RULES FOR THE CLASSIFICATION AND CONSTRUCTION

PART 2. INLAND WATERWAYS SHIP

VOLUME V
RULES FOR ADDITIONAL REQUIREMENT OF NOTATIONS
EDITION 2015

BIRO KLASIFIKASI INDONESIA

RULES FOR THE CLASSIFICATION AND CONSTRUCTION

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VOLUME V
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Foreword

Rules for Additional Requirements of Notations – Inland Waterways 2015 is divided into 4 (four) sections as follows:

Section 1. General Cargo Ship

The section explains ships complying with the requirements eligible for the assignment of the type and service Notation General Cargo Ship, as defined in BKI Rules for Classification and Surveys- Inland Waterways (Part 2, Vol. II), Section 2, B.3.1.1

Section 2. Other type & Ship Notations

The section explains ships complying with the requirements eligible for the assignment of the type and service Notation Tanker, Container, RoRo ship, wheeled vehicles, Passenger ship and Pontoon

Section 3. Transport of Dangerous Goods

The following requirements apply to ships intended for the carriage of dangerous goods.

Section 4. Additional Class Notations

The following requirements of Additional Class Notations apply to to ships with strengthened constructionTransport of Heavy Cargo, Equipped for Transport of Containers, Equipped for Transport of Wheeled Vehicles and etc

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Section 1

General Cargo Ships

A. Single Side General Cargo Ships

1. Symbols

L = Rule length [m] defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

B = breadth, in [m] defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

H = depth [m] defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

T = draught [m] defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

t = net thickness [mm] of plating

A_{sh} = net web sectional area [cm^2]

W = net section modulus [cm^3] of ordinary stiffeners or primary supporting members

S, s = stiffener spacing [m]

ℓ = stiffener span [m]

k = material factor defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 2, A.2.4 and Section 2, A.3.2

β_b, β_S= bracket coefficients defined in Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 2, B.5.2

n = navigation coefficient defined in Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 3, B.
= $0{,}85 \cdot H_w$

H_w = significant wave height [m]

2. General

2.1 Application

2.1.1 Ships complying with the requirements of this Section are eligible for the assignment of the type and service Notation **General Cargo Ship**, as defined in BKI Rules for Classification and Surveys- Inland Waterways (Part 2, Vol. II), Section 2, B.3.1.1.

2.1.2 Ships dealt with in this Section are to comply with the requirements stipulated in Volume I, Volume II and Volume III of BKI Rules for Inland Waterways, as applicable, and with the requirements of this Section, which are specific to single hull cargo Ships.

2.2. Stability

Depending on the Ship's design and operating conditions, proof of sufficient stability may be required by BKI.

3. Ship arrangement

3.1 General

3.1.1 Application

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

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

3.2 Protection of cargo holds

3.2.1 Coating

All metallic structures are to be protected against corrosion according to BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 8, B.

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.

3.2.2 Cargo hold ceiling

The cargo hold bottom is to be sheathed 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 ap propriate system.

3.3 Accesses

3.3.1 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 0,2·B from the axis of the Ship, 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.

3.3.2 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.

4. Structure design principles

4.1 Bottom structure

4.1.1 Single bottom Ships are to be fitted with girders in compliance with BKI Rules for Hull **-** Inland Waterways (Part 2, Vol. II), Section 5, B.3.2 or B.4.2.

4.1.2 Transversely framed single bottom

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

4.1.3 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.

4.2 Double bottom structure

4.2.1 Double bottom arrangement

Where it is not possible to visit the double bottoms, they are to be well protected against corrosion.

Where the height of the double bottom varies, the variation is generally to be made gradually and over an adequate length; the knuckles of inner bottom plating are to be located in way of plate floors.

Where this is impossible, suitable longitudinal structures such as partial girders, longitudinal brackets etc., fitted across the knuckle are to be arranged.

4.2.2 All double bottom Ships are to have a centre girder. A centre girder is not required where the Ship breadth measured on the top of floors or bottom transverses does not exceed 6 m.

The intercostal centre girder is to extend over the full length of the Ship or over the greatest length consistent with the lines.

4.2.3 Transversely framed double bottom

Where the double bottom is transversely framed, floors are to be fitted at every frame.

Watertight floors are to be fitted:

– in way of transverse watertight bulkheads

– in way of double bottom steps

4.2.4 Longitudinally framed double bottom

The spacing of transverses [m] is generally to be not greater than 8 frame spacing nor than 4 m, whichever is the lesser.

Additional transverses are to be fitted in way of transverse watertight bulkheads.

Bottom and inner bottom longitudinal ordinary stiffeners are generally to be continuous through the transverses.

In case the longitudinals are interrupted in way of a transverse, brackets on both sides of the transverse are to be fitted in perfect alignment.

In general, intermediate brackets are to be fitted connecting the centre girder to the nearest bottom and inner bottom ordinary stiffeners.

4.3. Transversely framed side

4.3.1 Connection of frames with floors

The frames are to be connected to the floors, generally by means of a lap weld the length of which is to be not less than:

– the frame depth, in case of frames made of a welded flat

– 1,5 times the frame depth, in case of frames made of a bulb profile or toe welded angle

The weld throat is to be not less than half the frame web thickness.

4.3.2 Connection with deck structure

At the upper end of frames, connecting brackets are to be provided, in compliance with BKI Rules for Hull - Inland Waterways (Part 2, Vol. II) Section 5, C.7. Such brackets are to extend to the hatch coaming.

4.3.3 Web frames

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

Their scantling is to be performed according to 5.2.2 herebelow.

4.3.4 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 Ship

4.4. Longitudinally framed side

4.4.1. Side transverses

Side transverses are to be fitted in general, with a spacing not greater than 8 frame spacings, nor than 4 m. Their scantling is to be performed according to 5.2.2 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.

4.4.2. 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.

4.5. Topside structure

4.5.1. 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 hatch-ways. 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 accomodation spaces.

5. Hull scantlings

5.1 General

The hull scantlings are to be as specified in BKI Rules for Hull **-** Inland Waterways (Part 2, Vol. II), Section 5, unless otherwise specified.

5.2 Transverse rings

5.2.1 General

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

5.2.2 Scantlings of transverse ring components

The ring component scantlings are not to be less than required in Table 1.1**.**

Table 1.1 Net scantlings of transverse rings

Primary supporting member	**w**	$\mathbf{A_{sh}}$
Side webs Floors	$w = k\ MAX\ (w_1, w_2)$ $w_1 = 1{,}96.\beta_b.k_o.p.S.l^2_0$ $w_2 = 0{,}58\cdot\beta_b\cdot p_{\gamma E}\cdot s\cdot\mathbf{B}^2$	$A_{sh} = k\ MAX\ (A_1, A_2)$ $A_1 = 0{,}063\cdot\beta_s\cdot k0\cdot p\cdot S\cdot l_0$ $A_2 = 0{,}045\cdot\beta_s\cdot p_{\gamma E}\cdot s\cdot\mathbf{B}$
Side transverses Bottom transverses	$w = k\ MAX\ (w_1, w_2)$ $w_1 = 1{,}96.\beta_b.k_0.p.S.l^2_0$ $w_2 = 0{,}58\cdot\beta_b\cdot p_{\gamma E}\cdot s\cdot B^2$	$A_{sh} = k\ MAX\ (A_1, A_2)$ $A_1 = 0{,}063\cdot\beta_s\cdot k_0\cdot p\cdot S\cdot l_0$ $A_2 = 0{,}045\cdot\beta_s\cdot p_{\gamma E}\cdot s\cdot\mathbf{B}$
Strong box beams	Volume II, Section 5, D.2.4.4	
P = side primary supporting members design load [kN/m2] = $4{,}9\cdot(\mathbf{T} + 0{,}6\cdot n)$ $p_{\gamma E}$ = bottom primary supporting members design load [kN/m2] = $9{,}81\cdot(\gamma\cdot\mathbf{T} + 0{,}6\cdot n)$ $\gamma = 1{,}0$ for loading/unloading in one run = 0,575 for loading/unloading in two runs $l_0 = \mathbf{T} + 0{,}6\cdot n$ $k_0 = 1 + (\mathbf{H} - l_0)/l_0$		

5.3 Transverse hold bulkhead structure

5.3.1 General

The number and location of transverse bulkheads are defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 5, E.

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

The scantlings of transverse hold bulkheads are to be not less than required in BKI Rules for Hull (2-II-5), Section 5, E.

5.3.2 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.

5.3.3 Horizontally framed plate bulkhead

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

5.3.4 Plate bulkhead end stringer

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

$$w = \frac{125.k}{(214 - \sigma_A)} p.S.l^2$$

p = bulkhead end stringer design load [kN/m^2] to be determined using applicable formulas given in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 3, C.6.

S = bulkhead stringer spacing [m]

σ_A = bulkhead end stringer axial stress [N/mm^2]

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

A = bulkhead end stringer sectional area [cm^2] to be determined in compliance with BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 5, D.10.2.2, where:

PS = $q \cdot D_1$

q = distributed transverse load acting on the stringer plate [kN/m] to be determined as stated under BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 5, D.3.4.1

D_1 = unsupported stringer plate length [m] defined under BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 5, D.3.4.2.

In way of hold end bulkheads D_1 is to be substituted by $0,5 \cdot D_1$

5.4 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 Section 4, A.3.

B. Double Hull Cargo Ships

1. Symbols

L = Rule length [m] defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

B = breadth, in [m] defined in BKI Rules for Hull **-** Inland Waterways (Part 2, Vol. II), Section 1, A.1.

H = depth [m] defined in BKI Rules for Hull **-** Inland Waterways (Part 2, Vol. II), Section 1, A.1.

T = draught [m]

t = net thickness [mm] of plating

2. General

2.1 Application

2.1.1 Ships complying with the requirements of this Section are eligible for the assignment of the type and service notation **General Cargo Ships**, as defined in BKI Rules for Classification and Surveys-Inland Waterways (Part 2, Vol. I) Section 2, B.3.1.1.

2.1.2 Ships dealt with in the following are to comply with the requirements stipulated in Volume I, Volume I and Volume I of BKI Rules for Inland Waterways, as applicable, and with the requirements, which are specific to double hull cargo Ships.

2.2 Stability

Depending on the Ship's design and operating conditions, proof of sufficient stability may be required by BKI.

3. Ship arrangement

3.1 General

3.1.1 Application

The following requirements apply to open deck ships of double hull construction, intended primarily to carry uniform or bulk dry cargoes.

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

3.2 Protection of cargo holds

3.2.1 Coating

All metallic structures are to be protected against corrosion according to BKI Rules for Hull **-** Inland Waterways (Part 2, Vol. II), Section 8, B.

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.

3.3. Access

3.3.1 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 0,2·B from the axis of the Ship, 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. BKI may wave this rule subject to direct calculation of the shear stresses.

3.3.2 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.

3.3.3 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.

3.4 Welding

3.4.1 General

Welding is to comply with the requirements of BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 8, A.

3.4.2 Arrangements applying to the shell plating and the double bottom

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 0,5·t, whereas the inner line of welding may be discontinuous with a ratio $p/d < 4$ and a throat thickness of 0,5·t; however, for spaces which are not accessible after construction, the inner weld is to be carried out with a continuous line welding.

3.4.3 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. Structure design principles

4.1 Double bottom structure

4.1.1 Double bottom arrangement

Where it is not possible to visit the double bottoms, they are to be well protected against corrosion.

Where the height of the double bottom varies, the variation is generally to be made gradually and over an adequate length; the knuckles of inner bottom plating are to be located in way of plate floors.

Where this is impossible, suitable longitudinal structures such as partial girders, longitudinal brackets etc., fitted across the knuckle are to be arranged.

4.1.2 Girders

A centre girder is to be fitted on all Ships exceeding 6 m in breadth.

This girder is to be formed by a vertical intercostal plate connected to the bottom plating and fitted with an appropriate faceplate.

The intercostal centre girder is to extend over the full length of the Ship or over the greatest length consistent with the lines. It is to have the same thickness as the floors. No manholes are provided into the centre girder.

On ships with ranges of navigation **D(1,2)** or **D(2)**, continuous or intercostal girders are to be fitted in the extension of the inner sides. These girders are to have a net thickness equal to that of the inner sides.

On ships with ranges of navigation **D(0,6)** or **D(0)**, built in the transverse system and without web frames, partial intercostal girders are to be fitted in way of the transverse bulkheads of the side tanks. These girders are to be extended at each end by brackets having a length equal to one frame spacing. They are to have a net thickness equal to that of the inner sides.

4.1.3 Transversely framed double bottom

Where the double bottom is transversely framed, floors are to be fitted at every frame.

Watertight floors are to be fitted:
- in way of transverse watertight bulkheads
- in way of double bottom steps

4.1.4. Longitudinally framed double bottom

The spacing of transverses, in m, is generally to be not greater than 8 frame spacing nor than 4 m, whichever is the lesser.

Additional transverses are to be fitted in way of transverse watertight bulkheads.

Bottom and inner bottom longitudinal ordinary stiffeners are generally to be continuous through the transverses.

In the case the longitudinals are interrupted in way of a transverse, brackets on both sides of the transverse are to be fitted in perfect alignment.

In general, intermediate brackets are to be fitted connecting the centre girder to the nearest bottom and inner bottom ordinary stiffeners.

4.1.5 Strength continuity

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

4.2 Transversely framed double side

4.2.1 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.

4.2.2 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.

4.2.3 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.

4.2.4 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 witch is not to be greater than 1 m.

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

4.3 Longitudinally framed double side

4.3.1 Inner side plating

The requirements of 4.2.1 also apply to longitudinally framed double side, with the transverses instead of web frames.

4.3.2 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.

4.3.3 Side transverses

The requirements of 4.2.3 also apply to longitudinally framed double side, with the transverses instead of web frames.

4.3.5 Plate webs

The requirements of 4.2.4 also apply to longitudinally framed double side.

4.4 End structure

4.4.1 Arrangements for self-propelled Ships

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 which is 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.

4.4.2 Arrangements for pushed Ships

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 Ship’s centreline. Where the Ship 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 BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 7, F.3.2.

5. Hull scantlings

5.1 General

The hull scantlings and arrangements are to be determined according to BKI Rules for Hull (2-I-5), Section 5, unless otherwise specified.

5.2 Double bottom structure

5.2.1 General arrangements

Where the inner side plating does not extend down to the bottom plating, the floors of Ships 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 [cm^2] is not to be less than:

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

t_F = net thickness of floor web [mm]

b = section height [mm]
= $100 \cdot H_D$

H_D = double bottom height [m]

Where the floors cannot be welded to the inner bottom by means of fillet welds, the attachment may be obtained by plug welds, in compliance with BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 8, A. In that case, the floors are to be fitted with a flange of adequate width in the double bottom area.

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

5.3 Transverse hold bulkhead structure

Arrangements and scantlings of transverse hold bulkheads are to be in compliance with BKI Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 5, E.

5.4 Strengthening of cargo hold structures

In case of grab loading/unloading, the scantlings of structural elements within the cargo hold are to be increase according to Section 4, A.3.

Section 2
Other Type and Service Notations

A. Tanker

1. Symbols

L = Rule length [m] defined in Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

B = breadth, in [m] defined in Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

D = depth [m] defined in Rules for Hull - Inland Waterways (Part 2, Vol. II), Section 1, A.1.

T = draught [m] defined in Rules for Hull - Inland Waterways (Part 2, Vol. II)Section 1, A.1.

B_2 = side tank breadth [m]

$B_1 = B - 2 \cdot B_2$

t = net thickness [mm] of plating

p = design load [kN/m^2]

p_{PV} = setting pressure [kN/m^2] of safety valves or maximum pressure [kN/m^2] in the tank during loading/unloading, which is the greater

s = spacing of ordinary stiffeners [m]

S = spacing of primary supporting members [m]

l = span [m]

w = net section modulus [cm^3]

A_{sh} = net web sectional area [cm^2]

k = material factor defined in Rules for Hull (2-II-2), Section 2, A. 2.4 and Section 2, A.3.2

z = Z co-ordinate [m] of the calculation point

z_{TOP} = Z co-ordinate [m] of the highest point of the tank

d_{AP} = distance from the top of air pipe to the top of compartment [m]

H_T = trunk height [m]

Z_L = Z co-ordinate [m] of the highest point of the liquid

ρL = density [t/m^3] of the liquid carried

σ_1 = In-plane hull girder normal stress [N/mm]

λ_b, λ_s = coefficients for vertical structural members, defined in Rules for Hull (I-2-2), Section 2, B.5.3

β_b, β_s = bracket coefficients defined in Rules for Hull (I-2-2), Section 2, B.5.2

n = navigation coefficient defined in Rules for Hull (I-2-2), Section 3, B.

= $0{,}85 \cdot H_w$

H_w = significant wave height [m]

η = $1 - s / (2 \cdot l)$

2. Application

2.1 General

2.1.1 Ships complying with the following requirements are eligible for the assignment of the type and service Notation **Tanker**, as defined in Rules for Classification and Surveys - Inland Waterways (Part 2, Vol. I), Section 2, B.4.1.1

2.1.2 Ships dealt with in this Section are to comply with the requirements stated under Volume I, Volume II and Volume III of the Rules for Inland Waterways, as applicable, and with the requirements of this Section, which are specific to tankers.

3. Vessel arrangement

3.1 Basic structural configuration

3.1.1 Single hull tankers

In a single hull tanker, see Fig. 2.1, 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.

3.1.2 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. 2.2. For certain products minimum distances between tank boundaries and bottom or side plating are to be observed. Accessibility shall, however, be guaranteed in every case.

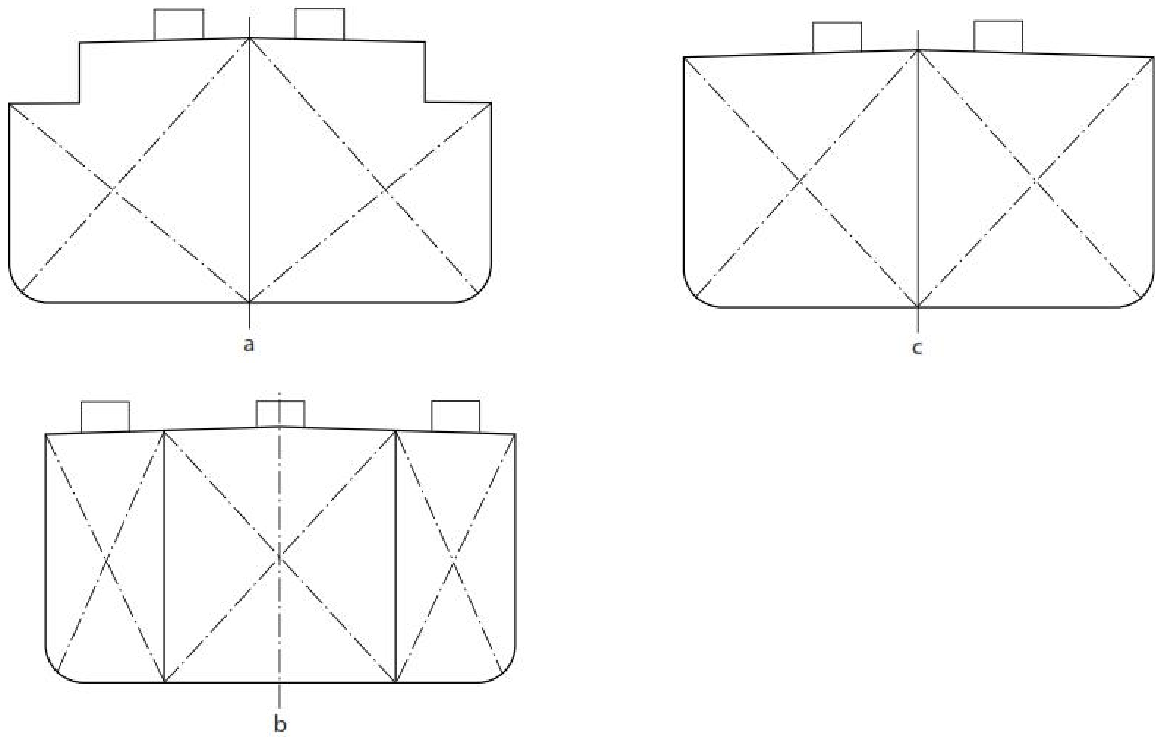


Fig. 2.1. Single hull tankers

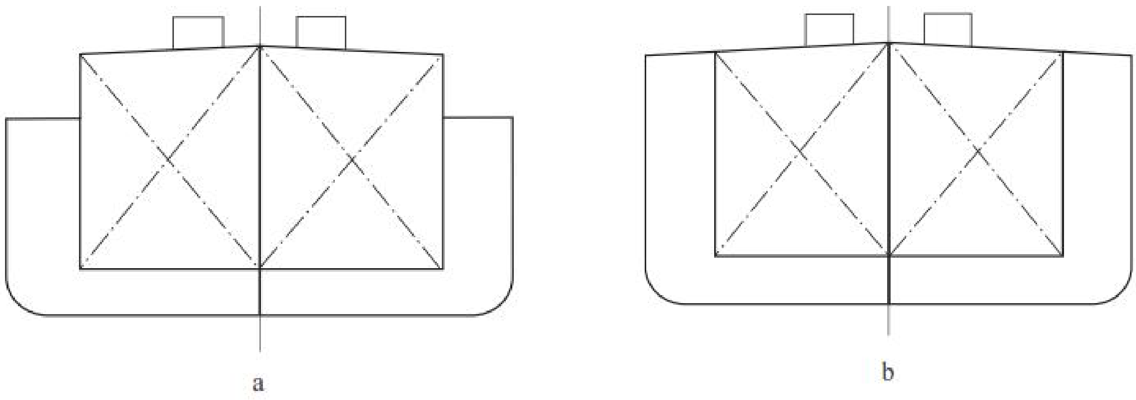


Fig. 2.2. Double hull tankers

3.1.3 Tankers with inserted cargo tanks

≥ 1 t/m3 In this type of vessel the cargo tanks are independent of the vessel's structure but are permanently installed, σ1 = In-plane hull girder normal stress [N/mm^2] see Fig. 2.3.

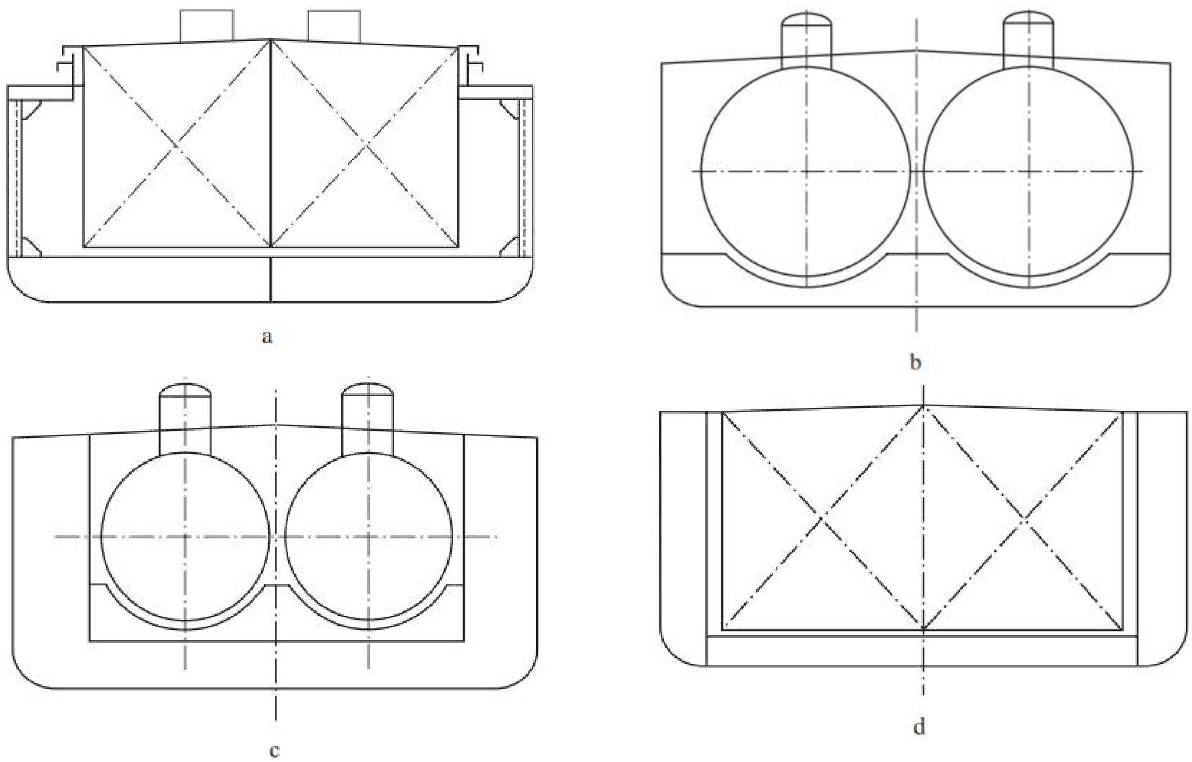


Fig. 2.1. Inserted cargo tank

3.2. Stability

3.2.1. Tankers carrying dangerous goods

For ships carrying dangerous goods, see Section 3.

3.2.2 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 has to be shown according to Section 4, F.

4. Hull scantlings

4.1 General

4.1.1 The hull scantlings are to be determined as specified in Rules for Hull-Inland Waterways (Part 2, Vol. II) Section 5, using the adequate design loads, unless otherwise specified in the following.

4.1.2 Additional requirements for Tankers Type C and N

The minimum net thickness, in mm, of strength deck and bulkhead plating of integrated tanks in the cargo area is to be not less than the values given in Table 2.1.

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 2.1 Minimum net thickness of integratedtanks

Plating	Minimum thickness [mm]
Strength deck	$t = 4{,}4 + 0{,}016 \cdot \mathbf{L} \cdot k^{0{,}5}$
Tank bulkhead	$t = 0{,}8 \cdot \mathbf{L}^{1/3} \cdot k^{0{,}5} + 3{,}6 \cdot s$
Watertight bulkhead	$t = 0{,}68 \cdot \mathbf{L}^{1/3} \cdot k^{0{,}5} + 3{,}6 \cdot s$
Wash bulkhead	$t = 0{,}64 + 0{,}011 \cdot \mathbf{L} \cdot k^{0{,}5} + 3{,}6 \cdot s$

4.1.3 Independent tanks

Scantlings of independent tanks are to be determined in compliance with Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 5, E.2.

4.1.4 Thermal stresses

Where heated liquids are intended to be carried intanks, 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 temperatures, the actual carriage temperature and the limit temperature specified above.

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.

4.1.5 Material factor

When steels with a minimum guaranteed yield stress R_{eH} other than 235 N/mm^2 are used on a vessel, thescantlings are to be determined by taking into account the material factor as follows:

– thickness:

see relevant articles in the following

– section modulus:

$w = k \cdot w_0$

– sectional area:

$A = k \cdot A_0$

w_0, A_0 = scantlings corresponding to a steel with a minimum guaranteed yield stress R_{eH}= 235 N/mm^2

4.2 Bottom and inner bottom structures

4.2.1 Minimum net thickness of web plating

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

– for **L**< 120 m: $t = 1{,}63 + 0{,}004 \cdot \mathbf{L} \cdot k^{0{,}5} + 4{,}5 \cdot s$

– for **L** ≥ 120 m: $t = 3{,}9 \cdot k^{0{,}5} + s$

The net thickness [mm] of the web plating of ordinary stiffeners of tankers type C and N is to be not less than:

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

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

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

4.2.2 Net scantlings of bottom and inner bottom structural members in service conditions

The net scantlings of bottom and inner bottom structural members in service conditions are to be obtained from Table 2.2 for single bottom structure and Table 2.3 for double bottom structure.

4.2.3 Net scantlings of bottom and inner bottomstructural members in testing conditions

The net scantlings of bottom and inner bottom structural members being part of compartments or structures containing liquid are to comply with Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, D.

4.2.4 Buckling check

Bottom and inner bottom structural members are to comply with the requirements stated under Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, C.

