, in t.m, for floating installations with vertical side walls may be calculated via the formula:

$M_a = \Delta\ GM \sin\varphi$

where:

GM : Metacentric height, in m

φ : List angle.

That formula shall apply up to list angles of 10° or up to a list angle corresponding to immersion of the edge of the deck or emergence of the edge of the bottom. In this instance the smallest angle shall be decisive. The formula may be applied to oblique side walls up to list angles of 5°.

If the particular shape of the floating installation(s) does not permit such simplification the lever-effect curves referred to in [5.1.2] item c) shall be required.

5.4 Intact stability in case of reduced residual freeboard

5.4.1 If a reduced residual freeboard is taken into account, it shall be checked for all operating conditions that:

a) after correction for the free surfaces of liquids, the metacentric height GM is not less than 0,15 m

b) for list angles between 0° and 30°, there is a righting lever, in m, of at least:

   $h = 0,30 - 0,28\ \varphi_n$

where:

φ_n : List angle, in radian, from which the lever arm curve displays negative values (stability limit); it may not be less than 20° or 0,35 rad and shall not be inserted into the formula for more than 30° or 0,52 rad:

$20° \leq \varphi_n \leq 30°$

c) the sum of trim and list angles does not exceed 10°

d) the residual safety clearance value is, at least:
- 0,30 m for watertight and weathertight openings
- 0,40 m for non-weathertight openings

e) the residual freeboard is at least 0,05 m

f) for list angles between 0° and 30°, the residual lever arm, in m, is at least:

$h = 0{,}20 - 0{,}23\ \varphi_n$

where:

φ_n : List angle, in radian, from which the lever arm curve displays negative values; this should not be inserted into the formula for more than 30° or 0,52 rad

Residual lever arm means the maximum difference existing between 0° and 30° list between the righting lever curve and the curve of the heeling lever. If an opening towards the inside of the vessel immerses at a list angle less than the one corresponding to the maximum difference between the lever arm curves, the lever arm corresponding to that list angle shall be taken into account.

5.5 Floating installations without confirmation of stability

5.5.1 The following floating installations may be exempted from requirements of [5.3] and [5.4]:

- those whose working gear may in no way alter their list or trim and
- those where there can in no way be any displacement of the centre of gravity.

However:

- at maximum load, the safety clearance shall be at least 0,30 m and the freeboard at least 0,15 m
- for apertures which cannot be closed in such a way as to exclude spray and bad weather, the safety clearance shall be at least 0,50 m.

SECTION 7 FIRE

1 General

1.1 Application

1.1.1 Vessels with type and service notation **Passenger vessel** complying with the requirements of this Section are eligible for the assignment of the additional class notation **Fire** as defined in Pt A, Ch 2, Sec 3, [5.2.2].

These vessels are to comply, as far ar applicable, with the requirements stated under Pt C, Ch 1, Sec 14 and Ch 1, Sec 6, [3].

1.2 Definitions

1.2.1 Non combustible material

"Non-combustible" material" is defined under Pt C, Ch 1, Sec 14, [1.4.2].

1.2.2 A-class divisions

A-class divisions are defined under Pt C, Ch 1, Sec 14, [1.4.5]

1.2.3 B-class divisions

B-class divisions are defined under Pt C, Ch 1, Sec 14, [1.4.6].

1.2.4 Low flame spread surface material

"Low flame spread surface material" is defined under Pt C, Ch 1, Sec 14, [1.4.3].

1.2.5 Not readily ignitable material

"Not readily ignitable material" is defined under Pt C, Ch 1, Sec 14, [1.4.4].

2 Fire integrity of bulkheads and decks

2.1

2.1.1 The minimum fire integrity of all bulkheads and decks shall be as shown in Tab 1 and Tab 2.

2.1.2 The following requirements shall govern the application of the tables:

- Tab 1 shall apply to spaces without an installed sprinkler installation.
- Tab 2 shall apply to spaces in which a sprinkler installation is provided on both sides of bulkheads and deck.

2.1.3 For the purpose of determining the appropriate fire integrity standard to be applied to boundaries between adjacent spaces, such spaces are classified according to their fire risk described in the following categories.

The title of each category is intended to be typical rather than restrictive.

a) Control stations

   wheelhouse, spaces containing the vessel's radio equipment, spaces containing centralized fire alarm equipment, spaces containing centralized emergency public address system stations and equipment.

b) Staircases

   Interior stairways, lifts, enclosed emergency escape tanks. In this connection a stairway which is enclosed at one level only shall be regarded as part of the space from which it is not separated by a fire door.

c) Assembly stations

d) Accommodation spaces

   Cabins, public spaces, sale shops, barber shops and beauty parlours, saunas, pantries containing no cooking appliances, small lockers (deck area < 4 m^2).

e) Machinery spaces

   Main propulsion machinery room, auxiliary machinery spaces.

f) Galleys

g) Store rooms

   Miscellaneous stores, lockers having deck area exceeding 4 m^2, air conditioning rooms.

3 Protection of stairways and lifts in accommodation and service spaces

3.1 General

3.1.1 All stairways in accommodation and service spaces are to be arranged within enclosures formed by division as stipulated in Tab 1 and Tab 2, with effective means of closure for all openings.

3.1.2 The following exceptions are admissible:

a) A stairway connecting only two decks need not be enclosed, provided that the integrity of the pierced deck is maintained by division/doors as stipulated in Tab 1 and Tab 2 at one of the two decks.

b) Stairways fitted within accommodation spaces need not be enclosed subject to the following:
   - the space extends over two decks only
   - the space reaching more than two decks is protected with a sprinkler installation, equipped with a smoke extraction system and the space has at each level access to a stairway.

Table 1 : Fire integrity of bulkheads and decks in spaces without sprinkler installation

Space	Control station	Staircases	Assembly stations	Accommodation spaces	Machinery spaces	Galleys	Store rooms
Control station	–	A0	A0 / B15 **(1)**	A30	A60	A60	A60
Staircases		–	A0	A30	A60	A60	A60
Assembly stations			–	A30 / B15 **(2)**	A60	A60	A60
Accommodation spaces				– / B15	A60	A60	A60
Machinery spaces					A60 / A0 **(3)**	A60	A60
Galleys						A0	A60 / B15 **(4)**
Store rooms							–

(1) Divisions between control stations and inside embarkation areas shall be of type A0, in case of exterior embarkation areas is type B15 sufficient.
(2) Divisions between accommodation spaces and inside embarkation areas shall be of type A30, in case of exterior embarkation areas is type B15 sufficient.
(3) Divisions between machinery spaces shall be of type A60, otherwise of type A0.
(4) For divisions between galleys and refrigerating spaces or storage spaces for food is B15 sufficient.

Table 2 : Fire integrity of bulkheads and decks in spaces with sprinkler installation

Space	Control station	Staircases	Assembly stations	Accommodation spaces	Machinery spaces	Galleys	Store rooms
Control station	–	A0	A0 / B15 **(1)**	A0	A60	A60	A30
Staircases		–	A0	A0	A60	A30	A0
Assembly stations			–	A30 / B15 **(2)**	A60	A60	A60
Accommodation spaces				– / B0	A60	A30	A0
Machinery spaces					A60 / A0 **(3)**	A60	A60
Galleys						–	B15
Store rooms							–

(1) Divisions between control stations and inside embarkation areas shall be of type A0, in case of exterior embarkation areas is type B15 sufficient.
(2) Divisions between accommodation spaces and inside embarkation areas shall be of type A30, in case of exterior embarkation areas is type B15 sufficient.
(3) Divisions between machinery spaces shall be of type A60, otherwise of type A0.

4 Openings in class A and B divisions

4.1 General

4.1.1 The construction of all doors and door frames in class A and B divisions, with the means of securing them when closed, shall provide resistance to fire as well as to the passage of smoke (only for doors in class A divisions) and flames equivalent to that of the bulkheads in which the doors are fitted.

Such doors and door frames shall be of an approved type.

Watertight doors need not be insulated.

4.1.2 Fire doors in divisions required by Tab 1 and Tab 2 to machinery spaces, to galleys and to staircases shall be of self-closing type.

4.1.3 It shall be possible for each door to be opened and closed from each side of the bulkhead by one person only.

4.1.4 Self-closing doors, which are normally open, shall be capable of remote release from a continuously manned central control station and shall also be capable of release individually from a position at both sides of the door. Status of each fire door (open/ closed position) shall be indicated on the bridge.

5 Fire protection materials

5.1 General

5.1.1 Insulation materials shall be non-combustible, except insulation of pipe fittings for cold service systems.

5.1.2 Ceilings and linings in accommodation spaces including their substructures shall be of non-combustible material, unless the space is protected with a sprinkler installation.

5.1.3 The following surface materials shall have low flame spread characteristics:

- exposed surfaces in corridors and stairways and of bulkhead and ceiling linings in all spaces, except machinery spaces and store rooms, and
- surfaces and grounds in concealed and inaccessible spaces.

5.1.4 Paints, varnishings and other finishes used on exposed interior surfaces shall not be capable of producing excessive quantities of smoke and toxic gases (see [5.1.5], Note 1).

Note 1: Reference is made to the Fire Test Procedure Code, Annex 1, Part 2, adopted by IMO by Resolution MSC.61 (67)

5.1.5 Fabrics, curtains and other hanging textiles (see [5.1.6], Note 1) as well as upholstered furniture (see [5.1.6], Note 2) and bedding components (see [5.1.6], Note 3) shall be fire retardant, unless the spaces are protected with a sprinkler installation.

Note 1: Reference is made to the Fire Test Procedure Code, Annex 1, Part 7, adopted by IMO by Resolution MSC.61(67).

Note 2: Reference is made to the Fire Test Procedure Code, Annex 1, Part 8, adopted by IMO by Resolution MSC.61 (67).

Note 3: Reference is made to the Fire Test Procedure Code, Annex 1, Part 9, adopted by IMO by Resolution MSC.61 (67).

5.1.6 Furniture and fittings in public spaces, which are also assembly station, shall be made of non-combustible material, unless the public spaces are protected with a sprinkler installation.

6 Means of escape

6.1 General

6.1.1 In case accommodation spaces for disabled passengers will be provided, the escape ways from these cabins should have a clear width of at least 1,3 m. Access doors to and doors from the vessel should have a clear width of not less than 1,5 m.

6.1.2 Dead-end corridors

No dead-end corridors having a length of more than 2 m are acceptable.

6.1.3 Escape routes and emergency exits shall be provided with a suitable safety guidance system.

7 Ventilation systems

7.1 General

7.1.1 They shall be so designed as to prevent the spread of fire and smoke through the system.

7.1.2 The main inlets and outlets of all ventilation system shall be capable of being closed from outside the respective spaces in the event of a fire.

7.1.3 Ducts shall be constructed of steel or other equivalent non-combustible material.

7.1.4 Ducts exceeding 0,02 m^2 and passing through class A divisions shall be fitted with fire dampers. The fire dampers shall operate automatically but shall also be capable of being manually closed from both sides of the penetrated division.

7.1.5 Ventilation systems for galleys and machinery spaces shall be independent of the ventilation system serving other spaces.

7.1.6 Exhaust ducts are to be provided with suitably arranged hatches for inspection and cleaning. The hatches shall be located near the fire dampers.

7.1.7 All power ventilation shall be capable of being stopped from a central place outside the machinery space.

7.1.8 Galleys have to be provided with separate ventilation systems and exhaust ducts from galley ranges.

Exhaust ducts from galley ranges shall comply with [7.1.1] to [7.1.7] and shall in addition be provided with a manually operated fire damper located in the lower end of the duct.

7.2 Smoke extraction system

7.2.1 Control stations, stairways and internal assembly stations shall be provided with a natural or a mechanical smoke extraction system.

Smoke extraction systems shall comply with [7.2.2] to [7.2.8]

7.2.2 They shall provide sufficient capacity and reliability.

7.2.3 They shall consider the operating conditions of passenger vessels.

7.2.4 When the normal ventilation system is used for this purpose it shall be designed that its function will not be impaired by smoke.

7.2.5 They shall be provided with manual actuation.

7.2.6 It shall be possible to operate mechanical smoke extraction systems from a position permanently occupied by crew.

7.2.7 Natural smoke extraction systems shall be provided with an opening mechanism, operated either manually or by a power source inside the ventilator.

7.2.8 Manually operated actuators and opening mechanism shall be accessible from inside and ouside of the protected space.

SECTION 8 UNATTENDED MACHINERY SPACES (AUT-UMS)

1 General

1.1 Application

1.1.1 The additional class notation **AUT-UMS** is assigned in accordance with Pt A, Ch 2, Sec 3, [9.5] to vessels fitted with automated installations enabling periodically unattended operation of machinery spaces, and complying with the requirements of this Section.

Machinery spaces are defined in Pt C, Ch 1, Sec 1, [1.4].

1.1.2 Applicable requirements stated under Pt C, Ch 2, Sec 13, are to be complied with too.

1.1.3 The arrangements provided shall be such as to ensure that the safety of the vessel in all sailing conditions, including manoeuvring, is equivalent to that of a vessel having the machinery spaces manned.

1.2 Exemptions

1.2.1 For vessels whose deadweight is less than 500 t, the requirements of [6.4.3] do not apply.

1.2.2 For cargo carriers, the Society may wave the requirements laid down in [3.3.1], insofar as the arrangements of the machinery space access make it unnecessary.

1.3 Communication system

1.3.1 Means of communication are to be capable of being operated even in the event of failure of supply from the main source of electrical power.

1.4 Monitoring and control of equipment

1.4.1 Monitoring and control of unattended machinery space equipment is to be performed according to Tab 2.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to those mentioned in Pt C, Ch 2, Sec 1, [2.1.6], the documents in Tab 1 are required for review/approval.

Table 1 : Documents to be submitted

Nº	Document
1	Means of communication diagram
2	Technical description of automatic engineer's alarm and connection of alarms to accommodation and wheelhouse, when applicable
3	System of protection against flooding
4	Fire detection system: diagram, location and cabling

3 Fire precautions

3.1 Fire prevention

3.1.1 For arrangements of remote stop, the requirements in Pt C, Ch 1, Sec 14, [2.3] are applicable.

3.2 Fire detection

3.2.1 An automatic fire detection system is to be fitted in machinery spaces intended to be unattended.

3.2.2 The fire detection system is to be designed with self-monitoring properties. Power or system failures are to initiate an audible alarm distinguishable from the fire alarm.

3.2.3 The fire indicating panel is to be located in the wheelhouse, fire control station or other accessible place where a fire in the machinery space will not render it inoperative.

3.2.4 The fire detection indicating panel is to indicate the place of the detected fire in accordance with the arranged fire zones by means of a visual signal. Audible signals clearly distinguishable in character from any other signals are to be audible throughout the wheelhouse and the accommodation area of the personnel responsible for the operation of the machinery space.

3.2.5 Fire detectors are to be of such type and so located that they will rapidly detect the onset of fire in conditions normally present in the machinery space. The type and location of detectors are to be approved by the Society and a combination of detector types is recommended in order to enable the system to react to more than one type of fire symptom.

3.2.6 Except in spaces of restricted height and where their use is specially appropriate, detection systems using thermal detectors only are not permitted. Flame detectors may be installed, although they are to be considered as complementary and are not to replace the main installation.

3.2.7 Fire detector zones are to be arranged in a manner that will enable the operating staff to locate the seat of the fire. The arrangement and the number of loops and the location of detector heads are to be approved in each case. Air currents created by the machinery are not to render the detection system ineffective.

3.2.8 When fire detectors are provided with the means to adjust their sensitivity, necessary arrangements are to be allowed to fix and identify the set point.

3.2.9 When it is intended that a particular loop or detector is to be temporarily switched off, this state is to be clearly indicated. Reactivation of the loop or detector is to be performed automatically after a preset time.

3.2.10 The fire detection indicating panel is to be provided with facilities for functional testing.

3.2.11 The fire detection system is to be fed automatically from the emergency source of power by a separate feeder if the main source of power fails.

3.2.12 Facilities are to be provided in the fire detecting system to manually release the fire alarm from the following places:

- passageways having entrances to machinery spaces
- the wheelhouse
- the control station in the machinery space.

3.3 Fire fighting

3.3.1 Unless otherwise stated, pressurisation of the fire main at a suitable pressure by starting a main fire pump and carrying out the other necessary operations is to be possible from the wheelhouse. Alternatively, the fire main system may be permanently under pressure.

4 Flooding precautions

4.1 Protection against flooding

4.1.1 Bilge wells or machinery spaces bilge levels are to be monitored in such a way that the accumulation of liquid is detected in normal angles of trim and heel, and are to be large enough to accommodate easily the normal drainage during the unattended period.

4.1.2 Bilge level alarms are to be given at the main control station and the wheelhouse.

4.1.3 Alarm is to be given to the wheelhouse in case of flooding into the machinery space situated below the load line, in compliance withTab 2

5 Machinery

5.1 General

5.1.1 Under all sailing conditions, including manoeuvring, the speed, direction of thrust and, if applicable, the pitch of the propeller shall be fully controllable from the wheelhouse.

5.1.2 All manual operations or services expected to be carried out with a periodicity of less than 24 h are to be eliminated or automated, particularly for: lubrication, toping up of make up tanks and filling tanks, filter cleaning, cleaning of centrifugal purifiers, drainage, load sharing on main engines and various adjustments. Nevertheless, the transfer of operation mode may be effected manually.

5.1.3 A centralised control position shall be arranged with the necessary alarm panels and instrumentation indicating any alarm.

5.1.4 Parameters for essential services which need to be adjusted to a preset value are to be automatically controlled.

5.1.5 The control system shall be such that the services needed for the operation of the main propulsion machinery and its auxiliaries are ensured through the necessary automatic arrangements.

5.1.6 It shall be possible for all machinery essential for the safe operation of the vessel to be controlled from a local position, even in the case of failure in any part of the automatic arrangements.

5.1.7 The design of the remote automatic control system shall be such that in the case of its failure an alarm will be given. Unless impracticable, the preset speed and direction of thrust of the propeller shall be maintained until local control is in operation.

5.1.8 Critical speed ranges, if any, are to be rapidly passed over by means of an appropriate automatic device.

5.1.9 Propulsion machinery is to stop automatically only in exceptional circumstances which could cause quick critical damage, due to internal faults in the machinery. The design of automation systems whose failure could result in an unexpected propulsion stop is to be specially examined. An overriding device for cancelling the automatic shutdown is to be considered.

5.1.10 Where the propulsive plant includes several main engines, a device is to be provided to prevent any abnormal overload on each of them.

5.1.11 Where standby machines are required for other auxiliary machinery essential to propulsion, automatic changeover devices shall be provided.

5.2 Control of machinery

5.2.1 Monitoring and control of machinery equipment is to be performed according to Tab 2.

6 Alarm system

6.1 General

6.1.1 A system of alarm displays and controls is to be provided which readily allows identification of faults in the machinery and satisfactory supervision of related equipment. This may be arranged at a main control station or, alternatively, at subsidiary control stations. In the latter case, a master alarm display is to be provided at the main control station showing which of the subsidiary control stations is indicating a fault condition.

6.1.2 Unless otherwise justified, separation of monitoring and control systems is to be provided.

Table 2 : Monitoring and control of machinery installations

Symbol convention H = High, HH = Very high L = Low I = Individual alarm G = Group alarm		Monitoring				
Identification of system parameter		Alarms	Indication local	Alarms wheelhouse **(4)**	Indication wheelhouse	Shut down
MAIN ENGINE						
Engine speed	All engines		x		x	
	Engine power > 220kW	HH	x	I		x
Shaft revolution indicator			x		x	
Lubricating oil pressure		L	x	G	x	
Lubricating oil temperature		H	x	G		
Fresh cooling water system inlet pressure **(1)**		L	x	G		
Fresh cooling water system outlet temperature **(1)**		H	x	G		
Fuel oil temperature for engines running on HFO		L	x	G		
Exhaust gas temperature (single cylinder when the dimensions permit)			x			
Starting air pressure		L	x	I	x	
Charge air pressure			x			
Control air pressure			x		x	
Exhaust gas temperature at turbocharger inlet/outlet (where the dimensions permit)			x			
Manual emergency stop of propulsion		x	x		x	x **(3)**
Fault in the electronic governor		x	x	G		
REDUCTION GEAR						
Tank level			x		x	
Lubricating oil temperature			x			
Lubricating oil pressure			x		x	
AUXILIARY MACHINE **(2)**						
Engine speed	All engines		x			
	Engine power > 220 kW	HH	x	I		x
Low pressure cooling water system **(1)**		L	x	G		
Fresh cooling water system outlet temperature **(1)**		H	x	G		
Lubricating oil pressure		L	x	G		
Fault in the electronic governor		x	x	G		
DIESEL BOW THRUSTER **(2)**						
Engine speed	All engines		x			
	Engine power > 220 kW	HH	x	G		x
Low pressure cooling water system **(1)**		L	x	G		
Fresh cooling water system outlet temperature **(1)**		H	x	G		
Direction of propulsion			x		x	
Lubricating oil pressure		L	x	G		
Lubricating oil temperature			x			
Fault in the electronic governor		x	x	G		

(1) A combination of level indication/alarm in expansion tank and indication/alarm cooling water temperature can be considered as equivalent with consent of the Society
(2) Exemptions can be given for diesel engines with a power of 50 kW and below
(3) Openings of clutches can, with the consent of the Society, be considered as equivalent
(4) Group of alarms are to be detailed in the machinery space or control room (if any)

Symbol convention H = High, HH = Very high L = Low I = Individual alarm G = Group alarm	Monitoring				
Identification of system parameter	Alarms	Indication local	Alarms wheelhouse **(4)**	Indication wheelhouse	Shut down
PROPULSION					
Propulsion remote control ready		x		x	
Pitch control		x		x	
ELECTRICITY					
Earth fault (when insulated network)	x	x	G		
Main supply power failure	x	x	G		
FUEL OIL TANKS					
Fuel oil level in service tank or tanks supplying directly services essential for safety or navigation	L	x	G		
STEERING GEAR					
Rudder angle indicator		x		x	
Level of each hydraulic fluid	L	x	I	x	
Hydraulic fluid temperature	H	x	I	x	
Indication that electric motor of each power unit is running		x		x	
Failure of rate of turn control	x		I	x	
Overload failure	x	x	I	x	
Phase failure	x	x	I	x	
Loss of power supply	x	x	I	x	
Loss of control supply	x	x	I	x	
STEAM BOILER OR HEATING OIL					
High pressure	HH				x
FIRE					
Fire detection	x			x	
Fire manual call point	x			x	
Automatic fixed fire extinguishing system activation, if fitted	x			x	
FLOODING					
Level of machinery space bilges/drain wells	x			x	
ALARM SYSTEM					
Alarm system power supply failure	x	x		x	

(1) A combination of level indication/alarm in expansion tank and indication/alarm cooling water temperature can be considered as equivalent with consent of the Society
(2) Exemptions can be given for diesel engines with a power of 50 kW and below
(3) Openings of clutches can, with the consent of the Society, be considered as equivalent
(4) Group of alarms are to be detailed in the machinery space or control room (if any)

6.1.3 The alarm system is to be designed to function independently of control and safety systems, so that a failure or malfunction of these systems will not prevent the alarm system from operating. Common sensors for alarms and automatic slowdown functions may be accepted in specific cases.

6.1.4 The alarm system shall be continuously powered and shall have an automatic change-over to a standby power supply in the case of loss of normal power supply.

6.2 Alarm system design

6.2.1 The alarm system and associated sensors are to be capable of being tested during normal machinery operation.

6.2.2 Insulation faults on any circuit of the alarm system are to generate an alarm, when an insulated earth distribution system is used.

6.2.3 An engineer's alarm is to be activated when the machinery alarm has not been accepted in the machinery spaces or control room within 5 minutes.

6.3 Machinery alarm system

6.3.1 The local silencing of the alarms in the wheelhouse or in accommodation spaces is not to stop the audible machinery space alarm.

6.3.2 Machinery faults are to be indicated at the control locations for machinery.

6.4 Alarm system in wheelhouse

6.4.1 Alarms associated with faults requiring speed reduction or automatic shutdown are to be separately identified in the wheelhouse.

6.4.2 The alarm system is to activate an audible and visual alarm in the wheelhouse for any situation which requires action by or the attention of the officer on watch.

6.4.3 Individual alarms are to be provided in the wheelhouse indicating any power supply failures of the remote control of propulsion machinery.

7 Safety system

7.1 General

7.1.1 Safety systems of different units of the machinery plant are to be independent. Failure in the safety system of one part of the plant is not to interfere with the operation of the safety system in another part of the plant.

7.1.2 In order to avoid undesirable interruption in the operation of machinery, the system is to intervene sequentially after the operation of the alarm system by:

- starting of standby units
- load reduction or shutdown, such that the least drastic action is taken first.

7.1.3 The arrangement for overriding the shutdown of the main propelling machinery is to be such as to preclude inadvertent operation.

7.1.4 After stoppage of the propulsion engine by a safety shutdown device, the restart is only to be carried out, unless otherwise justified, after setting the propulsion wheelhouse control level on "stop".

8 Testing

8.1 General

8.1.1 The tests of automated installations are to be carried out according to Pt C, Ch 2, Sec 17, [3] to determine their operating conditions. The details of these tests are defined, in each case, after having studied the concept of the automated installations and their construction. A complete test program is to be submitted for approval.

SECTION 9 ANNUAL SURVEY

1 General

1.1 Application

1.1.1 The additional class notation **Annual survey** is assigned in accordance with Pt A, Ch 2, Sec 3, [9.6], to vessels submitted to annual survey complying with the requirements of this Section. This Section applies in addition to applicable provisions of Pt A, Ch 3, Sec 2 to Pt A, Ch 3, Sec 7.

1.1.2 Vessels assigned additional class notation **Annual survey** are to be submitted to annual surveys carried out within three months before or after each anniversary date.

1.1.3 At the time of annual surveys, the vessel is to be generally examined. The survey is to include a visual inspection of the hull and hull equipment of the vessel and some tests thereof, so far as necessary and practicable in order to verify that the vessel is in a satisfactory and efficient general condition and is properly maintained.

1.1.4 Owners are reminded that, in compliance with the requirements in Pt A, Ch 1, Sec 2, [6.4], any modification to the vessel's hull and equipment affecting its classification is to be made known to the Society.

1.2 Links between anniversary dates and annual surveys, intermediate surveys and class renewal surveys

1.2.1 The link between the anniversary dates, the class renewal survey (when carried out according to the normal system), and the annual and intermediate surveys is given in Fig 1.

2 Hull and hull equipment

2.1 General

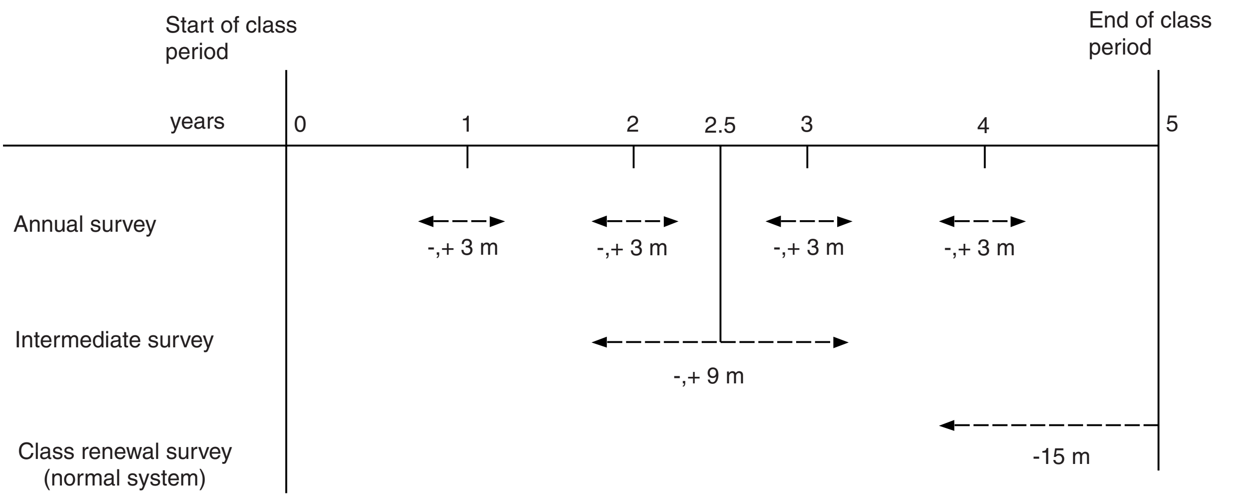
2.1.1 The main structural elements of the hull are to be subjected to a general visual inspection, as far as accessible. If applicable, ballast tank, storage and engine rooms are to be surveyed at random, depending on the vessel type and the age and general condition of the vessel. Where damages or excessive wastage affecting the class are suspected, the Surveyor is entitled to carry out further investigations as well as thickness measurements, if required.

2.1.2 The rudder and manoeuvring arrangement and the anchor equipment are to be checked for visible damages. For the related machinery and for operability, see Pt A, Ch 3, Sec 2, [4.1.1].

2.1.3 The foundations and their substructure of special equipment, particularly on the upper deck, shall be inspected for damages.

2.1.4 Compartments and rooms normally not accessible, or accessible only after special preparations, may be required to be opened for inspection, depending on the vessel's age and available information about service conditions.

Figure 1 : Links between anniversary date and annual, intermediate and class renewal surveys



2.2 Ballast tanks

2.2.1 Depending on the vessel's age, the Surveyor may require opening of ballast tanks for visual inspection, particularly if deterioration of the coating or excessive wastage has already been observed at previous surveys.

If coating is to be partly or totally renewed, only approved coating is applicable in case of a repair. The whole working procedure including the surface preparation has to be documented.

2.3 Hatches and covers, bow, side and stern doors

2.3.1 Hatches and covers, bulkhead and hull doors, ramps and any openings in the outer shell shall be surveyed regarding structural integrity as well as tightness and operability of all closures.

2.3.2 Additionally to the overall survey the following structural members of bow, side and stern doors are to be thoroughly inspected:

- all hinges and the pertinent hydraulic cylinders in way of their securing points
- all securing elements of the locking devices and stoppers.

2.3.3 Where considered necessary by the Surveyor, additionally crack tests shall be carried out at structural members of bow, side and stern doors.

Essentially, the crack tests will cover:

- main joining welds and their interfacial areas both on the vessel's hull and on the doors
- highly stressed areas in way of the centres of rotation of the hinges
- highly stressed areas of the locking devices and their stoppers
- repair welding.

For crack detection the dye penetration method or the magnetic particle inspection method shall be employed, and a test protocol is to be prepared.

3 Machinery and systems

3.1 General machinery installations

3.1.1 The survey of general machinery installations is to cover the following items:

- general examination of machinery and boiler spaces with particular attention to the fire and explosion hazards; confirmation that emergency escape routes are practicable and not blocked
- general examination of the machinery, steam, hydraulic, pneumatic and other systems and their associated fittings, for confirmation of their proper maintenance
- testing of the means of communication and order transmission between the navigating bridge and the machinery control positions and other control stations
- confirmation that the rudder angle indicator on the bridge is in working order
- examination, as far as practicable, of the bilge pumping systems and bilge wells, including operation of the pumps, remote reach rods and level alarms, where fitted
- visual examination of the condition of any expansion joints in river water systems
- external examination of pressure vessels other than boilers and their appurtenances, including safety devices, foundations, controls, relieving gear, high pressure piping, insulation and gauges.

3.1.2 When the vessel is equipped with a refrigerating plant (whether or not covered by an additional class notation), the annual survey is to include the external examination of:

- pressure vessels of the installation to the same extent as indicated in [3.1.1]
- refrigerant piping, as far as practicable
- for refrigerating machinery spaces using ammonia as refrigerant:
  - ventilation system including functional test
  - water-spraying fire-extinguishing system; see [3.4.2] item d)
  - bilge system including functional test
  - electrical equipment, confirming its proper maintenance
  - gas detection system
  - breathing apparatus and protective clothing.