4.3 Side and inner side ordinary stiffeners

4.3.1 Minimum net thickness of web plating

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

– for **L** < 120 m: $t = 1{,}63 + 0{,}004 \cdot \mathbf{L} \cdot k^{0{,}5} + 4{,}6 \cdot s$

– for **L** ≥ 120 m: $t = 3{,}9 \cdot k^{0{,}5} + s$

Table 2.2 Net scantlings of single bottom structure

Item	w [cm3]	Ash [cm2]
Bottom longitudinals	$w = \frac{83,3}{214 - \sigma_1} \cdot \beta_b \cdot \eta \cdot P_E \cdot s \cdot \ell^2$	$Ash = 0,045 \cdot \beta_s \cdot \eta \cdot P_E \cdot s \cdot \ell$
Floors [1, 2]	$w = 0,58 \cdot \beta \cdot p \cdot s \cdot \ell^2$	$Ash = 0,045 \cdot \beta_s \cdot p \cdot s \cdot \ell$
Bottom transverses [2]	$w = 0,58 \cdot \beta_b \cdot p \cdot S \cdot \ell^2$	$Ash = 0,045 \cdot \beta_s \cdot p \cdot s \cdot \ell$
Bottom centre and side girders [3]	$w = \frac{125}{197 - \sigma_1} \cdot \beta_b \cdot p \cdot s \cdot \ell^2$	$Ash = 0,056 \cdot \beta_s \cdot p \cdot s \cdot \ell$

p = design load [kN/m2] of bottom primary supporting members:

= MAX ($p_{\gamma E}$; $p_{\gamma I}$)

PγE = design load [kN/m2] of bottom primary supporting members:

= 9,81· (γ · T + 0,6 · n)

γ = 0,575, in general

= 1,0 for loading/unloading in one run or for ships fitted with independent tanks

PγI = design load [kN/m2] of bottom primary supporting members:

$= P_C - P_M$

P_M = minimum external pressure [kN/m2]: $P_M \geq 0$:

= 9,81· (0,15 · T − 0,6 · n)

P_C = pressure transmitted to the bottom structure defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.5.

P_E = design load [kN/m2] defined in D.6.1.1

[1] In way of side ordinary frames, $\beta_b = \beta_s = 1$

[2] Scantlings of floors and bottom transverses have to be adequate to those of web frames or side transverses connected to them.

[3] The span ℓ is to be taken equal to the web frame spacing or the bottom transverse spacing.

The net thickness [mm] of the web plating of ordinary stiffeners of tankers type C and N is to be not less than:

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

4.3.2 Net scantlings of side and inner side ordinary stiffeners in service conditions

The net scantlings of side ordinary stiffeners in service conditions are to be obtained from Table 2.4 or Table 2.5, as applicable.

4.3.3 Net scantlings of side and inner side ordinary stiffeners in testing conditions

The net scantlings of side and inner side stiffeners being part of compartments or structures containing liquid are to comply with Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, D.

Table 2.3 Net scantlings of double bottom structure

Item	Parameter	Transverse framing	Longitudinal framing
Double bottom	height [mm]	d = MAX (d_1;d_2) $d_1 = 34{,}2 \cdot A_c \cdot \left[\sqrt{\frac{2 \cdot W_0}{3 - A_u^2} + 1} - 1\right]$ $d_2 = 600$	
Floors in the tank 2	section modulus [cm3] thickness [mm] shear sectional area [cm2]	w = MAX (w1;w2) $w_1 = 0{,}58 \cdot \beta_b \cdot p_1 \cdot s \cdot \ell^2$ $w_2 = 0{,}58 \cdot \beta_b \cdot p_{\gamma I} \cdot s \cdot (\ell^2 - 4 \cdot B_3^2)$ t = MAX (t1;t2) $t_1 = 1.14 \cdot L^{1/3} \cdot k^{0.5}$ t2 = d /100 Ash = MAX (A1;A2) $A_1 = 0{,}067 \cdot \beta_s \cdot p_1 \cdot s \cdot \ell$ $A_2 = 0{,}067 \cdot \beta_s \cdot p_{\gamma I} \cdot s \cdot (\ell - 2 \cdot B_3)$	NA NA NA
Floors in the side tank 2	section modulus [cm3] shear sectional area [cm2]	w = MAX (w1;w2) $w_1 = 2{,}32 \cdot \beta_b \cdot p_I \cdot s \cdot B_2 \cdot (\ell - B_2)$ $w_2 = 2{,}32 \cdot \beta_b \cdot p_{\gamma I} \cdot s \cdot B_2 \cdot (\ell - 2B_2$ Ash = MAX (A1;A2) $A_1 = 0{,}067 \cdot \beta_s \cdot p_1 \cdot s \cdot \ell$ $A_2 = 0{,}067 \cdot \beta_s \cdot p_{\gamma I} \cdot s \cdot (\ell - 2 \cdot B_3)$	NA NA
Bottom and inner Bottom longitudinals	section modulus [cm3] shear sectional area [cm2]	NA NA	$w = \frac{83{,}3}{214 - \sigma_1} \cdot \beta_b \cdot \eta \cdot p_2 \cdot s \cdot \ell^2$ $A_{sh} = 0{,}045 \cdot \beta_s \cdot \eta \cdot p_2 \cdot s \cdot \ell$
Bottom transverses in the tank	section modulus [cm3] thickness [mm] shear sectional area [cm2]	NA NA NA	w = MAX (w_1;w_2) $w_1 = 0{,}58 \cdot \beta_b \cdot p_1 \cdot S \cdot \ell^2$ $w_2 = 0{,}58 \cdot \beta_b \cdot p_{\gamma I} \cdot S \cdot (\ell^2 - 4 \cdot B_3^2)$ t = MAX (t_1;t_2) $t_1 = 1{,}14 \cdot L^{1/3} \cdot k^{0{,}5}$ $t_2 = d/90$ A_{sh} = MAX (A_1;A_2) $A_1 = 0{,}067 \cdot \beta_s \cdot p_1 \cdot S \cdot \ell$ $A_2 = 0{,}067 \cdot \beta_s \cdot p_{\gamma I} \cdot S \cdot (\ell - 2 \cdot B_3)$

Table 2.3 Net scantlings of double bottom structure

Item	Parameter	Transverse framing	Longitudinal framing
Bottom transverses in the side tank	section modulus [cm3]	NA	$w = MAX(w_1; w_2)$ $w_1 = 2{,}32 \cdot \beta_b \cdot p_1 \cdot S \cdot B_2 \cdot (\ell - B_2)$ $w_2 = 2{,}32 \cdot \beta_b \cdot p_{\gamma I} \cdot S \cdot B_2 \cdot (\ell - 2 \cdot B_2)$
	shear sectional area [cm2]	NA	$A_{sh} = MAX(A_1; A_2)$ $A_1 = 0{,}067 \cdot \beta_s \cdot p_1 \cdot S \cdot \ell$ $A_2 = 0{,}067 \cdot \beta_s \cdot p_{\gamma I} \cdot S \cdot (\ell - 2 \cdot B_3)$
Bottom centre and side girders 1	shear sectional area [cm2]	$A_{sh} = 0{,}051 \cdot \beta_s \cdot p \cdot S \cdot \ell$	

p = design load [kN/m2] of bottom primary supporting members
= MAX (p_1; $p_{\gamma I}$)

p_1 = $p_{\gamma E}$

p_2 = design load of bottom and inner bottom longitudinals [kN/m2]:

- in way of ballast tanks:
  - for bottom longitudinals: p_2 = MAX (p_E;($p_B - p_M$))
  - for inner bottom longitudinals: p_2 = MAX (p_C;p_B)
- elsewhere:
  - for bottom longitudinals: $p_2 = p_E$
  - for inner bottom longitudinals: $p_2 = p_C$

$p_{\gamma E}$ = design load [kN/m2] of bottom primary supporting members
= 9,81·(γ·T + 0,6·n)

γ = 0,575 in general
= 1,0 for loading/unloading in one run or for ships fitted with independent tanks

$p_{\gamma I}$ = design load [kN/m2] of bottom primary supporting members
= $p_C - p_M$

p_M = minimum external pressure [kN/m2], $p_M \geq 0$
= 9,81· (0,15 · T − 0,6 · n)

p_E, p_B, p_C = pressures transmitted to the double bottom structure, defined in D.6.1.1 and in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.5.

A_a = cross sectional area of attached inner bottom plating [cm2]

w_0 = section modulus [cm3] of floors or bottom transverses in the tank

ℓ = floor or bottom transverse span [m]:

- where no intermediate longitudinal bulkhead is fitted: ℓ = B
- where intermediate longitudinal bulkheads are fitted, ℓ is the distance between outer side and intermediate longitudinal bulkhead, or the distance between intermediate longitudinal bulkheads

B_3 = parameter [m] defined as follows:

- where no longitudinal bulkhead is fitted: $B_3 = B_2$
- where intermediate longitudinal bulkheads are fitted:
- for outer tank: $B_3 = 0{,}5 \cdot B_2$
- for other tanks: $B_3 = 0$
- on ships fitted with independent tanks, B_3 is the distance between the hull outer side and the independent tank wall

1 The span ℓ is to be taken equal to the web frame or side transverse spacing.

2 In way of ordinary stiffeners, $\beta_b = \beta_s = 1$

Note

NA = not applicable.

Table 2.4 Side single skin structure

Item	w [cm3]	Ash [cm2]
Side frames	$w = MAX(w_1; w_2)$ $w_1 = 0.58 \cdot \beta_b \cdot \eta \cdot s \cdot (1{,}2 \cdot k_0 \cdot P_E \cdot \ell_0^2 + \lambda_t \cdot P_{\gamma E} \cdot \ell_F^2)$ $w_1 = 0.58 \cdot \beta_b \cdot \eta \cdot s \cdot (\lambda_b \cdot P_2 \cdot \ell^2 + \lambda_t \cdot P_{\gamma l} \cdot \ell_F^2)$	$A_{sh} = MAX(A_1; A_2)$ $A_1 = 0{,}08 \cdot \beta_s \cdot \eta \cdot k_0 \cdot P_E \cdot s \cdot \ell_0$ $A_2 = 0{,}058 \cdot \lambda_s \cdot \beta_2 \cdot p_2 \cdot s \cdot \ell$
Side longitudinals	$w = \frac{83{,}3}{214 - \sigma_1} \cdot \beta_b \cdot \eta \cdot p \cdot s \cdot \ell^2$	$A_{sh} = 0{,}045 \cdot \beta_s \cdot \eta \cdot p \cdot S \cdot \ell$
Side web frames Side transverses 1	$w = MAX(w_1; w_2)$ $w_1 = 1{,}96 \cdot \beta_b \cdot k_0 \cdot P_E \cdot S \cdot \ell_0^2$ $w_2 = 1{,}63 \cdot \lambda_b \cdot \beta_b \cdot P_2 \cdot S \cdot \ell^2$	$A_{sh} = MAX(A_1; A_2)$ $A_1 = 0{,}063 \cdot \beta_s \cdot k_0 \cdot P_E \cdot s \cdot \ell_0$ $A_2 = 0{,}045 \cdot \lambda_s \cdot \beta_2 \cdot p_2 \cdot s \cdot \ell$
Side stringers 2	$w = \frac{125}{197 - \sigma_1} \cdot \beta_b \cdot p \cdot S \cdot \ell^2$	$A_2 = 0{,}056 \cdot \beta_2 \cdot p \cdot S \cdot \ell$

p = design load of side structural members [kN/m2]
= MAX (p_E ; p_2)

p_E = external pressure transmitted to the side structural members, defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.4. For vertical structural members:
p_E = 4,9·(T − H_F + 0,6·n)

p_2 = design load [kN/m2]
= $|p_C - p_M|$
p_C = 0 for ships with independent tanks

$p_{\gamma E}$ = floor design load [kN/m2]
= 9,81·(γ·T + 0,6·n)
γ = 0,575 in general
= 1,0 for loading/unloading in one run or for ships fitted with independent tanks

$p_{\gamma l}$ = floor design load [kN/m2]
= $p_C - p_M$

p_M = minimum external pressure [kN/m2], $p_M \geq 0$:
– for z ≤ 0,15·T: p_M= 9,81·(0,15·T − z − 0,6·n)
– for z > 0,15·T: p_M= 0

ℓ_0 = T − HF + 0,6·n

ℓ_F = floor span [m]

H_F = floor height or bottom transverse height [m]

k_0 = coefficient given by the formula:
= $1 + (\ell - \ell_0)/\ell_0$

λt = coefficient
– in transverse framing:
= $0.1 \cdot \left[0.8 - \frac{\ell^2}{\ell_F^2}\right]$, λt ≥ 0
– in combination framing: λt = 0

p_C = pressure transmitted to the double side structure, defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.5.

[1] Scantlings of web frames and side transverses at the lower end have to be adequate to those of floors or bottom transverses connected to them, and at the upper end they are to be the same as those of the deck transverses connected to them.

[2] The span of side stringers is to be taken equal to the side transverse spacing or the web frame spacing.

Table 2.5 Side double skin structure

Item	w [cm3]	Ash [cm2]
Side frames subjected to external load	$w = 0{,}7 \cdot \beta_b \cdot k_0 \cdot p \cdot s \cdot \ell_0^2$	$A_{sh} = 0{,}08 \cdot \beta_s \cdot k_0 \cdot p \cdot s \cdot \ell_0$
Side frames (other loading cases) and inner side frames	$w = 0{,}58 \cdot \lambda_b \cdot \beta_b \cdot p \cdot s \cdot \ell^2$	$A_{sh} = 0{,}058 \cdot \lambda_s \cdot \beta_s \cdot p \cdot s \cdot \ell$
Side longitudinal Inner side longitudinals	$w = \frac{83{,}3}{214 - \sigma_1} \cdot \beta_b \cdot \eta \cdot p \cdot s \cdot \ell^2$	$A_{sh} = 0{,}045 \cdot \beta_s \cdot \eta \cdot p \cdot s \cdot \ell$
Side web frames and side transverses subjected to external load	$w = 0{,}7 \cdot \beta_b \cdot k_0 \cdot p \cdot s \cdot \ell_0^2$	$A_{sh} = 0{,}08 \cdot \beta_s \cdot k_0 \cdot p \cdot S \cdot \ell_0$
Side web frames, inner side web frames, side transverses and inner side transverses in other loading cases	$w = 0{,}58 \cdot \lambda_b \cdot \beta_b \cdot p \cdot s \cdot \ell^2$	$A_{sh} = 0{,}045 \cdot \lambda_s \cdot \beta_s \cdot p \cdot S \cdot \ell$
Plate web frames subjected to external load	$w = 1{,}96 \cdot \beta_b \cdot k_0 \cdot p \cdot s \cdot \ell_0^2$	$A_{sh} = 0{,}063 \cdot \beta_s \cdot p \cdot S \cdot \ell_0$
Plate web frames in other loading cases	$w = 1{,}63 \cdot \lambda_b \cdot \beta_b \cdot p \cdot s \cdot \ell^2$	$A_{sh} = 0{,}045 \cdot \lambda_s \cdot \beta_s \cdot k_0 \cdot p \cdot S \cdot \ell$
Side stringers [1] Inner side stringers [1]	$w = \frac{125}{197 - \sigma_1} \cdot \beta_b \cdot p \cdot s \cdot \ell^2$	$A_{sh} = 0{,}056 \cdot \beta_s \cdot p \cdot S \cdot \ell$

p = design load of double side structural members [kN/m2]:
- for inner side structure:
  - in way of ballast tanks: p = MAX (p_C;p_B)
  - elsewhere: p = p_C
- p_C= 0 for ships with independent tanks
- for side structure:
  - in way of ballast tanks: p = MAX (p_E; ($p_B - p_M$))
  - elsewhere: p = p_E

p_E = external pressure transmitted to the side structural members, defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.4. For vertical structural members:
$p_E = 4{,}9 \cdot (T - H_F + 0{,}6 \cdot n)$

$\ell_0 = T - H_F + 0{,}6 \cdot n$

H_F = floor height or bottom transverse height [m]

k_0 = coefficient given by the formula:
$= 1 + (\ell - \ell_0) / \ell_0$

p_M = minimum external pressure [kN/m2], $p_M \geq 0$:
- for $z \leq 0{,}15 \cdot T$: $p_M = 9{,}81 \cdot (0{,}15 \cdot T - z - 0{,}6 \cdot n)$
- for $z > 0{,}15 \cdot T$: $p_M = 0$

p_B, p_C = pressures transmitted to the double side structure, defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.5.

[1] The span of side stringers is to be taken equal to the side transverse spacing or the web frame spacing

4.3.4 Buckling check

Side and inner side ordinary stiffeners are to comply with the requirements stated under Rules for Hull-Inland Waterways (Part 2, Vol. II) Section 2, C.

4.3.5 Minimum side tank width

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

4.4 Side and inner side primary supporting members

4.4.1 Minimum net thickness of web plating

The net thickness of the web plating of primary supporting members is to be not less than:

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

4.4.2 Net scantlings of side and inner side primary supporting members in service conditions

The net scantlings of side primary supporting members in service conditions are to be obtained fromTable 2.4 or Table 2.5, as applicable.

4.4.3 Net scantlings of side and inner side primary supporting members in testing conditions

The net scantlings of side and inner side primary supporting members being part of compartments or structures containing liquid are to comply with Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, D.

4.4.4 Buckling check

Side and inner side primary supporting members are to comply with the requirements stated under Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, C.

5. Transverse rings

5.1 General

5.1.1 The strength check of the transverse rings is to be performed by direct calculation according to Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, E.

In particular, the requirements of 5.2 to 5.4 below, are to be complied with.

5.1.2 The following loading conditions are to be considered:

– light vessel draught, fully loaded tank subjected to cargo load as per Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.5.

– fully loaded tank subjected to test pressure (see Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.6.)

– fully loaded vessel draught, empty tank subjected to external pressure, as per Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 3, C.4.

5.2 Floors and bottom transverses in way of rings

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

5.3 Web frames and side transverses in way of rings

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.

5.4 Strong beams and deck transverses in way of rings

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

5.5 Pillars

5.5.1 Strong beams and deck transverses in way of rings are to be supported by pillars. The pillar scantlings are to be determined according to Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 5, D.9. 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.

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

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

5.6 Break in the deck

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

6. Structural arrangements

6.1 Ships with integrated tanks, transverse framing system

6.1.1 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.

6.1.2 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 asto ensure strength continuity.

6.1.3 Web frames

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

6.1.4 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.

6.2 Ships with integrated tanks, longitudinal framing system

6.2.1 Side transverses

The side transverses are to be spaced not more than3 m apart.

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

6.2.2 Deck longitudinals

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

6.3 Ships with integrated tanks, combinationsystem (vessel diganti ship)

6.3.1 Web frames

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

6.4 Ships with independent tanks

6.4.1 General

Ships with independent tanks are to be built on thet ransverse framing system. When a longitudinal framing system is applied, it is to be specially considered by BKI.

6.4.2 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.

6.4.3 Frames

The side frames may be inside or outside the tank.

When tank longitudinal sides are framed vertically, stiffeners are to form continuous frames with the top and bottom stiffeners, whether the frames are connectedor 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.

6.5 Fastening of self-supporting tanks

6.5.1 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 a stringer 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 tobe provided to avoid an accidental shifting during navigation.

6.5.2 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.

6.5.3 The strength check of the seatings and stays is to be carried out in compliance with Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, E,using a partial safety factor γ_R = 1,5.

6.5.4 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.

6.6 Double hull arrangements

6.6.1 General

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

6.6.2 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 thatstrictly necessary to provide the man access. Where manholes of greater sizes are needed, edge reinforcement by means of flat bar rings or other suitable stiffenersmay be required.

As a rule, the manholes height is not to be more than0,6 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** 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, ifthere is no web frame. BKI may waive this rule subject to direct calculation of the shear stresses.

6.6.3 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.

6.6.4 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.

6.6.5 Floor reinforcement

Where the inner side plating does not extend down to the bottom plating, the floors of ships 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 [cm^2] is not to be less than:

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

b = section height [mm]: $b = 100 \cdot H_{DB}$

where H_{DB} is the double bottom height [m]

t_F = net thickness of floor web [mm]

6.7 Expansion tanks

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

Scantlings of expansion tank covers are to be specially examined by BKI.

7. Subdivision

7.1 General

7.1.1 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.

7.1.2 The bulkhead scantlings are to be determined in compliance with Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 5, E., taking into account additional requirements stated under 7.2 and 7.3.

7.2 Minimum thickness of bulkhead plating

7.2.1 Minimum plating thickness

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

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

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

7.3 Minimum net thickness of structural

7.3.1 Ordinary stiffeners

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

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

7.3.2 Primary supporting members

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

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

7.4 Corrugated bulkheads

7.4.1 General

In place of plane bulkheads provided with stiffeners,corrugated bulkheads, determined according to Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 5, E., may be built in.

7.4.2 Direct calculation

The relevant service and test pressure related to thevessel 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 continuityof web in double bottom

For the allowable stresses, see Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, E.

7.5 Ends of cargo zone

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

B. Container Ships

1. Symbols

L = Rule length [m] defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 1, A.1.

B = breadth [m] defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 1, A.1.

H = depth [m] defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 1, A.1.

T = draught [m] defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 1, A.1.

t = net thickness [mm] of plating

k = material factor defined in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, A.2.4 and Section 2, A.3.2

2. General

2.1 Application

2.1.1 The type and service notation **Container** is assigned, in accordance with Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 2, B.3.1.2, to ships intended to carry dry unit cargoes.

2.1.2 Ships dealt with in this Section are to comply with the requirements stated under Volume I, Volume II and Volume III of the Rules for Inland Waterways, as applicable, and with the following requirements, which are specific to container ships.

2.1.3 Applicable requirements stated under Section 1, A. and Section 1, B. are also to be complied with.

2.2 Stability

Compliance with the applicable stability requirements according to Section 4, F. is to be proven.

3. Structure arrangements

3.1 Strength principles

3.1.1 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.

3.1.2 Structural continuity

In double hull ships, the inner side is to extend as far aft as possible and be tapered at the ends.

3.2 Bottom structure

3.2.1 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.

3.2.2 Strength continuity

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

3.2.3 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.

3.3 Fixed cell guides

3.3.1 General

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

3.3.2 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.

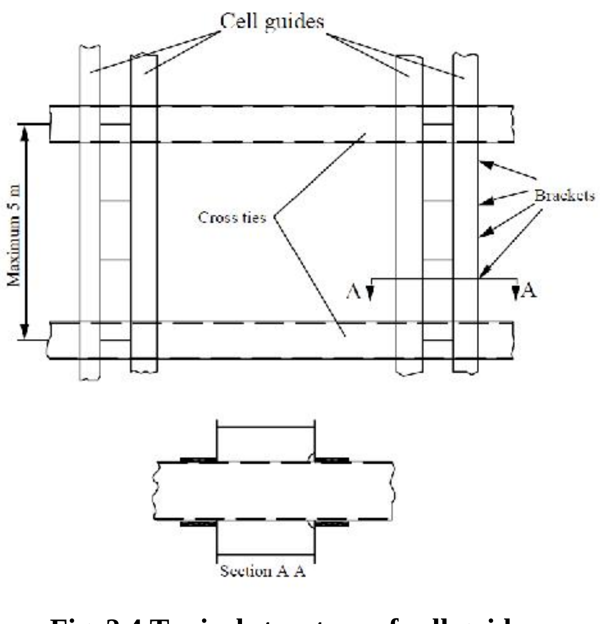


Fig. 2.4 Typical structure of cell guides

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

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.

3.4 Fixed cargo securing devices

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

3.4.2 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

3.5 Hatch covers carrying containers

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 on to 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.

4. Design loads

4.1 Design torsional torque

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 [kN.m] from the following formula:

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

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)

4.2 Force on containers

4.2.1 The force Fi applied to one container located at the level "I", as defined in Fig. 2.5, is to be determined in compliance with Rules for Hull – Inland Waterways (Part 2, Vol. II) Section. 3, C.6.5.
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: mi = 27 t

– for 20 feet containers: mi = 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

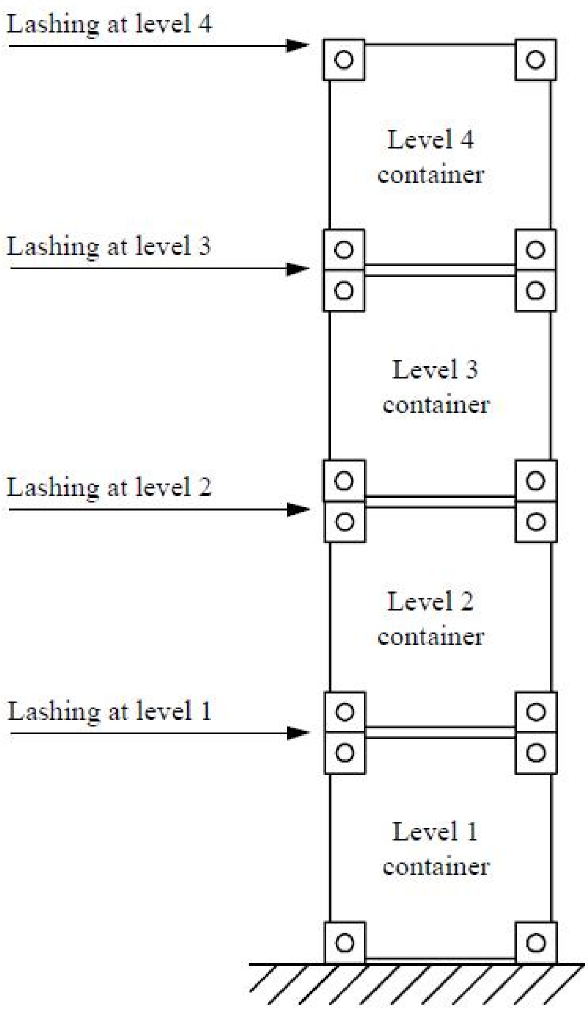


Fig. 2.5 Container levels in a stack

4.2.2 Stacks of containers

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

$$P = F / 4$$

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

N = number of containers in a stack

4.2.3 Securing load

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

5. Hull scantlings

5.1 General

5.1.1 In general, the hull scantlings and arrangements are to be in compliance with Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 5.

5.1.2 Scantlings of structural members subjected to concentrated loads are to be determined by direct calculation according to Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 2, E. In particular, the requirements of 6. are to be complied with.

5.1.3 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 4.1.

5.2 Container seating

The net thickness [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_{WL} $= .\sqrt{k . n_C . P}$

C_{WL} = coefficient

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

Where is to be taken not greater than 3

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

A_T = area of a stack of container corner [m²]

n_C = number of stacks of container corners on the seating

= MAX (a, b)

s = MIN (a, b)

a, b = spacings [m] of container supporting members

6. Direct calculation

6.1 General

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 Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 2, E.

6.2 Loading cases

6.2.1 Bottom structure

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

– full container load and scantling draught equalto 0,575 .**T**

– maximum ship draught **T**, without containers

6.2.2 Deck structure

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

6.3 Structure checks

The following checks are to be carried out:

– level of bending stresses and shear stresses, inparticular, in way of holes and passage of longitudinal

– buckling strength of unstiffened web

– continuity of double bottom in the side tank, for bottom structure

C. RoRo Ships

1. Symbols

L = Rule length [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

B = breadth [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

H = depth [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

T = draught [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

t = net thickness [mm] of plating

s = spacing [m] of ordinary stiffeners

S = spacing [m] of primary supporting members

ℓ = span [m] of ordinary stiffeners or primarysupporting members

σ_1 = hull girder normal stress [N/mm^2]

w = net section modulus [cm^3] of ordinary stiffenersor primary supporting members

A_{sh} = net web shear sectional area [cm^2]

k = material factor defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 2, A.2.4 and Section 2, A.3.2

C

z = Z co-ordinate [m] of the calculation point

M_H = design bending moment [kN.m] in hoggingcondition

M_S = design bending moment [kN.m] in saggingcondition

F = wheeled force [kN] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 3, C.6.6

2. General

2.1 Application

2.1.1 The type and service Notation **RoRo ship** is assigned, in accordance with Rules for Classification and Surveys - Inland Waterways (Part 2, Vol. I), Section 2, B.3.1.3 to ships intended to carry wheeled vehicles.

2.1.2 Ships dealt with in this Section are to comply with the requirements stated under Volume I, Volume II,Volume III and Volume IV of the Rules for Inland Navigation Ships, as applicable, and with the requirements of this Section, which are specific to RoRo ships.

2.1.3 Applicable requirements stated under Section 1, A. and Section 1, B. are also to be complied with.

2.2 Stability

Depending on the ship's design and operating conditions,proof of sufficient stability may be required by BKI.

3. Ship arrangements

3.1 Sheathing

Wood sheathing is recommended for heavy loader trucks and unusual vehicles.

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

3.2 Drainage of ro-ro cargo spaces, intended for the carriage of motor vehicles with fuelin their tanks for their own propulsion

3.2.1 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.

3.3 Hull structure

3.3.1 Framing

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

Where a transverse framing system is adopted for suchstructures, it is to be considered by BKI on a case by case basis.

4. Hull scantlings

4.1 General

4.1.1 In general, the hull scantlings and arrangements are to be in compliance with Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 5.