3.1.3 When the vessel is equipped with thruster installations, the annual survey is to include:

- an external examination of the machinery installation
- an operating test of the complete installation.

3.2 Boilers

3.2.1 For main and auxiliary boilers, the annual survey consists of an external examination of boilers and their appurtenances, including safety devices, foundations, controls, relieving, high pressure and steam escape piping, insulation and gauges.

3.2.2 For thermal oil heaters, a functional test while in operation is to be carried out, during which the following items are checked:

- the heater for detection of leakages
- the condition of the insulation
- the operation of indication, control and safety devices
- the condition of remote controls for shut-off and discharge valves

A satisfactory analysis of the quality of oil is to be made available to the Surveyor.

3.2.3 For exhaust gas thermal oil heaters, in addition to the requirements of [3.2.2], a visual examination and a tightness testing to the working pressure of the heater tubes are to be carried out.

3.3 Electrical machinery and equipment

3.3.1 The survey of electrical machinery and equipment is to cover the following items:

- general examination, visually and in operation, as feasible, of the electrical installations for power and lighting, in particular main and emergency generators, electric motors, switchboards, switchgears, cables and circuit protective devices, indicators of electrical insulation and automatic starting, where provided, of emergency sources of power
- checking, as far as practicable, the operation of emergency sources of power and, where they are automatic, also including the automatic mode.

3.3.2 The survey is also to cover the bridge control of propulsion machinery, and related arrangements (alarms and safety devices), when fitted.

3.4 Fire protection, detection and extinction

3.4.1 The survey of fire prevention and other general arrangements is to cover the following items:

- checking that fire control plans are properly posted
- examination and testing, as feasible, of the operation of manual and/or automatic fire doors, where fitted
- checking, as far as practicable, that the remote controls for stopping fans and machinery and shutting off fuel supplies in machinery spaces and, where fitted, the remote controls for stopping fans in accommodation spaces and the means of cutting off power to the galley are in working order
- examination of the closing arrangements of ventilators, funnel annular spaces, skylights, doorways and tunnel, where applicable
- examination, as far as practicable, and testing, as feasible and at random, of the fire and/or smoke detection systems.

3.4.2 The operational readiness and maintenance of fire fighting systems is to be checked. The survey requirements for all types of fire-fighting systems that are usually found on board vessels related either to machinery spaces or to cargo areas and/or spaces or to accommodation spaces, irrespective of the service notation assigned, are the following:

a) water fire system
    - examination of the fire main system and confirmation that each fire pump including the emergency fire pump can be operated separately so that the two required powerful jets of water can be produced simultaneously from different hydrants, at any part of the vessel whilst the required pressure is maintained in the fire main
    - checking that fire hoses, nozzles, applicators, spanners and international shore connection (where fitted) are in satisfactory working condition and situated at their respective locations

b) fixed gas fire-extinguishing system
    - external examination of receivers of CO_2 (or other gas) fixed fire-extinguishing systems and their accessories, including the removal of insulation for insulated low pressure CO_2 containers
    - examination of fixed fire-fighting system controls, piping, instructions and marking; checking for evidence of proper maintenance and servicing, including date of last system tests
    - test of the alarm triggered before the CO_2 is released

c) sprinkler system
    - examination of the system, including piping, valves, sprinklers and header tank
    - test of the automatic starting of the pump activated by a pressure drop
    - check of the alarm system while the above test is carried out

d) water-spraying system
    - examination of the system, including piping, nozzles, distribution valves and header tank
    - test of the starting of the pump activated by a pressure drop (applicable only for machinery spaces)

e) fixed foam systems (low or high expansion)
    - examination of the foam system
    - test to confirm that the minimum number of jets of water at the required pressure in the fire main is obtained when the system is in operation
    - checking the supplies of foam concentrate and receiving confirmation that it is periodically tested (not later than three years after manufacture and annually thereafter) by the manufacturer or an agent

f) dry powder system
    - examination of the dry powder system, including the powder release control devices
    - checking the supplies of powder contained in the receivers and that it has maintained its original smoothness
    - checking that the pressure of propelling inert gas contained in the relevant bottles is satisfactory.

3.4.3 As far as other fire-fighting equipment is concerned, it is to be checked that:

- semi-portable and portable fire extinguishers and foam applicators are in their stowed positions, with evidence of proper maintenance and servicing, and detection of any discharged containers
- firemen's outfits are complete and in satisfactory condition.

SECTION 10 GRABLOADING

1 General

1.1 Application

1.1.1 The additional class notation **Grabloading** is assigned, in accordance with Pt A, Ch 2, Sec 3, [3.2.6] to bulk cargo vessels with holds specially reinforced for loading/unloading cargoes by means of buckets or grabs and complying with the requirements of this Section.

2 Scantlings

2.1 General

2.1.1 The net scantlings of plating and structural members within the cargo hold obtained from Ch 1, Sec 2 are to be increased in compliance with [2.2] [2.3].

2.2 Inner bottom

2.2.1 The net scantlings of inner bottom plating and longitudinals, where no continuous wooden ceiling is fitted, obtained from Ch 1, Sec 2 are to be reinforced as follows:

- inner bottom plating net thickness is to be increased by 2 mm
- inner bottom longitudinal net section modulus is to be increased 1,4 times.

2.3 Hold sides and bulkheads

2.3.1 The net thicknesses of:

- hold side plating up to 1,5 m from the inner bottom
- hold bulkhead plating up to 1,5 m from the inner bottom

are to be increased by 1,5 mm

2.3.2 The net section modulus of:

- hold side secondary stiffeners up to 1,5 m from the inner bottom
- hold bulkhead secondary stiffeners up to 1,5 m from the inner bottom

2.3.3 Above 1,5 m from the inner bottom, the net scantlings of plating and structural members may be tapered to those obtained from Ch 1, Sec 2.

Part D

Additional Requirements for Notations

Chapter 3

TRANSPORT OF DANGEROUS GOODS

SECTION 1 GENERAL

1 General

1.1 Application

1.1.1 The requirements of this Section apply to vessels intended for the carriage of dangerous goods.

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C, as applicable.

Additional measures and Regulations varying from country to country or from continent to continent are to be complied with too.

1.1.3 The basis of the following requirements is the **ADN** Regulations, Edition 2009 (see [1.4.2]). In any case the actual edition of Regulations for the transport of dangerous goods has to be observed. For vessels not falling under **ADN**, the Society may approve equivalent arrangements providing the same level of safety.

1.2 Classification of dangerous goods

1.2.1 In UN Model Regulations defined in [1.4.25], dangerous goods are assigned to different classes. Each class defines one type of dangerous goods. In some classes divisions are defined. The numerical order of the classes and divisions is not that of the degree of danger.

The classes defined in UN Model Regulations are given in Tab 1.

1.3 Substances approved for carriage in tankers

1.3.1 The dangerous goods of the classes listed below may be carried in tankers depending on their construction:

Class 2 - Gases compressed, liquefied or dissolved under pressure

Class 3 - Flammable liquids

Class 5.1 - Oxidizing substances

Class 6.1 - Toxic substances

Class 8 - Corrosive substances

Class 9 - Miscellaneous dangerous substances and articles.

1.3.2 Products listed in the Product List (see Part 3, Table C of actual **ADN/ADNR** Regulations) are permitted to be carried in tankers complying with the Rules of this Section.

1.3.3 Despite from foregoing, the current edition of the **ADN/ADNR** Regulations is always to be applied to the classification of substances and other requirements (e.g. the filling ratio).

1.4 Definitions

1.4.1 Accommodation

Accommodation means spaces intended for the use of persons normally living on board, including galleys, food stores, lavatories, washrooms, bathrooms, laundries, halls, alleyways, etc., but excluding the wheelhouse.

1.4.2 ADN

ADN means european agreement concerning the international carriage of dangerous goods by inland waterway.

Table 1 : Classification of dangerous goods

Class	Description
Class 1	Explosives
1.1	Substances and articles which have a mass explosion hazard
1.2	Substances and articles which have a projection hazard but not a mass explosion hazard
1.3	Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard
1.4	Substances and articles which present no significant hazard
1.5	Very intensive substances which have a mass explosion hazard
1.6	Extremely intensive articles which do not have a mass explosion hazard
Class 2	Gases
2.1	Flammable gases
2.2	Non-flammable, non-toxic gases
2.3	Toxic gases
Class 3	Flammable liquids
Class 4	Flammable solids; substances liable to spontaneous combustion; substances which, in contact with water, emit flammable gases
4.1	Flammable solids, self-reactive substances and solid desensitized explosives
4.2	Substances liable to spontaneous combustion
4.3	Substances which in contact with water emit flammable gases
Class 5	Oxidizing substances and organic peroxides
5.1	Oxidizing substances
5.2	Organic peroxides
Class 6	Toxic and infectious substances
6.1	Toxic substances
6.2	Infectious substances
Class 7	Radioactive material
Class 8	Corrosive substances
Class 9	Miscellaneous dangerous substances and articles

1.4.3 Bilge water

Bilge water means oily water from the engine room bilges, the peak, the cofferdams and the double hull spaces.

1.4.4 Bulkhead

Bulkhead means a metal wall, generally vertical, inside the vessel and which is bounded by the bottom, the side plating, a deck, the hatchway covers or by another bulkhead.

1.4.5 Cargo area of tank vessels

Cargo area of tank vessels means the whole of the following spaces (see Fig 1).

1.4.6 Cargo area of tank vessels (additional part above deck)

Cargo area of tank vessels (additional part above deck) (When anti-explosion protection is required, comparable to zone 1, see [1.4.12]) means the spaces not included in the main part of cargo area above deck comprising 1,00 m radius spherical segments centred over the ventilation openings of the cofferdams and the service spaces located in the cargo area part below the deck and 2,00 m spherical segments centred over the ventilation openings of the cargo tanks and the opening of the pump-rooms.

1.4.7 Cargo area of tank vessels (main part above deck)

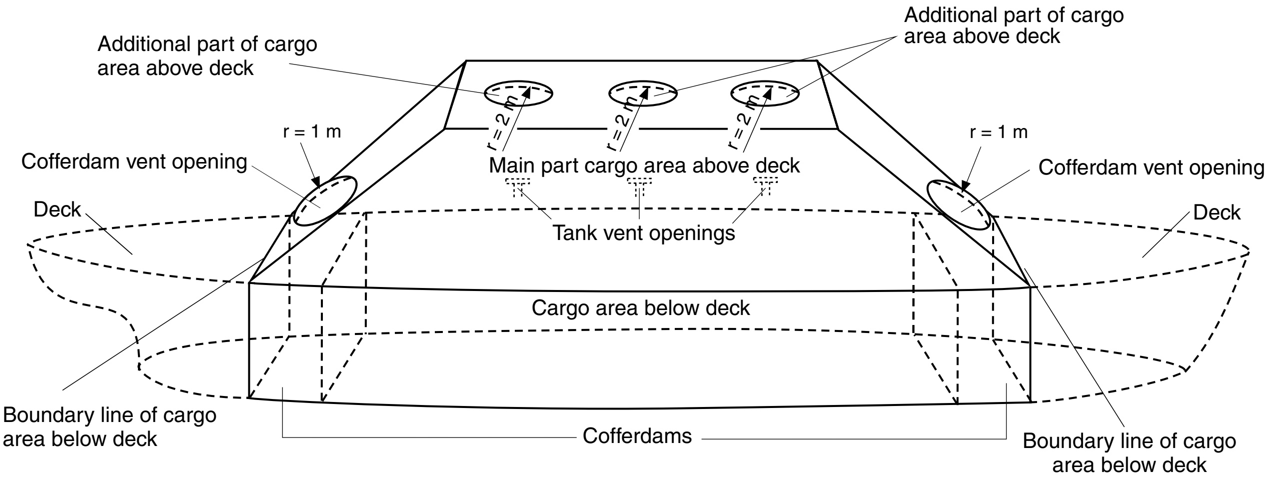
Cargo area of tank vessels (main part above deck) (When anti-explosion protection is required - comparable to zone 1, see [1.4.12]) means the space which is bounded:

- at the sides, by the shell plating extending upwards from the decks sides
- fore and aft, by planes inclined at 45° towards the cargo area, starting at the boundary of the cargo area part below deck
- vertically, 3,00 m above the deck.

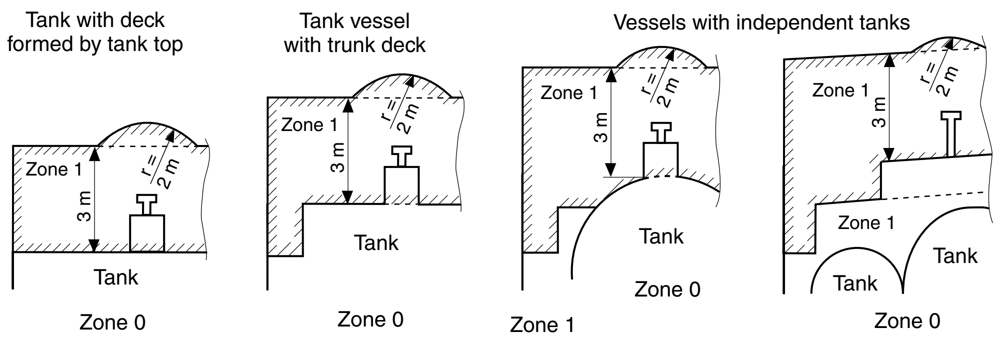
1.4.8 Cargo area of tank vessels (part below deck)

Cargo area of tank vessels (part below deck) means the space between two vertical planes perpendicular to the centre-line plane of the vessel, which comprises cargo tanks, hold spaces, cofferdams, double-hull spaces and double bottoms; these planes normally coincide with the outer cofferdam bulkheads or hold end bulkheads. Their intersection line with the deck is referred to as the boundary of the cargo area part below deck.

Figure 1 : Cargo area



Cargo area above deck for various tankers



Zone 0 = inside tank
Zone 1 = cargo areas
Zone 2 = other areas

1.4.9 Cargo area of dry cargo vessels

See [1.4.21], Protected area.

1.4.10 Cargo pump room

Cargo pump-room (When anti-explosion protection is required, comparable to zone 1, see [1.4.12]) means a service space where the cargo pumps and stripping pumps are installed together with their operational equipment.

1.4.11 Cargo tank

Cargo tank (When anti-explosion protection is required, comparable to zone 0, see [1.4.12]) means a tank which is permanently attached to the vessel and the boundaries of which are either formed by the hull itself or by walls separate from the hull and which is intended for the carriage of dangerous goods.

1.4.12 Classification of zones

Zone 0 : Areas in which dangerous explosive atmospheres of gases, vapours or sprays exist permanently or during long periods

Zone 1 : Areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur occasionally

Zone 2 : Areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur rarely and if so for short periods only.

1.4.13 Cofferdam

Cofferdam (when anti-explosion protection is required, comparable to zone 1, see [1.4.12]) means an athwartship compartment which is bounded by watertight bulkheads and which can be inspected.

1.4.14 Design pressure/underpressure

Design pressure/underpressure means the pressure on the basis of which the cargo tank or the residual cargo tank has been designed and built.

1.4.15 Dangerous goods

Dangerous goods mean those substances and articles the carriage of which is prohibited by **ADN**, or authorized only under the conditions prescribed therein.

1.4.16 Flash-point

Flash-point means the lowest temperature of a liquid at which its vapours form a flammable mixture with air.

1.4.17 Independent cargo tank

Independent cargo tank (when anti-explosion protection is required, comparable to zone 0) means a cargo tank which is permanently built in, but which is independent of the vessel's structure.

1.4.18 Limited explosion risk apparatus

Limited explosion risk electrical apparatus means an electrical apparatus which, during normal operation, does not cause sparks or exhibits surface temperatures which are above the required temperature class, including e.g.:

- three-phase squirrel cage rotor motors
- brushless generators with contactless excitation
- fuses with an enclosed fuse element
- contactless electronic apparatus

or means an electrical apparatus with an enclosure protected against water jets (degree of protection IP55) which during normal operation does not exhibit surface temperatures which are above the required temperature class.

1.4.19 Machinery spaces

Machinery spaces are all spaces containing propulsion machinery, boilers, fuel oil units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilising, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces.

1.4.20 Pressure tank

Pressure tank means a tank designed and approved for a working pressure ≥ 400 kPa (4 bar).

1.4.21 Protected area

Protected area means:

a) the cargo hold or holds (when anti-explosion protection is required, comparable to zone 1, see [1.4.12]) of the vessel

b) the space situated above the deck (when anti-explosion protection is required, comparable to zone 2, see [1.4.12]), bounded:
   - athwarships, by vertical planes corresponding to the side plating
   - fore and aft, by vertical planes corresponding to the end bulkheads of the hold; and
   - upwards, by a horizontal plane 2 m above the upper level of the load, but at least by a horizontal plane 3 m above the deck.

1.4.22 Service space

Service space means a space which is accessible during the operation of the vessel and which is neither part of the accommodation nor of the cargo tanks, with the exception of the forepeak and after peak, provided no machinery has been installed in these latter spaces.

1.4.23 Temperature class

Temperature class means a grouping of flammable gases and vapours of flammable liquids according to their ignition temperature; and of the electrical apparatus intended to be used in the corresponding potentially explosive atmosphere according to their maximum surface temperature.

1.4.24 Test pressure

Test pressure means the pressure at which a cargo tank, a residual cargo tank, a cofferdam or the loading and unloading pipes shall be tested prior to being brought into service for the first time and subsequently regularly within prescribed times.

1.4.25 UN Model Regulations

UN Model Regulations means the Model Regulations annexed to the fourteenth revised edition of the Recommendations on the Transport of Dangerous Goods published by the United Nations (ST/SG/AC.10/1/Rev.14).

1.4.26 UN number

UN number means the four-figure identification number of the substance or article taken from the United Nations Model Regulations.

2 General provisions for tankers

2.1 Carriage in cargo tanks

2.1.1 General

Substances, their assignment to the various types of tank vessels and the special conditions for their carriage in these tank vessels, are listed in **ADN/ADNR** Table C.

2.1.2 Substances, which have to be carried in a tank vessel of type N, open, may also be carried in a tank vessel of type N, open, with flame arresters; type N, closed; types C or G provided that all conditions of carriage prescribed for tank vessels of type N, open, as well as all other conditions of carriage prescribed in the list of substances of **ADN/ADNR** Table C are met.

2.1.3 Substances which have to be carried in a tank vessel of type N, open, with flame arresters, may also be carried in tank vessels of type N, closed, and types C or G provided that all conditions of carriage prescribed for tank vessels of type N, open, with flame arresters, as well as all other conditions of carriage prescribed in the list of substances of **ADN/ADNR** Table C are met.

2.1.4 Substances which have to be carried in a tank vessel of type N, closed, may also be carried in tank vessels of type C or G provided that all conditions of carriage prescribed for tank vessels of type N, closed, as well as all other conditions of carriage prescribed in the list of **ADN/ADNR** Table C are met.

2.1.5 Substances which have to be carried in tank vessels of type C may also be carried in tank vessels of type G provided that all conditions of carriage prescribed for tank vessels of type C as well as all other conditions of carriage prescribed in **ADN/ADNR** Table C are met.

2.1.6 Oily and greasy wastes resulting from the operation of the vessel may only be carried in fire resistant receptacles, fitted with a lid, or in cargo tanks.

2.2 Permitted vessels

2.2.1 Dangerous goods may be carried in tank vessels of Types N, C or G in accordance with the applicable requirements of Chapters Ch 3, Sec 1 to Ch 3, Sec 6. The type of tank vessel to be used is specified in **ADN/ADNR** Table C.

2.2.2 The substances accepted for carriage in the vessel will be indicated in a list issued by the Society.

2.2.3 The relief pressure of the safety valves or of the high-velocity vent valves, the design pressure and the test pressure of cargo tanks will be indicated.

2.3 Basic types of tankers

2.3.1 Type of vessel

With regard to kind of cargo, a distinction can be made between three different basic tanker types:

- Type G - a vessel with inserted pressure tanks generally intended for the carriage of liquefied gases belonging to class 2. See sketches b and c of Ch 1, Sec 3, Fig 3.

  Refrigerated cargo tanks shall be installed only in hold spaces bounded by double hull spaces and double bottom. These cargo tanks may be constructed with plane surface.
- Type C - a double-hull tanker as shown in sketch b of Ch 1, Sec 3, Fig 2 and double hull tankers with inserted cargo tanks analogous to sketches c and d of Ch 1, Sec 3, Fig 3.
- Type N - a vessel type which includes all three types of construction as shown in Ch 1, Sec 3, Fig 1 to Ch 1, Sec 3, Fig 3.

2.3.2 Basic structural configuration

- For single hull tankers, see Ch 1, Sec 3, [2.1.1]

  There are closed (tanker Type N - closed with 10kPa ≤ p ≤50 kPa) and open (tanker Type N open with flame arrester and tanker Type N open) versions of single hull tankers
- For double hull tankers, see Ch 1, Sec 3, [2.1.2]

  Double hull tankers also exist in closed and open structural versions
- For tankers with inserted cargo tanks, see Ch 1, Sec 3, [2.1.3]

  Independent cargo tanks exist in open and closed structural versions.

2.3.3 Minimum requirements for double hull arrangements

Where prescribed distances from **ADN/ADNR** or other Statutory Regulations do not have to be maintained between the tank wall and the vessel's side or bottom plating for the carriage of particular substances, the following minimum requirements are to be met:

- The distance between the tanks and the side plating of the vessel on each side shall not be less than 8% of the breadth B. This distance must afford easy access to the tanks
- The distance between the tanks and the bottom of the vessel must allow inspection and must be at least 60 cm. However, the distance between a tank pump well and the vessel's bottom may be reduced to 50 cm provided that the volume of the pump well is not greater than 0,1 m^3
- Independent tanks, if they are easy to move out of the vessel.

2.3.4 Stability

Where the tank breadth exceeds 0,7 B, cargo tanks are normally to be provided with centre longitudinal bulkheads. Where the tank breadth is greater than the figure mentioned and centre longitudinal bulkheads are not fitted, additional proof of stability is to be furnished in compliance with Ch 2, Sec 6, [3].

2.4 Materials

2.4.1 The vessel's hull and the cargo tanks must be constructed of hull structural steel conforming to the applicable requirements of NR 216 Materials and Welding. See also Pt B, Ch 2, Sec 1.

2.4.2 Independent cargo tanks may also be constructed of other materials provided these have at least equivalent mechanical properties and resistance against the effects of temperature and fire.

2.4.3 Every part of the vessel including any installation and equipment which may come into contact with the cargo shall consist of materials which can neither be dangerously affected by the cargo nor cause decomposition of the cargo or react with it so as to form harmful or hazardous products.

2.4.4 Vapour pipes and gas discharge pipes shall be protected against corrosion.

2.4.5 The use of wood, aluminium alloys or synthetic materials within the cargo area is only permitted for:

- gangways and external ladders
- movable items of equipment
- chocking of cargo tanks which are independent of the vessel's hull and chocking of installations and equipment
- masts and similar round timber
- engine parts
- parts of the electrical installation
- lids of boxes which are placed on the deck.

2.4.6 The use of wood or synthetic materials within the cargo area is only permitted for supports and stops of any kind.

2.4.7 The use of synthetic materials or rubber within the cargo area is only permitted for:

- all kinds of gaskets (e.g. for dome or hatch covers)
- electric cables
- hoses for loading and unloading
- insulation of cargo tanks and of hoses for loading and unloading.

2.4.8 All permanently fitted materials in the accommodation or wheelhouse, with the exception of furniture, shall not readily ignite. They shall not evolve fumes or toxic gases in dangerous quantities, if involved in a fire.

2.4.9 The paint used in the cargo area shall not be liable to produce sparks in case of impact.

2.4.10 The use of synthetic material for vessel's boats is permitted only if the material does not readily ignite.

2.5 Independent cargo tank supports and fastenings

2.5.1 Chocking of tanks

The tank supports are to be constructed in such a way as to make it impossible for the tanks to move in relation to the vessel structure.

The cargo tanks shall be fixed so that they cannot float.

2.5.2 Load case

The design of the tank supports is to be based on the following assumed forces.

Relaxation of the following may be granted by the Society on a case by case basis.

a) In the vertical direction:
   - The weight of the filled tanks acting downwards
   - The buoyancy of the empty tanks assuming the vessel in the damaged condition, acting upwards
   - The weight of the filled tanks assuming the vessel is capsized

b) Athwartships and in the capsized conditions:
   - The tank seatings in the athwartship direction must be designed for the total heeling range up to the completely capsized condition

c) Fore-and-aft:
   - The design of the tank seatings in the fore-and-aft direction is to be based on a force of 0,30 P.

     where:

     P : Weight of tank including contents

2.5.3 Checking criteria

The strength check of the seatings and stays (gross scantling) is to be carried out in compliance with Pt B, Ch 2, Sec 5, using a partial safety factor $\gamma_R = 1,5$.

2.5.4 Stress concentrations in the tank walls are to be avoided, and care is to be taken to ensure that the tank seatings do not impede the contraction of the tank when cooled down to transport temperature.

2.6 Protection against penetration of gases

2.6.1 The vessel shall be designed so as to prevent gases from penetrating into the accommodation and the service spaces.

2.6.2 Outside the cargo area, the lower edges of door-openings in the sidewalls of superstructures and the coamings of access hatches to under-deck spaces shall have a height of not less than 0,50 m above the deck.

This requirement needs not be complied with if the wall of the superstructures facing the cargo area extends from one side of the vessel to the other and has doors with sill height not less than 0,50 m. The height of this wall shall not be less than 2,00 m. In this case, the lower edges of door-openings in the sidewalls of superstructures and the coamings of access hatches behind this wall shall have a height of not less than 0,10 m. The sills of engine room doors and the coamings of its access hatches shall, however, always have a height of not less than 0,50 m.

2.6.3 In the cargo area, the lower edges of door-openings in the sidewalls of superstructures and the sills of hatches and ventilation openings of premises located under the deck shall have a height of not less than 0,50 m above the deck. This requirement does not apply to access openings to double hull and double bottom spaces.

2.7 Tank sizes

2.7.1 The maximum permissible capacity of a cargo tank for single hull tank vessels, double hull tank vessels and vessels with tanks independent of the hull shall be determined in accordance with Tab 2.

where:

L_{OA} B D : Product of the tank vessel main dimensions, in m^3

L_{OA} : overall length of the hull, in m

In the case of trunk deck vessels, D' is to be substituted for D. D' is to be determined by the following formula:

$$D' = D + h_t \frac{b_t}{B} \frac{\ell_t}{L_{OA}}$$

where:

h_t : Height, in m, of trunk (distance between trunk deck and main deck on trunk side measured at $L_{OA}/2$)

b_t : Trunk breadth, in m

ℓ_t : Trunk length, in m

2.7.2 Alternative constructions in compliance with Ch 3, App 1 are permitted.

Table 2 : Tank sizes

L_{OA} B D, in m^3	Maximum permissible capacity of a cargo tank, in m^3
< 600	0,3 L_{OA} B D
600 to 3750	180 + (L_{OA} B D - 600) 0,0635
> 3750	380

2.8 Cofferdams

2.8.1 On all types of tankvessels for the carriage of dangerous goods the cargo tanks must be separated from all other spaces below deck by cofferdams at least 0,60 m wide, but the passage is to be not less than 0,50 m.

2.8.2 Where the cargo tanks are installed in a hold space, a space of not less than 0,50 m shall be provided between such tanks and the end bulkheads of the hold space. In this case an insulated end bulkhead meeting at least the definition for Class "A-60" according to Pt C, Ch 1, Sec 14, [1.4.5], shall be deemed equivalent to a cofferdam. For pressure cargo tanks, the 0,50 m distance may be reduced to 0,20 m.

2.8.3 Cofferdams or cofferdam compartments located next to a service space which has been arranged in accordance with [2.8.4] shall be accessible through an access hatch. The access hatches and ventilation inlets shall be located not less than 0,50 m above the deck.

2.8.4 A cofferdam, the centre part of a cofferdam or another space below deck in the cargo area may be arranged as a service space, provided the bulkheads bounding the service space extend vertically to the bottom. This service space shall only be accessible from the deck. The service space shall be watertight with the exception of its access hatches and ventilation inlets.

No pipes for loading and unloading shall be fitted within this service space.

Pipes for loading and unloading may be fitted in the cargo pump-rooms below deck only when they conform to the provisions of [2.13.3].

2.8.5 Cofferdam bulkheads not facing the cargo area are to be placed at right angles to the vessel's fore-and-aft centre plane and are to extend up to the open deck in one plane without any recess or knuckle. The corrugation of a corrugated bulkhead is not a recess or knuckle in the meaning of this requirement.

2.8.6 The cofferdam shall extend over the whole area of the end bulkheads of the cargo tanks. The bulkhead not facing the cargo area shall extend from one side of the vessel to the other and from the bottom to the deck in one frame plane.

2.8.7 A cofferdam may be arranged as a cargo pump room, provided the requirements in [2.13.3] and [3.1] are complied with.

2.9 Accommodation and service spaces

2.9.1 Accommodation spaces and the wheelhouse shall be located outside the cargo area, i.e. forward of the foremost or aft of the aftermost cofferdam bulkhead.

Windows of the wheelhouse which are located not less than 1 m above the wheelhouse floor may tilt forward.

2.9.2 Entrances to spaces and openings of superstructures shall not face the cargo area. Doors opening outward and not located in a recess the depth of which is at least equal to the width of the doors shall have their hinges facing the cargo area.

2.9.3 Entrances from the deck and openings of spaces facing the weather shall be capable of being closed. The following instruction shall be displayed at the entrance of such spaces:

"DO NOT OPEN DURING LOADING, UNLOADING OR GAS-FREEING WITHOUT PERMISSION FROM THE MASTER. CLOSE IMMEDIATELY."

2.9.4 Entrances and windows of superstructures and accommodation spaces which can be opened as well as other openings of these spaces shall be located not less than 2,00 m from the cargo area. No wheelhouse doors and windows shall be located within 2,00 m from the cargo area, except where there is no direct connection between the wheelhouse and the accommodation.

2.10 Fuel tanks

2.10.1 When the vessel is fitted with hold spaces and double bottoms, the double bottoms within the cargo area may be arranged as fuel oil tanks, provided their depth is not less than 0,60 m.

2.10.2 Fuel oil pipes and openings of such tanks are not permitted in the hold space.

2.10.3 The open ends of the air pipes of all fuel oil tanks shall extend to not less than 0,5 m above the open deck. These open ends and the open ends of overflow pipes leading to the deck shall be provided with a protecting screen.

2.11 Engine rooms

2.11.1 Internal combustion engines for the vessel's propulsion as well as internal combustion engines for auxiliary machinery shall be located outside the cargo area. Entrances and other openings of engine rooms shall be at a distance of not less than 2,00 m from the cargo area.

2.11.2 The engine rooms shall be accessible from the deck; the entrances shall not face the cargo area. When the doors are not located in a recess whose depth is at least equal to the door width, the hinges shall face the cargo area.

2.11.3 Every engine room must normally have two exits. The second exit may be an emergency exit. If a skylight is permitted as an escape, it must be possible to open it from the inside.

The second exit may be dispensed with if:

- The total floor area (average length x average width at the level of the floor plating) of the engine room does not exceed 35 m^2
- The path between each point where servicing or maintenance operations are to be carried out and the exit, or foot of the companionway near the exit providing access to the outside, is not longer than 5 m
- A fire extinguisher is located at the servicing point that is furthest removed from the exit door.

2.11.4 Machinery installation

Internal combustion machinery for main propulsion, generators, cargo pumps or compressors and oil fired boilers must be installed in a separate enclosed machinery space outside the cargo area.

Sufficient air for cooling and combustion shall be provided when determining ventilation for machinery spaces. In some cases it may be required to supply combustion air for engines through separate ducts from open deck (see Pt C, Ch 1, Sec 14, [2]).