4.1.2 Scantlings of plating and structural members subjected to wheeled loads are to be determined in compliance with 4.2 to 4.4.

4.2 Plating

4.2.1 The net thickness [mm] of plate panels subjected to wheeled loads is to be obtained from Table 2.7, where:

t_{WL} = plating net thickness [mm]

$$t_{WL} = 0,8 \cdot C_{WL} \cdot \sqrt{k \cdot n_P \cdot F}$$

C_{WL} = coefficient

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

Where $\frac{\ell}{s}$ is to be taken not greater than 3

$$\alpha = \frac{A_t}{\ell . s}$$

A_T = tyre print area [m2]. In the case of double or triple wheels, the area is that corresponding to the group of wheels.

n_p = number of wheels on 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.

4.2.2 Tyre print area

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

$$A_T = 9,81 \cdot \frac{n_p \cdot Q_A}{n_w \cdot p_T}$$

Q_A = axle load [t]

n_w = number of wheels for the axle considered

p_T = tyre pressure [kN/m2]. When the tyre pressureis not indicated by the designer, it maybe taken as defined in Table 2.6.

Table 2.6 Tyre pressure p_T for vehicles

Vehicle	Tyre pressure pT [kN/m2]	
	pneumatic tyres	solid rubber tyres
Privatecars	250	NA
Vans and forklift trucks	600	NA
Trucks and trailers	800	NA
Handling machines	1100	1600
NA= Not Applicable.		

4.2.3 For vehicles with the four wheels of the axle located on a plate panel as shown in Fig.2.6, the net thickness of the plating is to be not less than the greater of the values obtained [mm] from the following formulae:

$$t_{WL} = t_1$$

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

t_1 = net thickness obtained [mm] from 3.2.1 for n_P = 2, considering one group of two wheels located on the plate panel

t_2 = net thickness obtained [mm] from 3.2.1 for n_P = 1, considering one wheel located on the plate panel

Table 2.7 Net thickness of plating subjected to wheeled loads [mm]

Item	Tranverse framing	Longitudinal framing
Inner bottom plating	$t = MAX (t_i)$ $t_1 = 1,5 + 0.016 . \mathbf{L}. k^{0,5} + 3,6 . s$ $t_2 = t_{WL}$ and, for $\mathbf{L} \geq 40$ m [1]: $t_3 = 68 . \frac{s}{k_2} . \sqrt{\frac{M_H}{Z_{DB}}}$	$t = MAX (t_i)$ $t_1 = 1,5 + 0.016 . \mathbf{L}. k^{0,5} + 3,6 . s$ $t_2 = t_{WL}$ and, for $\mathbf{L} \geq 40$ m [1]: $t_3 = 39 . s . \sqrt{\frac{M_H}{Z_{DB}}}$
Deck Plating	$t = MAX (t_i)$ $t_1 = 0.9 + 0.034 . \mathbf{L}. k^{0,5} + 3,6 . s$ $t_2 = t_{WL}$ and, for $\mathbf{L} \geq 40$ m [1]: $t_3 = 74 . \frac{s}{k_2} . \sqrt{\frac{M_S}{Z_D}}$ if $t_3 / s > 23,9 / k^{0,5} . k_2$: $t_3 = \frac{7,76 . k^{0,5} . s}{k_2 . \sqrt{0,21 - \frac{M_S}{Z_D}}}$	$t = MAX (t_i)$ $t_1 = 0.57 + 0.031 . \mathbf{L}. k^{0,5} + 3,6 . s$ $t_2 = t_{WL}$ and, for $\mathbf{L} \geq 40$ m [1]: $t_3 = 39 . s . \sqrt{\frac{M_S}{Z_D}}$ if $t_3 / s > 12,5 / k^{0,5}$: $t_3 = \frac{4.41 . k^{0,5} . s}{k_2 . \sqrt{0,21 - \frac{M_S}{Z_D}}}$

$k_2 = 1 + \alpha^2$
$\alpha = s / b$
b = unsupported plate width in y direction [m]
t_{WL} = net thickness [mm] defined in 4.2
Z_D = deck net hull girder section modulus [cm^3]
Z_{DB} = inner bottom net hull girder section modulus [cm^3]

[1] A lower value of thickness t3 may be accepted if in compliance with the buckling analysis carried out according to Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 2, C.

$\beta 2,\beta 3,\beta 4$ = coefficients obtained from the following formula,by replacing i by 2, 3 and 4, respectively (see Fig.2.6):

– for xi / b<2:
$\beta_i = 0,8 . (1,2 – 2,02 . \alpha_i . + 1,17 . \alpha_i^2 – 0,23 . \alpha_i^3)$

– for xi / b≥2 :
$\beta_i = 0$

xi = distance [m] from the wheel considered to thereference wheel (see Fig. 2.6)

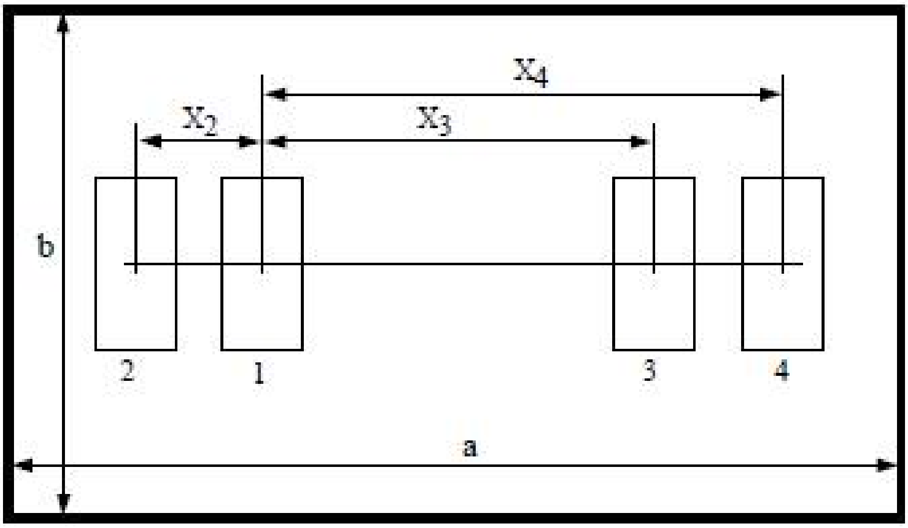


Fig. 2.6 Four wheel axle located on a plate panel

b = dimension [m] of the plate panel side perpendicular to the axle

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

4.3 Primary supporting members

4.3.1 Wheeled loads

The scantlings of primary supporting members sub-jected to wheeled loads are to be determined according to Table 2.11 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 unfavourable case, i.e. where the maximum number of axles is located on the same primary supporting member according to Fig. 2.8 to Fig 2.10, is to be considered.

The equivalent pressure may be determined using the formula:

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

n_V = maximum number of vehicles possible located on the primary supporting member

Q_A = maximum axle load [t]

X_1 = minimum distance [m] between two consecu- tive axles (see Fig. 2.9 and Fig. 2.10)

X_2 = minimum distance [m] between axles of two consecutive vehicles (see Fig. 2.10)

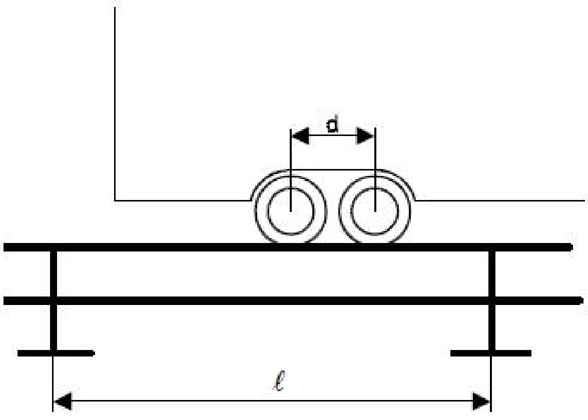


Fig. 2.7 Wheeled load on stiffeners – Double axles

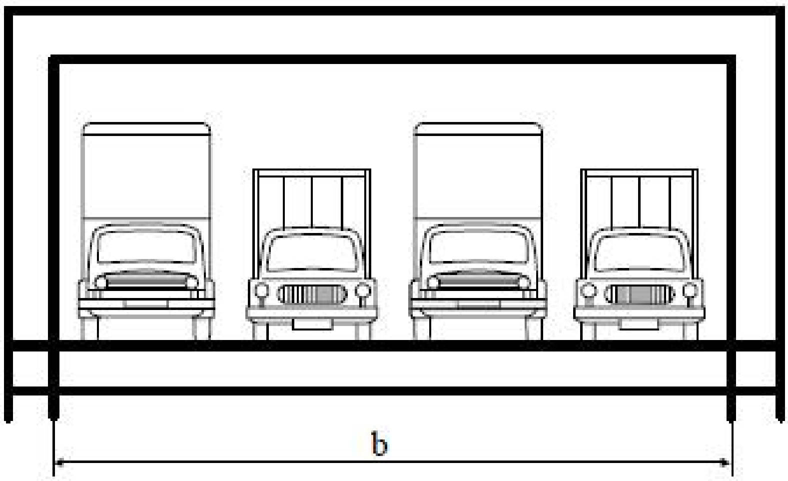


Fig. 2.8 Wheeled loads – Distribution of vehicles on a primary supporting member

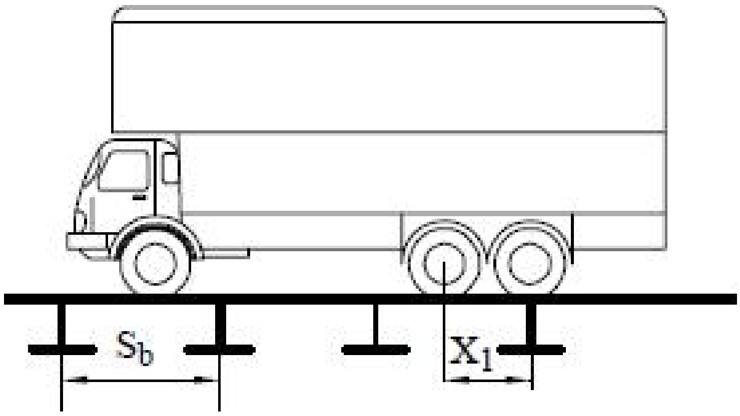


Fig. 2.9 Wheeled loads - Distance between twoconsecutive axles

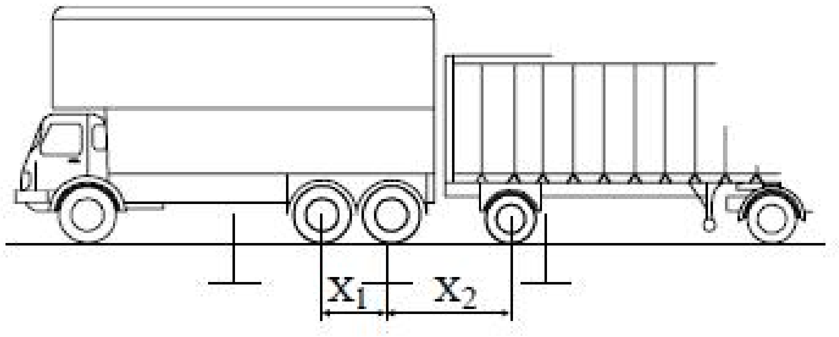


Fig. 2.10 Wheeled loads - Distance between axles of two consecutive vehicles

4.3.2 For arrangements different from those shown in Fig. 2.8 to Fig. 2.10, the scantlings of primary supporting members are to be determined by direct calculation, in compliance with Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 2, E.

4.4 Ordinary stiffeners subjected to wheeled loads

4.4.1 Net scantlings

The net section modulus w [cm^3] and the net shear sectional area A_{sh} [cm^2] of ordinary stiffeners subjected to wheeled loads are to be obtained from formulae given in Table 2.8.

Table 2.8 Net scantlings of ordinary stiffeners subjected to wheeled loads

	w[cm^3]	**A_{sh}[cm^2]**
L≥ 40 m	$w = \frac{167 \cdot k}{225 - \sigma 1} \cdot \alpha_W \cdot K_S \cdot F \cdot \ell$	$A_{sh} = 0{,}088 \,.\, k \,.\, \alpha_W \,.\, K_T \,.\, F$
L< 40 m	$w = 0{,}74 \,.\, k \,.\, \alpha_W \,.\, K_S \,.\, F \,.\ell$	
α_W = coefficient taking into account the number of wheels and wheels per axle considered as acting on the stiffener, defined Table 2.8 K_S, K_T = coefficient taking into account the number of axles considered as acting on the stiffener, defined in Table 2.9.		

5.1 Movable decks and inner ramps

The requirements applicable to movable decks and inner ramps are defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 6, F.1.

5.2 External ramps

The requirements applicable to external ramps are defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 6, F.2.

Table 2.9 Wheeled Load – Coefficients α_W

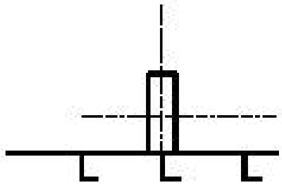
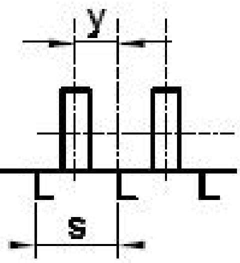
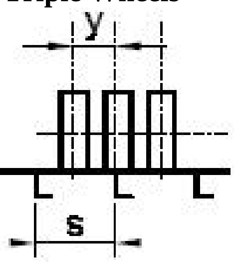
Configuration	α_W
Single Wheel 	1
Double Wheels 	$2 \cdot \left(1 - \frac{y}{s}\right)$
Triple Wheels 	$3 - 2 \cdot \frac{y}{s}$
y = distance [m] from the external wheel of a group of wheels to the stiffener under consideration, to be taken equal to the distance from the external wheel to the centre of the group of wheels	

Table 2.10 Wheeled loads - Coefficients KS and KT

Coefficients	Single axle	Double axles
K_S	1	- if d < 2. / 3 $\frac{43}{18} - \frac{7.d}{4.\ell} - \frac{d^2}{8.\ell^2} + \frac{9.d^3}{16.\ell^3}$ - if d ≥ 2. / 3 $\frac{9}{4} - \frac{3.d}{8.\ell} - \frac{3.d^2}{2.\ell^2}$
K_T	1	$2 - \frac{d}{2.\ell} - \frac{3.d^2}{2.\ell^2} + \frac{d^3}{\ell^3}$
d = distance [m] between two axles (see Fig.2.7)		

Table 2.11 Net scantlings of primary supporting members

Item	w [cm^3]	Ash [cm^2]
Transverse primary supporting members	$w = 0,58.k.\beta_b.p.s.\ ^{2}$	$A_{sh} = 0.045.k.\beta_s.p.s.$
Deck girders	$w = \frac{125.k}{214 - \sigma 1}.\ _b.p.s.\ell^2$	$A_{sh} = 0.045.k.\beta_s.p.s.$
Double bottom girders	$w = \frac{125.k}{197 - \sigma 1}.\beta_b.p.s.\ell^2$	$A_{sh} = 0.056.k.\beta_s.p.s.$
Vertical primary supporting members	$w = \frac{125.k}{214 - \sigma A}.\lambda_b\ \beta_b.p.s.\ell^2$	$A_{sh} = 0.045.k.\lambda_s.\ \beta_s.p.s.$

p = design load [kN/m^2]: p = peq

σ_A = axial stress, to be obtained [N/mm^2] from the following formula:

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

F_A = axial load transmitted to the vertical primary supporting members by the structures above (see calculation of PS in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 5, D.9.2.1).

A = net sectional area [cm2] of the vertical primary supporting members with attached plating of width b_P

D. Passenger Ships

1. Symbols

L = Rule length [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

B = breadth [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

H = depth [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

T = draught [m] defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 1, A.1.

L_{WL} = length of the hull [m] measured at the maximum draught

Δ = displacement of the laden ship [t]

v = maximum speed of the ship in relation to the water [m/s]

KG = height [m] of the centre of gravity above base line

$\mathbf{C_B}$ = block coefficient

S = spacing [m] of primary supporting members

n = navigation coefficient defined in Rules for Hull – Inland Waterways (Part 2, Vol. II) Section 3, B.
= 0,85 . H

H_w = significant wave height [m]

σ_1 = hull girder normal stress [N/mm^2]

z = Z co-ordinate [m] of the calculation point

2. General

2.1 Application

2.1.1 Ships complying with the requirements of this Section are eligible for the assignment of the type and service Notation Passenger ship, as defined in Rules for Classification and Surveys – Inlad Waterways (Part 2, Vol. I), Section 2, B.5.1.1

2.1.2 Ships dealt with in this Section are to comply with the requirements stated under Volume I, Volume II, Volume III of the Rules for Inland Waterways, as applicable, and with the requirements of this Section, which are specific to passenger ships.

2.1.3 Various requirements of these Rules are to be applied for safety of passengers and crew according to Table 2.12. Where available, statutory Regulations in the operating area of the ship are to take precedence over these requirements.

Table 2.12 Requirements applicable for safety of passengers and crew

Item	**Applicable requirements**
Subdivision, transverse bulkheads	3.1
Passenger rooms and areas	3.2
Propulsion system	3.3
Fire protection, detection and Extinguishing	4
Electrical installations	5

3. Ship arrangement

3.1 Subdivision, transverse bulkheads

3.1.1 In addition to the bulkheads called for in Rules for Hull-Inland Waterways (Part 2, Vol. II), Section 5, E., the ship is to be subdivided by further watertight transverse bulkheads in such a way that the requirements of 6. 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 6.3.3.

3.1.2 The first compartment aft of the collision bulkhead may be shorter than the length of damage stated in 6.3.3 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 $0{,}04 \cdot L_{WL}$ and

$(0{,}04 \cdot L_{WL} + 2)$ [m].

3.1.3 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 ship.

3.1.4 Bulkhead doors which are normally in the OPEN position shall be locally operable from both sides of the bulkhead, shall be capable of being closed from an accessible location above the bulkhead deck and shall 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 shall sound automatically.

– The door drive and signalling systems shall also be able to operate independently of the ship'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 shall be situated outside the penetration depth stated in 6.3.3.

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 6.3.3 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.

Note

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 ship'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.

3.2 Passenger rooms and areas

3.2.1 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 ships one of the means of escape may be replaced by two emergency exits.

For spaces below the freeboard 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 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.

3.2.2 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.

3.2.3 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 passengers.

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 ship in the same zone.

3.2.4 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 in- stalled 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.

3.3 Propulsion system

3.3.1 In addition to the main propulsion system, ships 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 ship can continue to make steerageway under its own power.

3.3.2 The second independent propulsion system be placed in a separate engine room. If both engine rooms have common partitions, these shall be built according to Section 4. G.2.

4 Fire protection, detection and extingusiher

4.1 Documents for review/approval

The following drawings and documents are to be submitted where applicable, at least in triplicate for review/approval. Those are ventilation plan, escape way plan, sprinkler system and fire division/ installation plan showing designation of each space, including information on applied materials and constructions.

4.2 Fire protection in accommodation areas

4.2.1 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.

4.2.2 Integrity of bulkheads and decks

The connectivity between bulkheads and decks should have sufficient integrity of fire protection. The following conditions are applied:

- 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 continous 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 leats class B bulkheads.
- Stairways connecting only two decks need to be protected at least at one deck level by class B bulkheads. Doord 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 fitting of ventilation terminals, lighting fixtures and similar devices, arrangements shall be made to ensure that the fire resistance is not impaired.

4.2.3 Internal subdivision

4.2.3.1 The ship 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.

4.2.3.2 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 there in shall have the same fire resistance and shall be self-closing and reasonable gastight.

4.2.3.3 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.

4.2.4 Means of escape

One of the means of escape required by 3.2.1 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 700 x 700 [mm^2] or with diameter of at least 700 mm. They shall open in the direction of escape and be marked on both sides.

4.2.5 Ventilation system

All parts of the system shall be made of noncombustible material, except that short ducts applied at the end of the ventilation device may be made of a material which has low-flame spread characteristics (*The reference is made to the Fire Test Procedure Code, Annex 1, Part 5, adopted by IMO by Resolution MSC. 61(67)*).

Ventilation ducts are to be subdivided by approved fire dampers analogously to the requirements of 4.2.3.1. 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.

4.3 General water fire extinguishing system

4.3.1 Passenger ships over 40 m L_{WL} and passenger ships with cabins for passengers over 25 m L_{WL} are subject to the additional requirements of 4.3.2 to 4.3.5.

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

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

4.3.4 If the fire pump is located in the engine room, a second power-driven fire pump shall be provided outside the engine room. The pump drive shall be independent of the engine room, and the pump capacity shall conform to the preceding requirements 4.3.2 and 4.3.3.

Connections in the piping system with the engine room shall 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.

4.3.5 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 ship.

4.4 Portable fire extinguisher

4.4.1 One additional fire extinguisher is to be provided for:

– each unit of 120 m^2, or part there of, of the gross floor area of public rooms, dining rooms and day rooms

– each group of 10 cabins, or part there of

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

4.4.3 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.

4.5 Fixed fire extingusing systems

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 Rules for Machinery Installations - Inland Waterway (Part 2, Vol.III) Section 1, H.3.

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

5 Electrical installations

5.1 General

Cabin ships and day trip ships ($L_{WL} \geq 25$ m) are required to comply with the following requirements in addition to the requirements stated under Rules for Electrical Installations - Inland Waterway (Part 2, Vol. IV) Section 1.

The excemption of these rules may be allowed for ferries and passenger ships in which only operate in daylight.

5.2 Generator plant

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.

5.3 Emergency power supply and emergency lighting

5.3.1 General

An emergency source of electrical power independent of the main power supply is to be provided which is capable to supply the electrical systems and consumers essential to the safety of passengers and crew. The electric supplying time depends on the purpose of the ship 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:

– navigation and signalling lights

– sound devices such as tyfon

- emergency lighting
- radio installations
- alarm systems for ship's safety
- public address system (general alarm)
- telecommunication systems essential to safety and the operation of the ship
- emergency search lights
- fire detection system
- sprinkler systems and other safety installations

5.3.2 Emergency source of electrical power

An emergency source of electrical power consists with the following:

- 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 45 s.

- 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.

5.3.3 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 shall 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 shall be possible without interference with other aspects of the ship's operation.

5.4 Alarm and communication systems

The requirements of Rules for Electrical Installations - Inland Waterway (Part 2, Vol.IV) Section 1, M are to be observed.

5.4.1 Fire detection and alarm system

All day rooms normally 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.

a) 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 damage (wire break, short circuit, etc.) only a part of the loop becomes faulty.

Smoke detectors shall be used in passageways, 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.

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

c) The requirements of items a) and b) are deemed to be met in the case of spaces protected by an automatic pressure water-spraying system designed in accordance with Rules for Machinery Installations - Inland Waterway (Part 2, Vol. III) Section 1, H.3.1

d) 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.

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

5.4.2 Passenger alarm system

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

5.4.3 Crew alarm system

Passenger ships with cabins shall 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.

5.4.4 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.

5.5 Intercommunications

5.5.1 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.

5.5.2 Public address systems

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

5.6 Fire door and watertight door closure indicators

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.

5.7 Lighting systems

5.7.1 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 ship normally accessible to the passengers and crew. This system is to be installed in accordance with Rules for Electrical Installations - Inland Waterway (Part 2, Vol. IV) Section 1, J.

5.7.2 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 5.3.

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 shall be marked as such for ease of identification.

b) Extent

Adequate emergency lighting shall 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 ship 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 shall 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.

5.7.3 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.

6 Buoyancy and stability

6.1 General requirements of Section 4, F.2.2 to F.2.5 are to be complied with. All stability calculations have to be based on ship-specific light ship data, to be determined by conducting an inclining experiment.

6.2 Intact stability

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

6.2.2 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 ship; 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 6.2.3, item d), shall be proved for the load condition of 100 % passengers, 50 % fuel and fresh water, 50 % waste water, and all other liquid (including ballast) tanks are considered filled to 50 %.

6.2.3 Intact stability criteria

The proof of adequate intact stability by means of a calculation shall be produced using the following intact stability criteria, and the standard load conditions as mentioned in 6.2.2, items a) to c):

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

b) The downflooding angle φ_f shall 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 Table 2.1, 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 6.2.4 and 6.2.5

– in application of the heeling moment due to passengers and turning according to 6.2.4 and 6.2.6

f) For a heeling moment resulting from moments due to passengers, wind and turning according to 6.2.4, 6.2.5 and 6.2.6, the residual freeboard shall be not less than 200 mm.

g) For ships 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).

6.2.4 Moment due to crowding of passengers

The heeling moment M_P [kNm] due to one-sided accumulation of persons is to be calculated according to the following formula:

$$M_p = g \cdot P \cdot y = g \cdot \sum \{P_i \cdot y_i\}$$

where,

P = total weight of persons on board [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 75Kg

y = lateral distance [m] of center of gravity of total weight of persons P from center line

g = acceleration of gravity (g = 9,81 m/s²)

P_i = weight of persons accumulated on area A_i, $[t] = 75 \cdot n_i \cdot A_i \cdot 10^{-3}$

A_i = area [m²] occupied by persons

n_i = number of persons per square meter

for free deck areas and deck areas with movable furniture; n_i = 3,75

for deck areas with fixed seating furniture such as benches, n_i shall be calculated by assuming an area of 50 cm in width and 75 cm in seat depth per person.

y_i = lateral distance [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 unfavourable 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 75Kg of each 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 [m]
- for day trip ships; $P = 1.1 \cdot n_{max} \cdot 75 \cdot 10^{-3}$
- for cabin ships; $P = 1.5 \cdot n_{max} \cdot 75 \cdot 10^{-3}$

where: n_{max} = maximum permitted number of passengers

6.2.5 Moment due to lateral wind pressure

The moment M_W [kNm] due to lateral wind pressure is to be determined by the following formula:

$$M_W = P_{WD} \cdot A_W \cdot \left(\ell_W + \frac{\mathbf{T}}{2} \right)$$

P_{WD} = specific wind pressure [kN/m²] defined in Table 2.13

ℓ_W = distance [m] of the centre of gravity of area A_W from the plane of draught according to the considered loading condition [m]

Table 2.13 Specific wind pressure P_{WD}

Range of navigation	P_{WD} [kN/m²]
D(1.2) to **D(2)**	$0.4 \cdot n$
D(0), **D(0.6)**	0.25

6.2.6 Turning circle moment

The moment M_{dr} [kNm] due to centrifugal force caused by the turning circle, is to be determined by the following formula:

$$M_{dr} = \frac{0.045 \cdot C_B \cdot v^2 \cdot \Delta}{L_{WL}} \left(KG - \frac{\mathbf{T}}{2} \right)$$

Where, v is maximum speed of the ship [m/s] and KG is distance of vertical centre of gravity and moulded keel [m]. If not known, the block coefficient C_B is to be taken as 1,0.

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

6.3 Damage stability

6.3.1 Proof of appropriate damage stability of the ship 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.

6.3.2 Buoyancy of the ship in the event of flooding shall be proven for the standard load conditions specified in 6.2.2. 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.

Table 2.14 Values of area A under the curve of righting lever arm

Case			A [m.rad]
1	$\varphi_{max} \le 15°$ or $\varphi_f \le 15°$		0.05 to angle $\varphi = \varphi_{max}$ or $\varphi = \varphi_f$, whichever is smaller
2	$15° < \varphi_{max} < 30°$	$\varphi_{max} \le \varphi_f$	$0.035 + 0.001 \cdot (30 - \varphi_{max})$ to angle φ_{max}
3	$15° < \varphi_f < 30°$	$\varphi_{max} > \varphi_f$	$0.035 + 0.001 \cdot (30 - \varphi_f)$ to angle φ_f
4	$\varphi_{max} \ge 30°$ and $\varphi_f \ge 30°$		0.035 to angle $\varphi = 30°$

6.3.3 Assumptions

In the event of flooding, assumptions concerning the extent of damage given in Table 2. 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 ship 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 10 cm 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

e) Table 2..

f) 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 2.15 Extent of damage

Dimension of the damage		**1-compartement status [m]**	**2-compartement status [m]**
Side damage	longitudinal ℓ	$0.1 \cdot L_{WL} \geq 4$	$0.05 \cdot L_{WL} \geq 2.25$
	transverse b	$B/5$	0.59
	vertical h	From ship bottom to top without delimination	
Bottom damage	longitudinal ℓ	$0.1 \cdot L_{WL} \geq 4$	$0.05 \cdot L_{WL} \geq 2.25$
	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 compartement, the pipework shall be regarded as intact in the event of this compartement being damaged, if it runs within the safe area and is more than 50cm off the bottom of the ship.			