2.11.5 Entrances to the machinery space must have a coaming at least 500 mm high.

2.11.6 Exhaust pipes on tankers

Exhausts shall be evacuated from the vessel into the open air either upwards through an exhaust pipe or through the shell plating. The exhaust outlet shall be located not less than 2,00 m from the cargo area. The exhaust pipes of engines shall be arranged so that the exhausts are led away from the vessel.

Exhaust pipes of engines shall be provided with a device preventing the escape of sparks, e.g. spark arresters.

2.12 Fire and naked light

2.12.1 The outlets of funnels shall be located not less than 2,00 m from the cargo area. Arrangements shall be provided to prevent the escape of sparks and the entry of water.

Heating, cooking and refrigerating appliances shall not be fuelled with liquid fuels, liquid gas or solid fuels. The installation in the engine room or in another separate space of heating appliances fuelled with liquid fuel having a flashpoint above 55°C is, however, permitted. Cooking and refrigerating appliances are permitted only in the accommodation.

Only electrical lighting appliances are permitted.

2.13 Cargo pump and compressors

2.13.1 Cargo pumps and compressors may be mounted on deck or in a room located below deck within the cargo area.

Drive motors are to be installed outside the cargo area. Subject to Society's approval, hydraulic or explosion-proof electrical prime movers may be installed in the cargo area.

2.13.2 Installation on deck

Cargo pumps, compressors and accessory loading and unloading piping shall be located in the cargo area.

Cargo pumps and compressors shall be capable of being shut down from the cargo area and, in addition, from a position outside the cargo area.

Cargo pumps and compressors situated on deck shall be located not less than 6 m from entrances to, or openings of, the accommodation and service spaces outside the cargo area.

2.13.3 Installation below deck

Cargo pumps, compressors including cargo handling equipment below deck are to be installed in special pump/compressor rooms separated from engine room or a service space by a cofferdam or a bulkhead with "A-60" fire protection insulation according to Pt C, Ch 1, Sec 14, [1.4.5].

Shaft penetrations through the "A-60" bulkhead are not allowed. Pipe or cable penetrations may be fitted if the penetrations have an equivalent fire protection standard.

All cargo and stripping pipes passing through the bulkhead below deck are to be provided with shut-off devices fitted directly at the bulkhead. Operation of these valves shall be from the open deck.

Pump/compressor rooms must be so arranged that they are easily accessible and the equipment located inside can be properly operated by personnel wearing their personal protection equipment. Access openings must be capable of being closed from deck and shall be arranged in a way that injured or unconscious persons can be evacuated from the space, and where necessary, with the aid of permanently fitted facilities.

A permanent installed gas detection and alarm system is to be provided. Alarms shall be activated at a concentration corresponding to 20% of the lower explosion limit of the cargo being carried. Alarms shall be indicated in the wheelhouse and, if provided, in the cargo control station. The sample point of the gas detection system shall be located in upper and lower portions of the spaces.

A fixed extraction type ventilation shall be installed providing 30 changes of air per hour. Ventilation in- and outlets shall be arranged at a horizontal distance of 6 m from entrances and openings of the accommodation and service spaces. Ventilation openings are to be fitted with means of closure operable from the open deck.

Every pump/compressor room below deck is to be equipped with a bilge level alarm being activated in the wheel house or cargo control station.

Following instructions shall be displayed at the entrance of the pump/compressor room:

BEFORE ENTERING THE CARGO PUMP ROOM CHECK WHETHER IT IS FREE FROM GASES AND CONTAINS SUFFICIENT OXYGEN.

DO NOT OPEN DOORS AND ENTRANCE OPENINGS WITHOUT THE PERMISSION OF THE MASTER. LEAVE IMMEDIATELY IN THE EVENT OF ALARM.

2.14 Special equipment

2.14.1 A shower and an eye and face bath shall be provided on the vessel at a location which is directly accessible from the cargo area.

3 Equipment and systems for tankers

3.1 Cargo pumps and compressors

3.1.1 Pressure indicators and controls for cargo operations, valves and start-stop of pumps and compressors shall be located on the open deck in a position from where the cargo operations are controlled. The maximum permissible working pressure is to be marked on the pressure indicators. This requirement applies regardless whether the pumps/compressors are installed on or below deck.

Cargo pumps of the displacement type and compressors are to be equipped with overpressure protection devices. If safety valves are fitted, the discharge is to be returned to the suction side of the pumps/compressors.

Cargo pumps/compressors shall be equipped with emergency stops arranged outside the cargo area.

3.2 Cargo piping

3.2.1 Installation

Cargo pipes must be permanently installed and completely separated from all other vessel's piping. Cargo piping shall not extend beyond the cargo area. Due regard shall be given to cargo segregation in respect of compatibility of different types of products allowed to be carried.

Cargo pipes shall be so installed that any remaining cargo can be drained into the cargo tanks. Cargo pumps and filters in pump rooms located below deck are to be equipped with draining arrangements.

Expansion loops or other approved expansion devices are to be fitted as necessary.

Compensators made of non-metallic materials may not be used in cargo lines.

3.2.2 Cargo pipes may be installed inside the cargo tanks provided that a stop valve operable from the deck is fitted inside the tanks to which they lead. In addition, the pump room stop valves are to be fitted in the relevant pipelines. The distance between the cargo pipes and the bottom or double bottom is not to be less than 70 cm.

3.2.3 Design

For the design of cargo lines, see Pt C, Ch 1, Sec 10, [3.1].

Welding is the preferred method of joining cargo lines.

3.2.4 Valves

Manifold connections are to be made of cast steel or other ductile materials and shall be fitted with shut down valves. Additional blank flanges shall be fitted when not in use.

Stop valves must be fitted with indicators showing whether they are open or closed. The control rods for stop valves inside cargo tanks are to be oil tight where they pass through the tank decks.

Emergency operating mechanisms are to be provided for stop valves which are actuated hydraulically or pneumatically. Manual pumps connectable to the control lines can be recognized as emergency controls.

3.2.5 Burst pressure

For hose assemblies and compensators in process and cargo piping for gas and chemical tankers the burst pressure is required to be at least 5 times the maximum allowable working pressure.

3.3 Tank heating and steaming out lines

3.3.1 General

This Rules applies to on board steam heating system.

Cargo tank heating systems are to be separate from the vessel's other heating systems.

Heating coils are to be fitted with screw-down non-return valves on the inlet side and with stop valves on the outlet side. A cock for testing the condensate is to be fitted upstream of the stop valve at the outlet.

Condensate from the heating system must be returned to the feed water system via an observation tank.

3.3.2 Steaming out lines

Connections for steaming out cargo tanks and cargo lines are to be fitted with screw-down non-return valves.

3.3.3 Tank heating with special heat-transfer media

For the design of heat transfer systems and pipes, see Pt C, Ch 1, Sec 10, [12].

The expansion tank is to be located at a sufficient height to ensure that when filled to the lowest level the static pressure in the heat transfer system exceeds the maximum possible pressure in the cargo tank. Alternatively, the expansion tank may be kept under overpressure, controlled by a low pressure alarm.

All shutoff valves in the return lines of the tank heating coils and the connecting line to the expansion tank must be capable of being blocked in the open position.

3.4 Bilge and ballast systems

3.4.1 General

Bilge systems for the cargo area are to be located in the cargo area and shall be independent of other vessel’s bilge systems.

Bilge systems for engine rooms may not be used for freeing spaces in the cargo area. For the calculation of engine room bilge lines, see Ch 1, Sec 3, [2.3.1].

Bilge systems for hold spaces in which independent tanks are installed, for cofferdams and void spaces in the cargo area shall comply with the following provisions. The diameter of bilge lines is to be not less than 35 mm nor than the value derived from the following formula:

$$d = 2,0\sqrt{(B + D)\ell} + 25$$

where:

d : Inside diameter of bilge pipe, in mm

ℓ : Length of void space or space in which the tank is installed, in m

For the calculation of bilge pump capacity and the design of the bilge system, see Pt C, Ch 1, Sec 10, [11.4].

The water for driving ejectors can be supplied from the engine room. The capacity of this pump shall be compatible with the capacity of the ejectors.

The ejectors may be connected to the wash-deck line by hoses with suitable couplings.

3.4.2 Bilge pumping of cargo pump rooms

Separate bilge pumping equipment must be provided for cargo pump rooms.

Means must be provided for pumping the bilges of cargo pump rooms even when special circumstances render the pump room inaccessible. The equipment necessary for this must then be capable of being operated from outside the pump room.

Discharge shall be arranged to a slop tank or to reception facilities.

3.4.3 Filling and draining of cofferdams

Provisions shall be made for filling within 30 minutes and draining by a pump located inside the cargo area. Not required for vessels outside **ADN/ADNR**.

Cofferdams in the cargo zone may be connected to the ballast system mentioned in [3.4.4].

No fixed pipe shall permit connection between a cofferdam and other piping of the vessel outside the cargo area.

3.4.4 Ballast systems in the cargo area

Ballast water systems for ballast tanks inside the cargo area must be independent of piping systems forward and aft of the cofferdams and shall be located in the cargo area. Ballast water intake shall be arranged through the cofferdam or a ballast side tank.

Ballast tanks may be pumped out via ejectors and filled through the fire main.

For ballasting of cargo tanks the intake pipe is to be arranged in the cofferdam and shall be fitted with a screw-down non-return valve and may be connected to the cargo pumps.

3.5 Ventilation

3.5.1 Cofferdams and hold spaces

Each hold space shall have two openings the dimensions and location of which shall be such as to permit effective ventilation of any part of the hold space. If there are no such openings, it shall be possible to fill the hold spaces with inert gas or dry air.

Double hull spaces and double bottoms within the cargo area which are not arranged for being filled with ballast water and cofferdams between engine rooms and pump/compressor rooms, if they exist, shall be provided with ventilation systems.

Any service space located in the cargo area below deck shall be provided with a system of forced ventilation with sufficient power for ensuring at least 20 changes of air per hour based on the volume rate of the space.

The ventilation exhaust ducts shall extend down to 50 mm above the bottom of the service space. The air shall be supplied through a duct at the top of the service space. The air inlets shall be located not less than 2 m above the deck, at a distance of not less than 2 m from tank openings and 6 m from the outlets of safety valves.

3.5.2 Design and construction of mechanically driven fans in the cargo area

Ventilators used in the cargo area shall be designed so that no sparks may be emitted on contact of the impeller blades with housing and no static electricity may be generated.

Ventilation duct in- and outlets are to be fitted with protective screens with a mesh size not exceeding 13 mm.

Overheating of the mechanical components of fans and the creation of sparks are to be avoided by appropriate design and by the choice of suitable materials. The safety clearance between the fan housing and the impeller shall not be less than 1/10 of the inner impeller bearing diameter, limited to a minimum of 2 mm and is to be such as to preclude any contact between the housing and the rotor. The maximum clearance need not to be more than 13 mm. The above requirement also applies to portable fans.

Following materials or combination of materials for impeller/housing may be used:

- non-metallic materials (plastic material having sufficient electric conductivity) with each other or with steel (incl. galvanized, stainless)
- non-ferrous materials having good heat conductivity (bronze, brass, copper, not aluminium) with each other or with steel (incl. galvanized, stainless)
- steel (incl. galvanized, stainless) with each other if a ring of adequate size made of above non-metallic/non-ferrous material is fitted in way of the impeller, or if a safety clearance of at least 13 mm is provided
- aluminium or magnesium alloys with each other or with steel (incl. galvanized, stainless) only, if a non-ferrous ring having a good heat conductivity, i.e. copper, brass, of adequate size is fitted in way of the impeller.

Electric motors are to be located outside the vent ducts and shall comply with Ch 3, Sec 8, [2.11].

3.5.3 Venting of cargo tanks

Cargo tank vent openings are to be located at least 500 mm above the cargo tank deck.

Venting of cargo tanks may only take place through approved relief devices which fulfil the following functions:

a) Flow of large volumes of vapour or air during cargo operations, thereby avoiding excessive over or under pressure

b) Venting of small volumes of vapour or air during the voyage caused by thermal variation.

The venting devices for cargo handling operations must be suitable for the tanker type and the type of the cargo. A distinction is made between controlled venting (closed system), in which vapour or air are relieved only after the pressure or vacuum in the tank has reached specified levels, and open venting (open system).

Vent systems may be arranged individually for each tank or combined for a number of tanks through common vent collectors. Vent collectors are to be provided with means of drainage or shall be arranged self draining into cargo tanks.

In open systems the free area of the venting devices shall be at least 1/3 of that of the corresponding filling pipe.

In closed systems the dimensions of the vent pipes, common collectors and venting devices are to be determined based on pressure loss calculations referring to the maximum loading/unloading rates. For loading in general a gas evolution factor of 1,25 shall be taken into account, unless specified otherwise.

Vapours shall in every case be vented vertically upwards.

Individual requirements for cargo tank venting systems are set out in the list of substances allowed to be carried (see Ch 3, App 1).

3.6 Inerting facility

3.6.1 In cases in which inerting or blanketing of the cargo is prescribed, the vessel shall be equipped with an inerting system.

3.6.2 This system shall be capable of maintaining a permanent minimum pressure of 7 kPa (0.07 bar) in the spaces to be inerted. In addition, the inerting system shall not increase the pressure in the cargo tank to a pressure greater than that at which the pressure valve is regulated. The set pressure of the vacuum-relief valve shall be 3.5 kPa.

3.6.3 A sufficient quantity of inert gas for loading or unloading shall be carried or produced on board if it is not possible to obtain it on shore. In addition, a sufficient quantity of inert gas to offset normal losses occurring during carriage shall be on board.

3.6.4 The premises to be inerted shall be equipped with connections for introducing the inert gas and monitoring systems so as to ensure the correct atmosphere on a permanent basis.

3.6.5 When the pressure or the concentration of inert gas in the gaseous phase falls below a given value, this monitoring system shall activate an audible and visible alarm in the wheelhouse. When the wheelhouse is unoccupied, the alarm shall also be perceptible in a location occupied by a crew member.

3.7 Flame arresters

3.7.1 General

Where required according to the list of products, cargo tank vents shall be fitted with flame arresters or flame arresting devices being designed, tested and approved in accordance with relevant national and international standards. These devices shall be approved by the Society for its specific application.

3.7.2 Flame arresters must be made of suitable materials which are resistant to the cargo/vapours.

3.7.3 High velocity vents providing a discharge velocity of at least 30 m/s for the removal of vapour from the immediate vicinity of the vessel may be used as flame arresters provided that they have been approved by the Society.

3.8 Level alarm and overfill protection devices

3.8.1 Level alarm

Every cargo tank must be equipped with a high level alarm activating an audible and visual alarm at 90% filling on type N and C vessels (86% on type G vessels). The actual filling level of the total tank volume depends on vessel type and category of cargo. Details are set out in the list of substances allowed to be carried. See Ch 3, App 1.

3.8.2 Overfill protection

Every cargo tank is to be equipped with an overfill protection device which:

- activates an audible and visible alarm at 97,5% filling, and
- provides a potential free contact which, acting via a standardized plug-and-socket connection, can actuate adequate shut down functions on shore facilities, if applicable.

3.8.3 Level alarm and overfill protection device must be mechanically and electrically independent of each other and shall provide different audible and visual alarms. The overfill protection may be combined with the level indicator. These devices are subject to type-testing by the Society or Authorities.

3.9 Tank level gauging and sampling equipment

3.9.1 Tank level gauges

The type and design of the equipment depend on vessel type and the type of cargo; see Ch 3, App 1. A distinction is made between:

a) open devices (ullage/observation ports) being equipped with self-closing covers

b) restricted devices (sounding pipes, vapour locks) being equipped with closing devices

c) closed devices (float, radar or other approved type).

3.9.2 Sounding pipes, observation ports

Sounding pipe penetrations through the tank deck must be welded tight, openings shall be located 500 mm above deck and in cargo tanks the sounding pipes shall terminate close to the tank bottom.

'Open' pressure-relief devices with flame arresters may be used as ullage /observation ports for level gauging on condition that the flame arrestor element can only be opened to an angle of 80°. When released, it must close automatically. In addition these devices must be capable of being closed with a cover which is provided with recess for pressure relief during the voyage.

3.9.3 Closed tank level gauges

Closed tank level gauges are subject to type approval by the Society.

3.9.4 Sampling devices

Sampling devices may be of 'open', 'partly closed' or 'closed' type, depending on the list of substances allowed to be carried. For open application, the device is limited to a diameter of 300 mm. Partly closed or closed devices may be connected to the tank via a standard connection which can only be opened after the device is connected.

3.10 Precautions against sparks from boiler and engine exhaust gases

3.10.1 Diesel engine exhaust lines are to be fitted with Society approved spark arresters.

Funnels of boiler plant and galleys are to be fitted with suitable spark traps.

3.11 Gas and vapour detection equipment

3.11.1 Depending on the list of substances allowed to be carried see Ch 3, App 1, portable instruments for the measurement of flammable or toxic gases and vapours as well as Oxygen shall be provided.

3.12 Water spray system

3.12.1 When water spraying is required in column (9) of **ADN/ADNR** Table C, a water spray system shall be installed in the cargo area on deck for the purpose of cooling the tops of cargo tanks by spraying water so as to avoid safely the activation of the high velocity vent valve at 10 kPa or as regulated.

3.12.2 The spray nozzles shall be so installed that the entire cargo deck area is covered and the gases released are precipitated safely.

The system shall be equipped with a shore connection and shall be capable being activated from the wheelhouse and from deck. Its capacity shall be such that when all the spray nozzles are in operation, the outflow is not less than 50 litres per square metre of cargo deck area and per hour.

3.13 Inert gas systems

3.13.1 The design of inert gas systems is to be agreed with the Society. In general the Rules for seagoing tankers will be applied.

4 Fire protection and fire extinction

4.1 General

4.1.1 In addition to fire rules of Pt C, Ch 1, Sec 14, the following additional fire extinguishing equipment is to be provided.

4.2 Portable fire extinguishers

4.2.1 In addition to the fire-extinguishing appliances prescribed in Pt C, Ch 1, Sec 14, [5.2], each vessel shall be equipped with at least two additional portable fire-extinguishers having the same capacity in cargo area.

These additional portable fire-extinguishers shall be suitable for fighting fires involving the dangerous goods carried.

4.3 Water fire extinguishing system

4.3.1 A water fire-extinguishing system complying with the following requirements shall be installed on the vessel.

- It shall be supplied by two independent fire or ballast pumps one of which shall be ready for use at any time. These pumps and their means of propulsion and electrical equipment shall not be installed in the same space
- It shall be provided with a water main fitted with at least three hydrants in the cargo area above deck. Three suitable and sufficiently long hoses with spray/jet nozzles having a diameter of not less than 12 mm shall be provided
- It shall be possible to reach any point of the deck in the cargo area simultaneously with at least two jets of water not supplied from the same hydrant
- A spring-loaded non-return valve shall be fitted to ensure that no gases can escape through the fire-extinguishing system into the accommodation or service spaces outside the cargo area. The non-return valve is not required for vessels not complying with **ADN/ADNR**
- The capacity of the system shall be at least sufficient for a jet of water to have a minimum reach of not less than the vessel's breadth from any location on board with two spray/jet nozzles being used at the same time.

4.4 Fixed fire extinguishing system

4.4.1 In addition the engine room, the pump room and all spaces containing essential equipment (switchboards, compressors, etc.) for the refrigeration equipment, if any, shall be provided with a fixed fire-extinguishing system, in compliance with Pt C, Ch 1, Sec 14, [5.3]or Pt C, Ch 1, Sec 14, [5.4].

SECTION 2 TYPE G

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **Type G**, as defined in Pt A, Ch 2, Sec 3, [4.2.2].

These Rules apply in addition to Ch 3, Sec 1 and Ch 1, Sec 3.

1.2 Applicable rules

1.2.1 For scantling of the hull of vessels with inserted tanks, see Ch 1, Sec 3, [3.1.1].

1.2.2 The design and construction of pressure tanks is to conform to Pt C, Ch 1, Sec 3, [1].

1.2.3 For the size of the tanks to be provided, reference is made to Ch 3, Sec 1, Tab 2.

1.3 Documents for review/approval

1.3.1 The following drawings and documents are to be submitted in addition to those listed in Pt B, Ch 1, Sec 2:

- List of the gases to be carried mentioning the loading and transport conditions
- General drawing giving the arrangement of cargo tanks, cofferdams, fuel tanks, ballasts and other spaces
- Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar
- Arrangement of gas dangerous zones
- Drawing showing the location of the electrical equipment within the dangerous areas
- Details of hull in way of cargo tanks
- Drawing of the cargo tanks, including its supports and attachments
- General and detailed drawings of the cargo tank insulation, when provided for
- Note giving the operating conditions of the cargo installations
- Cargo piping system
- Gas return system
- Water spray system
- Diagram of the ventilation systems
- Other piping systems in connection with the cargo
- Drawing of the fire protection, detection and extinction systems.

1.4 Definitions

1.4.1 Design pressure

The design pressure p_0 is defined in Ch 3, Sec 1, [1.4.14].

For cargo tanks where there is no temperature control and where the pressure of the cargo is dictated only by the ambient temperature, p_0 is not to be less than the gauge vapour pressure of the cargo at a temperature of 40°C.

In all cases p_0 is not to be less than MARVS.

1.4.2 Design temperature

The design temperature for selection of materials is the minimum temperature at which cargo may be loaded or transported in the cargo tanks. Provisions to the satisfaction of the Society are to be made that the tank or cargo temperature cannot be lowered below the design temperature.

1.4.3 MARVS

MARVS is the maximum allowable relief valve setting of a cargo tank.

2 Hull design and arrangements

2.1 Hull design

2.1.1 General

In the cargo area, the vessel shall be designed either as a double hull and double bottom vessel, or as a single hull vessel, according to the following requirements.

Alternative constructions in accordance with Ch 3, App 1 are permitted.

2.1.2 Double hull vessel

Vessels with double hull and double bottom shall comply with the following:

- the internal distance between the sideplatings of the vessel and the longitudinal bulkheads shall not be less than 0,80 m
- the height of the double bottom shall not be less than 0,60 m.

2.1.3 Single hull vessel

Single hull vessel shall comply with the following:

- it shall be fitted with sideplatings between gangboard and top of floor plates provided with side stringers at intervals of not more than 0,6 m which are supported by web frames spaced at intervals of not more than 2 m
- the side stringers and the web frames shall have a height of not less than 10% of the vessel depth, however, not less than 0,3 m
- the side stringers and web frames shall be fitted with a face plate made of a flat steel and having a cross section of not less than 7,5 cm^2 and 15 cm^2 respectively

- the distance between the sideplating of the vessel and the cargo tanks shall be not less than 0,8 m and between the bottom and the cargo tanks not less than 0,6 m. the depth below the suction wells may be reduced to 0,5 m
- the lateral distance between the suction well of the cargo tanks and the bottom structure shall be not less than 0,1 m.

2.1.4 Struts linking or supporting the load bearing components of the sides of the vessel with the load bearing components of the longitudinal walls of cargo tanks and side struts linking the load bearing components of the vessel's bottom with the tank bottom are prohibited.

2.1.5 Cargo tank supports and fastenings

The cargo tank supports and fastenings should extend to not less than 10° below the horizontal centreline of the cargo tanks.

2.2 Hold spaces

2.2.1 Cofferdams need not be placed in the fore and after body of vessels of all-welded construction.

The hold spaces shall be separated from the accommodation and service spaces outside the cargo area below deck by bulkheads provided with a class A-60 fire protection insulation according to Pt C, Ch 1, Sec 14, [1.4.5].

A space of not less than 0,20 m shall be provided between the cargo tanks and the end bulkheads of the hold spaces. Where the cargo tanks have plane end bulkheads this space shall be not less than 0,50 m.

2.2.2 All spaces in the cargo area shall be capable of being ventilated. Means for checking their gas-free condition shall be provided.

2.2.3 Double hull spaces and double bottoms in the cargo area may be arranged as ballast water tanks only. Double bottoms may, however, be used as fuel oil tanks, provided they comply with Ch 3, Sec 1, [2.10].

2.2.4 The bulkheads bounding the hold spaces shall be watertight. The cargo tanks and the bulkheads bounding the cargo area shall have no openings or penetrations below deck. The bulkhead between the engine room and the service spaces within the cargo area or between the engine room and a hold space may be fitted with penetrations provided that they conform to the requirements of Ch 3, Sec 1, [2.13.3].

2.3 Ventilation of cargo pump rooms and gas compressor rooms

2.3.1 Cargo pump and compressor rooms must be provided with extraction type ventilation systems, independent of other vessel's spaces, providing at least 30 cycles of air change per hour. Warning notices shall be placed requiring that the ventilation is in operation for at least 15 minutes prior to entering these spaces.

2.3.2 Portable means must be provided for gas-freeing of cargo tanks and other spaces not equipped with fixed ventilation.

3 Vessels for the carriage of liquefied gases under pressure

3.1 General

3.1.1 The following Rules apply to inland waterway vessels equipped for the carriage of liquefied gases under pressure.

3.1.2 For the tank arrangement, reference is to be made to sketches b and c of Ch 1, Sec 3, Fig 3.

3.2 Cargo tank design

3.2.1 Pressure vessels shall, in general, be designed as the domed type. Fittings must be mounted on the domes or elsewhere on the upper part of the tanks above the open deck in the cargo area. They shall be protected against damage and must be secured in such a way that undue stresses caused by vibration or expansion cannot occur. At least one manhole shall be arranged in the tank dome or as a separate dome with the access opening located on the open deck.

3.2.2 Pressure independent built-in cylindrical tanks shall have a length to diameter ratio ≤ 7.

3.3 Installation of cargo tanks

3.3.1 Pressure vessels must be so installed as to allow their inspection as well as the adjoining vessel's structure.

3.4 Insulation, protective painting

3.4.1 The insulation of pressure vessels is to be made of approved material covered with a vapour barrier of low flame spread type.

3.4.2 Pressure vessels shall be painted externally for protection against corrosion. Uninsulated or unprotected portions on the open deck shall be coated with reflecting paints.

3.5 Cargo piping

3.5.1 Pipes for loading and unloading shall be independent of any other piping of the vessel. No cargo piping shall be located below deck, except those inside the cargo tanks and in the service spaces intended for the installation of the vessel's own gas discharging system.

3.5.2 piping for loading and unloading shall be clearly distinguishable from other piping, e.g. by means of colour marking.

3.5.3 The pipes for loading and unloading on deck, the vapour pipes with the exception of the shore connections but including the safety valves, and the valves shall be located within the longitudinal line formed by the outer boundaries of the domes and not less than B/4 from the outer shell. This requirement does not apply to the relief pipes situated behind the safety valves. If there is, however, only one dome athwartships, these pipes and their valves shall be located at a distance not less than 2,7 m.

3.5.4 Where cargo tanks are placed side by side, all the connections to the domes shall be located on the inner side of the domes. The external connections may be located on the fore and aft centre line of the dome. The shut-off devices of the loading and unloading piping shall be duplicated, one of the devices being constituted by a remote-controlled quick-action stop device. When the inside diameter of a shut-off device is less than 50 mm this device may be regarded as a safety against bursts in the piping.

3.5.5 Pipe connections on tank domes with the exception of level gauges and safety valves shall be fitted with a manual shutoff and a remote operated quick-action stop valve. In piping with DN < 50 mm excess flow valves may be used instead of quick-action stop valves.

Cargo tank connections for gauging or measuring devices need not to be equipped with excess flow or emergency shut-off valves, provided that the devices are so constructed that the outward flow of tank contents cannot exceed that passed by a 1,5 mm diameter circular hole.

3.5.6 Controls for the release of quick-action stop valves are to be located in the cargo control station and at two suitable locations on deck.

3.5.7 The shore connections shall be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

3.5.8 Each shore connection of the vapour pipe and shore connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, shall be fitted with a shut-off device and a quick-action stop valve. However, each shore connection shall be fitted with a blind flange when it is not in operation.

3.5.9 The distance referred to in [3.5.1] to [3.5.8] may be reduced to 3 m if a transverse bulkhead complying with Ch 3, Sec 1, [2.6.2] is situated at the end of the cargo area. The openings shall be provided with doors.

3.5.10 Pipes for loading and unloading, and vapour pipes, shall not have flexible connections fitted with sliding seals.

3.5.11 Wherever necessary, pipelines, valves and fittings shall be thermal insulated.

3.6 Safety and control installations

3.6.1 Cargo tank level indicators

Each cargo tank is to be equipped with a closed gauging device approved by the Society. If only one device is installed per tank, it shall be so arranged/designed that any failure can be rectified and its function can be restored when tank under pressure.

When the degree of filling in per cent is determined, an error of not more than 0.5% is permitted. It shall be calculated on the basis of the total cargo tank capacity including the expansion trunk.

The level gauge shall allow readings from the control position of the shut-off devices of the particular cargo tank. The permissible maximum filling level of the cargo tank shall be marked on each level gauge.

Permanent reading of the overpressure and vacuum shall be possible from a location from which loading or unloading operations may be interrupted. The permissible maximum overpressure and vacuum shall be marked on each level gauge.

Readings shall be possible in all weather conditions.

3.6.2 Level alarm device

Cargo tank shall be provided with a level alarm device which is activated at the latest when a degree of filling of 86% is reached.

The level alarm device shall give a visual and audible warning on board when actuated. The level alarm device shall be independent of the level gauge.

The visual and audible signals given by the level alarm device shall be clearly distinguishable from those of the high level sensor.

The visual alarm shall be visible at each control position on deck of the cargo tank stop valves. It shall be possible to easily check the functioning of the sensors and electric circuits or these shall be of the "failsafe" design.

3.6.3 High level sensor

Cargo tank shall be provided with a high level sensor for actuating the facility against overflowing at the latest when a degree of filling of 97,5% is reached.

3.6.4 Cargo tank pressure monitoring

Each cargo tank shall be equipped with a pressure indicator for the vapour space activating a high pressure alarm when the working pressure is exceeded.

Pressure indicators shall be fitted on loading and discharge lines, pumps, compressors and manifold connections marked with the maximum permissible working pressure. Where the cargo operations are controlled in a centralized space adequate control and indicators are to be provided.

3.6.5 Cargo temperature monitoring

Temperature indicating devices in each cargo tank shall be provided for the mean temperature of the cargo.

3.6.6 Cargo tank sampling equipment

Each cargo tank shall be equipped with a connection for a closed sampling device.

3.6.7 Safety valves

Cargo pumps and compressors must be fitted with safety valves discharging to their suction side, in compliance with [3.7].

Pipeline sections of more than 50 litres volume which may be isolated in liquid full condition are to be provided with safety relief valves. The blow-off lines are to be returned to the cargo tanks or a blow down header.

3.7 Safety valves

3.7.1 The highest part of the vapour space (tank dome) of pressure vessels with a capacity of less than 20 m^3 is to be fitted with at least one, and pressure vessels with a capacity of more than 20 m^3 two independent, spring loaded safety valves. Means must be provided to prevent the accumulation of liquid cargo in the pipe upstream to the safety valves taking into account the vessel's trim and list.

3.7.2 The total discharge capacity of the safety valves shall be according to formula here below. During blow down the pressure in the tank shall not rise more than 20% above the maximum allowable relief valve setting (MARVS).

$Q = F\ G\ A^{0,82}$

where:

Q : Minimum required equivalent discharge rate of air, in m^3/s, at standard conditions of 273°K and 1,013 bar

F : Fire exposure factor for different cargo tank types:

- F = 1,0 for uninsulated tanks located on deck
- F = 0,5 for tanks above the deck when insulation is approved by the society. (Approval will be based on the use of an approved fire proofing material, the thermal conductance of insulation, and its stability under fire exposure)
- F = 0,5 for uninsulated independent tanks installed in holds
- F = 0,2 for insulated independent tanks in holds (or uninsulated independent tanks in insulated holds)
- F = 0,1 for insulated independent tanks in inerted holds (or uninsulated independent tanks in inerted, insulated holds)

For independent tanks partly protruding through the open deck the fire exposure factor is to be determined on the basis of the surface areas above and below deck.