Table 2.16 Permeability values

Spaces	**μ [%]**
Lounges	95
Engines and boiler rooms	85
Luggage and store rooms	75
Double bottoms, fuel bunkers and other tanks. According to their intending purpose, they are to be assumed to be full or empty for the ship floating at the plane of maximum draught	0 or 95

6.3.4 Damage stability criteria

a) For all intermediate stages of flooding referred to in 6.3.2, 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. 2.1) taking into account the heeling moment due to passengers in accordance with 6.2.4:

- 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.

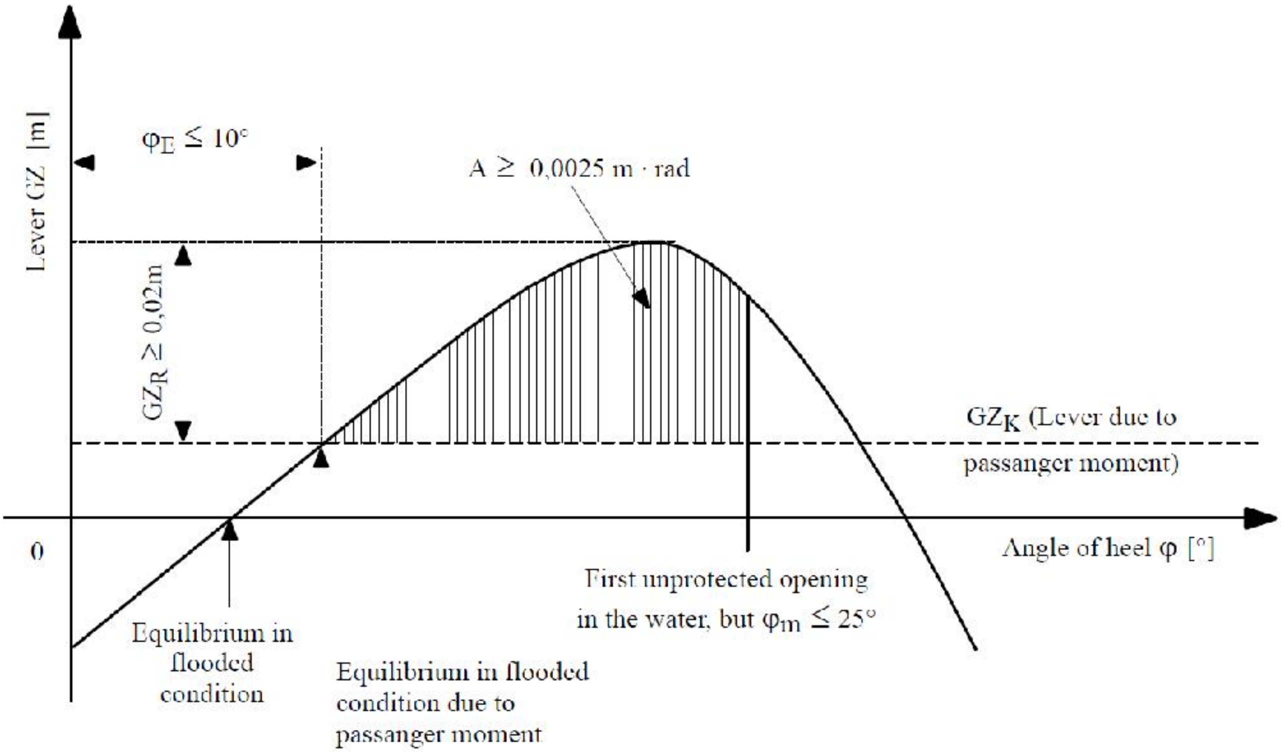


Fig. 2.11 Proof of damage stability (final stage of flooding)

6.3.5 The shut-off devices which shall be able to be closed watertight shall be marked accordingly.

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 MSC.245 (83) 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.

6.4 Derogations for certain passenger ships

6.4.1 As an alternative to proving adequate stability after damage according to 6.3, passenger ships with a length of not more than 25 m and authorized to carry up to a maximum of 50 passengers shall comply with the following criteria:

a) after symmetrical flooding, the immersion of the ship shall not exceed the margin line; and
b) the metacentric height GM_0 shall not be less than 0.10 m.

The necessary residual buoyancy shall be assured through the appropriate choice of material used for the construction of the hull or by means of highly cellular foam floats, solidly attached to the hull. In the case of ships with a length of more than 15 m, residual buoyancy can be ensured by a combination of floats and subdivision complying with the 1-compartment status according to 6.3.

6.4.2 By way of derogation from 6.3.3, passenger ships not exceeding 45 m in length and authorized to carry up to a maximum of 250 passengers do not need to have 2-compartment status.

6.5 Safety clearance and freeboard

6.5.1 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 6.2.3 e), and
b) the residual safety clearance according to 6.2.3 g).

For ships without a bulkhead deck, the safety clearance shall be at least 500 mm.

6.5.2 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 6.2.3 e), and
b) the residual freeboard according to 6.2.3 f)

The freeboard shall be at least 300 mm.

6.5.3 The plane of maximum draught is to be set so as to ensure compliance with the safety clearance according to 6.4.1, and the freeboard according to 6.4.2.

6.5.4 For safety reasons, BKI may stipulate a greater safety clearance or a greater freeboard.

7 Design loads

7.1 Pressure on sides

The design lateral pressure p_E [kN/m^2] at any point of the hull sides is to be obtained from the following:

$$p_E = \begin{cases} 9.81 \cdot (\mathbf{T} - z + 0.6 \cdot n) & \text{for } z \le \mathbf{T} \\ \max(5.9 \cdot n; 3) + \mathrm{P_{WD}} & \text{for } z > \mathbf{T} \end{cases}$$

P_{WD}= specific wind pressure [kN/m2] defined in Table 2.13

7.2 Pressure on superstructures and deckhouses

The lateral pressure, p [kN/m^2], to be used for the determination of scantlings of structure of sides and bulkheads of superstructures and deckhouses is to be obtained by following:

$$p = 2 + \mathrm{P_{WD}}$$

P_{WD}= specific wind pressure [kN/m2] defined in Table 2.13

7.3 Pressure on decks

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 Table 2..

7.4 Loads due to list and wind action

7.4.1 General

The loads inducing the racking in ship superstructures above deck 1 (see Fig. 2.2) are as follows:

- structural horizontal load P_S
- non-structural horizontal load P_C
- wind load P_W

Table 2.17 Pressure on decks

Items	**p [kN/m^2]**
Weather deck	$3.75 \cdot (n + 0.8)$
Exposed deck of superstructure ode deck house:	
- first tier (non public)	2.0
- upper tiers (non public)	1.5
- public	4.0
Accomodation compartements:	
- large spaces, ie: restaurants, halls, cinemas, lounges, kitchen, service spaces, games, and hobbies rooms, hospitals	4.0
- cabins	3.0
- other compartements	2.5

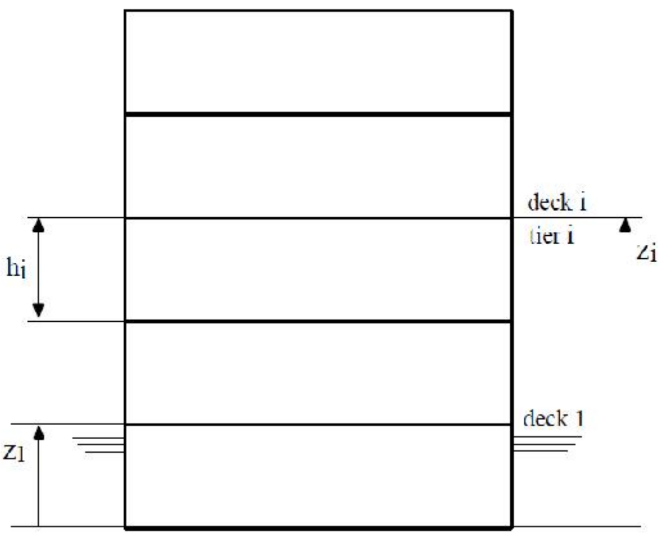


Fig. 2.2 Height and location of tier i

7.4.2 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 [kN/m^2] defined in Table 2.13

h_i = height [m] of tier-i of superstructure (see Fig. 2.2)

b_i = width [m] of tier-i of superstructure

7.4.3 Structural horizontal load

The structural horizontal load [kN] between successive gantries or transverse bulkheads, acting on deck-i is given by the formula:

$$P_{Si} = 9.81 \cdot m_{Si} \cdot \sin \text{¨}$$

where,

m_{Si} = is structural mass [t] of tier-i of superstructure between successive gantries or bulkheads. The approximation value of $0.08 \cdot S \cdot h_i \cdot b_i$ may be adopted.

7.4.4 Non-structural horizontal load

The non-structural horizontal load [kN] between successive gantries or transverse bulkheads, acting on deck-i is given by:

$$P_{Ci} = p_i \cdot S \cdot b_i \cdot \sin \text{¨}$$

Where, p_i is design pressure on deck-i [kN/m^2] as defined in Table 2..

7.4.5 Wind load

The wind load [kN] between successive gantries or transverse bulkheads, acting on deck-i, is given by the formula:

$$P_W = P_{WD} \cdot S \cdot (h_i + h_{i+1}) / 2$$

7.5 Innertial loads

7.5.1 General

For range of navigation higher than D(1,2) the following inertial loads inducing racking in ship superstructures above deck 1 (see Fig. 2.2) 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.

7.5.2 Definitions

Following parameters are used for the determination of inertial loads inducing racking:

h_i = height [m] of tier i of superstructure (see Fig.2.12)

b_i = width [m] of tier i of superstructure

z_i = height [m] of deck i above base line (see Fig.2.12)

z_G = height [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 = roll period [s]

GM = distance [m] from the ship'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:

= 0,07. B

= roll angle [rad]
= φ

φ = angle of list [rad] defined in 7.4.2

= roll acceleration [m/s²]

$$= \frac{40 \cdot \theta_R \cdot (z_i - z_G)}{T_R^2}$$

7.5.3 Structural horizontal inertial load

The structural horizontal inertial load [kN] between successive gantries or transverse bulkheads, acting on deck i, is given by the formula:

$$P_{SRi} = m_{si} \cdot a_R$$

m_{Si} = structural mass [t] defined in 7.4.3

7.5.4 Non-structural horizontal inertial load

The non-structural horizontal inertial load [kN] between successive gantries or transverse bulkheads,acting on deck i, is given by the formula:

$$P_{CRi}=\frac{P_i \cdot S \cdot b_i \cdot a_R}{9{,}81}$$

p_i = design pressure on deck i [kN/m^2] defined in Table 2.17.

See also Rules for Hull-Inland Waterways (Part 2, Vol. II) Section 3, C.6.6.4

7.6 Loads induced by collision

In the case of sensitive superstructures, BKI may require the structure to be checked against collision induced loads. The values of the longitudinal and transverse accelerations [m/s^2] are to be taken not less than:

– longitudinal acceleration: a = 3,0 m/s^2

– transverse acceleration: a = 1,5 m/s^2

7.7 Hull girder loads

The design bending moments in hogging and saggingconditions and the vertical design shear force are to be determined according to Rules for Hull-Inland Waterways (Part 2, Vol. II) Section 4.

8. Hull girder strength

8.1 Basic criteria

8.1.1 Superstructure efficiency

The superstructure efficiency indicating the contribution degree of a superstructure to the hull girder strength, may be defined as the ratio of actual stress atthe superstructure neutral axis, σ_1', to the hull girder stress at the same point σ, computed as if the hull and the superstructure behaved as a single beam.

$$\Psi=\frac{\sigma_1'}{\sigma_1}$$

The superstructure efficiency ψ may be determine dusing the formula:

$$\Psi=0{,}425\cdot\chi-0{,}0454\cdot\chi^2$$

χ = dimensionless coefficient defined as:

$= 100 \cdot j \cdot \lambda \leq 4{,}5$

λ = superstructure half length [m]

j = parameter [cm] defined as:

$$= \sqrt{\frac{1}{\frac{1}{A_{sh1}} + \frac{1}{A_{she}}} \cdot \frac{\Omega}{2.6}}$$

A_{sh1}, A_{she} = independent vertical shear areas [cm^2]of hull and superstructure, respectively

Ω = parameter [cm^{-4}], defined as:

$$= \frac{(A_1 + A_e) \cdot (i_1 + I_e) + A_1 \cdot A_e \cdot (e_1 + e_e)^2}{(A_1 + A_e) \cdot I_1 \cdot I_e + A_1 \cdot A_e \cdot \left(I_1 \cdot e_e^2 + I_e \cdot e_1^2\right)}$$

A_1,A_e = independent sectional areas [cm2] of hull and superstructure, respectively, determined incompliance with Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 4, C.2

I_1, I_e = independent section moments of inertia, [cm^4] of hull and superstructure, respectively, determined in compliance with Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 4, C.2., about their respective neutral axes

e_1, e_e = vertical distances [cm] from the main (upper) deck down to the neutral axis of the hull and up to the neutral axis of the superstructure respectively (see Fig. 2.13).

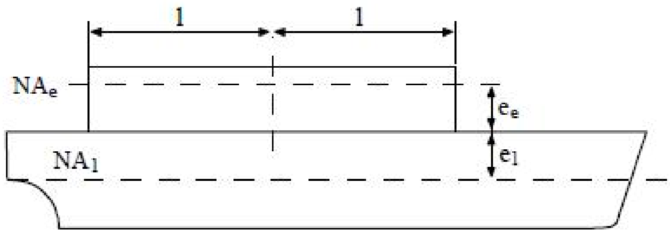


Fig. 2.13 Parameters determining the superstructure efficiency

An erection with large side entrances is to be split into sub-erections. The formulae given above are, therefore,to be applied to each individual sub-erection.

In the case of a multi-tier superstructure, the procedure is to be applied progressively to each tier i until ψ isless than 0,95, considering that the hull girder extends up to the superstructure deck (i − 1).

If the superstructure material differs from that of the hull, the geometric area Ae and the moment of inertiaIe shall be reduced according to the ratio E_e/E_1 of the respective material Young moduli.

8.1.2 Strength deck

The deck of a superstructure extending within the central part of the ship may be considered as a strength deck if its efficiency, determined according to8.1.1 is at least ψ = 0,95.

8.1.3 Hull girder section modulus

The hull girder section modulus to be used for the hull scantling is to be determined in compliance with Rules for Hull - Inland Waterways (Part 2, Vol. II) Section 4. C., considering the strength deck located just above the load waterline.

9. Scantlings

9.1 General

9.1.1 The hull scantlings are to be as specified in rules for Hull –Inland Waterways (Part 2, Vol. II) Section. 5.

9.1.2 Double hull

If a double bottom is provided, the height has to be atleast 0,60 m and the minimum width of any side void spaces provided has to be at least 0,6 m.

9.2 Additional requirements

9.2.1 Primary supporting members

The design pressure of bottom primary supporting members is to be determined using $\gamma = 1$ for the draught coefficient.

9.2.2 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 Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 2, E.

Special attention is to be paid to the staggering ofresistant members in the two hulls.

A method for the determination of scantlings of deckbeams connecting the hulls of a catamaran subject totorsional moment is given in Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 2, I.

Any other agreed method of calculation may be accepted by BKI.

9.3 Superstructures

9.3.1 The arrangement and scantlings of superstructuresare to be in compliance with Rules for Hull – Inland Waterways (Part 2, Vol. II), Section. 6, D.

Contributing superstructures are also to be in compliancewith applicable requirements of Rules for Hull – Inland Waterways (Part 2, Vol. II), Section. 5.

9.3.2 Transverse strength

The existing constructive dispositions shall ensure aneffective 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 guidancedefined in 9.4.

9.4 Racking analysis

9.4.1 General

The racking analysis is performed for checking strength of structure against lateral horizontal loads due to list and wind action defined in 7.4 and, eventually,to inertial loads induced by ship motion.

The racking analysis is to be performed where no complete transverse bulkheads efficiently restrain the transverse loads.

9.4.2 Analysis methodology

The following methodology is to be followed for checking strength of structure above the lowest deck (socalled deck 1 in Fig. 2.12):

a) Calculation of transverse forces

– determination of structural horizontal load oneach deck above deck 1, according to 7.4.3and, eventually, 7.5.3

– determination of non-structural horizontalload on each deck above deck 1, according to7.4.4 and, eventually, 7.5.4

– determination of wind load on each deckabove deck 1 according to 7.4.5

b) Distribution of transverse forces

– distribution of these loads on vertical structuralmembers efficiently acting against racking

c) Analysis of transverse structures

9.4.3 Checking criteria

It is to be checked that the normal stress σ, the shearstress τ and the equivalent stress σ_{VM} are in compliancewith the following formulae :

$$\frac{0{,}98 \cdot R_{EH}}{\gamma_R} \geq \sigma$$

$$\frac{0{,}48 \cdot R_{EH}}{\gamma_R} \geq \tau$$

$$\frac{0{,}98 \cdot R_{EH}}{\gamma_R} \geq \sigma_{VM}$$

R_{eH} = minimum yield stress [N/mm^2] of the material

γ_R = partial safety factor covering uncertainties regarding resistance, to be taken equal to 1,20

9.5 Scantling of window stiles

9.5.1 General

The geometric characteristics of the hull girder to beused for the scantling of window stiles are to be determinedin compliance with Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 4, C., assumingthat the hull girder extends up to the uppermost contributingsuperstructure deck.

9.5.2 Forces in the window stile

a) Local shear force [kN]

– In general:

$$F=\frac{100\cdot\Psi\cdot T_s\cdot\mu}{2\cdot I}\cdot \ell$$

– In way of highest contributing superstructuredeck:

$$F=\frac{100\cdot\Psi\cdot T_s\cdot A}{2\cdot w_1}\cdot \ell$$

b) Maximum local bending moment [kN·m]

$$M_B=\frac{F\cdot h}{2}$$

T_S = shear force [kN] to be determined according to Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 4, B.3.1.1

I = net hull girder moment of inertia [cm^4] with respect to the hull girder neutral axis

μ = net static moment [cm^3] with respect to the hull girder neutral axis, of the part including lateral strip of plate and all contributing tiers of superstructure located above the window considered

w_1 = net hull girder section modulus in way of the superstructure deck considered [cm^3] with respect to the hull girder neutral axis

A = net sectional area of the superstructure deck considered [cm^2] including lateral strip of plating above windows

h = window height [m]

ℓ = distance [m] between centres of two successive windows

9.5.3 Checking criteria

It is to be checked that the stresses in the window stileare in compliance with 9.4.3.

E. Tugs and Pushers

1. Symbols

L = Rule length [m] defined in Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 1, A.1

t = net thickness [mm] of plating

k = material factor defined in Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 2, A.2.4 and Section. 2, A.3.2

2. General

2.1 Application

2.1.1 Ships complying with the requirements ofthis Section are eligible for the assignment of the typeand service Notation **Tug** or **Pusher**, as defined in Rules for Classification and Survey – Inland waterways (Part 2. Vol. I), Section. 2, B.7.1.1 or Section. 2, B.7.1.2.

2.1.2 Ships dealt with in this Section are to complywith the requirements stated under Volume I,Volume II,Volume III and Volume IV of Rules for Inland Waterways, as applicable, and with the following requirements, which are specific to tugs and pushers.

In particular, when pushed convoy or side-by-sideformation comprises a ship carrying dangerous goods, ships used for propulsion shall meet the requirements of Section. 3, A.4. and Section. 3, A.5, as applicable.

2.2 Documents to be submitted

In addition to the documentation requested in the Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 1, B., a drawing showing the towing devices and their installation is to be submitted for review/approval to BKI. The maximum towing force contemplated is to be mentioned on that drawing.

3. Arrangement

3.1 Towing devices

3.1.1 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 tobe secured to stools adequately supported by webframes or bulkheads, the latter being located on eitherside of the bitts.

3.2 Pushing devices

3.2.1 Transom plate

Pushers are to be arranged with an efficient flat transom plate or any other equivalent device at the fore end of the ship the structure of which is to be incompliance with Rules forHull –Inland Waterways (Part 2, Vol. II), Section. 7, F.

3.3 Hull protection

3.3.1 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 light ship waterline to the fenders themselves.

4. Hull scantlings

4.1 General

The scantlings of the hull structure are to be determined in compliance with Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 5, taking into account additional requirements defined in 4.2.

4.2 Additional requirements

4.2.1 Minimum net thicknesses

The minimum thicknesses are to be obtained from Table 2.18.

Table 2.18 Minimum net thicknesses

Plating	t [mm]
Decks, sides, bottom,bulkheads, web of primary supporting members, web of ordinary stiffeners and other structures	$t=3,3+0,048 \cdot L \cdot k^{0,5}$
Keel plate	t = thickness of adjacent bottom plating

4.2.2 Topside structure

The topside structure scantlings are to be determined according to Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 5, D.4, where the minimum thicknessis to be taken equal to 5 mm.

4.2.3 Primary supporting members

The design pressure of bottom primary supporting members is to be determined using $\gamma = 1$ for the draught coefficient.

5. Other structures

5.1 Sternpost

Irrespective of the range of navigation assigned to the ship, the scantlings of the sternpost are not to be less than those determined according to requirements applicable to range of navigation **D(1,2)**.

6. Hull outfitting

6.1 Rudder

Irrespective of the range of navigation assigned to the ship, the rudder scantlings are not to be less than those determined according to the requirements applicableto range of navigation **D(1,2)**.

7. Machinery

7.1 Propelling machinery

Propulsion systems under the bottom of the ship areto be protected against damage by an effective structure around the propulsion system.

F. Pontoons

1. Symbols

L = Rule length [m] defined in Rules for Hull –Inland Waterways (Part 2, Vol. II), Section 1, A.1.

t = net thickness [mm] of plating

k = material factor defined in Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 2, A.2.4 and Section 2, A.3.2

2. General

2.1 Application

2.1.1 Ships complying with the requirements ofthis Section are eligible for the assignment of the typeand service Notation **Pontoon**, as defined in Rulesfor Classification and Survey – Inland waterways (Part 2. Vol. I), Section. 2, B.7.1.4

2.1.2 Ships dealt with in this Section are to comply with the requirements stated under Volume I, Volume II,Volume III and Volume IV of the Rules for Inland waterways, as applicable, and with the requirements of this Section, which are specific to pontoons.

2.2 Documents to be submitted

In addition to the documentation requested in the Rules for Hull –Inland Waterways (Part 2, Vol. II), Section 1, B., the following documents are to be submitted to BKI :

– cargo weight distribution on the deck

– equipment weight and distribution

3. Arrangement

3.1 Hull structure

3.1.1 Framing

In general, ships with service notation **Pontoon** are of flush deck single hull type, built in the longitudinal system. Longitudinal stiffening members are to be supported by transverses arranged to form ring systems.

3.1.2 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.

3.1.3 Truss arrangement supporting deck loads

Where truss arrangements may be used as supports ofthe deck loads, including top and bottom girders inassociation with pillars and diagonal bracing, the diagonal members are generally to have angles of inclination with the horizontal of about 45° and cross-sectional area of about 50 % that of the adjacent pillars.

3.2 Lifting appliances

3.2.1 Crane position during navigation

For pontoons where a crane is fitted on the deck, the crane boom is to be lowered and efficiently secured to the pontoon during the voyage.

4. Scantlings

4.1 General

The scantlings of the hull structure are to be determined in compliance with Rules for Hull –Inland Waterways (Part 2, Vol. II), Section 5, taking into account additional requirements defined in 4.2.

4.2 Additional requirements

4.2.1 Minimum net thicknesses

The minimum thicknesses are to be obtained fromTable 2.19.

Table 2.19 Minimum net thicknesses

Plating	t [mm]
Decks, sides, bottom,bulkheads, web of primary supporting members,web of ordinary stiffeners and other structures	– for **L** ≤ 40 m: $t = 3,3 + 0,048 \cdot \mathbf{L} \cdot k^{0,5}$ – for **L**> 40 m: $t = 4,8 + 0,019 \cdot \mathbf{L} \cdot k^{0,5}$
Keel plate	t = thickness of adjacent bottom plating

4.2.2 Plating and stiffeners subjected to wheeled loads are to comply with C.

4.2.3 Primary supporting members

The design pressure of bottom primary supporting members is to be determined using γ = 1 for the draught coefficient.

In the case of primary supporting members forming agrillage, the scantlings are to be determined by direct calculation as specified in B.5.

4.3 Reinforcements

Reinforcements are to be provided at places where the hull is heavily stressed, as the securing points of thetowing ropes.

G. Ships for Dredging Activities

1. Symbols

L = Rule length [m] defined in Rules for Hull –Inland Waterways (Part 2, Vol. II), Section 1, A.1

ρ = density of the water and spoil mixture; as ageneral rule, the value of ρ may be taken not greater than 1,8 t/m^3

2. General

2.1 Application

2.1.1 Ships complying with the requirements of this Section are eligible for the assignment of one of the following type and service Notations, as defined in Rules for Classification and Survey – Inland waterways (Part 2. Vol. I), Section 2, B.6.1.1 to B.6.1.4

– **Dredger**

– **Hopper dredger**

– **Hopper barge**

– **Split hopper barge**

2.1.2 Ships dealt with in this Section are to comply with the requirements stated under Volume I, Volume II,Volume III and Volume IV of the Rules for Inland waterways, as applicable, and with the requirements of this Section, which are specific to ships for dredging activities.

2.1.3 Only ranges of navigation **D(0,6)**, **D(1,2)** and **D(2)** may be assigned.

2.1.4 Dredging equipment and installations are notcovered by these Rules.

2.2 Dredger types

2.2.1 Hopper dredger and hopper barge

Hopper dredger and hopper barge are ships intended to carry out dredging operations and having one or several hopper spaces in the midship region, or a suction pipe well.

2.2.2 Dredger

A dredger is a ship intended to carry out dredging operations and that does not carry spoil, such as bucket dredger.

2.2.3 Split hopper barge

A split hopper barge is an hopper barge which opens longitudinally around hinges.

2.3 Documents to be submitted

In addition to the documentation requested in the Rules for Hull –Inland Waterways (Part 2, Vol. II), Section 1, B., the following documents are to be submitted to BKI :

– calculation of the maximum still water bending moments

– dredging equipment weight and distribution

– other equipment weight and distribution

3. Arrangement

3.1 Transverse rings

3.1.1 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 and a strong beam at deck level.

3.1.2 Gusset stays for coamings

Gusset stays for coamings are to be fitted in way ofthe transverse rings to which they are to be securely fixed.

3.2 Transverse and longitudinal bulkheads

It is recommended to provide a chafing allowance forplates subjected to rapid wear (hopper space bulkheads, weir, ...).

3.3 Suction pipe well

As far as the operation of the ships permits it, the side compartments are to be firmly connected together unless adequate arrangements are made and approvedby BKI.

Longitudinal strength continuity is to be ensured. Thetop 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.

3.4 Hopper space structure

At the ends of the hopper space, the transverse bulkheads are to extend from one side to the other of the ship. Where this is not the case, web rings with special scantlings are to be provided.

3.5 Particular arrangements

3.5.1 Dredgers

Where dredgers are likely to work in association with hopper barges, the sheer strake is to be protected. Thiscan be accomplished slightly below the deck by afender efficiently secured to the shell plating and extendingat least over two thirds of the ship length.The necessary compensations are to be provided in way of the break in the raised deck, if any.

3.5.2 Bucket dredgers

Dangerous flooding in case of damage to shell plating by metal debris (e.g. 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 compartmentis to be of sufficient size to allow surveys to be carried out.

3.6 Shifting of the structures at ends of thehopper spaces

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 up wards and downwards by large brackets each having, a rule length and width equal to about0,25 ·**H**.

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.

4. Design loads

4.1 Cargo load

The cargo load transmitted to the hull structure is tobe determined in compliance with Rules for Hull – Inland Waterways (Part 2, Vol. II), Section 3, C.5.where the cargo density of the water and spoil mixture,shall not be taken less than 1,8.

5. Hull scantlings

5.1 Split hopper barge

Scantlings and arrangements of ships with type and service Notation **Split hopper barge** will be consideredon a case-by-case basis, considering the applicable requirements of the BKI Rules.

5.2 Shell plating and topside plating

The net scantlings of the shell plating and the topside plating are to be determined in compliance with the applicable requirements stated under Section 1, B. Or F. in this Section.

5.3 Framing structure

5.3.1 The net scantlings of the hull structure are to be determined in compliance with the applicable requirements stated under Section 1, B. or F. in thisSection.

5.3.2 Transverse rings

The ring component scantlings are to be considered by BKI 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.

5.3.3 Transverse web plates in the side tanksabreast the hopper spaces

The scantlings of these web plates are to be considered by BKI on a case-by-case basis.

5.4 Rudders

The rudder stock diameter obtained from Rules for Hull –Inland Waterways (Part 2, Vol. II), Section 7, A. is to be increased by 5 %.

H. Launches (Boat)

1. Symbols

L = Rule length [m] defined in Hull –Inland Waterways (Part 2, Vol. II), Secton 1, A.1

t = net thickness [mm] of plating

k = material factor defined in Rules for Hull –Inland Waterways (Part 2, Vol. II), Section. 2,A.2.4 and Section. 2, A.3.2

2. Application

2.1 Ships complying with the requirements ofthis Section are eligible for the assignment of the type and service Notation **Launch**, as defined in Rules for Classification and Survey – Inland waterways (Part 2. Vol. I), Section 2, B.7.1.3

2.2 Ships dealt with in this Section are to comply with the requirements stated Volume I, Volume II, Volume III and Volume IV of Rules for Inland waterways, as applicable, and with the requirements of this Section, which are specific to launches.

3. Hull scantlings

3.1 General

The scantlings of the hull structure are to be determined in compliance with Rules for Hull –Inland Waterways (Part 2, Vol. II), Section 5, taking into account additional requirements defined in 3.2.

3.2 Additional requirements

3.2.1 Minimum net thicknesses

The minimum thicknesses are to be obtained fromTable 2.20.

Table 2.20 Minimum net thicknesses

Plating	t [mm]
Decks, sides, bottom,bulkheads, web of primary supporting members, web of ordinary stiffeners and other structures	$t = 3{,}3 + 0{,}048 \cdot L \cdot k^{0,5}$
Keel plate	t = thickness of adjacent bottom plating

3.2.2 Topside structure

The topside structure scantlings are to be determined according to Rules for Hull –Inland Waterways (Part 2, Vol. II), Section5, D.4., 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 γ = 1 for the draught coefficient.

Section 3

Transport of Dangerous Goods

A. General

1. Application

1.1 General

1.1.1 The following requirements apply to ships intended for the carriage of dangerous goods.

1.1.2 Ships dealt with in the following are to comply with the requirements stated under Volume I, Volume II, Volume III and Volume IV, as applicable, and with the following specific requirements:

– For transport of dangerous liquid cargoes: see Section 2, A. and B. in this Section.

– For transport of liquefied gases: see Section 2, A. and C. in this Section.

– For transport of dangerous, dry cargoes: see D.

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 2013. In any case the actual edition of the Regulations for the transport of dangerous goods has to be observed. For ships not falling under ADN, BKI may approve equivalent arrangements providing the same level of safety.

1.2 Classification of dangerous goods

In the UN Model Regulations, 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 the UN Model Regulations are given in the actual ADN.

1.3 Substances approved for carriage in tankers

1.3.1 The following 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 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 Regulations) are permitted to be carried in tankers complying with the following Rules.

1.3.3 Despite from foregoing, the current edition of the ADN 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 Waterways.

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 ship 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 ships

Cargo area of tank ships means the whole of the following spaces (see Fig. 3.1).

1.4.6 Cargo area of tank ships (part below deck)

Cargo area of tank ships (part below deck) means the space between two vertical planes perpendicular to the centre-line plane of the ship, 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.

1.4.7 Cargo area of tank ships (main part above deck)

Cargo area of tank ships (main part above deck) (When anti-explosion protection is required – comparable to zone 1, see 1.4.16) 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

Table 3.1 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

1.4.8 Cargo area of tank ships (additional part above deck)

Cargo area of tank ships (additional part above deck) (When anti-explosion protection is required, comparable to zone 1, see 1.4.16) means the spaces not included in the main part of cargo area above deck comprising 1 m radius spherical segments centred over the ventilation openings of the cofferdams and the service spaces located in the cargo area part below the deck and 2 m spherical segments centred over the ventilation openings of the cargo tanks and the opening of the pump-rooms.

1.4.9 Cargo area of dry cargo ships

See 1.4.10

1.4.10 Protected area

Protected area means:

a) the cargo hold or holds (when anti-explosionprotection is required, comparable to zone 1, see 1.4.16) of the ship

b) the space situated above the deck (when antiexplosion protection is required, comparable to zone 2, see 1.4.16), bounded:

– athwartships, by vertical planes corresponding to the side plating

– foremost and aftmost, by cargo hold bulkheads; and

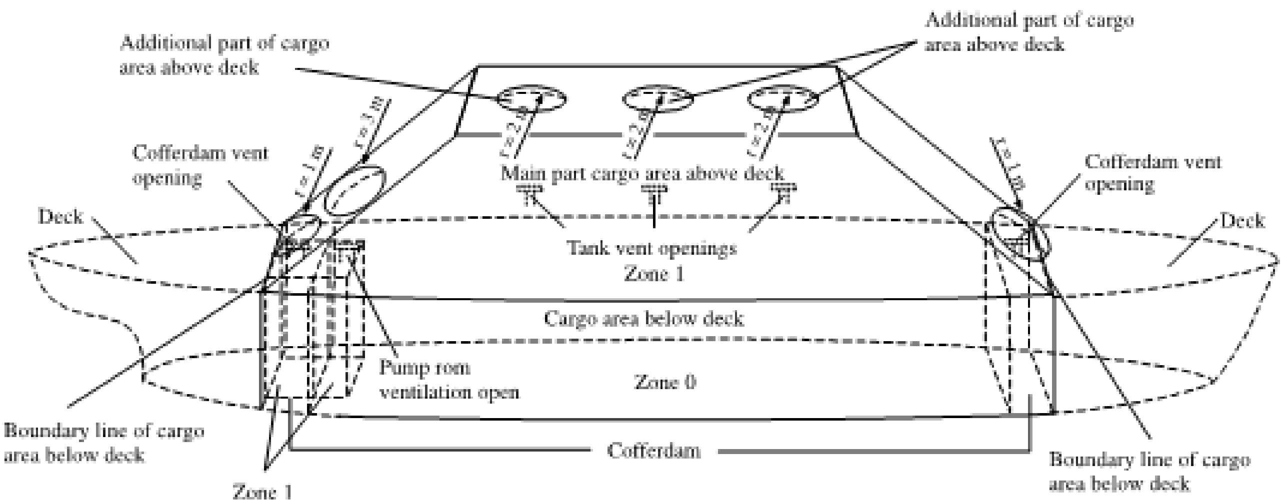
– upwards, by a horizontal plane 2 m above the upper level of the cargo, but at least by a horizontal plane 3 m above the deck.

1.4.11 Cargo pump room

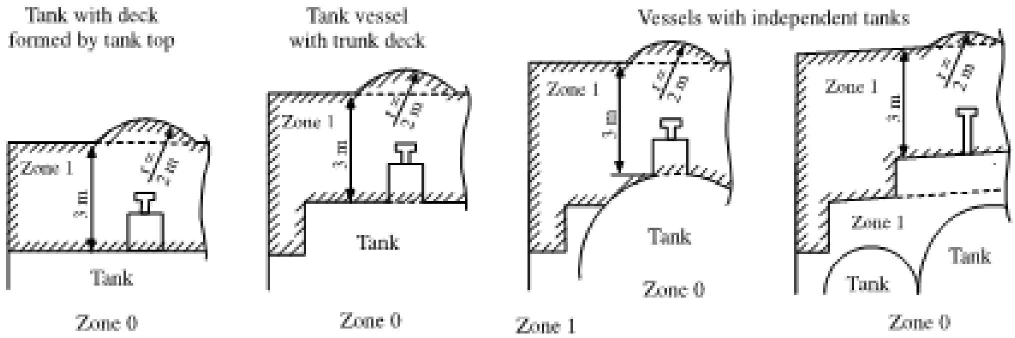
Cargo pump-room (When anti-explosion protection is required, comparable to zone 1, see 1.4.16) means a service space where the cargo pumps and stripping pumps are installed together with their operational equipment.

1.4.12 Cargo tank

Cargo tank (When anti-explosion protection is required, comparable to zone 0, see 1.4.16) means a tank which is permanently attached to the ship 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.



Cargo area above for various tankers



Zone 0 = inside tank
Zone 1 = cargo area
Zone 2 = other areas

Fig. 3.1 Cargo Area

1.4.13 Cofferdam

Cofferdam (when anti-explosion protection is required, comparable to zone 1, see 1.4.16) means an athwart ship compartment which is bounded by watertight bulkheads and which can be inspected.

1.4.14 Design pressure/under pressure

Design pressure/under pressure 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 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.

1.4.17 Explosion group

Explosion group means a grouping of flammable gases and vapours according to their maximum experimental safe gaps and minimum ignition currents, and of electrical apparatus which may be used in the corresponding potentially explosive atmosphere.

1.4.18 Flash point

Flash point means the lowest temperature of a liquid at which its vapours form a flammable mixture with air.

1.4.19 Independent cargo tank

Independent cargo tank (when anti-explosion protection is required, comparable to zone 0, see 1.4.16) means a cargo tank which is permanently built in, but which is independent of the ship's structure.

1.4.20 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.

1.4.21 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.

1.4.22 Pressure tank

Pressure tank means a tank designed and approved for a working pressure ≥ 400 kPa (4 bar).

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 its 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 twelfth revised edition of the Recommendations on the Transport of Dangerous Goods published by the United Nations (ST/SG/AC.10/1/Rev.12).

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.

1.4.27 Service space

Service space means a space which is accessible during the operation of the ship 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.

2. General provisions for tankers – Type G, C and N

2.1 Basic types of tankers

2.1.1 With regard to kind of cargo, a distinction can be made between three different basic tanker types:

– The tanker Type G - a ship with inserted pressure tanks dimensioned and approved for the carriage of gases liquefied under pressure or by cooling and belonging to class 2. See sketches b and c of Section 2, Fig. 2.3. A tank ship Type G may also transport products where in the product list, Table 3.9 a tanker Type C or Type N is claimed if the transportation conditions for the ship type are fulfilled.

– The tanker Type C - a double-hull tanker as shown in sketch b of Section 2, Fig. 2.2 and double hull tankers with inserted cargo tanks analogous to sketches c and d of Section 2, A., Fig. 2.3. The ship has to be used for the carriage of substances of class 6.1 or class 3 with flash point ≤ 23 °C. A tanker Type C may also transport products where in the product list, F., Table 3.9 a tanker Type N is claimed if the transportation conditions for the ship type are fulfilled.

– The tanker Type N - a ship type which includes all three types of construction as shown in Section 2, Fig. 2.1 to 2.3. This ship may be used for the carriage of products of class 3, class 8 or of class 9.

2.1.2 Basic structural configuration

– For single hull tankers, see Section 2, A.3.1.1
There are closed (tanker Type N - closed with 10 kPa ≤ 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 Section 2, A.3.1.2.
Double hull tankers also exist in closed and open structural versions.

– For tankers with inserted cargo tanks, see Section 2, A.3.1.3.
Independent cargo tanks exist in open and closed structural versions.

2.1.3 Minimum requirements for double hull arrangements

Where prescribed distances from ADN or other statutory regulations do not have to be maintained between the tank wall and the ship'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 ship on each side shall not be less than 8 % of the breadth **B**. This distance shall afford easy access to the tanks.

– The distance between the tanks and the bottom of the ship shall allow inspection and shall be at least 60 cm. However, the distance between a tank pump well and the ship's bottom may be reduced to 50 cm provided that the pump well is placed as close as possible to a transverse bulkhead and 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 ship.

2.1.4 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 B.7.2.2.

2.2 Protection against penetration of gases

2.2.1 The ship 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 to be complied with if the wall of the superstructures facing the cargo area extends from one side of the ship 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 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.

2.2.3 In the cargo area, the lower edges of door openings in the sidewalls of superstructures shall have a height of not less than 0,50 m above the deck, and the sills of hatches and ventilation openings of premises located under the deck 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.

2.2.4 The bulwarks, foot-rails, etc. shall be provided with sufficiently large openings which are located directly above the deck.

2.3 Materials

2.3.1 The ship's hull and the tanks shall be made from hull structural steel conforming to the Rules for Materials. See also the Rules for Hull Design and Construction (Part 2, Vol. II) Section 2, A.

2.3.2 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.

2.3.3 Every part of the ship, 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.

2.3.4 Vapour pipes and gas discharge pipes shall be protected against corrosion.

2.3.5 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 (aluminium gauging rods are, however, permitted provided that they are fitted with brass feet or protected in another way to avoid sparking)
- chocking of cargo tanks which are independent of the ship's hull and chocking of installations and equipment
- masts and similar round timber
- engine parts
- parts of the electrical installation
- loading and unloading appliances (not for tanker Type G)
- lids of boxes which are placed on the deck

2.3.6 The use of wood or synthetic materials within the cargo area is only permitted for supports and stops of any kind.

2.3.7 The use of synthetic materials or rubber within the cargo area is only permitted for:

- coating of cargo tanks and of pipes for loading and unloading (not for tanker Type G)

– 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

2.3.8 Materials of accommodations and wheelhouses

All permanently fitted materials in the accommodation or wheelhouse, with the exception of furniture, shall not readily ignite (see the Rules for Machinery – Inland Waterways (Part 2, Vol. III) Section 1, H.1.4.6). They shall not evolve fumes or toxic gases in dangerous quantities, if involved in a fire.

2.3.9 The paint used in the cargo area shall not be liable to produce sparks in case of impact.

2.3.10 The use of synthetic material for ship's boats is permitted only if the material does not readily ignite.

2.4 Cofferdams

2.4.1 The cargo tanks shall 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.

2.4.2 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 SOLAS II-2, Regulation 3, shall be deemed equivalent to a cofferdam. For pressure cargo tanks, the 0,50 m distance may be reduced to 0,20 m.

2.4.3 Cofferdams or cofferdam compartments located next to a service space which has been arranged in accordance with 2.3.4 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.

If, however, the cofferdam is connected to a double hull space, it is sufficient for it to be accessible from that space. In this case, an arrangement shall be made for possible monitoring in order to ascertain from the deck whether the cofferdam is empty.

2.4.4 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 2.8.

2.4.5 Cofferdam bulkheads not facing the cargo area are to be placed at right angles to the ship'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.

2.4.6 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 ship to the other and from the bottom to the deck in one frame plane.

2.4.7 A cofferdam may be arranged as a cargo pump room, provided the requirements in 2.8.3 and 3.1 are complied with.

2.5 Accommodations, wheelhouses and service spaces

2.5.1 Superstructures and wheelhouses shall be placed outside the cargo area, i.e. forward of the foremost or aft of the aftermost cofferdam bulkhead.

2.5.2 Windows of the wheelhouse at a height of at least 1 m above the wheelhouse floor may tilt forward.

2.5.3 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 face the cargo area.

2.5.4 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."**

2.5.5 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 m from the cargo area. No wheelhouse doors and windows shall be located within 2 m from the cargo area, except where there is no direct connection between the wheelhouse and the accommodation.

2.5.6 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.

2.6 Tank sizes

2.6.1 On tank ships, except with inserted cargo tanks, the spacing [m] of transverse bulkheads shall not exceed:

$$d = 5{,}5 + 0{,}13 \cdot \mathbf{L}$$

2.6.2 The maximum permissible capacity of a tank for single hull tank ships, double hull tank ships and ships with tanks independent of the hull are shown in Table 3.2.

$\mathbf{L}_{OA} \cdot \mathbf{B} \cdot \mathbf{H}$ = product of the tank ship main dimensions

$\mathbf{L}_{OA}$ = maximum length of the hull [m]

2.6.3 In the case of trunk deck ships, **H′** is to be substituted for **H**. **H′** is to be determined by the following formula:

$$\mathbf{H}' = \mathbf{H} + h_t \cdot \frac{b_t}{\mathbf{B}} \cdot \frac{\ell_t}{\mathbf{L}_{OA}}$$

h_t = height [m] of trunk (distance between trunk deck and main deck at side of trunk measured at $L_{OA}/2$)

b_t = breadth of trunk [m]

A_t = length of trunk [m]

2.6.4 Other cargo tank sizes could be accepted if sufficient strength according to F. and intact stability will be proven.

2.6.5 Residual tank

If the ship is provided with a tank for residual products, the maximum capacity of the tank is 30 m^3.

Note

ADN ships:

- *Type N and Type C ships:*
  - *For ships with a length of not more than 50 m, the length of a cargo tank shall not exceed 10 m; and*
  - *For ships with a length of more than 50 m, the length of a cargo tank shall not exceed 0,20·**L**. This provision does not apply to ships with independent built-in cylindrical tanks having a length to diameter ratio ≤ 7*
- *Type G ships:*
  - *For ships carrying liquefied gases, the pressure independent built-in cylindrical tanks shall have a length to diameter ratio ≤ 7*

Table 3.2 - Tank sizes

$\mathbf{L_{OA} \cdot B \cdot H}$ **[m³]**	**Maximum permissible content of a tank [m³]**
< 600	$0{,}3 \cdot \mathbf{L}_{OA} \cdot \mathbf{B} \cdot \mathbf{H}$
600 – 3750	$180 + (\mathbf{L}_{OA} \cdot \mathbf{B} \cdot \mathbf{H} - 600) \cdot 0{,}0635$
> 3750	380

2.7 Other requirements

2.7.1 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 2.8.

2.7.2 Cofferdams, double hull spaces, double bottoms, cargo tanks, hold spaces and other accessible spaces within the cargo area shall 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 shall be large enough to allow a person wearing breathing apparatus 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 shall 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.

2.7.3 All spaces in the cargo area shall be capable of being ventilated.

2.7.4 The bulkheads bounding the cargo tanks, cofferdams and 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 cofferdam or service space in the cargo area or between the engine room and a hold space may be fitted with penetrations, provided that they conform to the provisions of 2.10.3.

For tankers Type C and N, the bulkhead between the cargo tank and the cargo pump room below deck may be fitted with penetrations, provided that they conform to the provisions of 2.10.3. The bulkheads between the cargo tanks may be fitted with penetrations provided that the loading or unloading pipes are fitted with shut-off devices in the cargo tank from which they come. These shut-off devices shall be operable from the deck.

2.8 Fuel tanks

2.8.1 Where the ship is provided with hold spaces, the double bottoms within these spaces may be arranged as liquid fuels oil tanks, provided their depth is not less than 0,60 m.

2.8.2 Fuel oil pipes and openings of fuel tanks are not permitted in the hold space.

2.8.3 The open ends of the air pipes of all oil fuel tanks shall extend to not less than 0,5 m above the open deck. Their open ends and the open ends of overflow pipes leading to the deck shall be fitted with a protective device consisting of a gauze diaphragm or a perforated plate.

2.9 Engine rooms

2.9.1 Internal combustion engines for the ship'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 m from the cargo area.

2.9.2 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.

2.9.3 Every engine room shall normally have two exits. The second exit may be an emergency exit. If a skylight is permitted as an escape, it shall 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.

2.9.4 Installation

Internal combustion machinery for main propulsion, generators, cargo pumps or compressors and oil-fired boilers shall 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 the Rules for Machinery - Inland Waterways (Part 2, Vol. III) Section 1, H.2).

2.9.5 Entrances to the machinery space shall have a coaming at least 500 mm high.

2.9.6 Exhaust pipes on tankers

Exhausts shall be evacuated from the ship 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 m from the cargo area. The exhaust pipes of engines shall be arranged so that the exhausts are led away from the ship.

2.10 Cargo pump and compressors

2.10.1 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 BKI approval, hydraulic or explosion proof electrical prime movers may be installed in the cargo area.
For tankers Type N open see B.3.2.7.

2.10.2 Installation on deck

Cargo pumps, compressors including cargo handling equipment are to be located between the forward and aft cofferdam at a horizontal distance of 6 m from entrances or openings to accommodation and service spaces outside the cargo area.

2.10.3 Installation below deck

Cargo pumps, compressors including cargo handling equipment below deck are to be installed in special pump/compressor rooms separated from the engine room or a service space outside the cargo area by a cofferdam or a bulkhead with "A-60" fire protection insulation according to SOLAS Chapter II-2, Regulation 3, or by a service space or a hold space.

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.

Ventilation exhaust outlets are located not less than 6,00 m from entrances and openings of the accommodation and service spaces outside the cargo area.

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 shall 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 shall 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 which is activated in the wheelhouse 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.

2.11 Special equipment

A shower and an eye and face bath shall be provided on the ship at a location which is directly accessible from the cargo area.

2.12 Admittance on board

Notice boards displaying the prohibition of admittance on board and clearly legible from either side of the ship have to be installed.

2.13 Notice boards

Notice boards, clearly legible from either side of the ship, displaying the prohibition of admittance on board and prohibition of smoking on board have to be installed.

3. Equipment and systems for tankers

3.1 Cargo pumps and compressors

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 shall be permanently installed and completely separated from all other ship’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.

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 the Rules for Machinery - Inland Waterways (Part 2, Vol. III) Section 1, C.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 shall 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 Other lines and recesses on deck

All pipes linking the recess to the cargo tank shall be fitted with shut-off devices fitted directly on the bulkhead.

It shall be possible to drain the recess using a system installed on deck in the cargo area and independent of any other system.

Pipes connecting the recess to the hull shall not pass through the cargo tanks.

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 ship'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 shall 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 the Rules for Machinery - Inland Waterways (Part 2, Vol. III) Section 1, C.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 shall 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 ship'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 the Rules for Machinery - Inland Waterways (Part 2, Vol. III) Section 1, C.11.2.

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 given by the formula:

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

d = inside diameter of bilge pipe [mm]

A = length of void space or space in which the tank is installed [m]

The inside diameter of bilge lines shall not be less than 50 mm.

For the calculation of bilge pump capacity and the design of the bilge system, see the Rules for Machinery -Inland Waterways (Part 2, Vol. III) 1, C.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 shall be provided for cargo pump rooms.

Means shall be provided for pumping the bilges of cargo pump rooms even when special circumstances render the pump room inaccessible. The equipment necessary for this shall 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 ships outside ADN.

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 ship outside the cargo area.

3.4.4 Ballast systems in the cargo area

Ballast water systems for ballast tanks inside the cargo area shall 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 and gas freeing

3.5.1 Ventilation of pump rooms, cofferdams and ballast/hold/void spaces in the cargo area

For ventilation for pump rooms see 2.8.3.

For cofferdams, ballast tanks, hold and void spaces, portable ventilation equipment shall be provided. Fixed installations are subject to individual approval.

The open ends of the air pipes of each oil fuel 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.

3.5.2 Design and construction of mechanically driven fans in the cargo area

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 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 4.11.

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 shall 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.

Vent collectors and vent systems are to be protected against corrosion.

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 F.).

3.6 Flame arresters

3.6.1 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 BKI for its specific application.

3.6.2 Flame arresters shall be made of suitable materials which are resistant to the cargo/vapours.

3.6.3 High velocity vents providing a discharge velocity of at least 30 m/s for the removal of vapour from the immediate vicinity of the ship may be used as flame arresters provided that they have been approved by BKI.

3.7 Level alarm and overfill protection devices

3.7.1 Level alarm

Every cargo tank shall be equipped with a high level alarm activating an audible and visual alarm at 90 % filling on Type N and C ships (86 % on Type G ships). The actual filling level of the total tank volume depends on ship type and category of cargo. Details are set out in the list of substances allowed to be carried. See Part 3, Table C of actual ADN Regulations.

For Type G ships, an instrument for measuring the pressure of the gas phase in the cargo tank is to be provided.

3.7.2 Overfill protection

Every cargo tank is to be equipped with an overfill protection device which:

– activates 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. The signal shall be transmitted to the shore facility via a watertight two-pin plug of a connector device in accordance with standard EN 60309-2:1999 for direct current of 40 to 50 volts, identification colour white, position of the nose

10 h. The plug shall be permanently fitted to the ship close to the shore connections of the loading and unloading pipes. The high level sensor shall also be capable of switching off the ship's own discharging pump.

During discharging by means of the on-board pump, it shall be possible for the shore facility to switch it off. For this purpose, an independent intrinsically safe power line, fed by the ship, shall be switched off by the shore facility by means of an electrical contact.

1t shall be possible for the binary signal of the shore facility to be transmitted via a watertight two-pole socket or a connector device in accordance with standard EN 60309-2:1999, for direct current of 40 to 50 volts, identification colour white, position of the nose 10 h.

This socket shall be permanently fitted to the ship close to the shore connections of the unloading pipes.

3.7.3 Level alarm and overfill protection device shall 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 BKI or authorities.

3.7.4 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.

3.7.5 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.

3.7.6 Permanent reading on 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.

3.7.7 Readings shall be possible in all weather conditions.

3.7.8 Where the control elements of the shut-off devices of the cargo tanks are located in a control room, it shall be possible to stop the loading pumps and to read the level gauges in the control room, and to notice the visual and audible warning given by the level alarm device. The high level sensor referred to in 3.7.2 and the instruments for measuring the pressure and temperature of the cargo shall be noticeable in the control room and on deck. Satisfactory monitoring of the cargo area shall be ensured from the control room.

3.8 Tank level gauging and sampling equipment

3.8.1 Tank level gauges

The type and design of the equipment depend on ship type and the type of cargo; see Part 3, Table C of actual ADN Regulations. 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)

3.8.2 Sounding pipes, observation ports

Sounding pipe penetrations through the tank deck shall 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 shall close automatically. In addition, these devices shall be capable of being closed with a cover which is provided with recess for pressure relief during the voyage.

3.8.3 Closed tank level gauges

Closed tank level gauges are subject to type approval by BKI.

3.8.4 Sampling devices

Sampling devices may be of 'open', 'partly closed' or 'closed' type, depending on the list of substances allowed to be carried (see F.2.13). 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.

3.9 Precautions against sparks from boiler

Diesel engine exhaust lines are to be fitted with BKI approved spark arresters. Funnels of boiler plant and galleys are to be fitted with suitable spark traps.

3.10 Gas and vapour detection equipment

Depending on the list of substances allowed to be carried see F., portable instruments for the measurement of flammable or toxic gases and vapours as well as Oxygen shall be provided.

3.11 Water spray system

A fixed water spray system as required in the list of substances allowed to be carried see F., shall be provided capable of covering the entire cargo deck area. Spray nozzles are to be so arranged as to efficiently cover any vapours emitted. The system shall be equipped with a shore connection and shall be capable being activated from the wheelhouse and from deck. The system shall have an overall capacity of 50 litres per square metre of cargo deck area and per hour.

3.12 Inert gas systems

The design of inert gas systems is to be agreed with BKI. In general the Rules for seagoing ships related tankerswill be applied.

3.13 Slop/residue tanks IBC's

Slop or residue tanks shall be provided, which are to be located in the cargo area. The maximum permissible capacity is 30 m^3. Outfitting shall be according to the ship type (details see Part 3, Table C of actual ADN Regulations). Vent lines may not be connected with cargo tanks.

During the filling of the receptacles for residual products, means for collecting any leakage shall be placed under the filling connections.

Receptacles for slops shall be fire resistant and shall be capable of being closed with lids (drums with removable heads, code 1A2, ADR). The receptacles for slops shall be marked and be easy to handle.
Instead of fixed installed slop tanks residue, containers or IBCs (Intermediate Bulk Containers) may be used. They shall be equipped with appropriate means for filling (connections with valves for hoses, pipes) and determining the filling level. Arrangements shall be made for safe transport and handling.

The tank for residual products shall be equipped with:

- pressure-relief and vacuum-relief valves.

  The high-velocity vent valve shall be so regulated as not to open during carriage. This condition is met when the opening pressure of the valve meets the conditions set out in column (10) of Table C of Chapter 3.2 see ADN),
  When anti explosion protection is required in column (17) of Table C of Chapter 3.2, the vacuum-relief valve shall be capable of withstanding deflagrations and the high-velocity vent valve shall withstand steady burning;

- a level indicator;

- connections with shut-off devices, for pipes and hoses.

Receptacles for residual products shall be equipped with:

- a connection enabling gases released during filling to be evacuated safely;

Receptacles for residual products shall be connected to the vapour pipe of cargo tanks only for the time necessary to fill them.

Receptacles for residual products and receptacles for slops placed on the deck shall be located at a minimum distance from the hull equal to one quarter of the ship's breadth.

4. Pushed convoys and side-by-side formations for tankers- DGL

4.1 General

4.1.1 When a pushed convoy or a side-by-side formation comprises a tanker carrying dangerous substances, ships used for propulsion shall meet the requirements stated under 4.1.3 and 4.2 to 4.14.

4.1.2 Ships not carrying dangerous goods shall comply with the requirements of 5.

4.1.3 Materials

The ship'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 ship's boats is permitted only if the material does not readily ignite.