G : Gas factor defined as:

$$G = \frac{12,4}{rD}\sqrt{\frac{ZT}{M}}$$

where:

T : Temperature in K = (273 + °C) at the relieving conditions, i.e. 120% of the design pressure

r : Latent heat of the material being vaporized at relieving conditions, in kJ/kg

D : Constant based on relation of specific heats (k), shown in Tab 1; if k is not known, D = 0,606 shall be used.

The constant D may also be calculated by the following formula:

$$D = \sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

Z : Compressibility factor of the gas at relieving conditions;

if not known, Z = 1,0 shall be used

M : Molecular weight of the product

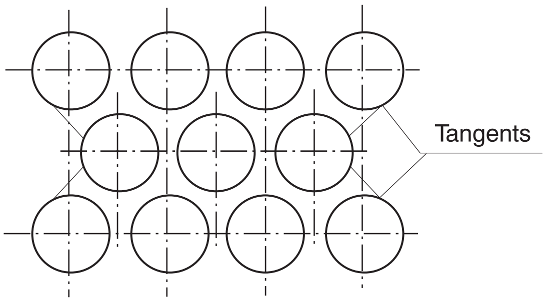
A : External surface area of the tank in, m^2, for different tank types

- for body of revolution type tanks, A = external surface area
- for other than bodies of revolution type tanks, A = external surface area less the projected bottom surface area
- for tanks consisting of an array of pressure vessels tanks, A = external surface area of the hold less its projected bottom area.
- insulation on the tank structure, A = external surface area of the array of pressure vessels excluding insulation, less the projected bottom area as shown in Fig 1.

Table 1 : Constant D

k	D	k	D
1,00	0,606	1,52	0,704
1,02	0,611	1,54	0,707
1.04	0,615	1,56	0,710
1,06	0,620	1,58	0,713
1,08	0,624	1,60	0,716
1,10	0,628	1,62	0,719
1,12	0,633	1,64	0,722
1,14	0,637	1,66	0,725
1,16	0,641	1,68	0,728
1,18	0,645	1,70	0,731
1,20	0,649	1,72	0,734
1,22	0,652	1,74	0,736
1,24	0,656	1,76	0,739
1,26	0,660	1,78	0,742
1,28	0,664	1,80	0,745
1,30	0,667	1,82	0,747
1,32	0,671	1,84	0,750
1,34	0,674	1,86	0,752
1,36	0,677	1,88	0,755
1,38	0,681	1,90	0,758
1,40	0,685	1,92	0,760
1,42	0,688	1,94	0,763
1,44	0,691	1,96	0,765
1,46	0,695	1,98	0,767
1,48	0,698	2,00	0,770
1,50	0,701	2,02	0,772
		2,20	0,792

Figure 1 : Array of pressure vessel tanks



3.7.3 The setting of the pressure relief valves is not to be higher than the maximum pressure for which the cargo tank is designed.

3.7.4 It is recommended that a device may be fitted enabling one safety valve at a time to be isolated for a short period for repair/maintenance. In this case, however, at least half the required safety valve cross-section must remain operative.

3.8 Safety valves blow-off lines

3.8.1 The blow-off lines of pressure vessel safety valves may be arranged individual or with common headers. The outlets are to be arranged at least 2 m above deck at a horizontal distance of 6 m from accommodation or other safe spaces. The height may be reduced to less than 2 m in case the area of 1 m around the high velocity valve is designed as non-accessible.

3.8.2 The total cross-section of the blow-off piping must be sufficient to discharge safely the quantity of gas calculated in [3.7].

3.9 Maximum filling and name plates

3.9.1 With the cargo at the reference temperature specified in [1.4], pressure vessels may not be filled to more than 91% for un-cooled and 95% for cooled carriage.

3.9.2 Each pressure vessel must bear a name plate showing the following data:

- Name of manufacturer, serial number, year of manufacture
- Cubic capacity in m^3
- Design pressure and test pressure (bar)
- Certificate No., month and year of test
- Stamp of certifying firm
- Lowest operation temperature, in °C
- Vapour pressure, in bar at reference temperature, in °C.

3.9.3 The name plates must be legible from the deck.

3.10 Gas detection and alarm system

3.10.1 For the hold spaces of pressure vessel cargo tanks, portable gas detectors are to be approved by the Society.

4 Vessels for the carriage of liquefied gases at atmospheric pressure

4.1 General

4.1.1 Requirements as set out in **ADN/ADNR** Rules are to be observed.

Further individual requirements are to be decided in consultation with the Society on a case by case basis in accordance with the provisions for liquefied gas tankers laid down in the Society's Rules.

4.1.2 Refrigerated cargo tanks shall be installed only in hold spaces bounded by double hull spaces and double bottom.

5 Electric plant

5.1 Documents to be submitted

5.1.1 In addition to the documents required by the Regulations referred to in Pt C, Ch 2, Sec 1, [2] the following documents shall be on board:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area

b) a list of the electrical equipment referred to in (a) above including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment shall be marked in red. See [5.3.3] and [5.3.4].

5.2 Electrical installations

5.2.1 Only distribution systems without return connection to the hull are permitted. This provision does not apply to:

- local installations outside the cargo area (e.g. connections of starters of diesel engines)
- device for checking the insulation level referred to in [5.2.2]
- active cathodic corrosion protection.

5.2.2 Every insulated distribution network shall be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

5.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried shall be taken into consideration.

5.3 Type and location of electrical equipment

5.3.1

a) Only measuring, regulation and alarm devices of the EEx (ia) type of protection may be installed in cargo tanks and pipes for loading and unloading (comparable to zone 0)

b) Only the following equipment may be installed in the cofferdams, double hull spaces, double bottoms and hold spaces (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection
   - hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck
   - cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices

c) Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection
   - motors driving essential equipment such as ballast pumps; they shall be of the certified safe type

d) The control and protective equipment of the electrical equipment referred to in (a), (b) and (c) above shall be located outside the cargo area if they are not intrinsically safe

e) The electrical equipment in the cargo area on deck (comparable to zone 1) shall be of the certified safe type.

5.3.2

a) Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area (comparable to zone 2) shall be at least of the "limited explosion risk" type.

b) This provision does not apply to:
   - lighting installations in the accommodation, except for switches near entrances to accommodation
   - radiotelephone installations in the accommodation or the wheelhouse
   - mobile and fixed telephone installations in the accommodation or the wheelhouse
   - electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:
     - These spaces are fitted with a ventilation system ensuring an overpressure of 0,1 kPa (0,001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system located as far away as possible, however, not less than 6,00 m from the cargo area and not less than 2,00 m above the deck
     - The spaces are fitted with a gas detection system with sensors:
       - at the suction inlets of the ventilation system
       - directly at the top edge of the sill of the entrance doors of the accommodation and service spaces
     - The gas concentration measurement is continuous
     - When the gas concentration reaches 20% of the lower explosive limit, the ventilators shall be switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with (a) above, shall be switched off. These operations shall be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which shall comply at least with the "limited explosion risk" type. The switching-off shall be indicated in the accommodation and wheelhouse by visual and audible signals
     - The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of (a) above
     - The automatic switch-off device is set so that no automatic switching-off may occur while the vessel is under way.

5.3.3 The electrical equipment which does not meet the requirements set out in [5.3.2] together with its switches shall be marked in red. The disconnection of such equipment shall be operated from a centralized location on board.

5.3.4 An electric generator which is permanently driven by an engine and which does not meet the requirements of [5.3.2], shall be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions shall be displayed near the switch.

5.3.5 Sockets for the connection of signal lights and gangway lighting shall be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting shall not be possible except when the sockets are not live.

5.3.6 The failure of the power supply for the safety and control equipment shall be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

5.4 Earthing

5.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service shall be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

The resistance between any point on the surface of the cargo tanks, cargo piping systems and equipment, and the hull of the vessel is not to be greater than 1 mega ohm.

5.4.2 The provisions of [5.4.1] apply also to equipment having service voltages of less than 50 V.

5.4.3 Independent cargo tanks shall be earthed.

5.4.4 Metal intermediate bulk containers (IBCs) and tank-containers, used as residual cargo tanks or slop tanks, shall be capable of being earthed.

5.5 Electrical cables

5.5.1 All cables in the cargo area shall have a metallic sheath.

5.5.2 Cables and sockets in the cargo area shall be protected against mechanical damage.

5.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights and gangway lighting.

5.5.4 Cables of intrinsically safe circuits shall only be used for such circuits and shall be separated from other cables not intended for being used in such circuits (e.g. they shall not be installed together in the same string of cables and they shall not be fixed by the same cable clamps).

5.5.5 For movable cables intended for signal lights and gangway lighting, only sheathed cables of type H 07 RN-F in accordance with standard IEC 60 245-4:1994 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm^2 shall be used. These cables shall be as short as possible and installed so that damage is not likely to occur.

5.6 Storage batteries

5.6.1 The installation of storage batteries inside dangerous areas is not permissible.

6 Buoyancy and stability

6.1 General

6.1.1 Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

6.1.2 General requirements of Pt B, Ch 2, Sec 6 shall be complied with.

6.1.3 Proof of sufficient stability shall be furnished including for stability in damaged condition.

6.1.4 The basic values for the stability calculation (the vessel's lightweight and location of the centre of gravity) shall be determined in compliance with Pt B, Ch 2, Sec 6, [2.2].

6.1.5 Proof of sufficient intact stability is to be provided for all loading/unloading stages and for the final loading condition.

6.1.6 Floatability after damage shall be proved for the most unfavourable loading condition. For this purpose, calculated proof of sufficient stability shall be established for critical intermediate stages of flooding and for the final stage of flooding.

Negative values of stability in intermediate stages of flooding may be accepted only if the continued range of curve of the righting lever in damaged condition indicates adequate positive values of stability.

6.2 Intact stability

6.2.1 The requirements for intact stability resulting from the damaged stability calculation shall be fully complied with.

6.3 Damage stability

6.3.1 The following assumptions shall be taken into consideration for the damaged condition.

a) extent of side damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 0,79 m
   - vertical extent: from base line upwards without limit

b) extent of bottom damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 3 m
   - vertical extent: from base line to 0,59 m upwards, except for pump well.

c) Any bulkhead within the damaged area shall be assumed damaged, which means that the location of bulkheads shall be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

   The following provisions are applicable:
   - For bottom damage, adjacent athwartship compartments shall also be assumed flooded
   - the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways) shall, at the final stage of flooding, be not less than 0,10 m above the damage waterline.

6.3.2 In general, permeability shall be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used.

However, minimum values of permeability, μ, given in Tab 2 are to be used.

For the main engine room only a one-compartment standard needs be taken into account, i.e. the end bulkheads of the engine room shall be assumed as not damaged.

Table 2 : Permeability values, in %

Spaces	μ
Engine room	85
Accommodation spaces	95
Double bottoms, oil fuel tanks, ballast tanks, etc., depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught	0 or 95

6.3.3 The damage stability is generally regarded sufficient if:

- At the stage of equilibrium (in the final stage of flooding), the angle of heel is not greater than 12°.

  Non-watertight openings shall not be flooded before reaching the stage of equilibrium.

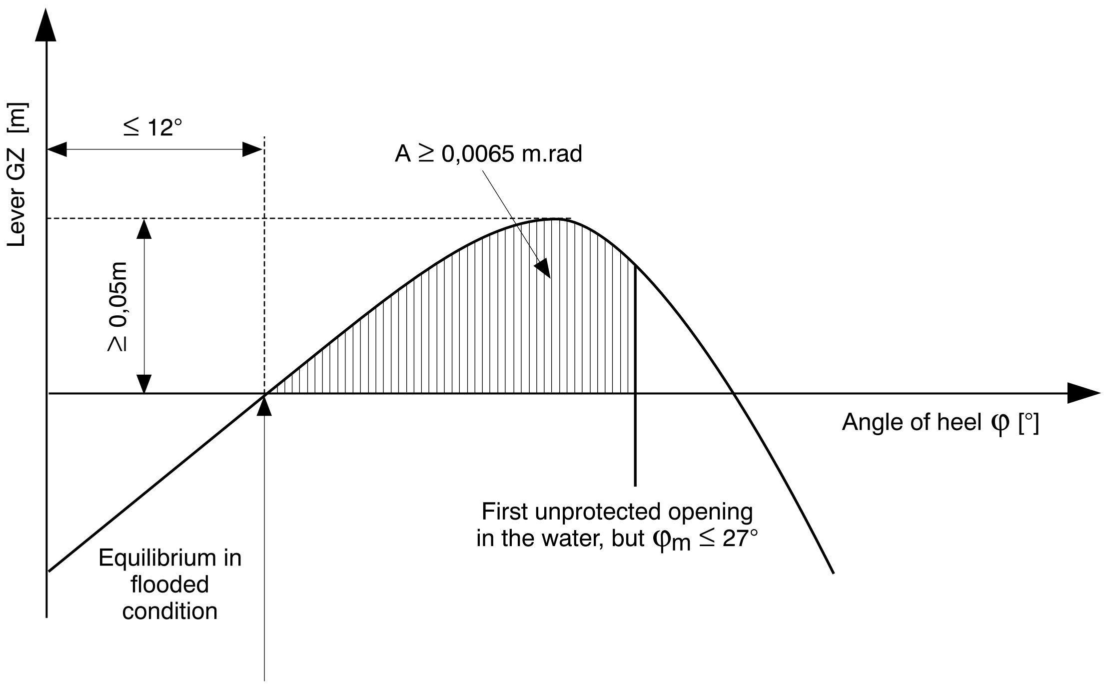
  If such openings are immersed before the stage of equilibrium, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

- The positive range of the righting lever curve beyond the stage of equilibrium has a righting lever of ≥ 0,05 m in association with an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability shall be satisfied up to immersion of the first non-watertight openings and in any event up to an angle of heel ≤ 27°. If non-watertight openings are immersed before that stage, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

6.3.4 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

6.3.5 Where cross- or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalisation shall not exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

Figure 2 : Proof of damage stability



SECTION 3 TYPE C

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]
B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]
D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]
T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]
t : Net thickness, in mm, of plating
k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4]

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **Type C** as defined in Pt A, Ch 2, Sec 3, [4.2].

1.1.2 These Rules apply in addition to Ch 1, Sec 3 and Ch 3, Sec 1.

1.2 Documents for review/approval

1.2.1 The following drawings and documents are to be submitted in addition to those listed in Pt B, Ch 1, Sec 2:

- List of the products to be carried mentioning the loading and transport conditions
- Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar
- Drawing showing the location of the electrical equipment within the dangerous areas
- General drawing giving the arrangement of cargo tanks, cofferdams, fuel tanks, ballasts and other spaces
- Cargo piping (loading/unloading and stripping systems)
- Water spray system
- Cargo heating system
- Other piping systems in connection with the cargo
- Pressure drop calculation note.
- Drawing of the fire protection, detection and extinction systems

2 Vessel design and arrangements

2.1 General

2.1.1 The tanker Type C is to be constructed as a double hull tanker as shown in sketch b of Ch 1, Sec 3, Fig 2 or a double hull tanker with inserted cargo tanks analogous to sketches c and d of Ch 1, Sec 3, Fig 3.

2.1.2 The scantlings and structural arrangements are to be in compliance with applicable requirements of Ch 1, Sec 3, [3] to Ch 1, Sec 3, [8].

2.2 Hull design

2.2.1 In the cargo area with the exception of the cofferdams, the vessel shall be designed as a flush-deck double-hull tanker, i.e. with double walls and double bottom but without trunk.

2.2.2 Cargo tanks independent of the vessel's hull and refrigerated cargo tanks may only installed in a hold space which is bounded by double hull spaces and double bottoms in accordance with [2.2.5]. The cargo tank shall not extend beyond the deck.

2.2.3 Side struts linking or supporting the load bearing components of the sides of the vessel with the load bearing components of the longitudinal walls of cargo tanks and side struts linking the load bearing components of the vessel's bottom with the tank bottom are prohibited.

2.2.4 A local recess in the cargo deck, contained on all sides, with a depth greater than 0.1 m, designed to house the loading and unloading pump, is permitted if it fulfils the following conditions:

- The recess shall not be greater than 1 m in depth
- The recess shall be located not less than 6 m from entrances and openings to accommodation and service spaces outside the cargo area
- The recess shall be located at a minimum distance from the side plating equal to one quarter of the vessel's breadth
- All pipes linking the recess to the cargo tanks shall be fitted with shut-off devices fitted directly on the bulkhead
- All the controls required for the equipment located in the recess shall be activated from the deck
- If the recess is deeper than 0.5 m, it shall be provided with a permanent gas detection system which automatically indicates the presence of explosive gases by means of direct-measuring sensors and actuates a visual and audible alarm when the gas concentration has reached 20% of the lower explosion limit. The sensors of this system shall be placed at suitable positions at the bottom of the recess. Measurement shall be continuous

- Visual and audible alarms shall be installed in the wheelhouse and on deck and, when the alarm is actuated, the vessel loading and unloading system shall be shut down. Failure of the gas detection system shall be immediately signalled in the wheelhouse and on deck by means of visual and audible alarms
- It shall be possible to drain the recess using a system installed on deck in the cargo area and independent of any other system
- The recess shall be provided with a level alarm device which activates the draining system and triggers a visual and audible alarm in the wheelhouse when liquid accumulates at the bottom
- When the recess is located above the cofferdam, the engine room bulkhead shall have an 'A-60' fire protection insulation according to Pt C, Ch 1, Sec 14, [1.4.5]
- When the cargo area is fitted with a water-spray system, electrical equipment located in the recess shall be protected against infiltration of water
- Pipes connecting the recess to the hull shall not pass through the cargo tanks.

2.2.5 To provide a reliable safeguard for the cargoes contained inside the vessel even in the event of slight or moderate collisions, the cargo tanks shall be separated from the side of the vessel by a distance of 1,0 m and from the vessel's bottom by an average distance of 0,70 m, and the depth of the double bottom shall at no point be less than 0,60 m.

2.2.6 A reduction of the lateral distance from 1,0 m to not less than 0,80 m is permitted if the scantlings of the vessel's side structures relative to the scantlings stipulated for double wall vessels of customary design in [2.4] are strengthened to such a degree that the narrower side structures can absorb at least the same impact energy without damage to the cargo tanks.

2.2.7 The condition according to [2.2.6] is deemed to be met if the structures laid down in Ch 1, Sec 3 are strengthened at least to the extent indicated below:

a) Increase in the thickness of the deck stringer plate by a factor of 1,25 and

b) Increase in the thickness of the side plating by a factor of 1,15 and

c) Mounting of a system of longitudinals in which the frame depth is not less than 0,15 m and the flange section of the longitudinals is not less than 7,0 cm²

d) Mounting of supports for the stringer or longitudinal systems in the form of frames similar to floor beams with lightening holes spaced at not more than 1,80 m.

2.2.8 Where the vessel is constructed on the transverse frame principle, a longitudinal stringer system must be fitted instead of [2.2.7] c). The spacing of the longitudinal stringers must not be greater than 0,80 m and the stringer depth must not be less than 0,15 m with full connection to the frames. As in [2.2.7] c), the flange section shall not be less than 7,0 cm².

If the frames are cut free, the web depth of the stringer must be increased by the depth of the frame cutout.

2.2.9 Alternative construction in compliance with Ch 3, App 1 are permitted.

2.2.10 In the area of pump wells a reduction of the distance from the vessel's bottom to 0,5 m is permitted provided that the volume of the pump well is not greater than 0,1 m³.

2.2.11 When a vessel is built with cargo tanks located in the hold space or refrigerated cargo tanks, the distance between the double walls of the hold space shall not be less than 0,80 m and the depth of the double bottom shall not be less than 0,60 m.

2.3 Cargo tank arrangements

2.3.1 The cargo tank is to comply with the following:

- for vessels with a length not more than 50 m, the length of a cargo tank shall not exceed 10 m
- for vessels with a length of more than 50 m, the length of a cargo tank shall not exceed 0,20 L, where L is the vessel rule length. This provision does not apply to vessels with independent built-in cylindrical tanks having a length to diameter ratio ≤ 7

2.4 Integrated tank scantlings

2.4.1 The scantlings of the integrated tank structure are to be determined in compliance with Ch 1, Sec 3, substituting to the values of minimum thickness those given in [2.4.2], [2.4.3] and [2.4.4].

2.4.2 Plating

The minimum net thickness, in mm, of strength deck and bulkhead plating in integrated tanks is to be not less than the values given in Tab 1.

Table 1 : Minimum net thickness of integrated tanks

Plating	Minimum thickness, in mm
Strength deck	$t = 4,4 + 0,016\ L\ k^{0,5}$
Tank bulkhead	$t = 0,8\ L^{1/3}\ k^{0,5} + 3,6\ s$
Watertight bulkhead	$t = 0,68\ L^{1/3}\ k^{0,5} + 3,6\ s$
Wash bulkhead	$t = 0,64 + 0,011\ L\ k^{0,5} + 3,6\ s$

Unless constructed wholly of corrosion-resistant materials or fitted with an approved lining, the plating thickness should take into account the corrosivity of the cargo.

2.4.3 Ordinary stiffeners

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$$t = 0,6\ L^{1/3} k^{0,5} + 3,6\ s$$

2.4.4 Primary supporting members

The net thickness of plating which forms the web of primary supporting members is to be not less than the value obtained, in mm, from following formula:

$t = 1,14\ L^{1/3} k^{0,5}$

2.5 Independent cargo tank supports and fastenings

2.5.1 The scantlings of the tank supports and fastenings are to be in compliance with Ch 3, Sec 1, [2.5].

2.6 Cargo area spaces

2.6.1 Double hull spaces and double bottoms in the cargo area may be arranged as ballast water tanks only. Double bottoms may, however, be used as fuel oil tanks, provided they comply with Ch 3, Sec 1, [2.10].

2.6.2 Cofferdams, double hull spaces, double bottoms, cargo tanks, hold spaces and other accessible spaces within the cargo area must be arranged so that they can be completely inspected and cleaned in an appropriate manner. In these spaces the distance between the reinforcements shall not be less than 0,50 m. In double bottoms this distance may be reduced to 0,45 m.

Access openings must be large enough to allow a person wearing a respirator to enter and leave the space without obstruction. The minimum size of the opening is 0,36 m² and the minimum length of side is 0,50 m. They must be constructed in such a way that injured or unconscious persons can be evacuated from the floor of the space in question without any particular difficulties, possibly with the aid of permanently fitted facilities.

Cargo tanks may have circular openings with a diameter of not less than 0,68 m.

2.6.3 Venting cofferdams

Cofferdams are to be provided with open venting facilities equipped with approved deflagration flame arresters. Flame arresters are not required for vessels outside **ADN/ADNR**.

3 Cargo tank equipment

3.1 Cargo piping

3.1.1 Pipes for loading and unloading shall be independent of any other piping of the vessel. No cargo piping shall be located below deck, except those inside the cargo tanks and inside the cargo pump room.

3.1.2 piping for loading and unloading shall be clearly distinguishable from other piping, e.g. by means of colour marking.

3.1.3 The pipes for loading and unloading located on deck, with the exception of the shore connections shall be located not less than B/4 from the outer shell.

3.1.4 The shore connections shall be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

3.1.5 Each shore connection of the vapour pipe and shore connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, shall be fitted with a shut-off device. However, each shore connection shall be fitted with a blind flange when it is not in operation.

3.1.6 Pipes for loading and unloading, and vapour pipes, shall not have flexible connections fitted with sliding seals.

3.1.7 The distance referred to in [3.1.4]may be reduced to 3 m if a transverse bulkhead complying with Ch 3, Sec 1, [2.6.2] is situated at the end of the cargo area. The openings shall be provided with doors.

3.1.8 Filling pipes for cargo tanks are to extend down as close as possible to the bottom of the tank.

3.2 Cargo tank heating

3.2.1 Cargo tank heating system is to be installed as a separate system, equipped with a heat exchanger located in the cargo area. Where special heat transfer media are used this requirement may be dispensed with upon approval by the Society.

Boilers which are used for heating the cargo shall be fuelled with a liquid fuel having a flashpoint of more than 55°C. They shall be placed either in the engine room or in another separate space below deck and outside the cargo area, which is accessible from the deck or from the engine room.

3.3 Cargo tank venting

3.3.1 A controlled venting system shall be provided in order to protect the cargo tanks against excessive overpressure and vacuum which may be arranged either individually or by vapour collecting system.

Overpressure protection is to be safeguarded by flameproof high-velocity vent valves, the openings of which shall be located 2 m above deck at a distance of at least 6 m from accommodation or other safe spaces. The height may be reduced to less than 2 m in case the area of 1 m around the high velocity valve is designed as non-accessible. The opening setting of high velocity vent valves shall be in general 50 kPa, other settings may be accepted depending on the list of substances allowed to be carried.

For vacuum protection, flameproof vacuum valves are to be fitted.

The cargo tanks are to be provided with a vapour return connection either individually or via the vapour collecting line. Vapour return connections are to be fitted with shutoff valves and blind flanges.

On each tank or each tank group means shall be provided for safe depressurizing, consisting in a shutoff valve showing its open/closed position. The outlet is to be provided with an approved flame arrester.

Where two or more tanks are connected to a vapour collecting line, at the inlet to each cargo tank an approved detonation arrester shall be fitted.

3.4 Stripping system

3.4.1 A fixed stripping system shall be provided in order to minimize the residues to 5 litres in each cargo tank and to 15 litres in associated cargo piping.

Discharge of residues shall be possible to a slop tank and to shore facilities. The piping for discharge to shore shall be connected on the outboard side of the main manifold valve.

Where different cargoes are carried adequate piping segregation shall be provided in the same manner as for the main cargo piping. Separate stripping pumps shall be provided where necessary.

3.5 Residual cargo tanks and slop tanks

3.5.1 The vessel shall be provided with at least one residual cargo tank and with slop tanks for slops which are not suitable for pumping. These tanks shall be located only in the cargo area.

Intermediate bulk containers (IBCs) or tank containers or portable tanks may be used instead of a fixed residual tank.

3.5.2 The maximum capacity of a residual cargo tank is 30 m^3.

3.5.3 The residual cargo tank shall be equipped with:

- controlled venting arrangement consisting of P/V valves combined with approved flame arresters. Closed gauging device
- P/V valve setting as for main cargo tanks
- closed gauging device
- pipe, connections with valves for connection of hoses/piping.

Note 1: ADN/ADNR requires high velocity vent valve.

3.5.4 Residual cargo tanks, intermediate bulk containers, tank containers and portable tanks placed on the deck shall be located at a minimum distance from the hull equal to B/4.

3.6 Safety and control installations

3.6.1 Cargo tank level indicators

Each cargo tank is to be equipped with a closed gauging device and is to be provided with a filling mark at 95% of the total tank volume.

3.6.2 Level alarm device

Cargo tank shall be provided with a level alarm device which is activated at the latest when a degree of filling of 90% is reached.

3.6.3 High level sensor

Cargo tank shall be provided with a high level sensor for actuating the facility against overflowing at the latest when a degree of filling of 97,5% is reached.

3.6.4 Cargo tank pressure monitoring

Each cargo tank shall be equipped with a pressure indicator for the vapour space.

Further alarm and shutdown functions are required according to ADN/ADNR in relation to the products allowed to be carried.

3.6.5 Cargo temperature monitoring

Tankers fitted with or required to be fitted with cargo tank heating arrangements shall be equipped with temperature indicating devices in each cargo tank.

Further alarm functions are required according to **ADN/ADNR** in relation to the products allowed to be carried.

3.6.6 Cargo tank sampling equipment

System for closed sampling equipment in accordance with the list of substances allowed to be carried (see Ch 3, App 1) is to be provided.

4 Electrical plant

4.1 Documents to be submitted

4.1.1 In addition to the documents required in accordance with the Regulations referred to in Pt C, Ch 2, Sec 1, [2], the following documents are to be submitted:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area

b) a list of the electrical equipment referred to in (a) above including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment shall be marked in red.

4.2 Electrical installations

4.2.1 Only distribution systems without return connection to the hull are permitted. This provision does not apply to:

- certain limited sections of the installations situated outside the cargo area (connections of starters of diesel engines)
- device for checking the insulation level referred to in [4.2.2]
- active cathodic corrosion protection.

4.2.2 Every insulated distribution network shall be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

4.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried shall be taken into consideration.

4.3 Type and location of electrical equipment

4.3.1

a) Only measuring, regulation and alarm devices of the EEx (ia) type of protection may be installed in cargo tanks, residual cargo tanks and pipes for loading and unloading (comparable to zone 0)

b) Only the following equipment may be installed in the cofferdams, double-hull spaces, double bottoms and hold spaces (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "pressurised enclosure" type of protection
   - hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck
   - cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices

c) Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection
   - motors driving essential equipment such as ballast pumps; they shall be of the certified safe type

d) The control and protective equipment of the electrical equipment referred to in paragraphs (a), (b) and (c) above shall be located outside the cargo area if they are not intrinsically safe

e) The electrical equipment in the cargo area on deck (comparable to zone 1) shall be of the certified safe type.

4.3.2

a) Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area shall (comparable to zone 2) be at least of the "limited explosion risk" type.

b) This provision does not apply to:
   - lighting installations in the accommodation, except for switches near entrances to accommodation
   - radiotelephone installations in the accommodation or the wheelhouse
   - mobile and fixed telephone installations in the accommodation or the wheelhouse
   - electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:
     - These spaces are fitted with a ventilation system ensuring an overpressure of 0,1 kPa (0,001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system shall be located as far away as possible, however, not less than 6,00 m from the cargo area and not less than 2,00 m above the deck
     - The spaces are fitted with a gas detection system with sensors:
       - at the suction inlets of the ventilation system
       - directly at the top edge of the sill of the entrance doors of the accommodation and service spaces
     - The gas concentration measurement is continuous
     - When the gas concentration reaches 20% of the lower explosive limit, the ventilators are switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with (a) above, shall be switched off. These operations shall be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which shall comply at least with the "limited explosion risk" type. The switching-off shall be indicated in the accommodation and wheelhouse by visual and audible signals
     - The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of (a) above
     - The automatic switching-off device is set so that no automatic switch off may occur while the vessel is under way.

4.3.3 The electrical equipment which does not meet the requirements set out in [4.3.2] together with its switches shall be marked in red. The disconnection of such equipment shall be operated from a centralised location on board.

4.3.4 An electric generator which is permanently driven by an engine and which does not meet the requirements of [4.3.2], shall be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions shall be displayed near the switch.

4.3.5 Sockets for the connection of signal lights and gangway lighting shall be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting shall not be possible except when the sockets are not live.

4.3.6 The failure of the power supply for the safety and control equipment shall be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

4.4 Earthing

4.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service shall be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

The resistance between any point on the surface of the cargo tanks, cargo piping systems and equipment, and the hull of the vessel is not to be greater than 1 mega ohm.

4.4.2 The provisions of [4.4.1] above apply also to equipment having service voltages of less than 50 V.

4.4.3 Independent cargo tanks, metal intermediate bulk containers and tank-containers shall be earthed.

4.4.4 Metal intermediate bulk containers (IBCs) and tank-containers, used as residual cargo tanks or slop tanks, shall be capable of being earthed.

4.5 Electrical cables

4.5.1 All cables in the cargo area shall have a metallic sheath.

4.5.2 Cables and sockets in the cargo area shall be protected against mechanical damage.

4.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights, gangway lighting and submerged pumps on board bilgesboat.

4.5.4 Cables of intrinsically safe circuits shall only be used for such circuits and shall be separated from other cables not intended for being used in such circuits (e.g. they shall not be installed together in the same string of cables and they shall not be fixed by the same cable clamps).

4.5.5 For movable cables intended for signal lights, gangway lighting, and submerged pumps on board bilgesboat, only sheathed cables of type H 07 RN-F in accordance with standard IEC 60 245-4:1994 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm² shall be used. These cables shall be as short as possible and installed so that damage is not likely to occur.