4.2 Protection against penetration of gases

4.2.1 The ship shall be designed so as to prevent gases from penetrating into the accommodation and the service spaces.

4.2.2 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 ship 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.

4.3 Ventilation

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.

4.4 Engine rooms

Internal combustion engines for the ship'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.

4.5 Accommodation and service spaces

The superstructures and wheelhouses shall be placed outside the cargo area, i.e. forward of the foremost or aft of the aftermost cofferdam bulkhead.

Windows of the wheelhouse at a height of at least 1 m above the wheelhouse floor may tilt forward.

Entrances to spaces and openings of superstructures shall not face the cargo area. Doors opening outward and not located in a recess whose depth is at least equal to the width of the doors shall have their hinges face the cargo area.

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 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.

4.6 Engines

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 4.12.1 c) are fully complied with. Not required for ships outside ADN.

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.

4.7 Fuel oil tanks

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.

4.8 Exhaust pipes

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.

4.9 Fire-extinguishing arrangements

In addition to general fire rules of the Rules for Machinery Installation-Inland waterways (Part 2, Vol. III), Section 1, H., each ship shall comply with additional requirements stated under E.

4.10 Fire and naked light

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.

4.11 Electrical installations

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 Part 3, Table C of actual ADN Regulations shall be taken into consideration.

4.12 Type and location of electrical equipment

4.12.1 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 ship is under way.

4.12.2 The electrical equipment which does not meet the requirements set out in 4.12.1 together with its switches shall be marked in red. The disconnection of such equipment shall be operated from a centralised location on board.

4.12.3 An electric generator which is permanently driven by an engine and which does not meet the requirements of 4.12.1 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.

4.12.4 Sockets for the connection of signal lights and gangway lighting shall be permanently fitted to the ship close to the signal mast or the gangway. Connecting and disconnecting shall not be possible except when the sockets are not live.

4.13 Electrical cables

For movable cables intended for signal lights, gangway lighting, and submerged pumps on board oil separator vessels, only sheathed cables of type H07 RN-F in accordance with 245 1EC 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.

4.14 Notice boards

Notice boards displaying the prohibition of admittance on board and prohibition of smoking, fire or naked light and clearly legible from either side of the vessel have to be installed.

5. Pushed convoys and side-by-side formations for dry cargo ships- DGD

5.1 General

5.1.1 When a pushed convoy or a side-by-side formation comprises a dry cargo ship carrying dangerous substances, ships used for propulsion shall meet the requirements stated under 5.1.2 and 5.2 to 5.10.

5.1.2 Materials

The ship'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.

5.2 Ventilation

Ventilation shall be provided for the accommodation and for service spaces.

5.3 Accommodation and service spaces

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.

5.4 Engines

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.

5.5 Fuel oil tanks

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.

5.6 Exhaust pipes

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.

5.7 Fire and naked light

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.

5.8 Type and location of electrical equipment

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 ship 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 ship in the vicinity of the hatches.

5.9 Electric cables

5.9.1 Cables and sockets in the protected area shall be protected against mechanical damage.

5.9.2 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.

5.9.3 For movable cables permitted in accordance with 5.9.2, 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.

5.10 Notice boards

Notice boards displaying the prohibition of admittance on board and prohibition of smoking, fire or naked light and clearly legible from either side of the ship have to be installed.

B. Liquid Cargoes

1. Symbols

L = Rule length [m] defined in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 1, A.1

B = breadth [m] defined in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 1, A.1

H = depth [m] defined in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 1, A.1

T = draught [m] defined in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 1, A.1

t = net thickness [mm] of plating

k = material factor defined in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 2, A.2.4 and Section 2, A.3.2

2. General

2.1 Application

2.1.1 Ships complying with the requirements of this Section are eligible for the assignment of the additional class Notation **Type C** or **Type N** as defined in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 2, B.4.2.

2.1.2 These Rules apply in addition to A. and Section 2, A.

2.2 Cargo tank openings

2.2.1 Cargo tank openings shall be located on deck in the cargo area. Cargo tank openings with a cross-section of more than 0,10 m^2 and openings of safety devices for preventing overpressures shall be located not less than 0,50 m above deck.

2.2.2 Cargo tank openings shall be fitted with gastight closures capable of withstanding the test pressure in accordance with the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 2, D.3.

2.2.3 Closures which are normally used during loading or unloading operations shall not cause sparking when operated.

3. Special requirements for tanker Type C

3.1 General

3.1.1 The tanker Type C may be constructed as a double hull tanker as shown in sketch b of Section 2, Fig. 2.2 or a double hull tanker with inserted cargo tanks analogous to sketches c and d of Section 2, Fig. 2.3.

3.1.2 The scantlings and structural arrangements are to be in compliance with applicable requirements of Section 2, A.6.

3.2 Tank arrangement

3.2.1 In the cargo area with the exception of the cofferdams, the ship shall be designed as a flush deck double hull tanker, with double walls and double bottom but without trunk.

3.2.2 Cargo tanks independent of the ship'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 3.2.9. The cargo tank shall not extend beyond the deck.

3.2.3 Side struts linking or supporting the load bearing components of the sides of the ship with the load bearing components of the longitudinal walls of cargo tanks, and side struts linking the load bearing components of the ship's bottom with the tank bottom, are prohibited.

3.2.4 Independent cargo tanks shall be fixed so that they cannot float (see C.3.6).

3.2.5 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 ship'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 ship 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 SOLAS 74, Chapter II-2, Regulation 3.

- 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.

3.2.6 To provide a reliable safeguard for the cargoes contained inside the ship even in the event of slight or moderate collisions, the cargo tanks shall be separated from the side of the ship by a distance of 1,0 m and from the ship'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.

3.2.7 A reduction of the lateral distance from 1,0 m to not less than 0,80 m is permitted if the scantlings of the ship's side structures relative to the scantlings stipulated for double wall ships of customary design in 5 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.

3.2.8 The condition according to 3.2.7 is deemed to be met if the structures laid down in Section 2, A. 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 cm^2

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

3.2.9 Where the ship is constructed on the transverse frame principle, a longitudinal stringer system shall be fitted instead of 3.2.8 c). The spacing of the longitudinal stringers shall not be greater than 0,80 m and the stringer depth shall not be less than 0,15 m with full connection to the frames. As in 3.2.8 c), the flange section shall not be less than 7,0 cm^2.

If the frames are cut free, the web depth of the stringer shall be increased by the depth of the frame cut-out.

3.2.10 Other kinds of construction are possible if the strength of the construction is comparable to the constructions prescribed in 3.2.7 to 3.2.9 concerning their collision absorbing capacity. Collision absorbing capacity has to be calculated on the basis of F.

3.2.11 In the area of pump wells, a reduction of the distance from the ship's bottom to 0,5 m is permitted, provided that the volume of the pump well is not greater than 0,1 m^3.

3.2.12 When a ship is built with cargo tanks located in a hold space or refrigerated cargo tanks, the distance between the double walls of the hold space shall be not less than 0,80 m and the depth of the double bottom shall be not less than 0,60 m.

3.3 Tank equipment

3.3.1 Cargo piping

With exception of manifolds, the cargo piping on deck shall be located at a distance of at least B/4 from the outer shell plating.

Flanges and glands are to be fitted with spray shields.

Filling pipes for cargo tanks are to extend down as close as possible to the bottom of the tank.

3.3.2 Double hull spaces

Double hull spaces may be arranged as ballast water spaces, systems (see A.3.4.4).

3.3.3 Venting cofferdams

Cofferdams are to be provided with open venting facilities equipped with approved deflagration flame arresters. Flame arresters are not required for ships outside ADN.

3.3.4 Cargo tank heating

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 BKI.

3.3.5 Cargo tank venting

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 in general 50 kPa, other settings may be accepted depending on the list of substances allowed to be carried (see Part 3, Table C of actual ADN Regulations).

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 shut-off 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.

3.3.6 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.

3.3.7 Cargo tank pressure monitoring

Each cargo tank shall be equipped with a pressure indicator for the vapour space.

Further alarm and shut-down functions are required according to ADN in relation to the products allowed to be carried.

3.3.8 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 in relation to the products allowed to be carried.

3.3.9 Cargo tank sampling equipment

Installation system for closed sampling equipment in accordance with the list of substances allowed to be carried (see Part 3, Table C of actual ADN Regulations) is to be provided.

3.3.10 Stripping system

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.

Exceptions are to be approved by BKI.

3.3.11 Residual cargo tanks

If a residual cargo tank exists following equipment is required:

- 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

ADN requires high velocity vent valve.

4. Special requirements for tanker Type N 4.1 General

4.1.1 Type N may be arranged in three different designs in respect of cargo tank venting with due regard to the products as specified in the list of substances allowed to be carried of Part 3, Table C of actual ADN Regulations:

- Type N, open venting

- Type N, open venting, flame arresters

- Type N, closed

4.1.2 The tanker Type N may be constructed as a single or double-hull tank vessel or as a tank vessel with inserted cargo tanks shown respectively in Section 2, Fig. 2.1 to 2.3.

4.1.3 Cofferdams, double-hull spaces, double bottoms, cargo tanks, hold spaces and other spaces within the cargo area shall be arranged so that they could be completely inspected. The dimensions of openings shall be sufficient to allow a person to enter or leave the space without difficulties. The openings shall have a minimum cross-section of 0,36 m^2 and a minimum side length of 0,50 m. In these spaces the distance between the reinforcements shall not be less than 0,50 m. In the double bottom this distance may be reduced to 0,45 m.

4.1.4 The scantlings and structural arrangements are to be in compliance with applicable requirements of Section 2, A.3 to Section 2, A.6.

4.2 Tank arrangement

4.2.1 Independent cargo tanks shall be fixed so that they cannot float (see C.3.6).

4.2.2 Where independent cargo tanks are used, or for double-hull construction where the cargo tanks are integrated in ship's structure, the distance between the wall of the ship and wall of the cargo tanks shall be not less than 0,60 m.

4.2.3 The distance between the bottom of the ship and the bottom of the cargo tanks shall be not less than 0.50 m.

4.2.4 In the area of pump wells, a reduction of the distance from the ship's bottom to 0,4 m is permitted, provided that the volume of the pump well is not greater than 0,1 m^3. The vertical distance between the pump well of a cargo tank and the bottom structures shall be not less than 0,10 m.

4.2.5 When a ship 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 A.2.6.2 are not feasible, it must be possible to remove the cargo tanks easily for inspection.

4.3 Type N with open venting

4.3.1 Cargo tank heating

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 BKI.

4.3.2 Venting of cargo tanks and hold spaces

Every cargo tank, cofferdam and hold space is to be provided with open venting facilities (without flame arrester).

4.3.3 Cargo tank level alarm

The level alarm shall be activated when the tank is filled to 90 % of its total volume.

4.3.4 Cargo tank overfill protection

The overfill protection shall be actuated when the level in the tank reaches 97,5 %, (see the list of substances allowed to be carried of Part 3, Table C of actual ADN Regulations).

4.3.5 Cargo tank level gauging

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.

4.3.6 Cargo tank sampling

Open sampling as defined in the list of substances allowed to be carried of Part 3, Table C of actual ADN Regulations.

4.3.7 Drives

On tankers of type N open internal combustion engines may be installed in the cargo area.

Penetrations for drive shafts through pump room bulkheads are to be of gastight design and are subject to approval.

4.3.8 Slop tanks

The following equipment is required: Open venting, sounding pipe, and connections with valves for the connection of hoses/piping.

4.4 Type N with open venting, with flame arresters

4.4.1 Cargo tank heating

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 BKI.

4.4.2 Venting of cargo tanks

Every cargo tank is to be provided with open venting facilities fitted with approved flame arresters.

4.4.3 Venting of cofferdams

Cofferdams are to be provided with open venting facilities equipped with approved deflagration flame arresters. Flame arresters are not required for ships outside ADN.

4.4.4 Cargo tank level indicators

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.

4.4.5 Cargo tank sampling

Open sampling as per list of substances allowed to be carried of Part 3, Table C of actual ADN Regulations.

4.4.6 Slop tanks

Following equipment is required: Open venting fitted with approved flame arresters, sounding pipe, connections with valves for connection of hoses/piping.

4.5 Type N closed

4.5.1 Cargo tank heating\

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 BKI.

4.5.2 Cargo tank venting

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 of Part 3, Table C of actual ADN Regulations).

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 shut-off valves and blind flanges.

On each tank or each tank group means shall be provided for safe depressurizing, consisting in a shut-off 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.

4.5.3 Venting cofferdams

Cofferdams are to be provided with open venting facilities equipped with approved flame arresters. Flame arresters are not required for ships outside ADN.

4.5.4 Cargo tank level alarm

The level alarm shall be tripped when the tank is filled to 90 % of its total volume.

4.5.5 Cargo tank overfill protection

The overfill protection shall be actuated when the level in the tank reaches 97,5 %, see list of substances allowed to be carried, Part 3, Table C of actual ADN Regulations.

4.5.6 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 97 % of the total tank volume.

4.5.7 Cargo tank pressure monitoring

Each cargo tank shall be equipped with a pressure indicator for the vapour space.

Further alarm and shut-down functions are required according to ADN in relation to the products allowed to be carried.

4.5.8 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.

Note

Further alarm functions are required according to ADN in relation to the products allowed to be carried.

4.5.9 Cargo tank sampling equipment

Closed sampling equipment is to be provided in accordance with the list of substances allowed to be carried as per Part 3, Table C, of the currently valid ADN Regulations.

4.5.10 Slop tanks

Following equipment is required:

- controlled venting arrangement consisting of P/V valves combined with approved flame arresters
- P/V valve setting as for main cargo tanks
- closed gauging device

- pipe, connections with valves for connection of hoses/piping

Note

ADN requires high velocity vent valve.

5. Electrical plant

5.1 Documents to be submitted

In addition to the documents required in accordance with the Regulations referred to in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 2, A.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.

5.2 Electrical installations

5.2.1 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 the paragraph below

- the installations for cathodic 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 in accordance with Part 3, Table C of actual ADN Regulations shall be taken into consideration.

5.3 Type and location of electrical equipment

5.3.1 Zone 0 and Zone 1

a) Only measuring, regulation and alarm devices of the Ex (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 "pressurized 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 pressuri- zation" 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.

5.3.2 Zone 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 ship 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 ship 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 ship.

5.4.2 The provisions of 5.4.1 above apply also to equipment having service voltages of less than 50 V.

5.4.3 Independent cargo tanks, metal intermediate bulk containers and tank containers 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, gangway lighting and submerged pumps on board bilges boat.

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, gangway lighting, and submerged pumps on board bilges boat, only 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 damage is not likely to occur.

5.6 Storage batteries

The installation of storage batteries inside dangerous areas is not permissible.

6. Hull scantlings

6.1 Integrated tanks

6.1.1 The scantlings of the hull structure are to be determined in compliance with Section 2, A.

7. Buoyancy and stability

7.1 General

7.1.1 Sufficient stability has to be shown. For Type N ships of the single skin type with cargo tanks of less than or equal to 0,70-**B** in width, this analysis is not required.

7.1.2 Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

7.1.3 General requirements of Section 4, F.2.2 to Section 4, F.2.5 shall be complied with.

7.1.4 The longitudinal centre bulkhead may be dispensed with only if sufficient stability is guaranteed.

7.2 Intact stability

7.2.1 Proof of intact stability is to be provided for all loading/unloading stages and for the final loading stage.

7.2.2 The intact stability is deemed to be sufficient if the ship complies with 7.2.4 and/or 7.2.3, as applicable.

7.2.3 For ships 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-rad
- the initial metacentric height GM0 value is to be at least 0,10 m.

7.2.4 Tank ships Type C

For tank ships Type C, with cargo tanks of less than or equal to 0,70-B in width the intact stability requirements resulting from the damaged stability calculation shall be fully complied with.

7.3 Damage stability

7.3.1 For tank ships of Type C and Type N with independent cargo tanks and of double hull construction with integrated cargo tanks, 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°.

7.3.2 The damage stability is generally regarded sufficient if, see Fig. 3.2:

- 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-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.

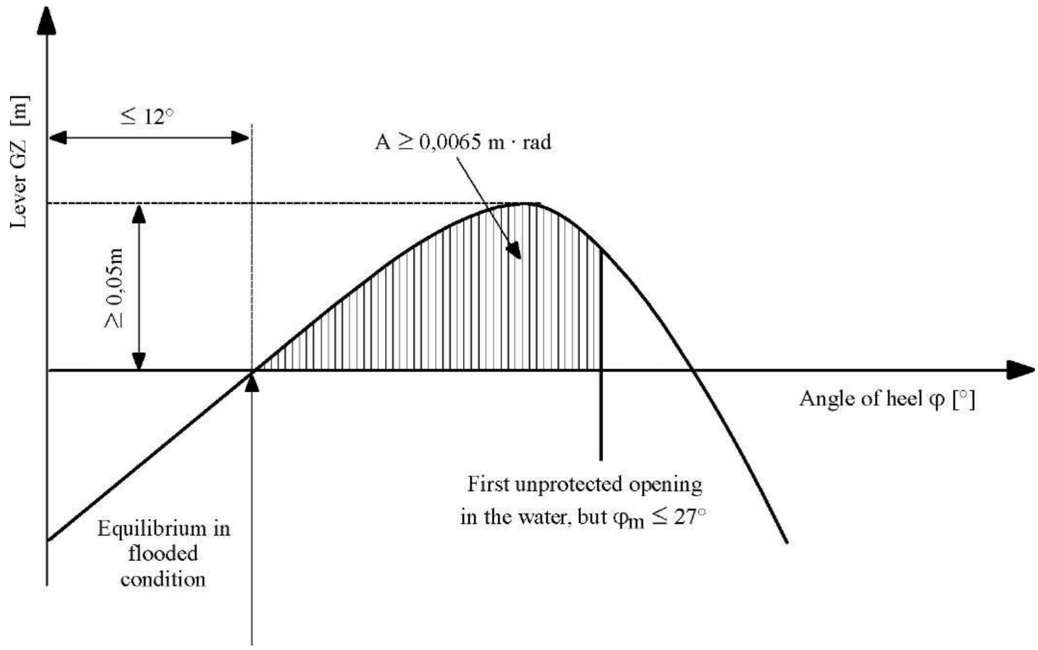


Fig. 3.2 Proof of damage stability

7.3.3 1f openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

7.3.4 Where cross- or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalization shall not exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

7.3.5 The damage condition calculation is to be based on the following assumptions:

a) extent of side damage:

   - longitudinal extent: at least 0,10-L but not less than 5 m

   - transverse extent:

Type C: 0,79 m

Type N: 0,59 m

- vertical extent: from base line upwards without limit

b) extent of bottom damage:

- longitudinal extent at least 0,10-L but not less than 5 m

- transverse extent: 3 m

- vertical extent from base line to 0,59 m upwards, except for pump well:

Type C: 0,59 m

Type N: 0,49 m

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 ship 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.

7.3.6 1n 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, |i, given in Table 3.3 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.

Table 3.3 Permeability values [%]

Spaces	μ
Engine room	85
Accommodation spaces	95
Double bottoms, oil fuel tanks, ballast tanks, etc. depending on weather, according to their function, they have to be assumed as full of empty for the ship floating at the maximum permissible draught.	0 or 95

C. Liquefied Gases

1. General

1.1 Application

Ships complying with the requirements of this Section are eligible for the assignment of the additional class Notation **Type G,** as defined in the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 2, B.4.2.2.

These Rules apply in addition to A. and Section 2, A.

1.2 Applicable rules

1.2.1 For scantling of the hull of ships with inserted tanks, see Section 2, A.3.1.1.

1.2.2 The calculation of the pressure tanks is to conform to the BKI Rules for

1.2.3 For the size of the tanks to be provided, reference is to be made to Table 3.2.

1.3 Definitions

1.3.1 Design pressure

The design pressure p_0 is the maximum gauge pressure at the top of the tank which has been used in the design of the tank.

For cargo tanks where there is no temperature control and where the pressure of the cargo is dictated only by the ambient temperature, p0 is not to be less than the gauge vapour pressure of the cargo at a tempera-ture of 40 °C.

In all cases p_0 is not to be less than MARVS.

1.3.2 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 BKI are to be made that the tank or cargo temperature cannot be lowered below the design temperature.

1.3.3 MARVS

MARVS is the maximum allowable relief valve setting of a cargo tank.

1.4 Cargo tank openings

1.4.1 Cargo tank openings shall be located on deck in the cargo area. Cargo tank openings with a cross-section of more than 0,10 m^2 shall be located not less than 0,50 m above deck.

1.4.2 Cargo tank openings shall be fitted with gastight closures capable of withstanding the test pressure in accordance with the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 2, D.3

1.4.3 The exhaust outlets of the pressure relief valves shall be located not less than 2,00 m above the deck at a distance of not less than 6,00 m from the accommodation and from the service spaces located outside the cargo area. This height may be reduced when, within a radius of 1,00 m around the pressure relief valve outlet, there is no equipment, no work is being carried out and signs indicate the area.

1.4.4 Closures which are normally used during loading or unloading operations shall not cause sparking when operated.

2. Special requirements for tanker Type G 2.1 Tank arrangement

2.1.1 Double hull ship

Ships with double hull and double bottom shall comply with the following:

- the internal distance between the side plating of the ship 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

- the cargo tanks shall be supported by saddles extending between the tanks to not less than 20° below the horizontal centreline of the cargo tanks.

2.1.2 Single hull ship

Single hull ships shall comply with the following:

- they shall be fitted with side plating between gang board and top of floor plates provided with side stringers at intervals of not more than 0,6 m and which are supported by web frames spaced at intervals of not more than 2,00 m

- the side stringers and the web frames shall have a height of not less than 10% of the ship 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 side plating of the ship 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

- the cargo tank supports and fastenings should extend to not less than 10° below the horizontal centreline of the cargo tanks.

2.1.3 Other kinds of construction are possible if the strength of the construction is comparable to the constructions prescribed in 2.1.1 to 2.1.2 concerning collision absorbing capacity. The collision absorbing capacity has to be calculated on the basis of F.

2.1.4 Struts

Struts linking or supporting the load bearing components of the sides of the ship with the load bearing components of the longitudinal walls of cargo tanks, and side struts linking the load bearing components of the ship's bottom with the tank bottom, are prohibited.

2.1.5 Refrigerated cargo tanks

Refrigerated cargo tanks shall be installed in hold spaces bounded by double-hull spaces and a double-bottom according to 2.1.1.

The cargo tank fastenings and other individual requirements are to be decided in consultation with BKI on a case-by-case basis in accordance with the provisions for liquefied gas tankers laid down in the BKI Rules.

2.2 Venting of hold spaces

Every hold space is to be provided with open venting facilities.

2.3 Ventilation of cargo pump rooms and gas compressor rooms

2.3.1 Cargo pump and compressor rooms shall be provided with extraction type ventilation systems, independent of other ship'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 shall be provided for gas freeing of cargo tanks and other spaces not equipped with fixed ventilation.

3. Ships for the carriage of liquefied gases under pressure

3.1 General

3.1.1 The following Rules apply to inland waterway ships 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 Section 2, Fig. 2.3.

3.1.3 Cofferdams need not be placed in the fore and after body of ships of all-welded construction.

The hold space end bulkheads shall be provided with a Class A-60 fire protection insulation according to SOLAS Chapter II-2, Regulation 3. 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.

3.1.4 If the tank arrangement corresponds to sketch c of Section 2, A. and if the double bottom and wing tanks are equipped to take ballast, the scantlings of the bottom longitudinals, side longitudinals or side transverse frames, as the case may be, are to conform to the formulae in Section 2, A.

3.2 Design, materials, testing and welding

Type G ships are to comply with the requirements of the applicable BKI Rules.

3.3 Cargo tank design

Pressure ships shall in general be designed as the domed type. Fittings shall 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 shall 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.

3.4 Installation of cargo tanks

Pressure ships shall be so installed as to allow their inspection as well as the adjoining ship's structure.

3.5 Insulation, protective painting

3.5.1 The insulation of pressure ships is to be made of approved material covered with a vapour barrier of low flame spread type.

3.5.2 Pressure ships shall be painted externally for protection against corrosion. Uninsulated or unprotected portions on the open deck shall be coated with reflecting paints.

3.6 Fastening of self-supporting tanks

3.6.1 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 ship structure.

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

When a stringer 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.

3.6.2 Design loads

The design of the tank seatings is to be based on the following assumed forces. Relaxation of the following may be granted by BKI 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 ship in the damaged condition, acting upwards
- the weight of the filled tanks assuming the ship is capsized

b) Athwartships and in the capsized conditions:

- The tank seatings in the athwartship direction shall 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.

P = weight of tank including contents

3.6.3 Checking criteria

The strength check of the seatings and stays is to be carried out in compliance with the Rules for Hull - Inland waterways (Part 2, Vol. II), Section 2, E., using a partial safety factor γ_R = 1,5.

3.6.4 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.

3.7 Cargo piping

3.7.1 With exception of manifolds, the cargo piping on deck shall be located at a distance of at least B/4 from the shell plating. Cargo piping including valves and outfitting shall in general be arranged inboard of the tank domes where two domes are provided athwartship. On ships having single domes arranged at centre line the minimum distance from the ship's side shall be 2,7 m.

3.7.2 In cargo piping welding is the preferred method of joining. As detachable pipe connections only flanged connections are permitted. Approved screwed pipe connections are permitted for pipe diameters not exceeding 25 mm. Sliding glands or pipe couplings are not permitted.

3.7.3 All cargo piping for liquid and vapour shall be fitted on deck. Except in cargo pump and gas compressor rooms no cargo piping shall be routed through any other ship's spaces.

3.7.4 Wherever necessary, pipelines, valves and fittings shall be thermal insulated.

3.7.5 Cargo piping shall be clearly marked and labelled.

3.8 Valves, fittings and equipment

3.8.1 All loading and discharge manifolds shall be fitted with a manual shut-off and a remote operated quick closing valve. When not in use blank flanges shall be fitted. Means are to be provided for the safe relief of pressure prior to disconnecting the shore connecting (hose or loading arm).

3.8.2 Pipe connections on tank domes with the exception of level gauges and safety valves shall be fitted with a manual shut-off and a remote operated quick closing valve. In piping with DN < 50 mm excess flow valves may be used instead of quick closing valves.

3.8.3 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.

3.8.4 Controls for the release of quick-closing valves are to be located in the cargo control station and at two suitable locations on deck.

3.8.5 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.

3.8.6 Cargo pumps and compressors shall be fitted with safety valves discharging to their suction side.

3.9 Cargo tank level indicators

Each cargo tank is to be equipped with a closed gauging device approved by BKI. 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.

3.10 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 design pressure is exceeded.

3.11 Cargo temperature monitoring

Temperature indicating devices in each cargo tank shall be provided for the mean temperature in the liquid.

3.12 Cargo tank sampling equipment

Each cargo tank shall be equipped with a connection for a closed sampling device.

3.13 Safety valves

3.13.1 The highest part of the vapour space (tank dome) of pressure ships with a capacity of less than 20 m^3 is to be fitted with at least one, and pressure ships with a capacity of more than 20 m^3 two independent, spring loaded safety valves. Means shall be provided to prevent the accumulation of liquid cargo in the pipe upstream to the safety valves taking into account the ship's trim and list.

3.13.2 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).

$$Q = F \cdot G \cdot A^{0,82}$$

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:

= 1,0 for uninsulated tanks located on deck

= 0,5 for tanks above the deck when insulation is approved by BKI. (Approval will be based on the use of an approved fire proofing material, the thermal conductance of insulation, and its stability under fire exposure)

= 0,5 for uninsulated independent tanks installed in holds

= 0,2 for insulated independent tanks in holds (or uninsulated independent tanks in insulated holds) Temperature [K] = (273 + °C) at the relieving conditions, i.e. 120 % of the design pressure latent heat of the material being vaporized at relieving conditions [kJ/kg]

= 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:

$$= \frac{12,4}{r \cdot D} \cdot \sqrt{\frac{Z \cdot T}{M}}$$

T = Temperature [K] = (273 + ˚C) at the relieving conditions, i.e. 120% of the design pressure.

r = latent heat of the material begin vaporized at relieving conditions [kJ/kg]

D = constant based on relation of specific heats (k), shown in Table 3.5; if k is not known, D = 0,606 shall be used. The constant D may also be calculated by the following formula:

$$= \sqrt{k \cdot \left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

Z = compressible 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 [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 ships 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 ships excluding insulation, less the projected bottom area as shown in Fig. 3.3.

3.13.3 The setting of the pressure relief valves is not to be higher than the maximum pressure for which the cargo tank is designed.

3.13.4 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 shall remain operative.

3.14 Safety valves blow-off lines

3.14.1 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.

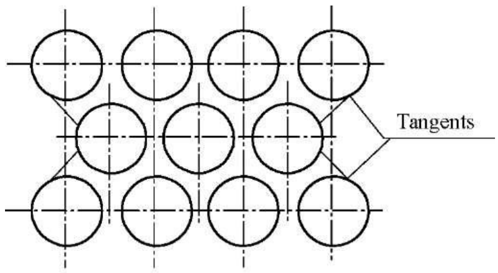


Fig. 3.3 Projected bottom area

3.14.2 The outlets to the atmosphere rising straight up shall be fitted with protective wire gauze.

3.14.3 The total cross-section of the blow-off piping shall be sufficient to discharge safely the quantity of gas calculated in 3.13.

3.15 Maximum filling and name plates

3.15.1 With the cargo at the reference temperature specified in 1.3, pressure ships may not be filled to more than 91 % for un-cooled and 95 % for cooled carriage.

3.15.2 Each pressure vessel shall bear a name plate showing the following data:

- name of manufacturer, serial number, year of manufacture

- cubic capacity [m^3]
- design pressure and test pressure [bar]
- Certificate No., month and year of test
- Classification society stamp
- lowest operation temperature [°C]
- vapour pressure [bar] at reference temperature [°C]

3.15.3 The name plates shall be legible from the deck.

3.16 Gas detection and alarm system

For the hold spaces of pressure vessel cargo tanks, portable gas detectors are to be approved by BKI.

4. Ships for the carriage of liquefied gases at atmospheric pressure

4.1 General

Requirements as set out in ADN Rules are to be observed.

Further individual requirements are to be decided in consultation with BKI on a case-by-case basis in accordance with the provisions for liquefied gas tankers laid down in BKI Rules.

5. Electrical plant

5.1 Documents to be submitted

In addition to the documents required by the Regulations referred to the Rules for Hull - Inland waterways (Part 2, Vol. IV), Section 2, A.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)

– the device for checking the insulation level referred to in 5.2.2

– the installations for cathodic protection

Table 3.4 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

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 in the list of substances shall be taken into consideration (see Part 3, Table C of actual ADN Regulations).

5.3 Type and location of electrical equipment

5.3.1 Zone 0 and Zone 1

a) Only measuring, regulation and alarm devices of the Ex (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 Zone 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
- radio 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.

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 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 damage is not likely to occur.

5.6 Storage batteries

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 Section 4, F.2.2 to F.2.5 shall be complied with.

6.2 Intact stability

6.2.1 Proof of intact stability is to be provided for all loading/ unloading stages and for the final loading stage.

6.2.2 The intact stability requirements resulting from the damage stability calculation shall be fully complied with.

6.3 Damage stability

6.3.1 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°.

6.3.2 The damage stability is generally regarded as sufficient if (see Fig. 3.4):

– 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-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.

6.3.3 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances shall be marked accordingly.

6.3.4 Where cross or down flooding openings are provided for reduction of unsymmetrical flooding, the time of equalization shall not exceed 15 minutes, provided during the intermediate stages of flooding sufficient stability has been proved.

6.3.5 The damage condition calculation is to be based on the following assumptions:

a) extent of side damage:

   – longitudinal extent: at least 0,10·L but not less than 5 m

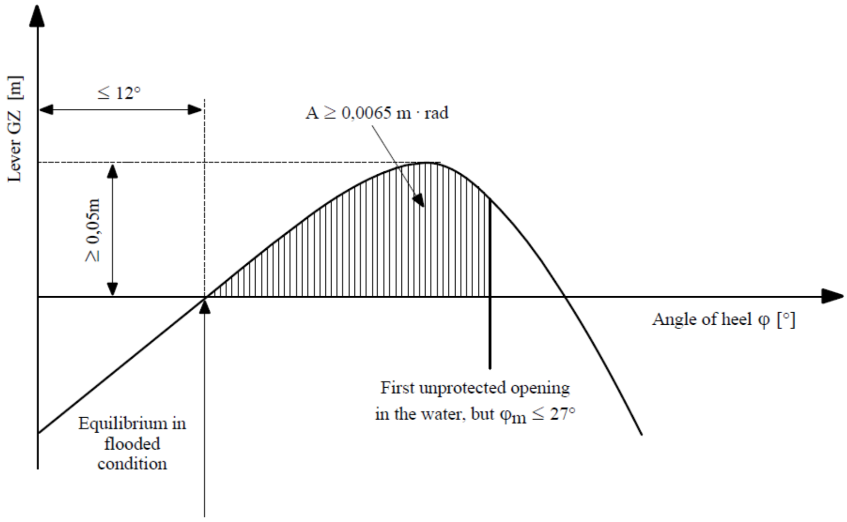


Fig 3.4 Proof of Damage Stability

– transverse extent: 0,79 m

– vertical extent: from base line upwards with-out limit

b) extent of bottom damage:

– longitudinal extent: at least 0,10·L but not less than 5 m

– transverse extent: 3 m

– vertical extent: from base line to 0,59 m up-wards, the well excepted

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 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.

6.3.6 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 Table 3.5 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.

Tabel 3.5 Permeability value [%]

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

D. Dry Cargoes

1. General

1.1 Application

1.1.1 The additional class Notation **DG** is assigned, in compliance with the Rules for Classification and Surveys – Inland Waterways (Part 1, Vol. I), Section 2, B.3.2.3, to vessels intended to carry dry dangerous goods.

1.1.2 Ships dealt with in this Section are to comply with the requirements stated under Chapter 1, Chapter 2 and Chapter 3, as applicable, and with the following requirements, which are specific to dry cargo vessels for the transport of dangerous goods.

2. Mode of carriage of goods

2.1 Carriage of packages

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

The carriage of containers, IBCs, large packagings, MEGCs, portable tanks and tank containers shall be in accordance with the ADN provisions applicable to the carriage of packages.

2.3 Vehicles and wagons

The carriage of vehicles and wagons shall be in accordance with the ADN provisions applicable to the carriage of packages.

2.4 Carriage in bulk

The carriage of dangerous goods in bulk is only per-mitted if the code "B" appears in column (8) of Table A, Chapter 3.2, Part 3 of ADN.

3. Vessels

3.1 Permitted vessels

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 are permitted to carry dangerous goods in restricted quantities. The maximum permitted quantities are specified in ADN 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

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 to be carried in quantities greater than those indicated in 3.1 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

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 shall be spraytight and weathertight. The use of waterproof tarpaulins is also possible to cover the cargo holds, if the tarpaulin consists of low flammability material.

4.2.5 Heating installation

It is not allowed to arrange heating installation 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 suit-able 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

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. approved spark arresters.

4.9 Stripping installation

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 Fixed fire-extinguishing systems

An approved fire-extinguishing system has to be in-stalled on the vessel according to the Rules for Machinery Installations – Inland Waterways (Part 2, Vol.III), Section 1, H.3.

4.11 Fire and naked light

4.11.1 The outlets of funnels shall be located not less than 2 m from the hatchway openings.

Arrangements shall be provided to prevent the escape of sparks and the entry of water.

4.11.2 Heating, cooking and refrigerating appliances shall not be fuelled with liquid fuels, liquid gas or solid fuels. The installation in the engine room or other 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.

4.11.3 Electric lighting appliances only are permitted outside the accommodation and the wheelhouse.

4.12 Type and location of electrical equipment

4.12.1 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.

4.12.2 Electric motors for hold ventilators which are arranged in the air flow shall be of the certified safe type.

4.12.3 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.

4.13 Electric cables

4.13.1 Cables and sockets in the cargo area shall be protected against mechanical damage.

4.13.2 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.

4.13.3 For movable cables permitted in accordance with 4.13.2, 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.

4.14 Metal wires, masts

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.

4.15 Storage batteries

The installation of storage batteries inside the protected area is not permissible.

4.16 Admittance on board

Notice boards displaying the prohibition of admittance on board and clearly legible from either side of the vessel have to be installed.

5. Additional rules applicable to double hull ships

5.1 Holds

5.1.1 The vessel shall be built as a double-hull ships with double hull spaces and double bottom within the protected area.

5.1.2 The distance between the sides of the ships 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.

   The section modulus and the web height of the web frames have to be not lower than the section modulus and the web height of the double bottom floors.

b) If the vessel's sides are constructed according to the transverse framing system strengthened by two longitudinal side shell stringers, the distance between the two stringers and between the uppermost stringer and the gang board 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 stringers have to be supported by web frames with a maximum spacing of 3,60 m.

   The section modulus and the web height of the web frames have to be not lower than the section modulus and the web height of the double bottom floors.

   The transverse shell frames and the hold bulkhead vertical stiffeners shall be connected at the bilge by a bracket plate with a height of not less than 0,90 m and thickness equal to the thickness of the floors.

c) If the ship's sides are constructed according to the transverse framing system with web frames on each transverse frame. The section modulus and the web height of the web frames have to be not lower than the section modulus and the web height of the double bottom floors.

   The depth of the double bottom shall be not less than 0,50 m. The depth below a suction well may, however, be locally reduced to 0,40 m, provided that the suction well has a capacity of not more than 0,12 m^3. If the clear spaces of the double bottom are between 0,40 m and 0,49 m, the surface area of the suction well shall not exceed 0,5 m^2.

5.2 Emergency exit

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 after peak.

5.3 Buoyancy and stability

5.3.1 General

Exceptions to the requirements stated in these Rules are possible where they are permitted by the statutory Regulations.

General requirements of Section 4, F.2.2 to F.2.5 are to be complied with.

5.3.2 Intact stability

The requirements for intact stability resulting from the damage stability calculation shall be fully complied with.

5.3.3 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. 3.5):

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 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-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.

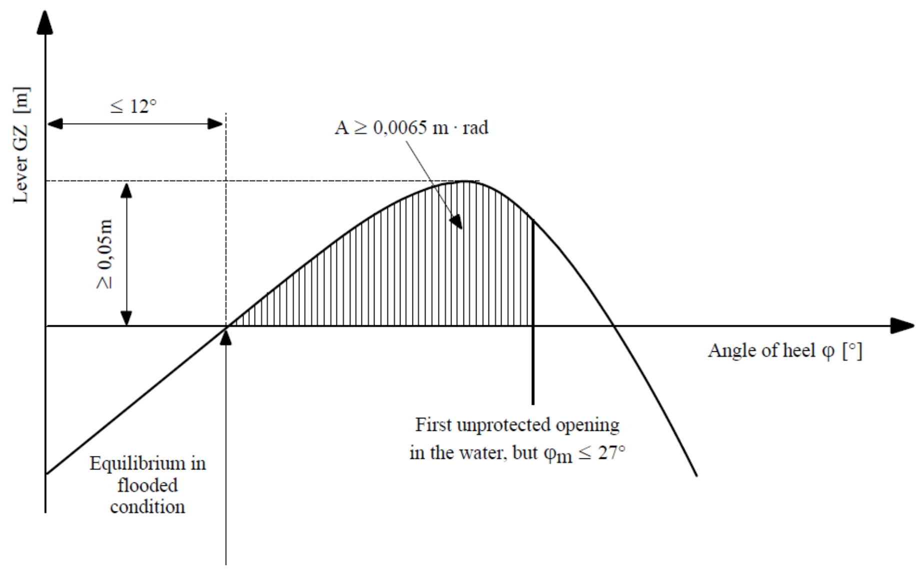


Fig 3.5 Proof of Damage Stability

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 equalization 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 0,10·L 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 0,10·L 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 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 Table 3.6 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.

Tabel 3.6 Permeability value [%]

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

5.3.4 Carriage of containers

Vessels carrying container shall be in compliance with Section 4, F.4.

E. Fire Protection and Fire Extinguishing

1. General

In addition to fire rules of the Rules for Machinery Installations – Inland Waterways (part 2, Vol.III), Section 1, H., the following additional fire extinguishing equipment is to be provided on DG vessels, tankers Type C, Type G and Type N.

2. Portable fire extinguishers

In addition to the fire-extinguishing appliances pre-scribed in the Rules for Machinery Installations – Inland Waterways (part 2, Vol.III) Section 1, H.5., 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.

3. Water fire-extinguishing system

A water fire-extinguishing system shall be installed on the vessel. This system shall comply with the following requirements:

– It shall be supplied by two independent fire or ballast pumps, one of which shall be ready for use at any time. These pumps 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

– 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. Fixed fire-extinguishing system

4.1 General

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 the Rules for Machinery Installations – Inland Waterways (part 2, Vol.III), Section 1, H.3.

F. Alternative Constructions

1. General

1.1 The maximum permissible capacity of a cargo tank in accordance with A.2.5 may be exceeded and the minimum distances in accordance with B.3.2.6and C.2.1may be deviated from, provided that the provisions of this Section are complied with. The capacity of a cargo tank shall not exceed 1000 m^3.

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 BKI Rules with the risk of a crashworthy construction (alternative construction).

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 F.3.

2. Approach

2.1 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:

$$R = P \times C$$

R = risk [m^2]

P = probability of cargo tank rupture [–]

C = consequence (measure of damage) of cargo tank rupture [m^2]

2.2 The probability P of cargo tank rupture depends on the probability distribution of the available collision energy represented by the vessel, which the victim is likely to encounter in a collision, and the capacity 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.

2.3 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 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. Table 3.7 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 fulfill the requirements specified in A and B for tankers Type C and N and in A and C for tanker Type G.

3.3 Step 2

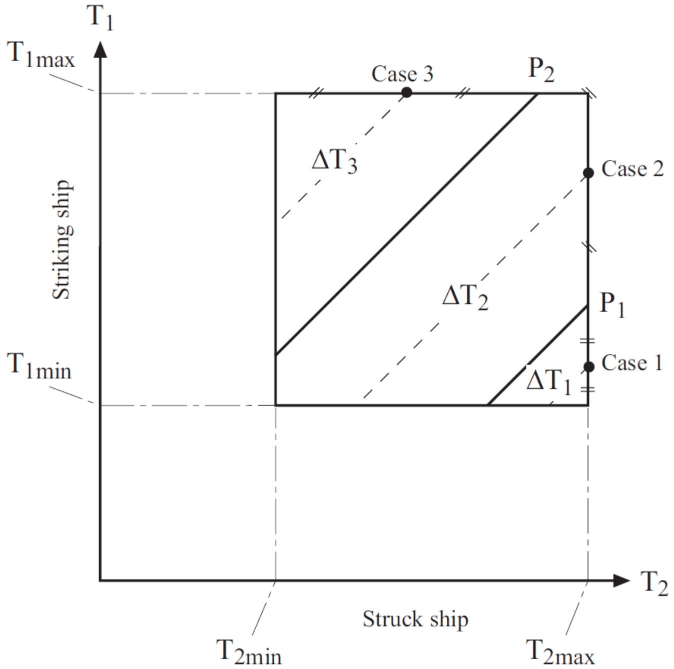
The relevant typical collision locations i = 1 through n shall be determined. Table 3.7 depicts the general case where there are 'n' typical collision locations.

The number of typical collision locations depends on the vessel design. The choice of the collision locations shall be accepted by the recognized classification society.

3.3.1 Vertical collision locations – Tank vessel Type C and N

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. 3.6).

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 mini-mum and maximum draughts of the struck vessel. Each draught combination has an equal probability of occurrence.



ig 3.6 Definition of Vertical Striking Locations

Table 3.7 Calculation of the 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	
Identify collision location and associated weighting factors, collision scen. I	Loc1	FEA	Eloc1	Calculate probability with CPDF 50%	P 50%	wf 50%	Pw 50%							
				Calculate probability with CPDF 66%	P 66%	wf 66%	Pw 66%	+						
				Calculate probability with CPDF 100%	P 100%	wf 100%	Pw 100%							
							sum	Ploc1	wf loc1	Pw loc1				
	Loci	FEA	Eloci	Calculate probability with CPDF 50%	P 50%	wf 50%	Pw 50%							
				Calculate probability with CPDF 66%	P 66%	wf 66%	Pw 66%							
				Calculate probability with CPDF 100%	P 100%	wf 100%	Pw 100%	+						
							sum	Ploci	wf loci	Pw loci				
	Locn	FEA	Elocn	Calculate probability with CPDF 50%	P 50%	wf 50%	Pw 50%							
				Calculate probability with CPDF 66%	P 66%	wf 66%	Pw 66%							
				Calculate probability with CPDF 100%	P 100%	wf 100%	Pw 100%	+						
							sum	Plocn	wf locn	Pw locn	+			
										sum	PscenI	wfscenI	PwscenI	
Identify collision location and associated weighting factors, collision scen. II	Loc1	FEA	Eloc1	Calculate probability with CPDF 30%	P 30%	wf 30%	Pw 30%							
				Calculate probability with CPDF 100%	P 100%	wf 100%	Pw 100%	+						
							sum	Ploc1	wf loc1	Pw loc1				
	Locn	FEA	Elocn	Calculate probability with CPDF 30%	P 30%	wf 30%	Pw 30%							
				Calculate probability with CPDF 100%	P 100%	wf 100%	Pw 100%	+						
							sum	Plocn	wf locn	Pw locn	+			
										sum	Pscen II	wfscenII	Pwscen II	+
													sum	Pw

Points on each inclined line in Fig. 3.6 indicate thesame draught difference. Each of these lines reflects avertical collision location. In the example in Fig. 3.6,three vertical collision locations are defined, depicted by three areas. Point P_1 is the point where the loweredge of the vertical part of the push barge or V-bowstrikes at deck level of the struck ship. The triangulararea 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 collisionlocation “collision below deck”.

The draughtdifference ΔT_i, i = 1, 2, 3 shall be used in the collisioncalculations (see following Fig.).

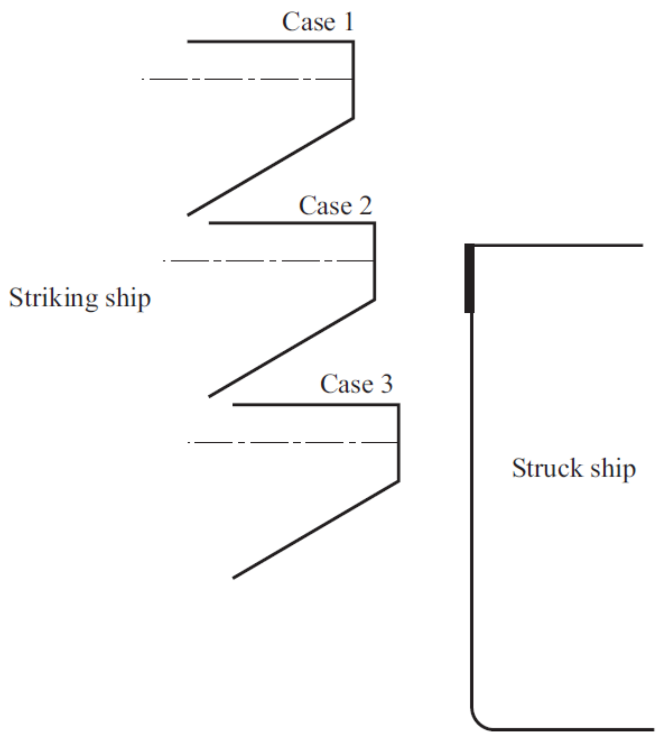


Fig. 3.7 Example of vertical collision locations

For the calculation of the collision energies, the maximum masses of both striking ship and struck ship must be used (highest point on each respective diagonal ΔT_i).

Depending on the ship’s design, additional collision locations may be required.

Vertical collision locations – Tank vessel Type G

For a tank vessel Type G, a collision at half tankheight shall be assumed.Depending on the vessel’s design, additional collision locations may be required.

3.3.2 Longitudinal collision location – Tank vessel Type C and N

At least the following three typical collision locations shall be considered:

– at bulkhead,

– between webs and

– at web.

Longitudinal collision location – Tank vessel Type G

For a tank vessel Type G, at least the following threetypical collision locations shall be considered:

– at cargo tank end,

– between webs and

– at web.

3.3.3 Number of collision locations – Tank vessel Type C and N

The combination of vertical and longitudinal collision locations in the example above results in $3 \cdot 3 = 9$ collision locations.

Number of collision locations – Tank vessel Type G

The combination of vertical and longitudinal collisionlocations in the example above results in $1 \cdot 3 = 3$ collision locations.

3.3.4 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 agree on a case-by-case basis.

3.4 Step 3

For each typical collision location, a weighting factorwhich indicates the relative probability that such atypical collision location will be struck shall bedetermined. In the Table 3.7 these factors are named $wf_{loc(i)}$ (column J).

The weighting factor for each collision location is theproduct of the factor for the vertical collision location and the factor for the longitudinal collision location.

3.4.1 Vertical collision locations – Tank vessel Type C and N

The weighting factors for the various 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. 3.6.

For example, for collision case 1 (see Fig. 3.7) 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 ships.

Vertical collision locations – 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 additional collision locations required, the weighting factor shall be determined analogously to the procedure for tank vessels Type C and N.

3.4.2 Longitudinal collision locations – Tank vessel 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:

a) collision on bulkhead:

0,2 · distance between web frame and bulkhead,but not larger than 450 mm,

b) collision on web frames:

sum of 0,2 · web frame spacing of the web frame, but not larger than 450 mm, and 0,2 · web frame spacing aft of the web frame,but not larger than 450 mm, and

c) collision between web frames:

cargo tank length minus the length “collision at bulkhead” and minus the length “collision at web frame”.

Longitudinal collision locations – Tank vessel Type G

The weighting factor for each longitudinal collision location is the ratio between the “calculation span length” and the length of the hold space.
The calculation span length shall be calculated as follows:

a) collision at cargo tank end:

distance between bulkhead and start of the cylindrical part of the cargo tank,

b) collision on web frame:

sum of 0,2 · web frame spacing forward of the web frame not larger than 450 mm, and 0,2 · web frame spacing aft of the web frame,but not larger than 450 mm, and

c) collision between web frames:

cargo tank length minus the length “collision at cargo tank end” and minus the length “collision on web frame”.

3.5 Step 4

For each collision location, the collision energy absorbing capacity shall be calculated. In this case, the collision energy absorbing capacity is the amount of collision energy absorbed by the ship structure up to initial rupture of the cargo tank (see Table 3.7,column D: $E_{loc(i)}$). For this purpose, a finite element analysis in accordance with 4.2 shall be used.

These calculations shall be done for two collisionscenarios according to Table 3.8. Collision scenario I shall be analysed under the assumption of a push barge bow shape. Collision scenario II shall be analysed under assumption of a V-shaped bow.

These bow shapes are defined in 4.8.

3.6 Step 5

For each collision energy absorption capacity $E_{loc(i)}$,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) shown below shall be used. The appropriate coefficients shall be selected from the Table 3.9 to 3.12 for the effectivemass of the struck ship.

$$P_{x\%} = C_1(E_{loc(i)})^3 + C_2\,(E_{loc(i)})^2 + C_3\,E_{loc(i)} + C_4$$

with:

$P_{x\%}$ = probability of tank rupture

C_{1-4} = coefficients from Table 3.9 to 3.12

$E_{loc(i)}$ = collision energy absorbing capacity

The effective mass shall be equal to the maximum displacement of the ship multiplied by a factor of 1,4. Both collision scenarios (see 3.5) shall be considered.

In the case of collision scenario I (push barge bow at 55°), three CPDF formulae shall be used:

CPDF 50 % (velocity 0.5 V_{max}),

CPDF 66 % (velocity 2/3 V_{max}),

CPDF 100 % (velocity V_{max}).

In the case of scenario II (V-shaped bow at 90°), the following two CPDF formula shall be used:

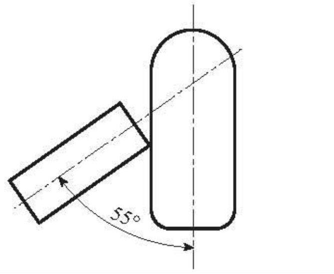
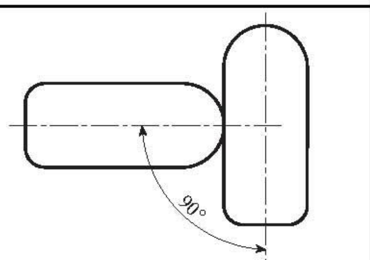
CPDF 30 % (velocity 0.3 V_{max}) and

CPDF 100 % (velocity V_{max}).

In Table 3.7, column F, these probabilities are called P50%, P66%, P100% and P30%, P100% respectively.

The range where the formula is valid is given in column 6. In case of an E_{loc} value below the range, the probability equals $P_{x\%}$ = 1.0. In case of a value abovethe range, $P_{x\%}$ equals 0.

Table 3.8 Speed reduction factors for scenario I or scenario II with weighting factors

					Causes		
					Communication error and poor visibility	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-shaped bow, striking angle 90°	0,20	0.30		1.00

3.7 Step 6

The weighted probabilities of cargo tank rupture$P_{wx\%}$ (Table 3.7, column H) shall be calculated by multiplying each cargo tank rupture probability $P_{x\%}$(Table 3.7, column F) by the weighting factors $wf_{x\%}$ according to Table 3.13.

Table 3.9 Coefficients for the CPDF formulae at V_{max}

Effective mass of struck vessel in tonnes	Velocity = Vmax				
	Coefficients				
	C1	C2	C3	C4	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 3.10 Coefficients for the CPDF formulae at 0.66 V_{max}

Effective mass of struck vessel in tonnes	Velocity = 0.66 Vmax				
	Coefficients				
	C1	C2	C3	C4	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	2.897E-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 3.11 Coefficients for the CPDF formulae at 0.5 V_{max}

Effective mass of struck vessel in tonnes	Velocity = 0.5 Vmax				
	Coefficients				
	C1	C2	C3	C4	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-01	5.419E-01	-6.348E-01	1.209E+00	$1 < E_{loc} < 3$

3.8 Step 7

The total probabilities of cargo tank rupture $P_{loc(i)}$(Table 3.7, column I) resulting from Step 6 shall be calculated as the sum of all weighted cargo tank rupture probabilities $P_{wf\%}$ (Table 3.7, column H) for each collision location considered.

3.9 Step 8

For both collision scenarios, the weighted total probabilities of cargo tank rupture $P_{wloc(i)}$ shall, in each case, be calculated by multiplying the total tank probabilities of cargo tank rupture $P_{loc(i)}$ for each collision location by the weighting factors $wf_{loc(i)}$ corresponding to the respective collision location (see Step 3 and Table 3.7, column J).

Table 3.12 Coefficients for the CPDF formulae at 0.3 V_{max}

Effective mass of struck vessel in tonnes	Velocity = 0.3 Vmax				
	Coefficients				
	C1	C2	C3	C4	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	$0.5 < E_{loc} < 1$

Table 3.13 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 50%	wf100%	0.3

3.10 Step 9

Through the addition of the weighted total probabilities of cargo tank rupture $P_{wloc(i)}$, scenario-specific total probabilities of cargo tank rupture P_{scenI} and P_{scenII} (Table 3.7, column L) shall be calculated for each collision scenario I and II separately.

3.11 Step 10

Finally, the weighted value of the overall total probability of cargo tank rupture P_w shall be calculated by the formula below (Table 3.7, column O):

$$P_w = 0.8 \cdot P_{scenI} + 0.2 \cdot P_{scenII}$$

3.12 Step 11

The overall total probability of cargo tank rupture P_w 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

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:

$$\frac{C_n}{C_r} = \frac{V_n}{V_r}$$

C_n/C_r = the 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 reference design

This formula was derived for characteristic cargoesas listed in Table 3.14.

Table 3.14 Characteristic cargoes

	UN	Desription
Benzene	1114	Flammable liquid Packing group II Hazardous to health
Acrylonitrile Stabilised ACN	1093	Flammable liquid Packing group I Toxic, stabilised
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

For cargo tanks with capacities between 380 m^3 and 1000 m^3 and 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).

If substances are to be carried in tank vessels which have been analysed according to this calculation procedure and 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 the previous point, the affected area shall be determined through a separate calculation. In this case, the comparison as described in 3.14 (Step 13) shall becarried out with this different value for the size of the affected area t.

3.14 Step 13

Finally, the ratio P_r/P_n between the overall total probabilityof 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 $\frac{C_n}{C_r} \leq \frac{P_n}{P_r}$ is fulfilled, the evidence according to 9.3.4.1.3 for the alternative design is provided.

4. Determination of the collision energy absorbing capacity

4.1 General

The determination of the collision energy absorbing capacity shall be carried out by means of the finite element analysis (FEA). The analysis shall be carried out using a customary finite element code (e.g. LSDYNA, PAM-CRASH, ABAQUS) capable of dealing with both geometrical and material non-linear effects. The code shall be able to simulate rupture realistically.