4.6 Storage batteries

4.6.1 The installation of storage batteries inside dangerous areas is not permissible.

5 Buoyancy and stability

5.1 General

5.1.1 Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

5.1.2 General requirements of Pt B, Ch 2, Sec 6 shall be complied with.

5.1.3 The longitudinal centre bulkhead may be dispensed with only if sufficient stability is guaranteed.

5.1.4 Proof of sufficient stability shall be furnished including for stability in damaged condition.

5.1.5 The basic values for the stability calculation (the vessel's lightweight and location of the centre of gravity) shall be determined in compliance with Pt B, Ch 2, Sec 6, [2.2].

5.1.6 Proof of intact stability is to be provided for all loading/unloading stages and for the final loading condition.

5.1.7 Floatability after damage shall be proved for the most unfavorable loading condition. For this purpose, calculated proof of sufficient stability shall be established for critical intermediate stages of flooding and for the final stage of flooding.

Negative values of stability in intermediate stages of flooding may be accepted only if the continued range of curve of the righting lever in damaged condition indicates adequate positive values of stability.

5.2 Intact stability

5.2.1 The requirements for intact stability resulting from the damage stability calculation shall be fully complied with.

5.2.2 For vessels with cargo tanks of more than 0,70B in width, the following intact stability requirements are to be complied with, bearing in mind the influence of all free surfaces in tanks for all stages of loading and unloading:

- the value of the righting lever GZ is not less than 0,10 m within the range of positive stability, limited by the angle at which unprotected openings become submerged
- the area below the GZ curve within the range of positive stability, limited by the angle at which unprotected openings become submerged or 27 degrees whichever is the lesser, is to be not less than 0,024 m.radians
- the initial metacentric height GM_0 value is to be at least 0,10 m.

5.3 Damage stability

5.3.1 The following assumptions shall be taken into consideration for the damaged condition.

a) extent of side damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 0,79 m
   - vertical extent: from base line upwards without limit

b) extent of bottom damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 3 m
   - vertical extent: from base line to 0,59 m upwards, except for pump well.

c) Any bulkhead within the damaged area shall be assumed damaged, which means that the location of bulkheads shall be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

The following provisions are applicable:

- For bottom damage, adjacent athwartship compartments shall also be assumed flooded
- the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways) shall, at the final stage of flooding, be not less than 0,10 m above the damage waterline.

5.3.2 In general, permeability shall be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used.

However, minimum values of permeability, μ, given in Tab 2 are to be used.

For the main engine room only a one-compartment standard needs be taken into account, i.e. the end bulkheads of the engine room shall be assumed as not damaged.

Table 2 : Permeability values, in %

Spaces	μ
Engine room	85
Accommodation spaces	95
Double bottoms, oil fuel tanks, ballast tanks, etc., depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught	0 or 95

5.3.3 The damage stability is generally regarded sufficient if:

- At the stage of equilibrium (in the final stage of flooding), the angle of heel is not greater than 12°.

  Non-watertight openings shall not be flooded before reaching the stage of equilibrium.

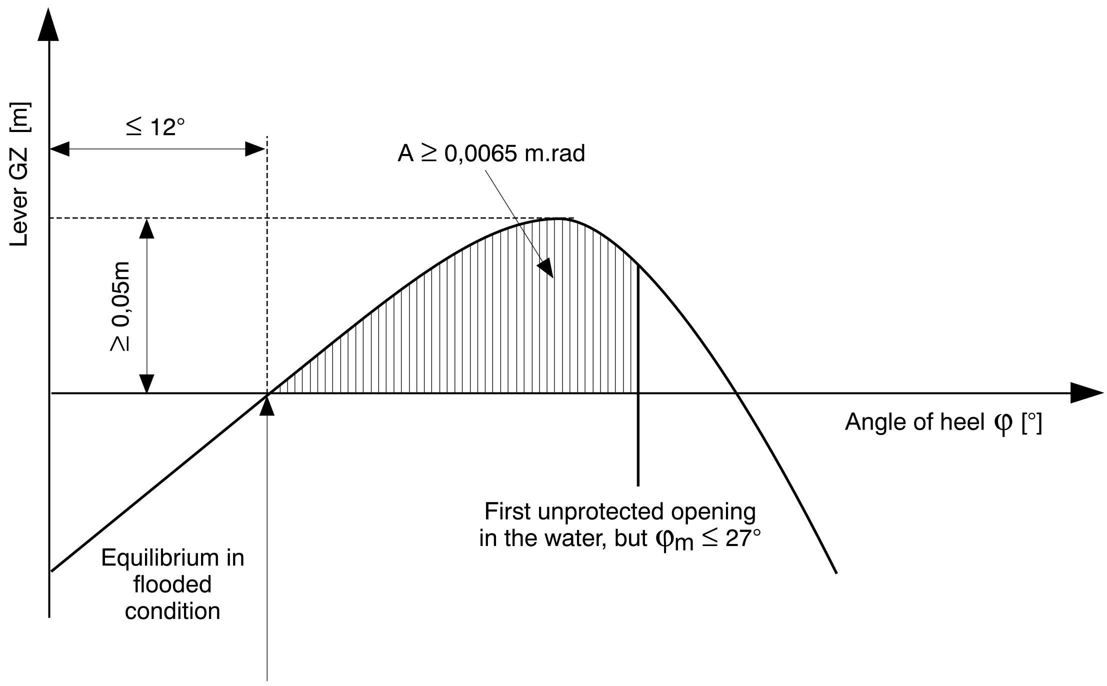
  If such openings are immersed before the stage of equilibrium, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

- The positive range of the righting lever curve beyond the stage of equilibrium has a righting lever of ≥ 0,05 m in association with an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability shall be satisfied up to immersion of the first non-watertight openings and in any event up to an angle of heel ≤ 27°. If non-watertight openings are immersed before that stage, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

5.3.4 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

5.3.5 Where cross- or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalisation shall not exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

Figure 1 : Proof of damage stability



SECTION 4 TYPE N

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4].

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **Type N** as defined in Pt A, Ch 2, Sec 3, [4.2].

1.1.2 These Rules apply in addition to Ch 1, Sec 3 and Ch 3, Sec 1.

1.1.3 Following requirements do not apply to Type N open vessels:

- Ch 3, Sec 1, [2.6]
- Second paragraph of Ch 3, Sec 1, [2.8.4]
- Ch 3, Sec 1, [2.9.4]
- Ch 3, Sec 1, [2.13.3].

1.2 Documents for review/approval

1.2.1 The following drawings and documents are to be submitted in addition to those listed in Pt B, Ch 1, Sec 2:

- List of the products to be carried mentioning the loading and transport conditions
- Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar
- Drawing showing the location of the electrical equipment within the dangerous areas
- General drawing giving the arrangement of cargo tanks, cofferdams, fuel tanks, ballasts and other spaces
- Cargo piping (loading/unloading and stripping systems)
- Water spray system
- Cargo heating system
- Other piping systems in connection with the cargo
- Pressure drop calculation note.
- Drawing of the fire protection, detection and extinction systems.

2 Vessel design and arrangements

2.1 General

2.1.1 Type N may be arranged in three different designs in respect of cargo tank venting with due regard to the products allowed to be carried:

- Type N, open venting
- Type N, open venting, flame arresters
- Type N, closed.

2.1.2 The Tanker Type N may be constructed as a single or double-hull tankvessel or as a tankvessel with inserted cargo tanks shown respectively in Ch 1, Sec 3, Fig 1 to Ch 1, Sec 3, Fig 3.

2.1.3 The scantlings and structural arrangements are to be in compliance with applicable requirements of Ch 1, Sec 3, [3] to Ch 1, Sec 3, [8].

2.2 Hull design

2.2.1 For double-hull construction with the tanks integrated in the vessel's structure or where hold spaces contain cargo tanks which are independent of the structure of the vessel, or where independent cargo tanks are used, or for double-hull construction where the cargo tanks are integrated in vessel's structure, the space between the wall of the vessel and wall of the cargo tanks shall be not less than 0.60 m.

The space between the bottom of the vessel and the bottom of the cargo tanks shall be not less than 0.50 m. The space may be reduced to 0.40 m under the pump sumps. The vertical space between the suction well of a cargo tank and the bottom structures shall be not less than 0.10 m.

When a hull is constructed in the cargo area as a double hull with independent cargo tanks located in hold spaces, the above values are applicable to the double hull. If in this case the minimum values for inspections of independent tanks referred to in [2.6.1] are not feasible, it must be possible to remove the cargo tanks easily for inspection.

2.2.2 Where service spaces are located in the cargo area under deck, they shall be arranged so as to be easily accessible and to permit persons wearing protective clothing and breathing apparatus to safely operate the service equipment contained therein. They shall be designed so as to allow injured or unconscious personnel to be removed from such spaces without difficulties, if necessary by means of fixed equipment.

2.2.3 Side stringers linking or supporting the load bearing components of the sides of the vessel with the load bearing components of the longitudinal walls of cargo tanks and side stringers linking the load bearing components of the vessel's bottom with the tank bottom are prohibited.

2.3 Cargo tank arrangements

2.3.1 The cargo tank is to comply with the following:

- for vessels with a length not more than 50 m, the length of a cargo tank shall not exceed 10 m
- for vessels with a length of more than 50 m, the length of a cargo tank shall not exceed 0,20 L, where L is the vessel rule length. This provision does not apply to vessels with independent built-in cylindrical tanks having a length to diameter ratio ≤ 7

2.4 Integrated tank scantlings

2.4.1 The scantlings of the integrated tank structure are to be determined in compliance with Ch 1, Sec 3, substituting to the values of minimum thickness those given in [2.4.2] to [2.4.4].

2.4.2 Plating

The minimum net thickness, in mm, of strength deck and bulkhead plating in integrated tanks is to be not less than the values given in Tab 1.

Unless constructed wholly of corrosion-resistant materials or fitted with an approved lining, the plating thickness should take into account the corrosively of the cargo.

Table 1 : Minimum net thickness of integrated tanks

Plating	Minimum thickness, in mm
Strength deck	$t = 4,4 + 0,016\ L\ k^{0,5}$
Tank bulkhead	$t = 0,8\ L^{1/3}\ k^{0,5} + 3,6\ s$
Watertight bulkhead	$t = 0,68\ L^{1/3}\ k^{0,5} + 3,6\ s$
Wash bulkhead	$t = 0,64 + 0,011\ L\ k^{0,5} + 3,6\ s$

2.4.3 Ordinary stiffeners

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$t = 0,6\ L^{1/3}k^{0,5} + 3,6\ s$

2.4.4 Primary supporting members

The net thickness of plating which forms the web of primary supporting members is to be not less than the value obtained, in mm, from following formula:

$t = 1,14\ L^{1/3}k^{0,5}$

2.5 Independent cargo tank supports and fastenings

2.5.1 The scantlings of the tank supports and fastenings are to be in compliance with Ch 3, Sec 1, [2.5].

2.6 Cargo area spaces

2.6.1 Cofferdams, double hull spaces, double bottoms, cargo tanks, hold spaces and other accessible spaces within the cargo area must be arranged so that they can be completely inspected and cleaned in an appropriate manner. In these spaces the distance between the reinforcements shall not be less than 0,50 m. In double bottoms this distance may be reduced to 0,45 m.

Access openings must be large enough to allow a person wearing a respirator to enter and leave the space without obstruction. The minimum size of the opening is 0,36 m^2 and the minimum length of side is 0,50 m. They must be constructed in such a way that injured or unconscious persons can be evacuated from the floor of the space in question without any particular difficulties, possibly with the aid of permanently fitted facilities.

Cargo tanks may have circular openings with a diameter of not less than 0,68 m.

2.6.2 Every cofferdam and hold space is to be provided with open venting facilities (without flame arrester).

3 Type N with open venting

3.1 Cargo piping

3.1.1 Pipes for loading and unloading shall be independent of any other piping of the vessel. No cargo piping shall be located below deck, except those inside the cargo tanks and inside the cargo pump room.

3.1.2 Piping for loading and unloading shall be clearly distinguishable from other piping, e.g. by means of colour marking.

3.1.3 The shore connections shall be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

3.1.4 Each shore connection of the vapour pipe and shore connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, shall be fitted with a shut-off device. However, each shore connection shall be fitted with a blind flange when it is not in operation.

3.1.5 Pipes for loading and unloading, and vapour pipes, shall not have flexible connections fitted with sliding seals when substances with corrosive properties are transported.

3.1.6 The distance referred to in Ch 3, Sec 3, [3.1.4]may be reduced to 3 m if a transverse bulkhead complying with Ch 3, Sec 1, [2.6.2] is situated at the end of the cargo area. The openings shall be provided with doors.

3.1.7 Filling pipes for cargo tanks are to extend down as close as possible to the bottom of the tank.

3.2 Cargo tank heating

3.2.1 Cargo tank heating system is to be installed as a separate system, equipped with a heat exchanger located in the cargo area. Where special heat transfer media are used this requirement may be dispensed with upon approval by the society.

3.3 Venting of cargo tanks

3.3.1 Every cargo tank is to be provided with open venting facilities (without flame arrester).

3.4 Cargo tank level alarm

3.4.1 The level alarm must be activated when the tank is filled to 90% of its total volume.

3.5 Cargo tank overfill protection

3.5.1 The overfill protection must be actuated when the level in the tank reaches 97,5%.

3.6 Cargo tank level gauging

3.6.1 Each cargo tank shall be fitted with a sounding pipe or ullage/observation port.

Every cargo tank is to be provided with a filling mark corresponding to 97% of the total tank volume.

3.7 Cargo tank sampling

3.7.1 Open sampling as required for substances allowed to be carried.

3.8 Drives

3.8.1 On tankers of type N open internal combustion engines may be installed in the cargo area.

3.9 Residual cargo tanks and slop tanks

3.9.1 The vessel shall be provided with at least one residual cargo tank and with slop tanks for slops which are not suitable for pumping. These tanks shall be located only in the cargo area.

Intermediate bulk containers (IBCs) or tank containers or portable tanks may be used instead of a fixed residual tank.

3.9.2 The maximum capacity of a residual cargo tank is 30 m^3.

3.9.3 The residual cargo tank shall be equipped with:

- a device for ensuring pressure equilibrium
- an ullage opening
- connections with stop valves, for pipes and hoses

3.9.4 Residual cargo tanks, intermediate bulk containers, tank containers and portable tanks placed on the deck shall be located at a minimum distance from the hull equal to B/4.

4 Type N with open venting, with flame arresters

4.1 Cargo piping

4.1.1 Pipes for loading and unloading shall be independent of any other piping of the vessel. No cargo piping shall be located below deck, except those inside the cargo tanks and inside the cargo pump room.

4.1.2 Piping for loading and unloading shall be clearly distinguishable from other piping, e.g. by means of colour marking.

4.1.3 The shore connections shall be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

4.1.4 Each shore connection of the vapour pipe and shore connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, shall be fitted with a shut-off device. However, each shore connection shall be fitted with a blind flange when it is not in operation.

4.1.5 Pipes for loading and unloading, and vapour pipes, shall not have flexible connections fitted with sliding seals when substances with corrosive properties are transported.

4.1.6 The distance referred to in Ch 3, Sec 3, [3.1.4]may be reduced to 3 m if a transverse bulkhead complying with Ch 3, Sec 1, [2.6.2] is situated at the end of the cargo area. The openings shall be provided with doors.

4.1.7 Filling pipes for cargo tanks are to extend down as close as possible to the bottom of the tank.

4.2 Cargo tank heating

4.2.1 Cargo tank heating system is to be installed as a separate system, equipped with a heat exchanger located in the cargo area. Where special heat transfer media are used this requirement may be dispensed with upon approval by the society.

4.3 Venting of cargo tanks

4.3.1 Every cargo tank is to be provided with open venting facilities fitted with approved flame arresters.

4.4 Venting of cofferdams

4.4.1 Cofferdams are to be provided with open venting facilities equipped with approved deflagration flame arresters. Flame arresters are not required for vessels outside **ADN/ADNR**.

4.5 Cargo tank level indicators

4.5.1 Each cargo tank shall be fitted with a sounding pipe.

Every cargo tank is to be provided with a filling mark corresponding to 97% of the total tank volume.

4.6 Cargo tank sampling

4.6.1 Open sampling as required for substances allowed to be carried.

4.7 Residual cargo tanks and slop tanks

4.7.1 The vessel shall be provided with at least one residual cargo tank and with slop tanks for slops which are not suitable for pumping. These tanks shall be located only in the cargo area.

Intermediate bulk containers (IBCs) or tank containers or portable tanks may be used instead of a fixed residual tank.

4.7.2 The maximum capacity of a residual cargo tank is 30 m^3.

4.7.3 The residual cargo tank shall be equipped with:

- a device for ensuring pressure equilibrium, fitted with a flamme arrester capable of withstanding steady burning
- an ullage opening
- connections with stop valves, for pipes and hoses

4.7.4 Residual cargo tanks, intermediate bulk containers, tank containers and portable tanks placed on the deck shall be located at a minimum distance from the hull equal to B/4.

5 Type N closed

5.1 Cargo piping

5.1.1 Pipes for loading and unloading shall be independent of any other piping of the vessel. No cargo piping shall be located below deck, except those inside the cargo tanks and inside the cargo pump room.

5.1.2 Piping for loading and unloading shall be clearly distinguishable from other piping, e.g. by means of colour marking.

5.1.3 The shore connections shall be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

5.1.4 Each shore connection of the vapour pipe and shore connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, shall be fitted with a shut-off device. However, each shore connection shall be fitted with a blind flange when it is not in operation.

5.1.5 Pipes for loading and unloading, and vapour pipes, shall not have flexible connections fitted with sliding seals when substances with corrosive properties are transported.

5.1.6 The distance referred to in Ch 3, Sec 3, [3.1.4]may be reduced to 3 m if a transverse bulkhead complying with Ch 3, Sec 1, [2.6.2] is situated at the end of the cargo area. The openings shall be provided with doors.

5.1.7 Filling pipes for cargo tanks are to extend down as close as possible to the bottom of the tank.

5.2 Cargo tank heating

5.2.1 Cargo tank heating system is to be installed as a separate system, equipped with a heat exchanger located in the cargo area. Where special heat transfer media are used this requirement may be dispensed with upon approval by the Society.

5.3 Cargo tank venting

5.3.1 A controlled venting system shall be provided in order to protect the cargo tanks against excessive overpressure and vacuum which may be arranged either individually or by vapour collecting system.

Overpressure protection is to be safeguarded by flameproof high-velocity vent valves, the openings of which shall be located 2 m above deck at a horizontal distance of at least 6 m from accommodation or other safe spaces. The height may be reduced to less than 2 m in case the area of 1 m around the high velocity valve is designed as non-accessible. The opening setting of high velocity vent valves shall be 10 kPa (see list of substances allowed to be carried, Part 3, Table C of **ADN/ADNR**).

For vacuum protection flameproof vacuum valves are to be fitted.

The cargo tanks are to be provided with a vapour return connection either individually or via the vapour collecting line. Vapour return connections are to be fitted with shutoff valves and blind flanges.

On each tank or each tank group means shall be provided for safe depressurizing, consisting in a shutoff valve showing its open/closed position. The outlet is to be provided with an approved flame arrester.

Where two or more tanks are connected to a vapour collecting line, at the inlet to each cargo tank an approved detonation arrester shall be fitted.

5.4 Venting of cofferdams

5.4.1 Cofferdams are to be provided with open venting facilities equipped with approved flame arresters. Flame arresters are not required for vessels outside ADN/ADNR.

5.5 Cargo tank level alarm

5.5.1 The level alarm must be tripped when the tank is filled to 90% of its total volume.

5.6 Cargo tank overfill protection

5.6.1 The overfill protection must be actuated when the level in the tank reaches 97,5%.

5.7 Cargo tank level indicators

5.7.1 Each cargo tank is to be equipped with a closed gauging device and is to be provided with a filling mark at 97% of the total tank volume.

5.8 Cargo tank pressure monitoring

5.8.1 Each cargo tank shall be equipped with a pressure indicator for the vapour space.

Further alarm and shutdown functions are required according to **ADN** in relation to the products allowed to be carried.

5.9 Cargo temperature monitoring

5.9.1 Tankers fitted with or required to be fitted with cargo tank heating arrangements shall be equipped with temperature indicating devices in each cargo tank.

Note 1: Further alarm functions are required according to ADN/ADNR in relation to the products allowed to be carried.

5.10 Cargo tank sampling equipment

5.10.1 Closed sampling equipment, as required for substances allowed to be carried, is to be provided.

5.11 Residual cargo tanks and slop tanks

5.11.1 The vessel shall be provided with at least one residual cargo tank and with slop tanks for slops which are not suitable for pumping. These tanks shall be located only in the cargo area.

Intermediate bulk containers (IBCs) or tank containers or portable tanks may be used instead of a fixed residual tank.

5.11.2 The maximum capacity of a residual cargo tank is 30 m^3.

5.11.3 The residual cargo tank shall be equipped with:

- controlled venting arrangement consisting of P/V valves combined with approved flame arresters. Closed gauging device
- P/V valve setting as for main cargo tanks
- closed gauging device
- pipe, connections with valves for connection of hoses/piping.

Note 1: **ADN/ADNR** requires high velocity vent valve.

5.11.4 Residual cargo tanks, intermediate bulk containers, tank containers and portable tanks placed on the deck shall be located at a minimum distance from the hull equal to B/4.

6 Electrical plant

6.1 Documents to be submitted

6.1.1 In addition to the documents required in accordance with the Regulations referred to in Pt C, Ch 2, Sec 1, [2], the following documents are to be submitted:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area

b) a list of the electrical equipment referred to in (a) above including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment shall be marked in red.

6.2 Electrical installations

6.2.1 Only distribution systems without return connection to the hull are permitted. This provision does not apply to:

- certain limited sections of the installations situated outside the cargo area (connections of starters of diesel engines)
- device for checking the insulation level referred to in [6.2.2]
- active cathodic corrosion protection.

6.2.2 Every insulated distribution network shall be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

6.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried shall be taken into consideration.

6.3 Type and location of electrical equipment

6.3.1

a) Only measuring, regulation and alarm devices of the EEx (ia) type of protection may be installed in cargo tanks, residual cargo tanks and pipes for loading and unloading (comparable to zone 0)

b) Only the following equipment may be installed in the cofferdams, double-hull spaces, double bottoms and hold spaces (comparable to zone 1):

  - measuring, regulation and alarm devices of the certified safe type
  - lighting appliances of the "flame-proof enclosure" or "pressurised enclosure" type of protection
  - hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck
  - cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices

c) Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection
   - motors driving essential equipment such as ballast pumps; they shall be of the certified safe type

d) The control and protective equipment of the electrical equipment referred to in paragraphs (a), (b) and (c) above shall be located outside the cargo area if they are not intrinsically safe

e) The electrical equipment in the cargo area on deck (comparable to zone 1) shall be of the certified safe type.

6.3.2

a) Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area shall (comparable to zone 2) be at least of the "limited explosion risk" type.

b) This provision does not apply to:
   - lighting installations in the accommodation, except for switches near entrances to accommodation
   - radiotelephone installations in the accommodation or the wheelhouse
   - electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:
     - These spaces are fitted with a ventilation system ensuring an overpressure of 0,1 kPa (0,001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system shall be located as far away as possible, however, not less than 6,00 m from the cargo area and not less than 2,00 m above the deck
     - The spaces are fitted with a gas detection system with sensors:
       - at the suction inlets of the ventilation system
       - directly at the top edge of the sill of the entrance doors of the accommodation and service spaces
     - The gas concentration measurement is continuous
     - When the gas concentration reaches 20% of the lower explosive limit, the ventilators are switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with (a) above, shall be switched off. These operations shall be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which shall comply at least with the "limited explosion risk" type. The switching-off shall be indicated in the accommodation and wheelhouse by visual and audible signals
     - The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of (a) above
     - The automatic switching-off device is set so that no automatic switch off may occur while the vessel is under way.

6.3.3 The electrical equipment which does not meet the requirements set out in Ch 3, Sec 3, [4.3.2] together with its switches shall be marked in red. The disconnection of such equipment shall be operated from a centralised location on board.

6.3.4 An electric generator which is permanently driven by an engine and which does not meet the requirements of Ch 3, Sec 3, [4.3.2], shall be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions shall be displayed near the switch.

6.3.5 Sockets for the connection of signal lights and gangway lighting shall be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting shall not be possible except when the sockets are not live.

6.3.6 The failure of the power supply for the safety and control equipment shall be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

6.4 Earthing

6.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service shall be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

The resistance between any point on the surface of the cargo tanks, cargo piping systems and equipment, and the hull of the vessel is not to be greater than 1 mega ohm.

6.4.2 The provisions of Ch 3, Sec 3, [4.4.1] above apply also to equipment having service voltages of less than 50 V.

6.4.3 Independent cargo tanks, metal intermediate bulk containers and tank-containers shall be earthed.

6.4.4 Metal intermediate bulk containers (IBCs) and tank-containers, used as residual cargo tanks or slop tanks, shall be capable of being earthed.

6.5 Electrical cables

6.5.1 All cables in the cargo area shall have a metallic sheath.

6.5.2 Cables and sockets in the cargo area shall be protected against mechanical damage.

6.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights, gangway lighting and submerged pumps on board bilgesboat.

6.5.4 Cables of intrinsically safe circuits shall only be used for such circuits and shall be separated from other cables not intended for being used in such circuits (e.g. they shall not be installed together in the same string of cables and they shall not be fixed by the same cable clamps).

6.5.5 For movable cables intended for signal lights, gangway lighting, and submerged pumps on board bilgesboat, only sheathed cables of type H 07 RN-F in accordance with standard IEC 60 245-4:1994 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm^2 shall be used. These cables shall be as short as possible and installed so that damage is not likely to occur.

6.6 Storage batteries

6.6.1 The installation of storage batteries inside dangerous areas is not permissible.

7 Buoyancy and stability

7.1 General

7.1.1 Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

7.1.2 General requirements of Pt B, Ch 2, Sec 6 shall be complied with.

7.1.3 The longitudinal centre bulkhead may be dispensed with only if sufficient stability is guaranteed.

7.1.4 Proof of sufficient stability shall be furnished. This proof is not required for single hull vessels with cargo tanks the width of which is not more than 0,70B.

7.1.5 The basic values for the stability calculation (the vessel's lightweight and location of the centre of gravity) shall be determined in compliance with Pt B, Ch 2, Sec 6, [2.2].

7.1.6 Proof of intact stability is to be provided for all loading/unloading stages and for the final loading condition.

7.1.7 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, floatability after damage shall be proved for the most unfavorable loading condition. For this purpose, calculated proof of sufficient stability shall be established for critical intermediate stages of flooding and for the final stage of flooding.

Negative values of stability in intermediate stages of flooding may be accepted only if the continued range of curve of the righting lever in damaged condition indicates adequate positive values of stability.

7.2 Intact stability

7.2.1 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, the requirements for intact stability resulting from the damage stability calculation shall be fully complied with.

7.2.2 For vessels with cargo tanks of more than 0,70B in width, the following intact stability requirements are to be complied with, bearing in mind the influence of all free surfaces in tanks for all stages of loading and unloading:

- the value of the righting lever GZ is not less than 0,10 m within the range of positive stability, limited by the angle at which unprotected openings become submerged
- the area below the GZ curve within the range of positive stability, limited by the angle at which unprotected openings become submerged or 27 degrees whichever is the lesser, is to be not less than 0,024 m.radians
- the initial metacentric height GM_0 value is to be at least 0,10 m.

7.3 Damage stability

7.3.1 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, the following assumptions shall be taken into consideration for the damaged condition.

a) extent of side damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 0,59 m
   - vertical extent: from base line upwards without limit

b) extent of bottom damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 3 m
   - vertical extent: from base line to 0,49 m upwards, except for pump well.

c) Any bulkhead within the damaged area shall be assumed damaged, which means that the location of bulkheads shall be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

   The following provisions are applicable:
   - For bottom damage, adjacent athwartship compartments shall also be assumed flooded
   - the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways) shall, at the final stage of flooding, be not less than 0,10 m above the damage waterline.

7.3.2 In general, permeability shall be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used.

However, minimum values of permeability, μ, given in Tab 2 are to be used.

For the main engine room only a one-compartment standard needs be taken into account, i.e. the end bulkheads of the engine room shall be assumed as not damaged.

Table 2 : Permeability values, in %

Spaces	μ
Engine room	85
Accommodation spaces	95
Double bottoms, oil fuel tanks, ballast tanks, etc., depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught	0 or 95

7.3.3 The damage stability is generally regarded sufficient if:

- At the stage of equilibrium (in the final stage of flooding), the angle of heel is not greater than 12°.

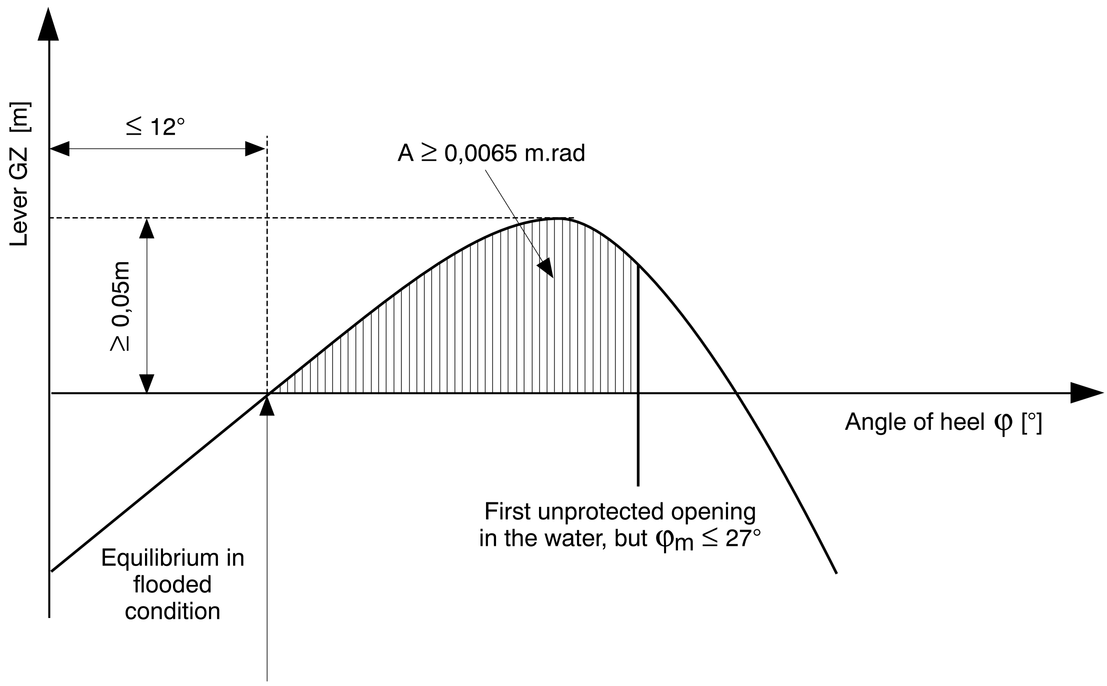
  Non-watertight openings shall not be flooded before reaching the stage of equilibrium.

  If such openings are immersed before the stage of equilibrium, the corresponding spaces shall be considered flooded for the purpose of stability calculation.
- The positive range of the righting lever curve beyond the stage of equilibrium has a righting lever of ≥ 0,05 m in association with an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability shall be satisfied up to immersion of the first non-watertight openings and in any event up to an angle of heel ≤ 27°. If non-watertight openings are immersed before that stage, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

7.3.4 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

7.3.5 Where cross- or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalisation shall not exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

Figure 1 : Proof of damage stability



SECTION 5 BILGESBOAT

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4].

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **Type N open - Bilgesboat** as defined in Pt A, Ch 2, Sec 3, [4.2].

1.1.2 These Rules apply in addition to Ch 3, Sec 1 and Ch 1, Sec 3, the following requirements excepted:

- Ch 3, Sec 1, [2.6]
- Second paragraph of Ch 3, Sec 1, [2.8.4]
- Last sentence of Ch 3, Sec 1, [2.9.2]
- Last sentence of Ch 3, Sec 1, [2.9.3]
- Ch 3, Sec 1, [2.9.4]
- Last sentence of Ch 3, Sec 1, [2.11.2]
- Ch 3, Sec 1, [2.13.3]
- Ch 3, Sec 1, [3.9.4].

1.2 Documents for review/approval

1.2.1 The following drawings and documents are to be submitted in addition to those listed in Pt B, Ch 1, Sec 2:

- List of the products to be carried mentioning the loading and transport conditions
- Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar
- Drawing showing the location of the electrical equipment within the dangerous areas
- General drawing giving the arrangement of cargo tanks, cofferdams, fuel tanks, ballasts and other spaces
- Cargo piping (loading/unloading and stripping systems)
- Other piping systems in connection with the cargo
- Drawing of the fire protection, detection and extinction systems.

2 Vessel and tank arrangements

2.1 General

2.1.1 A bilgesboat may be constructed as a single or double-hull tankvessel or as a tankvessel with inserted cargo tanks shown respectively in Ch 1, Sec 3, Fig 1 to Ch 1, Sec 3, Fig 3.

2.1.2 The scantlings and structural arrangements are to be in compliance with applicable requirements of Ch 1, Sec 3, [3] to Ch 1, Sec 3, [8].

2.2 Cargo piping

2.2.1 Pipes for loading and unloading shall be independent of any other piping of the vessel. No cargo piping shall be located below deck, except those inside the cargo tanks and inside the cargo pump room.

2.2.2 Piping for loading and unloading shall be clearly distinguishable from other piping, e.g. by means of colour marking.

2.2.3 The shore connections shall be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

2.2.4 Each shore connection of the vapour pipe and shore connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, shall be fitted with a shut-off device. However, each shore connection shall be fitted with a blind flange when it is not in operation.

2.2.5 Pipes for loading and unloading, and vapour pipes, shall not have flexible connections fitted with sliding seals when substances with corrosive properties are transported.

2.2.6 The distance referred to in Ch 3, Sec 3, [3.1.4]may be reduced to 3 m if a transverse bulkhead complying with Ch 3, Sec 1, [2.6.2] is situated at the end of the cargo area. The openings shall be provided with doors.

2.2.7 Filling pipes for cargo tanks are to extend down as close as possible to the bottom of the tank.

2.3 Cargo tank heating

2.3.1 Cargo tank heating system is to be installed as a separate system, equipped with a heat exchanger located in the cargo area. Where special heat transfer media are used this requirement may be dispensed with upon approval by the society.

2.4 Venting of cargo tanks

2.4.1 Every cargo tank is to be provided with open venting facilities.

2.5 Cargo tank overfill protection

2.5.1 The overfill protection must be actuated when the level in the tank reaches 97,5%.

2.6 Drives

2.6.1 On tankers of type N open internal combustion engines may be installed in the cargo area.

2.7 Slop tanks

2.7.1 The slop tanks shall be equipped with:

- a device for ensuring pressure equilibrium
- an ullage opening
- connections with stop valves, for pipes and hoses.

3 Electrical plant

3.1 Documents to be submitted

3.1.1 In addition to the documents required in accordance with the Regulations referred to in Pt C, Ch 2, Sec 1, [2], the following documents are to be submitted:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area

b) a list of the electrical equipment referred to in (a) above including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment shall be marked in red.

3.2 Electrical installations

3.2.1 Only distribution systems without return connection to the hull are permitted. This provision does not apply to:

- certain limited sections of the installations situated outside the cargo area (connections of starters of diesel engines)
- the device for checking the insulation level referred to in [3.2.2]
- active cathodic corrosion protection.

3.2.2 Every insulated distribution network shall be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

3.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried shall be taken into consideration.

3.3 Type and location of electrical equipment

3.3.1

a) Only measuring, regulation and alarm devices of the EEx (ia) type of protection may be installed in cargo tanks, residual cargo tanks and pipes for loading and unloading (comparable to zone 0)

b) Only the following equipment may be installed in the cofferdams, double-hull spaces, double bottoms and hold spaces (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "pressurised enclosure" type of protection
   - hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck
   - cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices

c) Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection
   - motors driving essential equipment such as ballast pumps; they shall be of the certified safe type

d) The control and protective equipment of the electrical equipment referred to in paragraphs (a), (b) and (c) above shall be located outside the cargo area if they are not intrinsically safe

e) The electrical equipment in the cargo area on deck (comparable to zone 1) shall be of the certified safe type.

3.3.2

a) Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area shall (comparable to zone 2) be at least of the "limited explosion risk" type.

b) This provision does not apply to:
   - lighting installations in the accommodation, except for switches near entrances to accommodation
   - radiotelephone installations in the accommodation or the wheelhouse

- electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:
  - These spaces are fitted with a ventilation system ensuring an overpressure of 0,1 kPa (0,001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system shall be located as far away as possible, however, not less than 6,00 m from the cargo area and not less than 2,00 m above the deck
  - The spaces are fitted with a gas detection system with sensors:
    - at the suction inlets of the ventilation system
    - directly at the top edge of the sill of the entrance doors of the accommodation and service spaces
  - The gas concentration measurement is continuous
  - When the gas concentration reaches 20% of the lower explosive limit, the ventilators are switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with (a) above, shall be switched off. These operations shall be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which shall comply at least with the "limited explosion risk" type. The switching-off shall be indicated in the accommodation and wheelhouse by visual and audible signals
  - The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of (a) above
  - The automatic switching-off device is set so that no automatic switch off may occur while the vessel is under way.

3.3.3 The electrical equipment which does not meet the requirements set out in Ch 3, Sec 3, [4.3.2] together with its switches shall be marked in red. The disconnection of such equipment shall be operated from a centralised location on board.

3.3.4 An electric generator which is permanently driven by an engine and which does not meet the requirements of Ch 3, Sec 3, [4.3.2], shall be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions shall be displayed near the switch.

3.3.5 Sockets for the connection of signal lights and gangway lighting shall be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting shall not be possible except when the sockets are not live.

3.3.6 The failure of the power supply for the safety and control equipment shall be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

3.4 Earthing

3.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service shall be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

The resistance between any point on the surface of the cargo tanks, cargo piping systems and equipment, and the hull of the vessel is not to be greater than 1 mega ohm.

3.4.2 The provisions of Ch 3, Sec 3, [4.4.1] above apply also to equipment having service voltages of less than 50 V.

3.4.3 Independent cargo tanks, metal intermediate bulk containers and tank-containers shall be earthed.

3.4.4 Metal intermediate bulk containers (IBCs) and tank-containers, used as residual cargo tanks or slop tanks, shall be capable of being earthed.

3.5 Electrical cables

3.5.1 All cables in the cargo area shall have a metallic sheath.

3.5.2 Cables and sockets in the cargo area shall be protected against mechanical damage.

3.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights, gangway lighting and submerged pumps on board bilgesboat.

3.5.4 Cables of intrinsically safe circuits shall only be used for such circuits and shall be separated from other cables not intended for being used in such circuits (e.g. they shall not be installed together in the same string of cables and they shall not be fixed by the same cable clamps).

3.5.5 For movable cables intended for signal lights, gangway lighting, and submerged pumps on board bilgesboat, only sheathed cables of type H 07 RN-F in accordance with standard IEC 60 245-4:1994 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm^2 shall be used. These cables shall be as short as possible and installed so that damage is not likely to occur.

3.6 Storage batteries

3.6.1 The installation of storage batteries inside dangerous areas is not permissible.

4 Hull scantlings

4.1 Integrated tanks

4.1.1 The scantlings of the hull structure are to be determined in compliance with Ch 1, Sec 3, substituting to the values of minimum thickness those given in Ch 3, Sec 3, [2.4.2], Ch 3, Sec 3, [2.4.3] and Ch 3, Sec 3, [2.4.4].

4.1.2 Plating

The minimum net thickness, in mm, of strength deck and bulkhead plating in integrated tanks is to be not less than the values given in Tab 1.

Unless constructed wholly of corrosion-resistant materials or fitted with an approved lining, the plating thickness should take into account the corrosivity of the cargo.

Table 1 : Minimum net thickness of integrated tanks

Plating	Minimum thickness, in mm
Strength deck	$t = 4,4 + 0,016\ L\ k^{0,5}$
Tank bulkhead	$t = 0,8L^{1/3}\ k^{0,5} + 3,6\ s$
Watertight bulkhead	$t = 0,68\ L^{1/3}k^{0,5} + 3,6\ s$
Wash bulkhead	$t = 0,64 + 0,011\ L\ k^{0,5} + 3,6\ s$

4.1.3 Ordinary stiffeners

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$t = 0,6\ L^{1/3}k^{0,5} + 3,6\ s$

4.1.4 Primary supporting members

The net thickness of plating which forms the web of primary supporting members is to be not less than the value obtained, in mm, from following formula:

$t = 1,14\ L^{1/3}k^{0,5}$

5 Buoyancy and stability

5.1 General

5.1.1 Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

5.1.2 General requirements of Pt B, Ch 2, Sec 6 shall be complied with.

5.1.3 The longitudinal centre bulkhead may be dispensed with only if sufficient stability is guaranted.

5.1.4 Proof of sufficient stability shall be furnished. This proof is not required for single hull vessels with cargo tanks the width of which is not more than 0,70B.

5.1.5 The basic values for the stability calculation (the vessel's lightweight and location of the centre of gravity) shall be determined in compliance with Pt B, Ch 2, Sec 6, [2.2].

5.1.6 Proof of intact stability is to be provided for all loading/unloading stages and for the final loading condition.

5.1.7 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, floatability after damage shall be proved for the most unfavourable loading condition. For this purpose, calculated proof of sufficient stability shall be established for critical intermediate stages of flooding and for the final stage of flooding.

Negative values of stability in intermediate stages of flooding may be accepted only if the continued range of curve of the righting lever in damaged condition indicates adequate positive values of stability.

5.2 Intact stability

5.2.1 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, the requirements for intact stability resulting from the damage stability calculation shall be fully complied with.

5.2.2 For vessels with cargo tanks of more than 0,70B in width, the following intact stability requirements are to be complied with, bearing in mind the influence of all free surfaces in tanks for all stages of loading and unloading:

- the value of the righting lever GZ is not less than 0,10 m within the range of positive stability, limited by the angle at which unprotected openings become submerged
- the area below the GZ curve within the range of positive stability, limited by the angle at which unprotected openings become submerged or 27 degrees whichever is the lesser, is to be not less than 0,024 m.radians
- the initial metacentric height GM_0 value is to be at least 0,10 m.

5.3 Damage stability

5.3.1 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, the following assumptions shall be taken into consideration for the damaged condition.

a) extent of side damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 0,59 m
   - vertical extent: from base line upwards without limit

b) extent of bottom damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 3 m
   - vertical extent: from base line to 0,49 m upwards, except for pump well.

c) Any bulkhead within the damaged area shall be assumed damaged, which means that the location of bulkheads shall be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

   The following provisions are applicable:
   - For bottom damage, adjacent athwartship compartments shall also be assumed flooded
   - the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways) shall, at the final stage of flooding, be not less than 0,10 m above the damage waterline.

5.3.2 In general, permeability shall be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used.

However, minimum values of permeability, μ, given in Tab 2 are to be used.

For the main engine room only a one-compartment standard needs be taken into account, i.e. the end bulkheads of the engine room shall be assumed as not damaged.

Table 2 : Permeability values, in %

Spaces	μ
Engine room	85
Accommodation spaces	95
Double bottoms, oil fuel tanks, ballast tanks, etc., depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught	0 or 95

5.3.3 The damage stability is generally regarded sufficient if:

- At the stage of equilibrium (in the final stage of flooding), the angle of heel is not greater than 12°.

  Non-watertight openings shall not be flooded before reaching the stage of equilibrium.

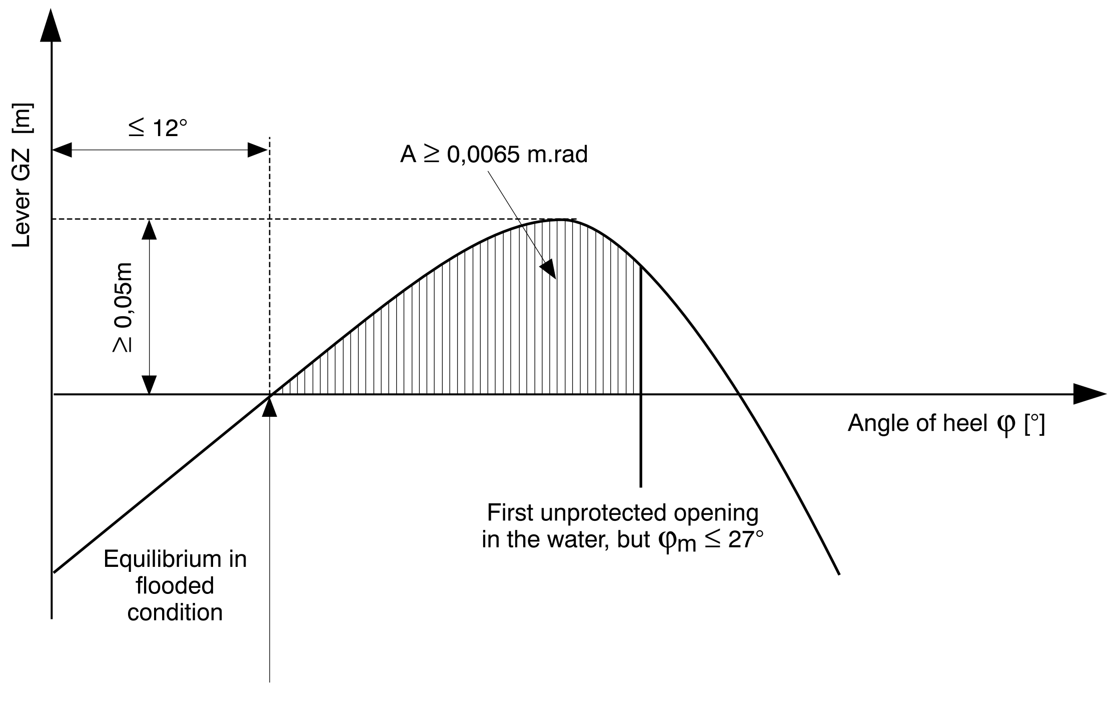
  If such openings are immersed before the stage of equilibrium, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

- The positive range of the righting lever curve beyond the stage of equilibrium has a righting lever of ≥ 0,05 m in association with an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability shall be satisfied up to immersion of the first non-watertight openings and in any event up to an angle of heel ≤ 27°. If non-watertight openings are immersed before that stage, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

5.3.4 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

5.3.5 Where cross- or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalisation shall not exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

Figure 1 : Proof of damage stability



SECTION 6 BUNKERBOAT

Symbols

L : Rule length, in m, defined in Pt B, Ch 1, Sec 1, [1]

B : Breadth, in m, defined in Pt B, Ch 1, Sec 1, [1]

D : Depth, in m, defined in Pt B, Ch 1, Sec 1, [1]

T : Draught, in m, defined in Pt B, Ch 1, Sec 1, [1]

t : Net thickness, in mm, of plating

k : Material factor defined in Pt B, Ch 2, Sec 1, [2.4] and Pt B, Ch 2, Sec 1, [3.4].

1 General

1.1 Application

1.1.1 Vessels complying with the requirements of this Section are eligible for the assignment of the additional class notationType N open - Bunkerboat as defined in Pt A, Ch 2, Sec 3, [4.2].

1.1.2 These Rules apply in addition to Ch 3, Sec 1 and Ch 1, Sec 3, the following requirements excepted:

- Ch 3, Sec 1, [2.6]
- Second paragraph of Ch 3, Sec 1, [2.8.4]
- Last sentence of Ch 3, Sec 1, [2.9.2]
- Last sentence of Ch 3, Sec 1, [2.9.3]
- Ch 3, Sec 1, [2.9.4]
- Last sentence of Ch 3, Sec 1, [2.11.2]
- Ch 3, Sec 1, [2.13.3]
- Ch 3, Sec 1, [3.9.4].

1.2 Documents for review/approval

1.2.1 The following drawings and documents are to be submitted in addition to those listed in Pt B, Ch 1, Sec 2:

- List of the products to be carried mentioning the loading and transport conditions
- Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar
- Drawing showing the location of the electrical equipment within the dangerous areas
- General drawing giving the arrangement of cargo tanks, cofferdams, fuel tanks, ballasts and other spaces
- Cargo piping (loading/unloading and stripping systems)
- Other piping systems in connection with the cargo
- Drawing of the fire protection, detection and extinction systems.

2 Vessel and cargo tank arrangements

2.1 General

2.1.1 A bunkerboat may be constructed as a single or double-hull tankvessel or as a tankvessel with inserted cargo tanks shown respectively in Ch 1, Sec 3, Fig 1 to Ch 1, Sec 3, Fig 3.

2.1.2 The scantlings and structural arrangements are to be in compliance with applicable requirements of Ch 1, Sec 3, [3] to Ch 1, Sec 3, [8].

2.2 Cargo piping

2.2.1 Pipes for loading and unloading shall be independent of any other piping of the vessel. No cargo piping shall be located below deck, except those inside the cargo tanks and inside the cargo pump room.

2.2.2 Piping for loading and unloading shall be clearly distinguishable from other piping, e.g. by means of colour marking.

2.2.3 The shore connections shall be located not less than 6 m from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

2.2.4 Each shore connection of the vapour pipe and shore connections of the pipes for loading and unloading, through which the loading or unloading operation is carried out, shall be fitted with a shut-off device. However, each shore connection shall be fitted with a blind flange when it is not in operation.

2.2.5 Pipes for loading and unloading, and vapour pipes, shall not have flexible connections fitted with sliding seals when substances with corrosive properties are transported.

2.2.6 The distance referred to in Ch 3, Sec 3, [3.1.4]may be reduced to 3 m if a transverse bulkhead complying with Ch 3, Sec 1, [2.6.2] is situated at the end of the cargo area. The openings shall be provided with doors.

2.2.7 Filling pipes for cargo tanks are to extend down as close as possible to the bottom of the tank.

2.3 Cargo tank heating

2.3.1 Cargo tank heating system is to be installed as a separate system, equipped with a heat exchanger located in the cargo area. Where special heat transfer media are used this requirement may be dispensed with upon approval by the society.

2.4 Venting of cargo tanks

2.4.1 Every cargo tank is to be provided with open venting facilities.

2.5 Cargo tank overfill protection

2.5.1 The overfill protection must be actuated when the level in the tank reaches 97,5%.

2.6 Drives

2.6.1 On tankers of type N open internal combustion engines may be installed in the cargo area.

2.7 Residual cargo tanks and slop tanks

2.7.1 The vessel shall be provided with at least one residual cargo tank and with slop tanks for slops which are not suitable for pumping. These tanks shall be located only in the cargo area.

Intermediate bulk containers (IBCs) or tank containers or portable tanks may be used instead of a fixed residual tank.

2.7.2 The maximum capacity of a residual cargo tank is 30 m^3.

2.7.3 The residual cargo tank shall be equipped with:

- a device for ensuring pressure equilibrium
- an ullage opening
- connections with stop valves, for pipes and hoses.

2.7.4 Residual cargo tanks, intermediate bulk containers, tank containers and portable tanks placed on the deck shall be located at a minimum distance from the hull equal to B/4.

3 Electrical plant

3.1 Documents to be submitted

3.1.1 In addition to the documents required in accordance with the Regulations referred to in Pt C, Ch 2, Sec 1, [2], the following documents are to be submitted:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area

b) a list of the electrical equipment referred to in (a) above including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment shall be marked in red.

3.2 Electrical installations

3.2.1 Only distribution systems without return connection to the hull are permitted. This provision does not apply to:

- certain limited sections of the installations situated outside the cargo area (connections of starters of diesel engines)
- device for checking the insulation level referred to in [3.2.2]
- active cathodic corrosion protection.

3.2.2 Every insulated distribution network shall be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

3.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried shall be taken into consideration.

3.3 Type and location of electrical equipment

3.3.1

a) Only measuring, regulation and alarm devices of the EEx (ia) type of protection may be installed in cargo tanks, residual cargo tanks and pipes for loading and unloading (comparable to zone 0)

b) Only the following equipment may be installed in the cofferdams, double-hull spaces, double bottoms and hold spaces (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "pressurised enclosure" type of protection
   - hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck
   - cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices

c) Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):
   - measuring, regulation and alarm devices of the certified safe type
   - lighting appliances of the "flame-proof enclosure" or "apparatus protected by pressurization" type of protection
   - motors driving essential equipment such as ballast pumps; they shall be of the certified safe type

d) The control and protective equipment of the electrical equipment referred to in paragraphs (a), (b) and (c) above shall be located outside the cargo area if they are not intrinsically safe

e) The electrical equipment in the cargo area on deck (comparable to zone 1) shall be of the certified safe type.

3.3.2

a) Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area shall (comparable to zone 2) be at least of the "limited explosion risk" type.

b) This provision does not apply to:
   - lighting installations in the accommodation, except for switches near entrances to accommodation
   - radiotelephone installations in the accommodation or the wheelhouse
   - electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:
     - These spaces are fitted with a ventilation system ensuring an overpressure of 0,1 kPa (0,001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system shall be located as far away as possible, however, not less than 6,00 m from the cargo area and not less than 2,00 m above the deck
     - The spaces are fitted with a gas detection system with sensors:
       - at the suction inlets of the ventilation system
       - directly at the top edge of the sill of the entrance doors of the accommodation and service spaces
     - The gas concentration measurement is continuous
     - When the gas concentration reaches 20% of the lower explosive limit, the ventilators are switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with (a) above, shall be switched off. These operations shall be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which shall comply at least with the "limited explosion risk" type. The switching-off shall be indicated in the accommodation and wheelhouse by visual and audible signals
     - The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of (a) above
     - The automatic switching-off device is set so that no automatic switch off may occur while the vessel is under way.

3.3.3 The electrical equipment which does not meet the requirements set out in Ch 3, Sec 3, [4.3.2] together with its switches shall be marked in red. The disconnection of such equipment shall be operated from a centralised location on board.

3.3.4 An electric generator which is permanently driven by an engine and which does not meet the requirements of Ch 3, Sec 3, [4.3.2], shall be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions shall be displayed near the switch.

3.3.5 Sockets for the connection of signal lights and gangway lighting shall be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting shall not be possible except when the sockets are not live.

3.3.6 The failure of the power supply for the safety and control equipment shall be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

3.4 Earthing

3.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service shall be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

The resistance between any point on the surface of the cargo tanks, cargo piping systems and equipment, and the hull of the vessel is not to be greater than 1 mega ohm.

3.4.2 The provisions of Ch 3, Sec 3, [4.4.1] above apply also to equipment having service voltages of less than 50 V.

3.4.3 Independent cargo tanks, metal intermediate bulk containers and tank-containers shall be earthed.

3.4.4 Metal intermediate bulk containers (IBCs) and tank-containers, used as residual cargo tanks or slop tanks, shall be capable of being earthed.

3.5 Electrical cables

3.5.1 All cables in the cargo area shall have a metallic sheath.

3.5.2 Cables and sockets in the cargo area shall be protected against mechanical damage.

3.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights, gangway lighting and submerged pumps on board bilgesboat.

3.5.4 Cables of intrinsically safe circuits shall only be used for such circuits and shall be separated from other cables not intended for being used in such circuits (e.g. they shall not be installed together in the same string of cables and they shall not be fixed by the same cable clamps).

3.5.5 For movable cables intended for signal lights, gangway lighting, and submerged pumps on board bilgesboat, only sheathed cables of type H 07 RN-F in accordance with standard IEC 60 245-4:1994 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm² shall be used. These cables shall be as short as possible and installed so that damage is not likely to occur.

3.6 Storage batteries

3.6.1 The installation of storage batteries inside dangerous areas is not permissible.

4 Hull scantlings

4.1 Integrated tanks

4.1.1 The scantlings of the hull structure are to be determined in compliance with Ch 1, Sec 3, substituting to the values of minimum thickness those given in Ch 3, Sec 3, [2.4.2], Ch 3, Sec 3, [2.4.3] and Ch 3, Sec 3, [2.4.4].

4.1.2 Plating

The minimum net thickness, in mm, of strength deck and bulkhead plating in integrated tanks is to be not less than the values given in Tab 1.

Unless constructed wholly of corrosion-resistant materials or fitted with an approved lining, the plating thickness should take into account the corrosivity of the cargo.

Table 1 : Minimum net thickness of integrated tanks

Plating	Minimum thickness, in mm
Strength deck	$t = 4,4 + 0,016\ L\ k^{0,5}$
Tank bulkhead	$t = 0,8L^{1/3}\ k^{0,5} + 3,6\ s$
Watertight bulkhead	$t = 0,68\ L^{1/3}k^{0,5} + 3,6\ s$
Wash bulkhead	$t = 0,64 + 0,011\ L\ k^{0,5} + 3,6\ s$

4.1.3 Ordinary stiffeners

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$t = 0,6\ L^{1/3}k^{0,5} + 3,6\ s$

4.1.4 Primary supporting members

The net thickness of plating which forms the web of primary supporting members is to be not less than the value obtained, in mm, from following formula:

$t = 1,14\ L^{1/3}k^{0,5}$

5 Buoyancy and stability

5.1 General

5.1.1 Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

5.1.2 General requirements of Pt B, Ch 2, Sec 6 shall be complied with.

5.1.3 The longitudinal centre bulkhead may be dispensed with only if sufficient stability is guaranted.

5.1.4 Proof of sufficient stability shall be furnished. This proof is not required for single hull vessels with cargo tanks the width of which is not more than 0,70B.

5.1.5 The basic values for the stability calculation (the vessel's lightweight and location of the centre of gravity) shall be determined in compliance with Pt B, Ch 2, Sec 6, [2.2].

5.1.6 Proof of intact stability is to be provided for all loading/unloading stages and for the final loading condition.

5.1.7 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, floatability after damage shall be proved for the most unfavourable loading condition. For this purpose, calculated proof of sufficient stability shall be established for critical intermediate stages of flooding and for the final stage of flooding.

Negative values of stability in intermediate stages of flooding may be accepted only if the continued range of curve of the righting lever in damaged condition indicates adequate positive values of stability.

5.2 Intact stability

5.2.1 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, the requirements for intact stability resulting from the damage stability calculation shall be fully complied with.

5.2.2 For vessels with cargo tanks of more than 0,70B in width, the following intact stability requirements are to be complied with, bearing in mind the influence of all free surfaces in tanks for all stages of loading and unloading:

- the value of the righting lever GZ is not less than 0,10 m within the range of positive stability, limited by the angle at which unprotected openings become submerged
- the area below the GZ curve within the range of positive stability, limited by the angle at which unprotected openings become submerged or 27 degrees whichever is the lesser, is to be not less than 0,024 m.radians
- the initial metacentric height GM_0 value is to be at least 0,10 m.

5.3 Damage stability

5.3.1 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, the following assumptions shall be taken into consideration for the damaged condition.

a) extent of side damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 0,59 m
   - vertical extent: from base line upwards without limit

b) extent of bottom damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 3 m
   - vertical extent: from base line to 0,49 m upwards, except for pump well.

c) Any bulkhead within the damaged area shall be assumed damaged, which means that the location of bulkheads shall be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

The following provisions are applicable:

- For bottom damage, adjacent athwartship compartments shall also be assumed flooded
- the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways) shall, at the final stage of flooding, be not less than 0,10 m above the damage waterline.

5.3.2 In general, permeability shall be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used.

However, minimum values of permeability, μ, given in Tab 2 are to be used.

For the main engine room only a one-compartment standard needs be taken into account, i.e. the end bulkheads of the engine room shall be assumed as not damaged.

Table 2 : Permeability values, in %

Spaces	μ
Engine room	85
Accommodation spaces	95
Double bottoms, oil fuel tanks, ballast tanks, etc., depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught	0 or 95

5.3.3 The damage stability is generally regarded sufficient if:

- At the stage of equilibrium (in the final stage of flooding), the angle of heel is not greater than 12°.

  Non-watertight openings shall not be flooded before reaching the stage of equilibrium.

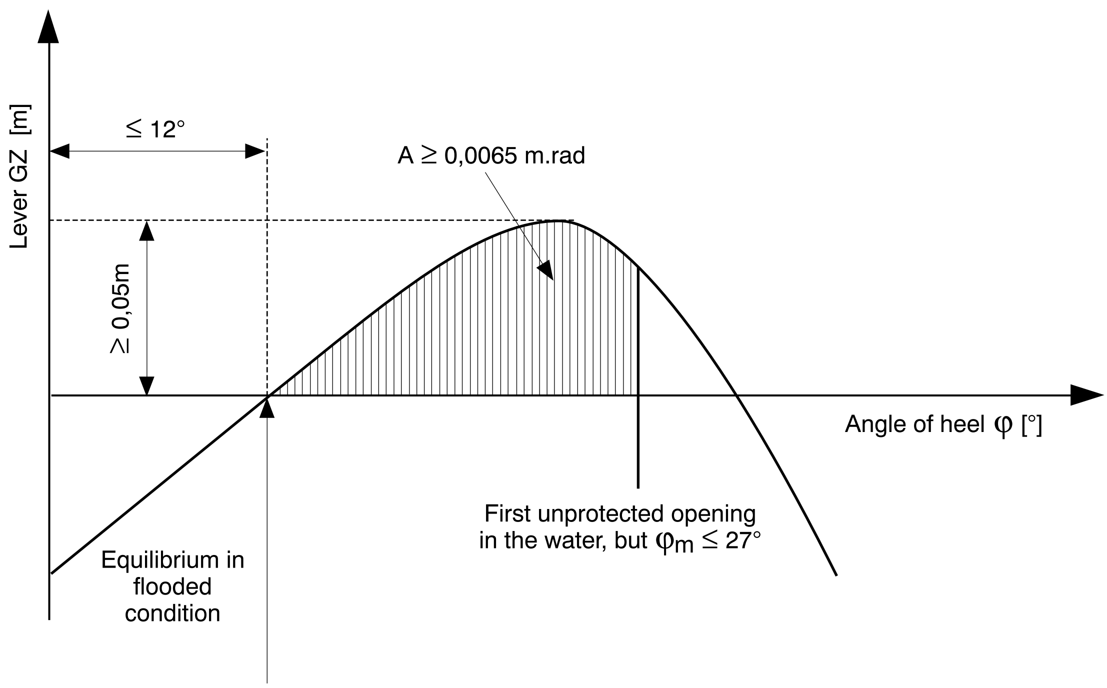
  If such openings are immersed before the stage of equilibrium, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

- The positive range of the righting lever curve beyond the stage of equilibrium has a righting lever of ≥ 0,05 m in association with an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability shall be satisfied up to immersion of the first non-watertight openings and in any event up to an angle of heel ≤ 27°. If non-watertight openings are immersed before that stage, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

5.3.4 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

5.3.5 Where cross- or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalisation shall not exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

Figure 1 : Proof of damage stability



SECTION 7 DG

1 General

1.1 Application

1.1.1 The additional class notation **DG** is assigned, in compliance with Pt A, Ch 2, Sec 3, [3.2.3], to vessels intended to carry dry dangerous goods.

1.1.2 Vessels dealt with in this Section are to comply with the requirements stated under Part A, Part B and Part C, as applicable, and with the requirements of this Section, which are specific to dry cargo vessels for the transport of dangerous goods.

1.2 Documents for review/approval

1.2.1 The following drawings and documents are to be submitted in addition to those listed in Pt B, Ch 1, Sec 2:

- List of the products to be carried mentioning the loading and transport conditions
- Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar
- General drawing giving the arrangement of cargo holds, fuel tanks, ballasts and other spaces
- Drawing showing the location of the electrical equipment within the dangerous areas
- Drawing of the fire protection, detection and extinction systems.

2 Mode of carriage of goods

2.1 Carriage of packages

2.1.1 Unless otherwise specified, the masses given for packages shall be the gross masses. When packages are carried in containers or vehicles, the mass of the container or vehicle shall not be included in the gross mass of such packages.

2.2 Carriage in containers, in intermediate bulk containers (IBCs) and in large packagings, in MEGCs, in portable tanks and in tank-containers

2.2.1 The carriage of containers, IBCs, large packagings, MEGCs, portable tanks and tankcontainers shall be in accordance with the ADN/ADNRprovisions applicable to the carriage of packages.

2.3 Vehicles and wagons

2.3.1 The carriage of vehicles and wagons shall be in accordance with the ADN/ADNR provisions applicable to the carriage of packages.

2.4 Carriage in bulk

2.4.1 The carriage of dangerous goods in bulk is only permitted if the code "B" appears in column (8) of Table A, Chapter 3.2., Part 6 of ADN/ADNR.

3 Vessels

3.1 Permitted vessels

3.1.1 Vessels carrying dangerous goods in quantities not exceeding those indicated in 7.1.4.1.1, or, if applicable, in 7.1.4.1.2 of ADN/ADNR are permitted to carry dangerous goods in restricted quantities. The maximum permitted quantities are specified in ADN/ADNR Regulations, Part 7, 7.1.4.1 or in other Regulations implemented by the Local Authority. Vessels for the transport of dangerous goods in restricted quantities have to comply with the applicable Rules of [4].

3.2 Structural configuration

3.2.1 Vessels for the transport of dangerous goods of classes 2, 3, 4.1, 5.2, 6.1, 7, 8 or 9, with the exception of those for which a No. 1 model label is required in column (5) of table A of Chapter 3.2, Part 3 of ADN/ADNR to be carried in quantities greater than those indicated in [3.1.1] have to be built as double-hull dry cargo vessels. These vessels have also to comply with the applicable additional Rules of [5].

4 Design, construction and arrangement

4.1 Materials of construction

4.1.1 The hull has to be constructed of shipbuilding steel or other metal, provided that this metal has at least equivalent mechanical properties and resistance to the effects of temperature and fire.

4.2 Cargo holds

4.2.1 Each cargo hold shall be bounded fore and aft by watertight metal bulkheads.

4.2.2 The cargo holds shall have no common bulkhead with the fuel oil tanks.

4.2.3 The bottom of the holds shall be such as to permit them to be cleaned and dried.

4.2.4 Hatch covers for the cargo holds must be spraytight and weathertight. The use of waterproof tarpaulins is also possible to cover the cargo holds, if the tarpaulin shall not readily ignite.

4.2.5 Heating installation

It is not allowed to arrange heating appliances in the cargo holds.

4.3 Ventilation

4.3.1 Ventilation of each hold shall be provided by means of two mutually independent extraction ventilators having a capacity of not less than five changes of air per hour based on the volume of the empty hold. The ventilator fan shall be designed so that no sparks may be emitted on contact of the impeller blades with the housing and no static electricity may be generated. The extraction ducts shall be positioned at the extreme ends of the hold and extend down to not more than 50 mm above the bottom. The extraction of gases and vapours through the duct shall also be ensured for carriage in bulk.

If the extraction ducts are movable they shall be suitable for the ventilator assembly and capable of being firmly fixed. Protection shall be ensured against bad weather and spray. The air intake shall be ensured during ventilation.

4.3.2 The ventilation system of a hold shall be arranged so that dangerous gases cannot penetrate into the accommodation, wheelhouse or engine rooms.

4.3.3 Ventilation shall be provided for the accommodation and for service spaces.

4.4 Accommodation and service spaces

4.4.1 The accommodation shall be separated from the holds by metal bulkheads having no openings.

4.4.2 Gastight closing appliances shall be provided for openings in the accommodation and wheelhouse facing the holds.

4.4.3 No entrances or openings of the engine rooms and service spaces shall face the protected area.

4.5 Water ballast

4.5.1 Double-hull spaces and double bottoms may be used for water ballast.

4.6 Engines

4.6.1 Only internal combustion engines running on fuel having a flashpoint above 55°C are allowed.

4.6.2 The air vents in the engine rooms and the air intakes of the engines which do not take air in directly from the engine room shall be located not less than 2,00 m from the protected area.

4.6.3 Sparking shall not be possible in the protected area.

4.7 Oil fuel tanks

4.7.1 The double bottoms within the cargo hold area may be used as oil fuel tanks provided their depth is not less than 0,6 m. Fuel oil pipes and openings to such tanks are not permitted in the holds.

4.7.2 The air pipes of all oil fuel tanks shall be led to 0,50 m above the open deck. Their open ends and the open ends of the overflow pipes leaking to the deck shall be fitted with a protecting screen.

4.8 Exhaust pipes

4.8.1 Exhausts shall be evacuated from the vessel into the open air either upwards through an exhaust pipe or through the shell plating. The exhaust outlet shall be located not less than 2,00 m from the hatchway openings. The exhaust pipes of engines shall be arranged so that the exhausts are led away from the vessel. The exhaust pipes shall not be located within the cargo area.

4.8.2 Exhaust pipes shall be provided with a device preventing the escape of sparks, e.g. spark arresters.

4.9 Stripping installation

4.9.1 The stripping pumps intended for the holds shall be located in the protected area. This requirement shall not apply when stripping is effected by eductors.

4.10 Type and location of electrical equipment

4.10.1 It shall be possible to isolate the electrical equipment in the protected area by means of centrally located switches except where:

- in the holds, it is of a certified safe type corresponding at least to temperature class T4 and explosion group II B and
- in the protected area on deck it is of the limited explosion risk type.

The corresponding electrical circuits shall have control lamps to indicate whether or not the circuits are live.

The switches shall be protected against unintended unauthorized operation. The sockets used in this area shall be so designed as to prevent connections being made except when they are not live.

Submerged pumps installed or used in the holds shall be of the certified safe type at least for temperature class T4 and explosion group II B.

4.10.2 Electric motors for hold ventilators which are arranged in the air flow shall be of the certified safe type.

4.10.3 Sockets for the connection of signal lights, gangway lighting and containers shall be fitted to the vessel close to the signal mast or the gangway or the containers. Sockets intended to supply the submerged pumps and hold ventilators shall be permanently fitted to the vessel in the vicinity of the hatches.

4.11 Electric cables

4.11.1 Cables and sockets in the cargo area shall be protected against mechanical damage.

4.11.2 Movable cables are prohibited in the protected area, except for intrinsically safe electric circuits or for the supply of signal lights and gangway lighting, for containers, for submerged pumps, hold ventilators and for electrically operated cover gantries.

4.11.3 For movable cables permitted in accordance with [4.11.2], only rubber-sheathed cables of type H07 RN-F in accordance with standard IEC-60 245-4:1994 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm^2, shall be used. These cables shall be as short as possible and installed so that accidental damage is not likely to occur.

4.12 Metal wires, masts

4.12.1 All metal wires passing over the holds and all masts shall be earthed, unless they are electrically bonded to the metal hull of the vessel through their installation.

4.13 Storage batteries

4.13.1 The installation of storage batteries inside the protected area is not permissible.

4.14 Admittance on board

4.14.1 Notice boards, clearly legible from either side of the vessel, displaying the prohibition of admittance on board and prohibition of smoking on board have to be installed.

5 Additional rules applicable to double hull vessels

5.1 Application

5.1.1 The requirements of this Article are applicable to double hull vessels intended to carry dangerous goods in quantities exceeding those indicated in 7.1.4.1.1 of ADN/ADNR Regulations.

5.2 Holds

5.2.1 The vessel shall be built as a double-hull vessel with double-hull spaces and double bottom within the protected area.

5.2.2 The distance between the sides of the vessel and the longitudinal bulkheads of the cargo hold shall be not less than 0,80 m.

This distance may be reduced to a distance of 0,60 m if the following reinforcements of the hull structure are provided:

a) If the vessel's sides are constructed according to the longitudinal framing system, the frame spacing shall not exceed 0,60 m and the longitudinal frames have to be supported by web frames with a maximum spacing of 1,80 m. These intervals may be increased if the construction is correspondingly reinforced.

b) If the vessel's sides are constructed according to the transverse framing system either:

   - two longitudinal side shell stringersshall be fitted; the distance between the two stringers and between the uppermost stringer and the gangboard shall not exceed 0,80 m; the depth of the stringers shall be at least equal to that of the transverse frames and the cross-section of the face plate shall be not less than 15 cm^2.

     The longitudinal stringers shall be supported by web frames with lightening holes similar to plate floors in the double bottom and spaced 3,60 m apart.The transverse shell frames and the hold bulkhead vertical stiffeners shall be connected at the bilge by a bracket plate with height of not less than 0,90 m and thickness of the floos; or

   - web frames with lightning holes similar to the double bottom plate floors shall be arranged on each transverse frame.

c) The gangboards shall be supported by transverse bulkheads or cross ties spaced not more than 32 m apart.

   Alternative arrangements will be considered by the Society on a case-by-case basis.

5.2.3 The depth of the double bottom shall be at least 0.50 m. The depth below the suction wells may, however, be locally reduced, but the space between the bottom of the suction well and the bottom of the vessel floor shall be at least 0.40 m. If spaces are between 0.40 m and 0.49 m, the surface area of the suction well shall not exceed 0.5 m^2.

The capacity of the suction wells must not exceed 0.120 m^3.

5.3 Emergency exit

5.3.1 Spaces not flooded of which the entrances or exits are partly or fully immersed in damage condition shall be provided with an emergency exit not less than 0,10 m above the waterline. This does not apply to forepeak and aftpeak.

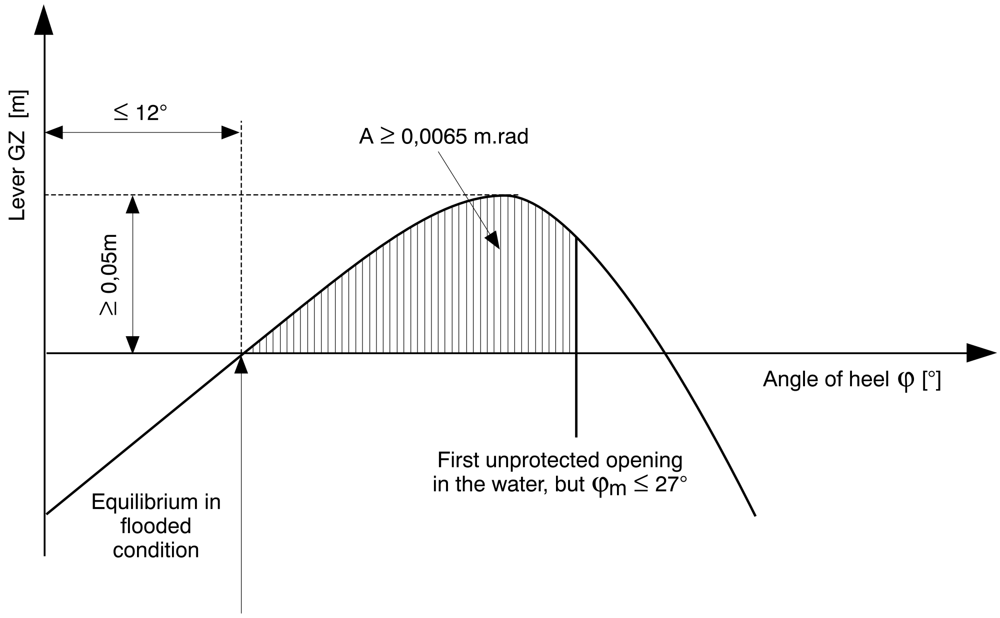
5.4 Buoyancy and stability

5.4.1 General

Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

General requirements of Pt B, Ch 2, Sec 6 are to be complied with.

Figure 1 : Proof of damage stability



5.4.2 Intact stability

The requirements for intact stability resulting from the damage stability calculation shall be fully complied with.

For the carriage of containers, proof of sufficient stability shall also be furnished in accordance with Ch 2, Sec 6, [4].

5.4.3 Damage stability

Proof of floatability in the damage condition is to be furnished for the most unfavourable loading condition.

For this purpose, calculated proof of sufficient stability shall be established for critical intermediate stages of flooding and for the final stage of flooding. For critical intermediate stages of flooding, the righting lever curve has to show, beyond the equilibrium stage, a righting lever ≥ 0,03 m and a positive range ≥ 5°.

The damage stability is generally regarded sufficient if (see Fig 1):

a) At the stage of equilibrium (in the final stage of flooding), the angle of heel is not greater than 12°.

   Non-watertight openings shall not be flooded before reaching the stage of equilibrium.

   If such openings are immersed before the stage of equilibrium, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

b) The postive range of the righting lever curve beyond the stage of equilibrium has a righting lever of ≥ 0,05 m in association with an area under the curve of ≥ 0,0065 m.rad. The minimum values of stability shall be satisfied up to immersion of the first non-weathertight openings and in any event up to an angle of heel = 27°. If non-weathertight openings are immersed before that stage, the corresponding spaces shall be considered flooded for the purpose of stability calculation.

If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

Where cross or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalisation shall not exceed 15 minutes, if during the intermediate stages of flooding sufficient stability has been proved.

The damage condition calculation is to be based on the following assumptions:

a) extent of side damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 0,59 m
   - vertical extent: from base line upwards without limit

b) extent of bottom damage:
   - longitudinal extent: at least 0,10L but not less than 5 m
   - transverse extent: 3 m
   - vertical extent: from base line to 0,49 m upwards, except for pump well.

c) Any bulkhead within the damaged area shall be assumed damaged, which means that the location of bulkheads shall be chosen to ensure that the vessel remains afloat after the flooding of two or more ajdacent compartments in the longitudinal direction.

   The following provisions are applicable:
   - For bottom damage, adjacent athwartship compartments shall also be assumed as flooded.
   - the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways) shall, at the final stage of flooding, be not less than 0,10 m above the damage waterline.

In general, permeability shall be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used.

However, minimum values of permeability, μ, given in Tab 1 are to be used.

For the main engine room only a one-compartment status needs to be taken into account, i.e. the end bulkheads of the engine room shall be assumed not damaged.

5.4.4 Carriage of containers

Vessels carrying container shall be in compliance with Ch 2, Sec 6, [4].

Table 1 : Permeability values, in %

Spaces	μ
Engine room	85
Accommodation spaces	95
Double bottoms, oil fuel tanks, ballast tanks, etc., depending on whether, according to their function, they have to be assumed as full or empty for the vessel floating at the maximum permissible draught	0 or 95

SECTION 8 DGL

1 General

1.1 Application

1.1.1 The additional class notation **DGL** is assigned, in compliance with Pt A, Ch 2, Sec 3, [3.2.3], to propulsion vessels involved in a pushed convoy or a side-by-side formation comprising a tank vessel carrying dangerous substances.

1.1.2 These vessels are to comply with the requirements stated under Part A, Part B and Part C, as applicable, and with the requirements of this Section, which are specific to additional class notation **DGL**.

2 Vessel arrangements

2.1 General

2.1.1 When a pushed convoy or a side-by-side formation comprises a tank vessel carrying dangerous substances, vessels used for propulsion shall meet the requirements stated under [2.1.3] and [2.2] to [2.14].

2.1.2 Vessels (in the convoy or side-by-side formation) not carrying dangerous goods shall comply with the requirements of Ch 3, Sec 9, [2].

2.1.3 Materials

The vessel's hull shall be constructed of shipbuilding steel or other at least equivalent metal.

All permanently fitted materials in the accommodation or wheelhouse, with the exception of furniture, shall not readily ignite. They shall not evolve fumes or toxic gases in dangerous quantities, if involved in a fire.

The use of plastic material for vessel's boats is permitted only if the material does not readily ignite.

2.2 Protection against penetration of gases

2.2.1 The vessel shall be designed so as to prevent gases from penetrating into the accommodation and the service spaces.

2.2.2 Outside the cargo area, the lower edges of door-openings in the sidewalls of superstructures and the coamings of access hatches to under-deck spaces shall have a height of not less than 0,50 m above the deck.

This requirement needs not be complied with if the wall of the superstructures facing the cargo area extends from one side of the vessel to the other and has doors the sills of which have a height of not less than 0,50 m. The height of this wall shall not be less than 2,00 m. In this case, the lower edges of door-openings in the sidewalls of superstructures and the coamings of access hatches behind this wall shall have a height of not less than 0,10 m. The sills of engine room doors and the coamings of its access hatches shall, however, always have a height of not less than 0,50 m.

2.3 Ventilation

2.3.1 Ventilation of accommodation shall be possible.

Notice boards shall be fitted at the ventilation inlets indicating the conditions when they shall be closed. Any ventilation inlets of accommodation leading outside shall be fitted with fire flaps. Such ventilation inlets shall be located not less than 2,00 m from the cargo area.

2.4 Engine rooms

2.4.1 Internal combustion engines for the vessel's propulsion as well as internal combustion engines for auxiliary machinery shall be located outside the cargo area. Entrances and other openings of engine rooms shall be at a distance of not less than 2,00 m from the cargo area.

The engine rooms shall be accessible from the deck; the entrances shall not face the cargo area. Where the doors are not located in a recess whose depth is at least equal to the door width, the hinges shall face the cargo area.

2.5 Superstructures

2.5.1 The superstructures and wheelhouses must be placed outside the cargo area, i.e. forward of the foremost or aft of the aftermost cofferdam bulkhead.

Parts of the wheelhouse at a height of at least 1 m above the wheelhouse floor may tilt forward.

Entrances and openings are not to face the cargo area. Doors and windows hinges on the sides of superstructures must be mounted on the side of the door or window facing the cargo area so that, when they are open, vapours coming from the cargo area are not led into the superstructure.

Entrances from the deck and openings of spaces facing the weather shall be capable of being closed.

The following instruction shall be displayed at the entrance of such spaces:

"DO NOT OPEN DURING LOADING, UNLOADING OR GAS-FREEING WITHOUT PERMISSION FROM THE MASTER. CLOSE IMMEDIATELY."

Entrances and windows of superstructures and accommodation spaces which can be opened as well as other openings of these spaces must be located not less than 2,00 m from the cargo area. No wheelhouse doors and windows shall be located within 2,00 m from the cargo area, except where there is no direct connection between the wheelhouse and the accommodation.

2.6 Engines

2.6.1 Only internal combustion engines running on fuel with a flashpoint of more than 55°C are allowed.

Ventilation inlets of the engine room and, when the engines do not take in air directly from the engine room, air intakes of the engines shall be located not less than 2,00 m from the cargo area.

Machinery producing sparks shall not be located within the cargo area.

The surface temperature of the outer parts of engines used during loading or unloading operations, as well as that of their air inlets and exhaust ducts shall not exceed the allowable temperature according to the temperature class. This provision does not apply to engines installed in service spaces provided the provisions of [2.12.1] c) are fully complied with. Not required for vessels outside AND/ADNR.

The ventilation in the closed engine room shall be designed so that, at an ambient temperature of 20°C, the average temperature in the engine room does not exceed 40°C.

2.7 Fuel oil tanks

2.7.1 The open ends of the air pipes of each liquid fuel oil tank shall extend to 0,5 m above the open deck. These open ends and the open ends of overflow pipes leading to the deck shall be provided with a protecting screen.

2.8 Exhaust pipes

2.8.1 The exhaust outlet shall be located not less than 2,00 m from the cargo area. The exhaust pipes shall not be located within the cargo area.

Exhaust pipes shall be provided with spark arresters.

2.9 Fire-extinguishing arrangements

2.9.1 In addition to general fire rules of Pt C, Ch 1, Sec 14, each vessel shall comply with additional requirements stated under Ch 3, Sec 1, [4]. However, one single fire or ballast pump shall be sufficient.

2.10 Fire and naked light

2.10.1 The outlets of funnels shall be located not less than 2,00 m from the cargo area. Arrangements shall be provided to prevent the escape of sparks and the entry of water.

Heating, cooking and refrigerating appliances shall not be fuelled with liquid fuels, liquid gas or solid fuels. The installation in the engine room or in another separate space of heating appliances fuelled with liquid fuel having a flashpoint above 55°C is, however, permitted. Cooking and refrigerating appliances are permitted only in the accommodation.

Only electrical lighting appliances are permitted.

2.11 Electrical installations

2.11.1 Only distribution systems without return connection to the hull are permitted.

This provision does not apply to:

- certain limited sections of the installations situated outside the cargo area (e.g. connections of starters of diesel engines)
- the device for checking the insulation level referred to below
- the installations for cathodic protection.

Every insulated distribution network shall be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried in columns (15) and (16) of Ch 3, App 1 shall be taken into consideration.

2.12 Type and location of electrical equipment

2.12.1 Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area shall (comparable to zone 2) be at least of the "limited explosion risk" type.

This provision does not apply to:

a) lighting installations in the accommodation, except for switches near entrances to accommodation

b) radiotelephone installations in the accommodation or the wheelhouse

c) electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:

   - These spaces are fitted with a ventilation system ensuring an overpressure of 0,1 kPa (0,001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system shall be located as far away as possible, however, not less than 6,00 m from the cargo area and not less than 2,00 m above the deck
   - The spaces are fitted with a gas detection system with sensors:
     - at the suction inlets of the ventilation system
     - directly at the top edge of the sill of the entrance
     - doors of the accommodation and service spaces
   - The gas concentration measurement is continuous
   - When the gas concentration reaches 20% of the lower explosive limit, the ventilators are switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with first paragraph above, shall be switched off

     These operations shall be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which shall comply at least with the "limited explosion risk" type. The switching-off shall be indicated in the accommodation and wheelhouse by visual and audible signals

- The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of first paragraph above
- The automatic switch-off device is set so that no automatic switching-off may occur while the vessel is under way.

2.12.2 The electrical equipment which does not meet the requirements set out in [2.12.1] together with its switches shall be marked in red. The disconnection of such equipment shall be operated from a centralised location on board.

2.12.3 An electric generator which is permanently driven by an engine and which does not meet the requirements of [2.12.1], shall be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions shall be displayed near the switch.

2.12.4 Sockets for the connection of signal lights and gangway lighting shall be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting shall not be possible except when the sockets are not live.

2.13 Electrical cables

2.13.1 For movable cables intended for signal lights, gangway lighting, and submerged pumps on board oil separator vessels, only sheathed cables of type H 07 RN-F in accordance with 245 IEC 66 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm^2 shall be used.

These cables shall be as short as possible and installed so that damage is not likely to occur.

2.14 Admittance on board

2.14.1 Notice boards, clearly legible from either side of the vessel, displaying the prohibition of admittance on board and prohibition of smoking on board have to be installed.

SECTION 9 DGD

1 General

1.1 Application

1.1.1 The additional class notation **DGD** is assigned, in compliance with Pt A, Ch 2, Sec 3, [3.2.3], to propulsion vessels involved in a pushed convoy or a side-by-side formation comprising a dry cargo vessel carrying dangerous substances.

1.1.2 These vessels are to comply with the requirements stated under Part A, Part B and Part C, as applicable, and with the requirements of this Section, which are specific to additional class notation **DGD**.

2 Vessel arrangements

2.1 General

2.1.1 When a pushed convoy or a side-by-side formation comprises a dry cargo vessel carrying dangerous substances, vessels used for propulsion shall meet the requirements stated under [2.1.2] and [2.2] to [2.11].

2.1.2 Materials

The vessel's hull shall be constructed of shipbuilding steel or other metal, provided that this metal has at least equivalent mechanical properties and resistance to the effects of temperature and fire.

2.2 Ventilation

2.2.1 Ventilation shall be provided for the accommodation and for service spaces.

2.3 Superstructures

2.3.1 Gastight closing appliances shall be provided for openings in the accommodation and wheelhouse facing the holds.

No entrances or openings of the engine rooms and service spaces shall face the protected area.

2.4 Engines

2.4.1 Only internal combustion engines running on fuel having a flashpoint above 55°C are allowed.

The air vents of the engine rooms and the air intakes of the engines which do not take air in directly from the engine room shall be located not less than 2,00 m from the protected area.

Equipment producing sparks shall not be located in the protected area.

2.5 Fuel oil tanks

2.5.1 Double bottoms within the hold area may be arranged as fuel oil tanks provided their depth is not less than 0,6 m. Fuel oil pipes and openings to such tanks are not permitted in the holds.

The air pipes of all fuel oil tanks shall be led to 0,50 m above the open deck. Their open ends and the open ends of the overflow pipes leaking to the deck shall be fitted with a protective device consisting of a gauze gird or a perforated plate.

2.6 Exhaust pipes

2.6.1 Exhaust shall be evacuated from the vessel into the open air either upwards through an exhaust pipe or through the shell plating. The exhaust outlet shall be located not less than 2,00 m from the hatchway openings. The exhaust pipes of engines shall be arranged so that the exhausts are led away from the vessel. The exhaust pipes shall not be located within the protected area.

Exhaust pipes shall be provided with a device preventing the escape of sparks, e.g. spark arresters.

2.7 Fire-extinguishing arrangements

2.7.1 In addition to general fire rules of Pt C, Ch 1, Sec 14, each vessel shall comply with additional requirements stated under Ch 3, Sec 1, [4].

2.8 Fire and naked light

2.8.1 The outlets of funnels shall be located not less than 2,00 m from the hatchway openings. Arrangements shall be provided to prevent the escape of sparks and the entry of water.

Heating, cooking and refrigerating appliances shall not be fuelled with liquid fuels, liquid gas or solid fuels. The installation in the engine room or in another separate space of heating appliances fuelled with liquid fuel having a flashpoint above 55°C is, however, permitted. Cooking and refrigerating appliances are permitted only in wheelhouses with metal floor and in the accommodation.

Electric lighting appliances only are permitted outside the accommodation and the wheelhouse.

2.9 Type and location of electrical equipment

2.9.1 Electric motors for hold ventilators which are arranged in the air flow shall be of the certified safe type.

Sockets for the connection of signal lights, gangway lighting and containers shall be fitted to the vessel close to the signal mast or the gangway or the containers. Sockets intended to supply the submerged pumps and hold ventilators shall be permanently fitted to the vessel in the vicinity of the hatches.

2.10 Electric cables

2.10.1 Cables and sockets in the protected area shall be protected against mechanical damage.

2.10.2 Movable cables are prohibited in the protected area, except for intrinsically safe electric circuits or for the supply of signal lights and gangway lighting, for containers, for submerged pumps, hold ventilators and for electrically operated cover gantries.

2.10.3 For movable cables permitted in accordance with [2.10.2], only rubber-sheathed cables of type H07 RN-F in accordance with 245 IEC 66 or cables of at least equivalent design having conductors with a cross-section of not less than 1,5 mm^2, shall be used. These cables shall be as short as possible and installed so that accidental damage is not likely to occur.

2.11 Admittance on board

2.11.1 Notice boards, clearly legible from either side of the vessel, displaying the prohibition of admittance on board and prohibition of smoking on board have to be installed.

APPENDIX 1 ALTERNATIVE CONSTRUCTIONS

1 General

1.1

1.1.1 The maximum permissible capacity of a cargo tank in accordance with Ch 3, Sec 1, [2.7] may be exceeded and the minimum distances in accordance with Ch 3, Sec 2, [2.1] and Ch 3, Sec 3, [2.2] may be deviated from provided that the provisions of this Appendix are complied with. The capacity of a cargo tank shall not exceed 1000 m^3.

1.1.2 Tank vessels whose cargo tanks exceed the maximum allowable capacity or where the distance between the side wall and the cargo tank is smaller than required, shall be protected through a more crashworthy side structure. This shall be proved by comparing the risk of a conventional construction (reference construction), complying with the Society's Rules with the risk of a crashworthy construction (alternative construction).

1.1.3 When the risk of the more crashworthy construction is equal to or lower than the risk of the conventional construction, equivalent or higher safety is proven. The equivalent or higher safety shall be proven in accordance with [3].

2 Approach

2.1 Probability of cargo tank rupture

2.1.1 The probability of cargo tank rupture due to a collision and the area around the vessel affected by the cargo outflow as a result thereof are the governing parameters. The risk is described by the following formula:

R = P.C

where:

R	:	Risk, in m^2
p	:	Probability of cargo tank rupture
C	:	Consequence (measure of damage) of cargo tank rupture, in m^2

2.1.2 The probability P of cargo tank rupture depends on the probability distribution of the available collision energy represented by vessels, which the victim is likely to encounter in a collision, and the capability of the struck vessel to absorb collision energy without cargo tank rupture. A decrease of this probability can be achieved by means of a more crashworthy side structure.

The consequence C of cargo spillage resulting from cargo tank rupture is expressed as an affected area around the struck vessel.

2.1.3 The procedure according to [3] shows how tank rupture probabilities shall be calculated as well as how the collision energy absorbing capacity of side structure and a consequence increase shall be determined.

3 Calculation procedure

3.1 General

3.1.1 The calculation procedure shall follow 13 basic steps. Steps 2 through 10 shall be carried out for both the alternative design and the reference design. Tab 1 shows the calculation of the weighted probability of cargo tank rupture.

3.2 Step 1

3.2.1 Besides the alternative design, which is used for cargo tanks exceeding the maximum allowable capacity or a reduced distance between the side wall and the cargo tank as well as a more crashworthy side structure, a reference design with at least the same dimensions (length, width, depth, displacement) shall be drawn up. This reference design shall fulfil the requirements specified in Ch 3, Sec 2 (Type G), Ch 3, Sec 3 (Type C) or Ch 3, Sec 4 (Type N).

3.3 Step 2

3.3.1 The relevant typical collision locations i=1 through n shall be determined. Tab 1 depicts the general case where there are 'n' typical collision locations.

The number of typical collision locations depends on the vessel design. The choice of the collision locations shall be accepted by the Society.

3.3.2 Vertical collision locations

a) Tank vessels type C and N

1) The determination of the collision locations in the vertical direction depends on the draught differences between striking and struck vessel, which is limited by the maximum and minimum draughts of both vessels and the construction of the struck vessel. This can be depicted graphically through a rectangular area which is enclosed by the values of the maximum and minimum draught of both striking and struck vessel (see Fig 1).

2) Each point in this area represents a possible draught combination. T_{1max} is the maximum draught and T_{1min} is the minimum draught of the striking vessel, while T_{2max} and T_{2min} are the corresponding minimum and maximum draughts of the struck vessel.

Each draught combination has an equal probability of occurrence.

3) Points on each inclined line in Fig 1 indicate the same draught difference. Each of these lines reflects a vertical collision location. In the example in figure 1 three vertical collision locations are defined, depicted by three areas. Point P_1 is the point where the lower edge of the vertical part of the push barge or V-bow strikes at deck level of the struck vessel. The triangular area for collision case 1 is bordered by point P_1. This corresponds to the vertical collision location "collision at deck level". The triangular upper left area of the rectangle corresponds to the vertical collision location "collision below deck". The draught difference ΔT_i, i=1,2,3 shall be used in the collision calculations (see Fig 2).

4) For the calculation of the collision energies the maximum masses of both striking vessel and struck vessel must be used (highest point on each respective diagonal ΔT_i).

5) Depending on the vessel design, the Society may require additional collision locations.

b) Tank vessel type G

For a tank vessel type G a collision at half tank height shall be assumed. The Society may require additional collision locations at other heights. This shall be agreed with the Society.

3.3.3 Longitudinal collision location

a) Tank vessels type C and N

At least the following three collision locations shall be considered:

- at bulkhead
- between webs and
- at web

b) Tank vessel type G

For a tank vessel type G at least the following three typical collision locations shall be considered:

- at cargo tank end
- between webs and
- at web.

3.3.4 Number of collision locations

a) Tank vessels type C and N

The combination of vertical and longitudinal collision locations in the example mentioned in [3.3.2], item a) 1) and [3.3.3] item a) results in 3 x 3 = 9 collision locations.

b) Tank vessel type G

The combination of vertical and longitudinal collision locations in the example mentioned in [3.3.2], item b) and [3.3.3] item b) results in 1 x 3 = 3 collision locations.

c) Additional examinations for tank vessels type G, C and N with independent cargo tanks

As proof that the tank seatings and the buoyancy restraints do not cause any premature tank rupture, additional calculations shall be carried out. The additional collision locations for this purpose shall be agreed with the Society.

3.4 Step 3

3.4.1 For each typical collision location a weighting factor which indicates the relative probability that such a typical collision location will be struck shall be determined. In Tab 1 these factors are named wfloc(i) (column J). The assumptions shall be agreed with the Society.

The weighting factor for each collision location is the product of the factor for the vertical collision location by the factor for the longitudinal collision location.

Figure 1 : Definition of vertical striking locations

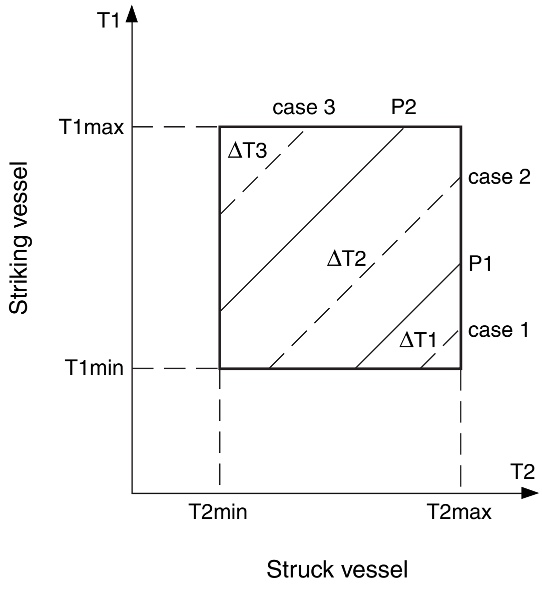


Figure 2 : Example of vertical collision locations

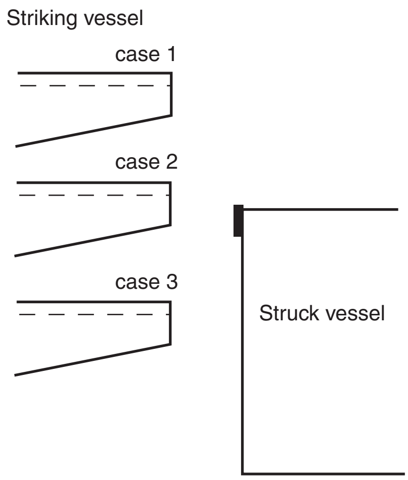


Table 1 : Calculation of weighted probability of cargo tank rupture

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
							F x G			I x J			L x M	
scenario I **(1)**	Loc1	FEA	E_{loc1}	CPDF 50 **(3)**	P50	wf50	Pw50							
				CPDF 66 **(4)**	P66	wf66	Pw66							
				CPDF 100 **(5)**	P100	wf100	Pw100	+						
							sum	Ploc1	wfloc1	Pwloc1				
	Loci	FEA	E_{loci}	CPDF 50 **(3)**	P50	wf50	Pw50							
				CPDF 66 **(4)**	P66	wf66	Pw66							
				CPDF 100 **(5)**	P100	wf100	Pw100	+						
							sum	Ploci	wfloci	Pwloci				
	Locn	FEA	E_{locn}	CPDF 50 **(3)**	P50	wf50	Pw50							
				CPDF 66 **(4)**	P66	wf66	Pw66							
				CPDF 100 **(5)**	P100	wf100	Pw100	+						
							sum	Plocn	wflocn	Pwlocn	+			
										sum	PscnI	wfscnI	PwscI	
scenario II **(6)**	Loc1	FEA	E_{loc1}	CPDF 30 **(2)**	P30	wf30	Pw30							
				CPDF 100 **(5)**	P100	wf100	Pw100	+						
							sum	Ploc1	wfloc1	Pwloc1				
	Locn	FEA	E_{locn}	CPDF 30 **(2)**	P30	wf30	Pw30							
				CPDF 100 **(5)**	P100	wf100	Pw100	+						
							sum	Plocn	wflocn	Pwlocn	+			
										sum	PscnII	wfscII	PwscII	+
													sum	Pw

(1) Identify collision locations and associated weighting factors for collision scenario I
(2) Calculate probability with CPDF 30%
(3) Calculate probability with CPDF 50%
(4) Calculate probability with CPDF 66%
(5) Calculate probability with CPDF 100%
(6) Identify collision locations and associated weighting factors for collision scenario II
Note 1:CPDF = Cumulative probability density function

3.4.2 Vertical collision locations

a) Tank vessels type C and N

The weighting factors for the various vertical collision locations are in each case defined by the ratio between the partial area for the corresponding collision case and the total area of the rectangle shown in Fig 1.

For example, for collision case 1 (see Fig 2) the weighting factor equals the ratio between the triangular lower right area of the rectangle, and the area of the rectangle between minimum and maximum draughts of striking and struck vessels.

b) Tank vessel type G

The weighting factor for the vertical collision location has the value 1.0, if only one collision location is assumed. When the Society requires additional collision locations, the weighting factor shall be determined analogous to the procedure for tank vessels type C and N.

3.4.3 Longitudinal collision locations

a) Tank vessels type C and N

The weighting factor for each longitudinal collision location is the ratio between the "calculational span length" and the tank length.

The calculational span length shall be calculated as follows:

1) collision on bulkhead:

0.2 x distance between web frame spacing forward of the web frame, but not larger than 450 mm

2) collision on web frame:

sum of 0.2 x web frame spacing forward of the web frame, but not larger than 450 mm, and 0.2 x web frame spacing aft of the web frame, but not larger than 450 mm, and

3) collision between web frames:

cargo tank length minus the length "collision at bulkhead" and minus the length "collision at web frame".

b) Tank vessel type G

The weighting factor for each longitudinal collision location is the ratio between the "calculational span length" and the length of the hold space. The calculational span length shall be calculated as follows:

1) collision at cargo tank end

distance between bulkhead and the start of the cylindrical part of the cargo tank,

2) collision on web frame:

sum of 0.2 x web frame spacing forward of the web frame, but not larger than 450 mm, and 0.2 x web frame spacing aft of the web frame, but not larger than 450 mm, and

3) collision between web frames

cargo tank length minus the length "collision at cargo tank end" and minus the length "collision at web frame".

3.5 Step 4

3.5.1 For each collision location the collision energy absorbing capacity shall be calculated. For that matter the collision energy absorbing capacity is the amount of collision energy absorbed by the vessel structure up to initial rupture of the cargo tank (see Tab 1, column D: Eloc(i)). For this purpose a finite element analysis in accordance with [4.2] shall be used.

3.5.2 These calculations shall be done for two collision scenarios according to Tab 2. Collision scenario I shall be analysed under the assumption of a push barge bow shape. Collision scenario II shall be analysed under the assumption of a V-shaped bow.

These bow shapes are defined in [4.8.2].

3.6 Step 5

3.6.1 For each collision energy absorption capacity Eloc(i), the associated probability of exceedance is to be calculated, i.e. the probability of cargo tank rupture. For this purpose, the formula for the cumulative probability density functions (CPDF) below shall be used. The appropriate coefficients shall be selected from Tab 3 to Tab 6 for the effective mass of the struck vessel.

$$P_{X\%} = C_1(E_{loc(i)})^3 + C_2(E_{loc(i)})^2 + C_3 E_{loc(i)} + C_4$$

with

$P_{X\%}$: Probability of tank rupture

C_i : Coefficients from Tab 3 to Tab 6

$E_{loc(i)}$: Collision energy absorbing capacity

3.6.2 The effective mass shall be equal to the maximum displacement of the vessel multiplied by a factor of 1.4. Both collision scenarios ([3.5.2]) shall be considered.

Table 2 : Speed reduction factors for scenario I or scenario II with weighting factors

				CAUSES		
				Communication error	Technical error	Human error
				0.50	0.20	0.30
WORST CASE SCENARIO	I	Push barge-bow striking angle 55°	0.80	0.66	0.50	1.00
	II	V-shape-bow striking angle 90°	0.20	0.30		1.00

Table 3 : Coefficients for the CPDF formulas: Velocity V_{MAX}

Effective mass of struck vessel in tonnes	Coefficients				
	C_1	C_2	C_3	C_4	Range
14000	4.106E-05	-2.507E-03	9.727E-03	9.983E-01	$4 < E_{loc} < 39$
12000	4.609E-05	-2.761E-03	1.215E-02	9.926E-01	$4 < E_{loc} < 36$
10000	5.327E-05	-3.125E-03	1.569E-02	9.839E-01	$4 < E_{loc} < 33$
8000	6.458E-05	-3.691E-03	2.108E-02	9.715E-01	$4 < E_{loc} < 31$
6000	7.902E-05	-4.431E-03	2.719E-02	9.590E-01	$4 < E_{loc} < 27$
4500	8.823E-05	-5.152E-03	3.285E-02	9.482E-01	$4 < E_{loc} < 24$
3000	2.144E-05	-4.607E-03	2.921E-02	9.555E-01	$2 < E_{loc} < 19$
1500	-2.071E-03	2.704E-02	-1.245E-01	1.169E+00	$2 < E_{loc} < 12$

Table 4 : Coefficients for the CPDF formulas: Velocity $0.66.V_{MAX}$

Effective mass of struck vessel in tonnes	Coefficients				
	C_1	C_2	C_3	C_4	Range
14000	4.638E-04	-1.254E-02	2.041E-02	1.000E+00	$2 < E_{loc} < 17$
12000	5.377E-04	-1.427E-02	2.879E-02	9.908E-01	$2 < E_{loc} < 17$
10000	6.262E-04	-1.631E-02	3.849E-02	9.805E-01	$2 < E_{loc} < 15$
8000	7.363E-04	-1.861E-02	4.646E-02	9.729E-01	$2 < E_{loc} < 13$
6000	9.115E-04	-2.269E-02	6.285E-02	9.573E-01	$2 < E_{loc} < 12$
4500	1.071E-03	-2.705E-02	7.738E-02	9.455E-01	$1 < E_{loc} < 11$
3000	-1.709E-05	-1.952E-02	5.123E-02	9.682E-01	$1 < E_{loc} < 8$
1500	-2.479E-02	1.500E-01	-3.218E-01	1.204E+00	$1 < E_{loc} < 5$

Table 5 : Coefficients for the CPDF formulas: Velocity $0.5.V_{MAX}$

Effective mass of struck vessel in tonnes	Coefficients				
	C_1	C_2	C_3	C_4	Range
14000	2.621E-03	-3.978E-02	3.363E-02	1.000E+00	$1 < E_{loc} < 10$
12000	2.947E-03	-4.404E-02	4.759E-02	9.932E-01	$1 < E_{loc} < 9$
10000	3.317E-03	-4.873E-02	5.843E-02	9.878E-01	$2 < E_{loc} < 8$
8000	3.963E-03	-5.723E-02	7.945E-02	9.739E-01	$2 < E_{loc} < 7$
6000	5.349E-03	-7.407E-02	1.186E-01	9.517E-01	$1 < E_{loc} < 6$
4500	6.303E-03	-8.713E-02	1.393E-01	9.440E-01	$1 < E_{loc} < 6$
3000	2.628E-03	-8.504E-02	1.447E-01	9.408E-01	$1 < E_{loc} < 5$
1500	-1.566E-03	5.419E-01	-6.348E-01	1.209E+00	$1 < E_{loc} < 3$

Table 6 : Coefficients for the CPDF formulas: Velocity $0.3.V_{MAX}$

Effective mass of struck vessel in tonnes	Coefficients				
	C_1	C_2	C_3	C_4	Range
14000	5.628E-02	-3.081E-01	1.036E-01	9.991E-01	$1 < E_{loc} < 3$
12000	5.997E-02	-3.212E-01	1.029E-01	1.002E+00	$1 < E_{loc} < 3$
10000	7.477E-02	-3.949E-01	1.875E-01	9.816E-01	$1 < E_{loc} < 3$
8000	1.021E-02	-5.143E-01	2.983E-01	9.593E-01	$1 < E_{loc} < 2$
6000	9.145E-02	-4.814E-01	2.421E-01	9.694E-01	$1 < E_{loc} < 2$
4500	1.180E-01	-6.267E-01	3.542E-01	9.521E-01	$1 < E_{loc} < 2$
3000	7.902E-02	-7.546E-01	5.079E-01	9.218E-01	$1 < E_{loc} < 2$
1500	-1.031E+00	2.214E-01	1.891E-01	9.554E-01	$0.5 < E_{loc} < 1$

3.6.3 In the case of collision scenario I (push barge bow at 55°), three CPDF formulas shall be used:

- CPDF 50% (velocity $0.5.V_{MAX}$)
- CPDF 66% (velocity $0.66.V_{MAX}$) and
- CPDF 100% (velocity V_{MAX})

3.6.4 In the case of scenario II (V-shaped bow at 90°), the following two CPDF formulas shall be used:

- CPDF 30% (velocity $0.3.V_{MAX}$)
- CPDF 100% (velocity V_{MAX})

3.6.5 In Tab 1, column F, these probabilities are called P50%, P66%, P100% and P30%, P100% respectively.

3.6.6 The range where the formula is valid is given in column 6. In case of an Eloc value below the range the probability equals Px% = 1.0. In case of a value above the range Px% equals 0.

3.7 Step 6

3.7.1 The weighted probabilities of cargo tank rupture Pwx% (Tab 1, column H) shall be calculated by multiplying each cargo tank rupture probability Px% (Tab 1, column F) by the weighting factors wfx% according to Tab 7.

3.8 Step 7

3.8.1 The total probabilities of cargo tank rupture Ploc(i) (Tab 1, column I) resulting from [3.7] (step 6) shall be calculated as the sum of all weighted cargo tank rupture probabilities Pwx% (Tab 1, column H) for each collision location considered.

3.9 Step 8

3.9.1 For both collision scenarios the weighted total probabilities of cargo tank rupture Pwloc(i) shall, in each case, be calculated by multiplying the total tank probabilities of cargo tank rupture Ploc(i) for each collision location, by the weighting factors wfloc(i) corresponding to the respective collision location (see [3.4] (step 3) and Tab 1, column J).

3.10 step 9

3.10.1 Through the addition of the weighted total probabilities of cargo tank rupture Pwloc(i), the scenario specific total probabilities of cargo tank rupture PscI and PscII (Tab 1, column L) shall be calculated, for each collision scenario I and II separately.

3.11 Step 10

3.11.1 Finally the weighted value of the overall total probability of cargo tank rupture Pw shall be calculated by the formula below (Tab 1, column O):

$P_w = 0.8P_{scI} + 0.2P_{scII}$

3.12 Step 11

3.12.1 The overall total probability of cargo tank rupture Pw for the alternative design is called P_n. The overall total probability of cargo tank rupture P_w for the reference design is called P_r.

3.13 step 12

3.13.1 The ratio (C_n/C_r) between the consequence (measure of damage) C_n of a cargo tank rupture of the alternative design and the consequence C_r of a cargo tank rupture of the reference design shall be determined with the following formula:

$C_n/C_r = V_n/V_r$

where:

C_n/C_r : Ratio between the consequence related to the alternative design, and the consequence related to the reference design

V_n : Maximum capacity of the largest cargo tank in the alternative design

V_r : Maximum capacity of the largest cargo tank in the reference design

3.13.2 The formula in [3.13.1] was derived for characteristic cargoes as listed in Tab 8.

3.13.3 For cargo tanks with capacities between 380 m^3 and 1000 m^3 containing flammable, toxic and acid liquids or gases it shall be assumed that the effect increase relates linearly to the increased tank capacity (proportionality factor 1.0).

3.13.4 If substances are to be carried in tank vessels, which have been analysed according to this calculation procedure, where the proportionality factor between the total cargo tank capacity and the affected area is expected to be larger than 1.0, as assumed in [3.13.3], the affected area shall be determined through a separate calculation. In this case the comparison as described in [3.14] (step 13) shall be carried out with this different value for the size of the affected area, t.

Table 7 : Weighting factors for each characteristic collision speed

			Weighting factor
SCENARIO I	CPDF 50%	wf50%	0.2
	CPDF 66%	wf66%	0.5
	CPDF 100%	wf100%	0.3
SCENARIO II	CPDF 30%	wf30%	0.7
	CPDF 100%	wf100%	0.3

Table 8 : Characteristic cargoes

	UN	Description
Benzene	1114	Flammable liquid Packing group II Hazardous to health
Acrylonitrile stabilized ACN	1093	Flammable liquid Packing group I Toxic
n-Hexane	1208	Flammable liquid Packing group II
Nonane	1920	Flammable liquid Packing group III
Ammonia	1005	Toxic, corrosive gas Liquefied under pressure
Propane	1978	Flammable gas Liquefied under pressure

3.14 Step 13

3.14.1 Finally the ratio P_r / P_n between the overall total probability of cargo tank rupture P_r for the reference design and the overall total probability of cargo tank rupture P_n for the alternative design shall be compared with the ratio C_n / C_r between the consequence related to the alternative design, and the consequence related to the reference design.

When $C_n / C_r \leq P_r / P_n$ is fulfilled, the evidence according to [1.1.3] for the alternative design is provided.

4 Determination of the collision energy absorbing capacity

4.1 General

4.1.1 The determination of the collision energy absorbing capacity shall be carried out by means of a Finite Element Analysis (FEA). The analysis shall be carried out using a customary finite element code (e.g. LS-DYNA, PAM-CRASH, ABAQUS etc.) capable of dealing with both geometrical and material nonlinear effects. The code shall also be able to simulate rupture realistically.

4.1.2 The program actually used and the level of detail of the calculations shall be agreed upon with the Society.

4.2 Creating the finite element (FE) models

4.2.1 First of all, FE models for the more crashworthy design and one for the reference design shall be generated. Each FE model shall describe all plastic deformations relevant for all collision cases considered. The section of the cargo area to be modelled shall be agreed upon with the Society.

4.2.2 At both ends of the section to be modelled all three translational degrees of freedom are to be restrained. Because in most collision cases the global horizontal hull girder bending of the vessel is not of significant relevance for the evaluation of plastic deformation energy it is sufficient that only half beam of the vessel needs to be considered. In these cases the transverse displacements at the centre line (CL) shall be constrained. After generating the FE model, a trial collision calculation shall be carried out to ensure that there is no occurrence of plastic deformations near the constraint boundaries. Otherwise the FE modelled area has to be extended.

4.2.3 Structural areas affected during collisions shall be sufficiently finely idealized, while other parts may be modelled more coarsely. The fineness of the element mesh shall be suitable for an adequate description of local folding deformations and for determination of realistic rupture of elements.

4.2.4 The calculation of rupture initiation must be based on fracture criteria which are suitable for the elements used. The maximum element size shall be less than 200 mm in the collision areas. The ratio between the longer and the shorter shell element edge shall not exceed the value of three. The element length L for a shell element is defined as the longer length of both sides of the element. The ratio between element length and element thickness shall be larger than five. Other values shall be agreed upon with the Society.

4.2.5 Plate structures, such as shell, inner hull (tank shell in the case of gas tanks), webs as well as stringers can be modelled as shell elements and stiffeners as beam elements. While modelling, cut outs and manholes in collision areas shall be taken into account.

4.2.6 In the FE calculation the 'node on segment penalty' method shall be used for the contact option. For this purpose the following options shall be activated in the codes mentioned:

- “contact_automatic_single_surface” in LS-DYNA
- “self impacting” in PAMCRASH, and
- similar contact types in other FE-programs.

4.3 Material properties

4.3.1 Because of the extreme behaviour of material and structure during a collision, with both geometrical and material non-linear effects, true stress-strain relations shall be used:

$$\sigma = C.\varepsilon^n$$

where:

n : Parameter defined as:

$$n = \ln(1 + A_g)$$

C : Parameter defined as:

$$C = R_m\left(\frac{e}{n}\right)^n$$

A_g : Maximum uniform strain related to the ultimate tensile stress R_m

e : Euler constant.

4.3.2 The values of A_g and R_m shall be determined through tensile tests.

4.3.3 If only the ultimate tensile stress R_m is available, for shipbuilding steel with a yield stress R_{eH} of not more than 355 N/mm² the following approximation shall be used in order to obtain the A_g value from a known R_m [N/mm²] value:

$$A_g = \frac{1}{0.24 + 0.01395 R_m}$$

4.3.4 If the material properties from tensile tests are not available when starting the calculations, minimum values of A_g and R_m, as defined in NR 216 Materials and Welding, shall be used instead. For shipbuilding steel with a yield stress higher than 355 N/mm² or materials other than shipbuilding steel, material properties shall be agreed upon with the Society.

4.4 Rupture criteria

4.4.1 The first rupture of an element in a FEA is defined by the failure strain value. If the calculated strain, such as plastic effective strain, principal strain or, for shell elements, the strain in the thickness direction of this element exceeds its defined failure strain value, the element shall be deleted from the FE model and the deformation energy in this element will no longer change in the following calculation steps.

4.4.2 The following formula shall be used for the calculation of rupture strain:

$$\varepsilon_f(l_e) = \varepsilon_g + \varepsilon_e \frac{t}{l_e}$$

where:

ε_g : Uniform strain

ε_e : Necking

t : Plate thickness, in mm

l_e : Individual element length, in mm

4.4.3 The values of uniform strain and the necking for shipbuilding steel with a yield stress R_{eH} of not more than 355 N/mm² shall be taken from Tab 9.

Table 9 : ε_g and ε_e for steel with $R_{eH} \leq 355$ N/mm²

Stress states	1-D	2-D
ε_g	0.079	0.056
ε_e	0.76	0.54
Element type	truss beam	shell plate

4.4.4 Other ε_g and ε_e values taken from thickness measurements of exemplary damage cases and experiments may be used in agreement with the Society.

4.4.5 Other rupture criteria may be accepted by the Society if proof from adequate tests is provided.

4.4.6 Tank vessel type G

For a tank vessel type G the rupture criterion for the pressure tank shall be based on equivalent plastic strain. The value to be used while applying the rupture criterion shall be agreed upon with the Society. Equivalent plastic strains associated with compressions shall be ignored.

4.5 Calculation of the collision energy absorbing capacity

4.5.1 The collision energy absorbing capacity is the summation of internal energy (energy associated with deformation of structural elements) and friction energy.

The friction coefficient is defined as:

$$\mu_c = FD + (FS - FD)e^{-DC|v_{rel}|}$$

where:

v_{rel} : Relative friction velocity

Following FD, FS and DC default values may be adopted for shipbuilding steel:

FD = 0.1

FS = 0.3

DC = 0.01

4.5.2 The force penetration curves resulting from the FE model calculation shall be submitted to the Society.

4.5.3 Tank vessel type G

In order to obtain the total energy absorbing capacity of a tank vessel type G the energy absorbed through compression of the vapour during the collision shall be calculated.

The energy E absorbed by the vapour shall be calculated as follows:

$$E = \frac{p_1 V_1 - p_0 V_0}{1 - \gamma}$$

where:

γ : $\gamma = \frac{c_p}{c_v}$

$\gamma = 1.4$ (default value)

c_p : Specific heat at constant pressure, in J/kgK

c_v : Specific heat at constant volume, in J/kgK

p_0 : Pressure at start of compression, in Pa

p_1 : Pressure at end of compression, in Pa

V_0 : Volume at start of compression, in m³

V_1 : Volume at end of compression, in m³

4.6 Definition of striking vessel and striking bow

4.6.1 At least two types of bow shapes of the striking vessel shall be used for calculating the collision energy absorbing capacities:

- bow shape I: push barge bow (see [4.8.1]
- bow shape II: V-shape bow without bulb (see [4.8.2]

4.6.2 Because in most collision cases the bow of the striking vessel shows only slight deformations compared to the side structure of the struck vessel, a striking bow will be defined as rigid. Only for special situations, where the struck vessel has an extremely strong side structure compared to the striking bow and the structural behaviour of the struck vessel is influenced by the plastic deformation of the striking bow, the striking bow shall be considered as deformable. In this case the structure of the striking bow should also be modelled. This shall be agreed upon with the Society.

4.7 Assumptions for collision cases

4.7.1 For the collision cases the following shall be assumed:

a) As collision angle between striking and struck vessel 90° shall be taken in case of a V-shaped bow and 55° in case of a push barge bow; and

b) The struck vessel has zero speed, while the striking vessel runs into the side of the struck vessel with a constant speed of 10 m/s.

The collision velocity of 10 m/s is an assumed value to be used in the FE analysis.

4.8 Types of bow shapes

4.8.1 Push barge bow

Characteristic dimensions shall be taken from Tab 10.

See also Fig 3.

4.8.2 V-bow

Characteristic dimensions shall be taken from Tab 11.

See also Fig 4.

Figure 3 : Push barge bow illustration

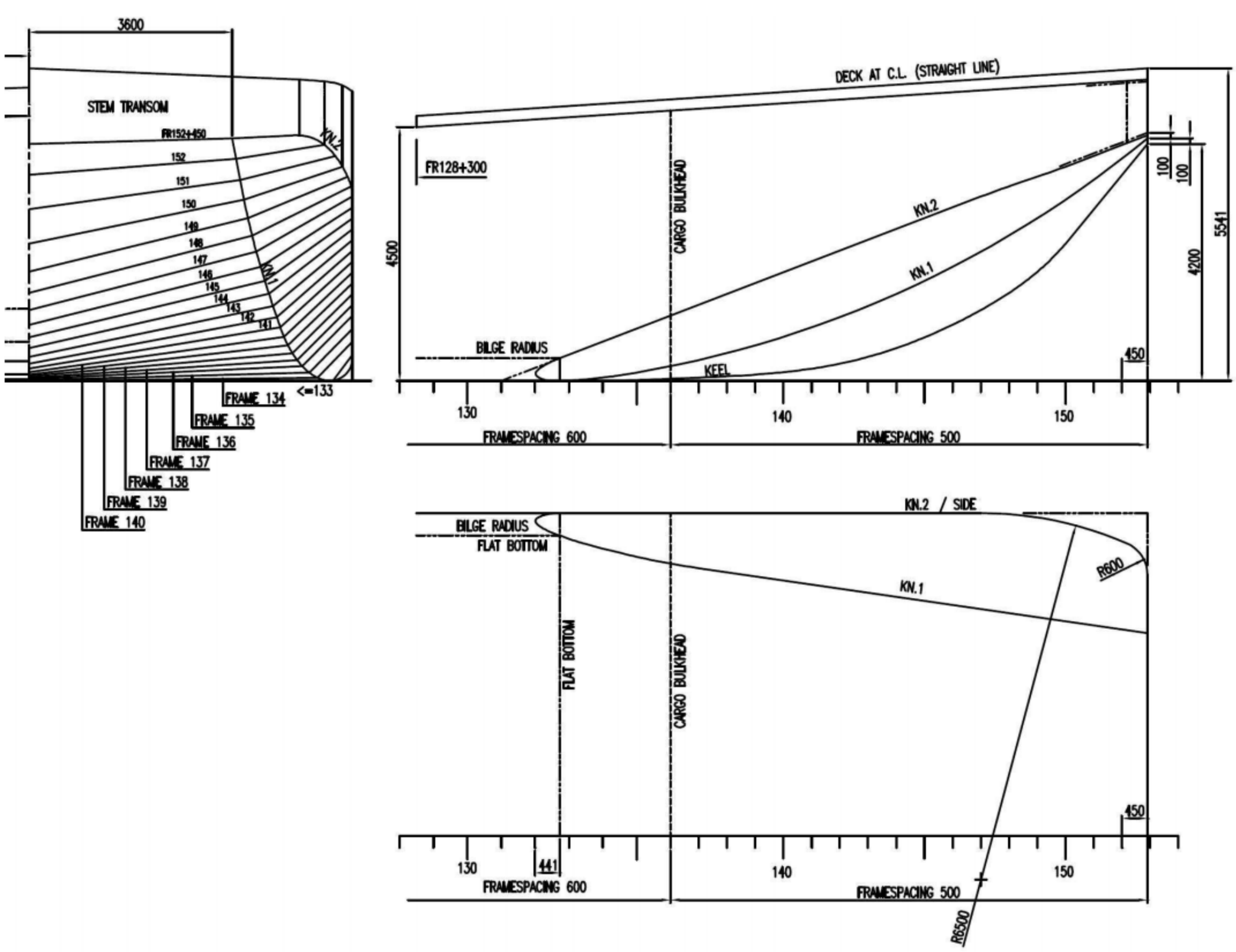


Table 10 : Characteristic dimensions of push barge bow

	Half breadths			Heights			
Frame	Knuckle 1	Knuckle 2	Deck	Stem	Knuckle 1	Knuckle 2	Deck
145	4.173	5.730	5.730	0.769	1.773	2.882	5.084
146	4.100	5.730	5.730	0.993	2.022	3.074	5.116
147	4.028	5.730	5.730	1.255	2.289	3.266	5.149
148	3.955	5.711	5.711	1.559	2.576	3.449	5.181
149	3.883	5.653	5.653	1.932	2.883	3.621	5.214
150	3.810	5.555	5.555	2.435	3.212	3.797	5.246
151	3.738	5.415	5.415	3.043	3.536	3.987	5.278
152	3.665	5.230	5.230	3.652	3.939	4.185	5.315
transom	3.600	4.642	4.642	4.200	4.300	4.351	5.340

Figure 4 : V-bow illustration

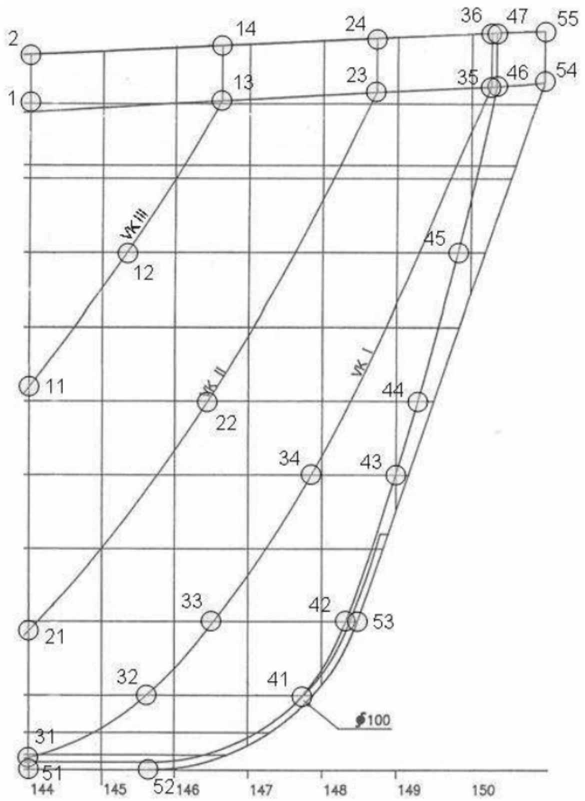


Table 11 : Characteristic dimensions of V-bow

Reference nr	x	y	z
1	0.000	3.923	4.459
2	0.000	3.923	4.852
11	0.000	3.000	2.596
12	0.652	3.000	3.507
13	1.296	3.000	4.535
14	1.296	3.000	4.910
21	0.000	2.000	0.947
22	1.197	2.000	2.498
23	2.346	2.000	4.589
24	2.346	2.000	4.955
31	0.000	1.000	0.085
32	0.420	1.000	0.255
33	0.777	1.000	0.509
34	1.894	1.000	1.997
35	3.123	1.000	4.624
36	3.123	1.000	4.986
41	1.765	0.053	0.424
42	2.131	0.120	1.005
43	2.471	0.272	1.997
44	2.618	0.357	2.493
45	2.895	0.588	3.503
46	3.159	0.949	4.629
47	3.159	0.949	4.991
51	0.000	0.000	0.000
52	0.795	0.000	0.000
53	2.212	0.000	1.005
54	3.481	0.000	4.651
55	3.485	0.000	5.004