The program actually used and the level of detail of the calculations shall be agreed with BKI.

4.2 Creating the finite element models (FEmodels)

First of all, FE models for the more crash worthy 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 with BKI.

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 ship is not of significant relevance for evaluation of the plastic deformation energy, it is sufficient that only half the beam of the vessel 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 areas covered by the FE model has to be extended.

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 the realistic rupture of elements. 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 with BKI.

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, any cut-outs and man holes in collision areas shall be taken into account.

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 example codes as mentioned:

– “contact_automatic_single_surface” in LSDYNA,
– “self impacting” in PAM-CRASH, and
– similar contact in other FE-programs.

4.3 Material properties

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:

$$\sigma = C \cdot \varepsilon^n$$

Where

$n = \text{In}(1 + A_g)$,

$$C = R_m \cdot \left(\frac{e}{n}\right)^n$$

A_g = the maximum uniform strain related to the ultimate tensile stress R_m

e = the natural logarithmic constant

The values A_g and R_m shall be determined through tensile tests.

If only the ultimate tensile stress R_m is available, the following approximation shall be used for shipbuilding steel with a yield stress R_{eH} of not more than 355 N/mm^2 in order to obtain the A_g value from a known R_m [N/mm^2] value:

$$A_g = \frac{1}{0.24 + 0.01395 \,.\, Rm}$$

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 the rules of the recognized classification society, shall be used instead. For shipbuilding steel with a yield stress higher than 355 N/mm^2 or materials other than shipbuilding steel, material properties shall be agreed with BKI.

4.4 Rupture criteria

4.4.1 The first rupture of an element in an 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 is its defined failure strain value, the element shall be deleted from the FE model and the deformation energy in this element will not longer change in the following calculation steps.

4.4.2 The following formula shall be used for the calculation of rupture strain:

$$\varepsilon_f(\ell_e) = \varepsilon_g + \varepsilon_e \cdot \frac{t}{\ell_e}$$

Where

ε_g = uniform strain

ε_e = necking

t = plate thickness

ℓ_e = individual element length

4.4.3 The value of uniform strain and the necking for shipbuilding steel with a yield stress R_{eH} of not more than 355 N/mm^2 shall be taken from Table3.15.

Table 3.15

Stress states	1-D	2-D
εg	0.079	0.056
εe	0.79	0.55
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 BKI.

4.4.5 Other rupture criteria may be accepted byBKI 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 with BKI. Equivalent plastic strains associated with compressions shall be ignored.

4.5 Calculation of the collision 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 μ_c is defined as:

$$\mu_c = FD+(FS-FD)\cdot e^{-DC|v_{rel}|}$$

With:

FD = 0.1

FS = 0.3

DC = 0.01

$|v_{rel}|$ = relative friction velocity

Note

Figures given are the default valuest for shipbuilding steel.

4.5.2 The force penetration curves resulting from the FE model calculation shall be submitted to BKI.

4.5.3 Tank vessel Type G

In order to obtain the total energy absorbing capacity of the 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:

$$E = \frac{p_1 \cdot V_1 - p_0 \cdot V_0}{1 - \gamma}$$

γ = 1.4

(*Note* **:** *The value 1.4 is the default value cp/cv with, in principle:*

c_p *= specific heat at constant pressure[J/(kgK)],* c_v *= specific heat at constant volume[J/(kgK)])*

p_0 = pressure at start of compression [P_a]

p_1 = pressure at end of compression [P_a]

V_0 = volume at start of compression [m^3]

V_1 = volume at end of compression [m^3]

4.6 Definition of striking ship and striking bow

4.6.1 At least two types of bow shapes of the striking ship shall be used for calculating the collision energy absorbing capacities:

– bow shape I: push barge bow (see 4.8)

– bow shape II: V-shaped bow without bulb (see 4.8)

4.6.2 Because in most collision cases the bow of the striking ship shows only slight deformations compared to the side structure of the struck ship, a striking bow will be defined as rigid. Only for special situations, where the struck ship has an extremely strong structure compared to the striking bow and the structural behaviour of the struck ship is influenced by the plastic deformation of the striking bow, shall the striking bow be considered as deformable. In this case, the structure of the striking bow should also be modelled. This shall be agreed with BKI.

4.7 Assumption for collision cases

For the collision cases, the following shall assumed:

a) As collision angle between striking and struck ship, 90° shall be taken in case of a V-shaped bow and 55° in case of a push barge bow; and
b) The struck ship has zero speed, while the striking ship runs into the side of the struck ship 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 Drawings

4.8.1 Push barge bow

Table 3.16 Characteristic dimensions for push barge bow

Half breadths				Heights			
Fr	**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

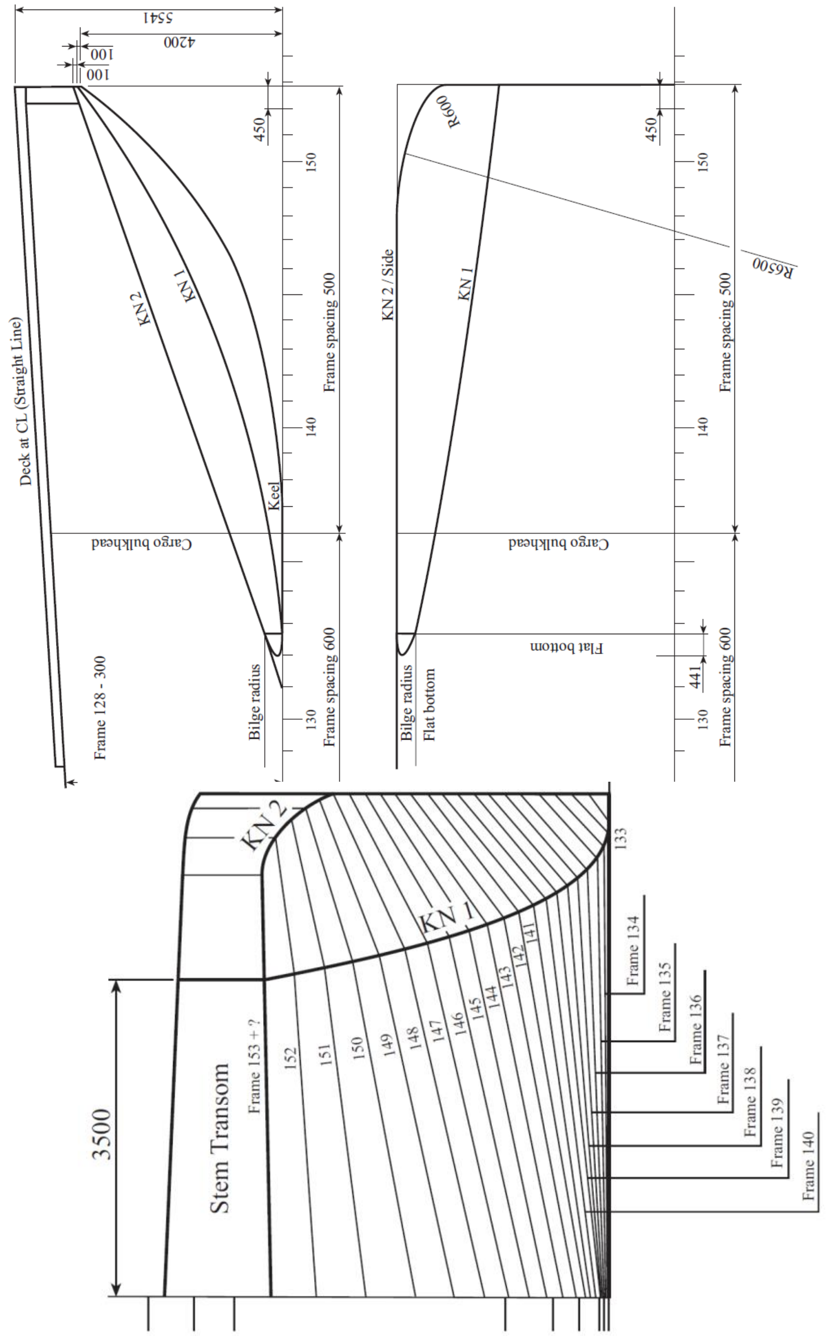


Fig. 3.8 Push barge bow

Table 3.17 Characteristic dimensions for V-shaped bow

Reference number	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

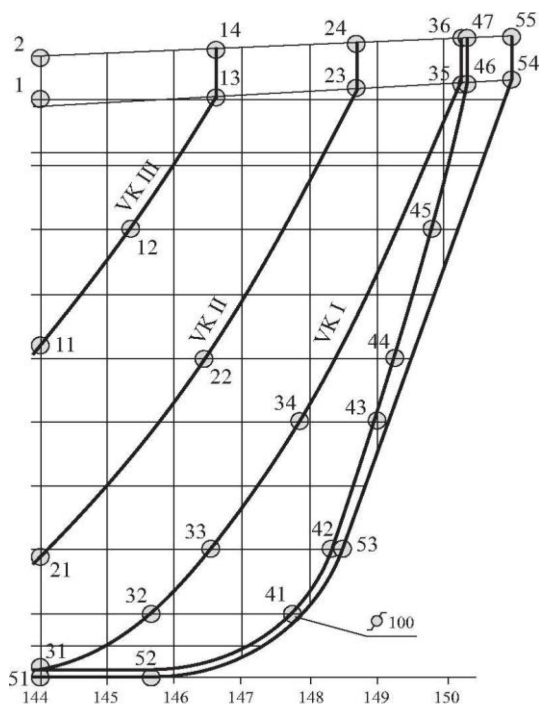


Fig. 3.9 V-shaped bow

Section 4

Additional Class Notations

A. Strengthened Construction

1. Symbols

L = Rule length [m] defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Section 1, A.1.

B = breadth [m] defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Section . 1, A.1.

T = draught [m] defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Section . 1, A.1.

t = thickness [mm]

A = sectional area [cm^2]

N = rotational speed [rev/min]

P_w = power transmitted by shaft [kW]

D = diameter of propeller [mm]

C_{EW} = strengthening factor for shafts:
= 1,10

C_{EP} = strengthening factor for propeller blades:
= 1,15

K_E = strengthening factor for gears and couplings:
= 1,08

T_{ice} = calculated/estimated ice torque [kNm] generated by the propeller working in ice

m = coefficient for calculation of ice torque

K_A = calculation factor for gear, defined in Rules for Machinery Installation - Inland waterways (Part 2, Vol. III) Section 1, B.4.3.2

T_{MCR} = nominal mean torque [Nm] delivered by the engine (referred to installed MCR of engine)

$T_{Nom, cpl}$ = proven nominal torque for coupling [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 [Nm] which the elastic coupling shall transmit safely, including the influence of ice operation

$T_{max1, cpl}$ = maximal permissible peak torque for elastic coupling [Nm] excluding reduction due to thermal loading (catalogue's permissible repetitive peak torque)

σ_H = calculated tooth flank contact (Hertzian) stress [N/mm^2] without ice load as referred to in Rules for Machinery Installations (Part 1, Vol. III) Section 5, C.

σ_{HP} = maximal permissible contact (Hertzian) stress [N/mm^2] depending on material's properties (see Rules for Machinery Installations (Part 1, Vol. III)).

σ_F = calculated tooth root bending stress without ice load [N/mm^2] as referred to in Rules for Machinery Installations (Part 1, Vol. III) Section 5, C.

σ_{FP} = maximal permissible tooth root bending stress [N/mm^2] depending on material's properties (see Rules for Machinery Installations (Part 1, Vol. III)).

t_{bl} = thickness of the propeller blade [mm] determined in compliance with Rules for Machinery Installation – Inland waterways (Part 2, Vol. III) Section 1, B.5.3 for unstrengthened machinery installations

$t_{bl, ice}$ = strengthened blade thickness of the propeller [mm]

$t_{0, ice}$ = strengthened thickness of blade's tip [mm]

$R_{m, pr}$ = tensile strength of the propeller's material [N/mm^2]

p = required mean pressure [N/mm^2] in the shrink fit between propeller hub and propeller shaft in accordance with the BKI Rules for Machinery Installation – Inland waterways (Part 2, Vol. III) Section 1, B.5.6.1

p_{ice} = required increased mean pressure [N/mm^2] in the shrink fit between propeller hub and propeller shaft

d = minimum diameter of shaft [mm] deter-mined in compliance with Rules for Machinery Installation – (Part 2, Vol. III) Section 1, B.3.3.2, for unstrengthened machinery installations

d_{ice} = strengthened minimum diameter of shaft [mm]

d_S = minimum required diameter [mm] of fitting pin of propeller connection in accordance with Rules for Machinery Installation – Inland waterways (Part 2, Vol. III) Section 1, B.5.6.2, for unstrengthened machinery installations

$d_{S, ice}$ = strengthened minimum diameter of fitting pin [mm]

2. General

2.1 Application

2.1.1 The following additional class notations may be assigned, in accordance with Rules for Classification and Surveys – Inland waterways (Part 2, Vol. I), Section 2, B.3.2.8 or B.9.3.1 to ships with strengthened construction complying with applicable requirements in the following:

- **Ice,** for ships complying with 3.

- **Grab loading,** for ships complying with 4.

Unless otherwise mentioned, these ships are to comply with the requirements stated under Volume I, Volume II, Volume III and Volume IV of the Rules for Inland waterways, as applicable.

3. Navigation in ice

The requirements of navigation in ice will be regulated in specific rules.

4. Grab loading

4.1 Strengthening requirements

4.1.1 General

In the case of grab loading and unloading, the scantlings of structural elements within the cargo hold are to be strengthened in compliance with 4.1.2.

4.1.2 Scantling increase

The scantlings of structural elements within the cargo hold are to be increased as follows:

- inner side and hold bulkheads
    - plating: $t = t_0 + 1{,}5$ mm
    - ordinary stiffeners: $w = 1{,}4 \cdot w_0$
- inner bottom
    - plating: $t = t_0 + 2$ mm
    - longitudinals: $w = 1{,}4 \cdot w_0$

where t_0 and w_0 are scantlings of corresponding struc¬tural elements in case of no grab loading.

B. Transport of Heavy Cargo

1. Symbols

L = Rule length [m] defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Section. 1, A.1.

B = breadth [m] defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Section. 1, A.1.

H = depth [m] defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Section. 1, A.1.

T = draught [m] defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Section. 1, A.1.

t = net thickness [mm] of plating

s = spacing [m] of ordinary stiffeners

S = spacing [m] of primary supporting members

ℓ = span [m] of ordinary stiffeners or primary supporting members

n = navigation coefficient defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 3, B.
= $0{,}85 \cdot H$

HW = significant wave height [m]

β_b, β_s = bracket coefficients defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 2, B.5.2

w = net section modulus [cm3] of ordinary stiff¬eners or primary supporting members

Ash = net web shear sectional area [cm2]

k = material factor defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 2, A.2.4 and A.3.2

z = z co-ordinate [m] of the calculation point

MH = design bending moment [kNm] in hogging condition

MS = design bending moment [kNm] in sagging condition

2. General

2.1 Application

2.1.1 The additional class Notation heavy cargo is assigned, in accordance with Rules for Classification and Surveys – Inland waterways (Part 2, Vol. I) Section 2, B.3.2.6, to ships intended to carry heavy unit cargoes or heavy dry bulk cargoes.

2.1.2 Unless otherwise mentioned, these ships are to comply with the requirements stated under Volume I, Volume II, Volume III, and Volume IV of the Rules for Inland waterways, as applicable.

2.1.3 These rules are applicable to ships intended to carry heavy bulk dry cargoes. The values of cargo density and angle of repose are to be submitted to BKI.

2.1.4 Ships intended for the carriage of heavy unit cargoes are to comply with Section 2, B.

3. Hull scantlings

3.1 General

3.1.1 In general, the hull scantlings are to be not less than required in Rules for Hull – Inland waterways (Part 2, Vol. II) Sec. 5, unless otherwise specified here below.

3.1.2 Grab loading and unloading

In the case of grab loading and unloading, the scant-lings of structural elements within the cargo hold are to be strengthened in compliance with A.3.

3.2 Bottom and inner bottom plating

In the central part, the bottom and inner bottom plating net thickness [mm] are not to be less than the values given in Table 4.1.

3.3 Double bottom structure

3.3.1 Minimum thickness of web plating

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

$$t = 3,8 + 0,016 \cdot L \cdot k0,5$$

Table 4.1 Bottom and inner bottom plating net thickness [mm]

Item	Transverse framing	Longitudinal framing
Bottom plating	$t = MAX\ (t_i)$ $t_1 = 1{,}85 + 0{,}03 \cdot L \cdot k^{0,5} + 3{,}6 \cdot s$ $t_2 = 1{,}6 \cdot s \cdot (k \cdot p)^{0,5}$ $t_3 = 68 \cdot \frac{s}{k_2} \cdot \sqrt{\frac{M_H}{Z_B}}$ if $t_3 / s > 22 / (k^{0,5} \cdot k_2)$ $t_3 = \frac{7{,}1 \cdot k^{0.5} \cdot s}{k_2 \sqrt{0.21 - \frac{M_H}{Z_B}}}$ see[1]	$T = MAX\ (t_i)$ $t_1 = 1{,}1 + 0{,}03 \cdot L \cdot k^{0,5} + 3{,}6 \cdot s$ $t_2 = 1{,}2 \cdot s \cdot (k \cdot p)^{0,5}$ $t_3 = 39 \cdot s \cdot \sqrt{\frac{M_H}{Z_B}}$ if $t_3 / s > 12{,}5 / k^{0,5}$ $t_3 = \frac{4{,}1 \cdot k^{0.5} \cdot s}{\sqrt{0.21 - \frac{M_H}{Z_B}}}$ see[1]
Inner bottom plating	$t = MAX\ (t_i)$ $t_1 = 2 \cdot L^{1/3} \cdot k^{0,5} + 3{,}6 \cdot s$ $t_2 = 1{,}6 \cdot s \cdot (k \cdot p_{MS})^{0,5}$ $t_3 = 1{,}25 \cdot t_{bottom}$	$t = MAX\ (t_i)$ $t_1 = 2 \cdot L^{1/3} \cdot k^{0,5} + 3{,}6 \cdot s$ $t_2 = 1{,}2 \cdot s \cdot (k \cdot p_{MS})^{0,5}$ $t_3 = 1{,}25 \cdot t_{bottom}$

p = design load [kN/m²] of bottom plating:
– in way of ballast tanks: p= MAX [$p_{E;}\ (p_B - p_M)$]
– elsewhere: P= P_E

p_M = minimum external pressure [kN/m²]
= 9,81 · (0,15·**T** –0,6·n)

p_E = external pressure [kN/m²]
= 9,81 · (**T** + 0,6 · n)

p_B = ballast pressure defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 3, C.5.

p_{MS} = inner bottom design pressure [kN/m²], defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 3, C.5.3.2

k_2 = $1 + \alpha^2$

α = b_2 / b_1

b_1 = unsupported plate width in y direction [m]

b_2 = unsupported plate width in x direction [m]

Z_B = bottom net hull girder section modulus [cm³]

1 A lower value of thickness t3 may be accepted if in compliance with the buckling analysis carried out according to Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 2, C.

3.3.2 Net scantlings of bottom primary sup-porting members in service conditions

The scantlings of the double bottom primary supportingstructural members are to be obtained from Table 4.2.

4. Hull arrangement

4.1 General

4.1.1 Hull arrangement is to be in compliance with requirements of Section 1, A. or B. as applicable.

Table 4.2 Double bottom structure

Item	Parameter	Transverse framing	Longitudinal framing
Floors in the hold [1]	section modulus [cm^3] thickness [mm] shear sectional area [cm^2]	$w = 0{,}58 \cdot k\ \beta_b \cdot p_{\gamma I} \cdot s \cdot (\ell^2 - 4 \cdot B_3^2)$ $t = MAX\ (t_1; t_2)$ $t_1 = 3{,}8 + 0{,}016 \cdot L \cdot k^{0,5}$ $t_2 = d / 90$ $A_{sh} = 0{,}067 \cdot k \cdot \beta s \cdot p_{\gamma I} \cdot s \cdot (\ell - 2 \cdot B_3)$	NA NA NA
Floors in the side tank [1]	section modulus [cm^3] shear sectional area [cm^2]	$w = 2{,}32 \cdot k \cdot \beta_b \cdot p_{\gamma I} \cdot s \cdot B_2 \cdot (\ell - 2 \cdot B_2)$ $A_{sh} = 0{,}067 \cdot k \cdot \beta s \cdot p\gamma I \cdot s \cdot (\ell - 2 \cdot B_3)$	NA NA
Bottom and inner bottom longitudinals	section modulus [cm^3] shear sectional area [cm^2]	NA NA	$w = \dfrac{83{,}3}{214 - \sigma_1} \beta_b \cdot \eta \cdot p \cdot s \cdot l^2$ $A_{sh} = 0{,}045 \cdot \beta s \cdot \eta \cdot p \cdot s \cdot \ell$
Bottom transverses in the hold	section modulus [cm^3] thickness [mm] shear sectional area [cm^2]	NA NA NA	$w = 0{,}58 \cdot k\ \beta_b \cdot p_{\gamma I} \cdot S(\ell^2 - 4 \cdot B_3^2)$ $t = MAX(t_1; t_2)$ $t_1 = 3{,}8 + 0{,}016 \cdot L \cdot k^{0,5}$ $t_2 = d / 80$ $A_{sh} = 0{,}067 \cdot k \cdot \beta s \cdot p_{\gamma I} \cdot S \cdot (\ell - 2 \cdot B_3)$
Bottom transverses in the side tank	section modulus [cm^3] shear sectional area [cm^2]	NA NA	$w = 2{,}32 \cdot k \cdot \beta_b \cdot p_{\gamma I} \cdot S \cdot B_2 \cdot (\ell - 2 \cdot B_2)$ $A_{sh} = 0{,}067 \cdot k \cdot \beta s \cdot p_{\gamma I} \cdot S \cdot (\ell - 2 \cdot B_3)$
Bottom centre and side girders [2]	shear sectional area [cm^2]	$A_{sh} = 0{,}051 \cdot k \cdot \beta_s \cdot p_{\gamma I} \cdot S \cdot \ell$	

p = design load of bottom and inner bottom longitudinals [kN/m^2]:

– in way of ballast tanks: – for bottom longitudinals: $p = MAX\ (p_E; (p_B - p_M))$
– for inner bottom longitudinals: $p = MAX\ (p_C; p_B)$

– elsewhere: – for bottom longitudinals: $p = p_E$
– for inner bottom longitudinals: $p = p_C$

p_E, p_B, p_C = pressures transmitted to the hull structure, defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 3, C.4. and C.5.

$p_{\gamma I}$ = internal load [kN/m2] taking into account the loading sequence: $p_{\gamma I} = 0{,}55 \cdot \gamma_1 \cdot (p_{MS} - p_M)$

γ_1 = $(\gamma - 0{,}15) / 0{,}85$

γ = loading sequence coefficient: γ = 1,0 for loading/unloading in one run
= 0,575 for loading/unloading in two runs

p_M = minimum external pressure [kN/m^2]: $p_M = 9{,}81 \cdot (0{,}15 \cdot T - 0{,}6 \cdot n)$

p_{MS} = inner bottom design load defined in Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 3, C.5.3

ℓ = floor or bottom transverse span [m]

B_2 = breadth of the side tank [m]

B_3 = parameter [m] to be derived from following formula: $B_3 = 0{,}5 \cdot 1 - \dfrac{p_{MS}}{9.81 \cdot \rho \cdot \tan\varphi}$

w_0 = section modulus [cm^3] of floors or bottom transverses in the hold

A_a = cross sectional area of attached inner bottom plating [cm2]

ρ = cargo density [t/m^3]: $\rho \geq 2{,}5$

φ = angle of repose of the bulk cargo considered: $\varphi \geq 35°$

d = double bottom height [mm]

[1] In way of ordinary stiffeners, $\beta_b = \beta_S = 1$

[2] The span ℓ is to be taken equal to the web frame or side transverse spacing.

NA = not applicable.

C Equipped for Transport of Containers

1. General

1.1 Application

Cargo ships 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 Rules for Classification and

Surveys – Inland waterways (Part 2, Vol. I), Section 2, B.3.2.1
These ships are to comply with the requirements stated under Section 1, A. or B., 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 ships, 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

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

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 [kN · m] from the following formula:

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

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. 4.1, is to be determined in compliance with Rules for Hull - Inland waterways (Part 2, Vol. II) Sec. 3, C.6.5

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 ton

- for 20 feet containers: m_i = 17 ton

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 [kN] using the following formula:

$$P = F / 4$$

$$F = \sum_i^N F_i$$

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°

4. Hull scantlings

4.1 General

4.1.1 In general, the hull scantlings are to be not less than required in Rules for Hull - Inland waterways (Part 2, Vol. II) Section. 5

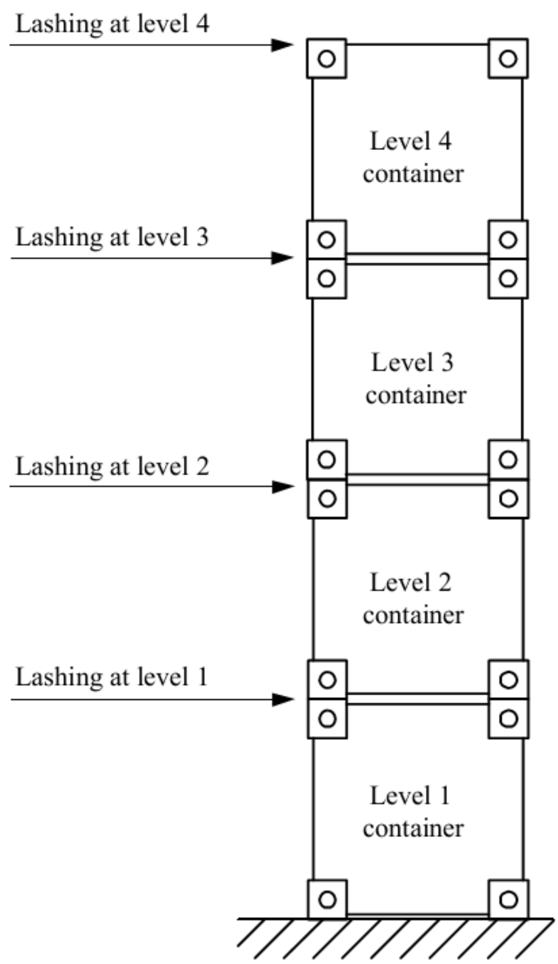


Fig. 4.1 Container levels in a stack

4.1.2 Scantlings of structural members subjected to concentrated loads are to be determined by direct calculation according to Rules for Hull - Inland waterways (Part 2, Vol. II) Section. 2, E. 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 Section 2, B.3.1.1.

5. Direct calculation

5.1 General

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 Rules for Hull - Inland waterways (Part 2, Vol. II) Section. 2, E.

5.2 Loading cases

5.2.1 Bottom structure

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

- full container load and scantling draught equal to 0,575 · **T**

- maximum ship draught **T**, without containers

5.2.2 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.

5.3 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

– continuity of double bottom in the side tank, for bottom structure D. Equipped for Transport of Wheeled Vehicles

D. Equipped for Transport of Wheeled Vehicles

1. General

1.1 Application

1.1.1 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 Rules for Classification and Surveys (Part 2, Vol. I), Section 2, B.3.2.2

1.1.2 These ships are to comply with the requirements stated under Section 1, A.or B., as applicable.

2. Ship arrangements

2.1 Sheathing

Wood sheathing is recommended for heavy loader 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, ro-ro cargo decks or platforms are to be longitudinally framed.

Where a transverse framing system is adopted, it is to be considered by BKI on a case by case basis

2.3 Drainage of ro-ro 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 Ro-ro cargo spaces

3.1.1 Design loads

The wheeled loads induced by vehicles are defined in BKI Rules for Hull - Inland Waterways(Part 2, Vol.II), Sec 3, C.6.6.

3.1.2 The scantlings of ro-ro cargo spaces are to be in compliance with Section 2, C.3.

3.2 Movable decks and inner ramps

The requirements applicable to movable decks and inner ramps are defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol.II), Sec 6, F.1.

3.3 External ramps

The requirements applicable to external ramps are defined in BKI Rules for Hull - Inland Waterways (Part 2, Vol.II), Sec 6, F.2.

E. Ferry

1. General 1.1 Application

1.1.1 Passenger ships complying with the requirements of this Section are eligible for the as-signment of the additional class Notation Ferry, as defined in BKI Rules for Classification and Surveys (Part 2, Vol.I), Sec 2, B.5.2.1

1.1.2 These ships are to comply with the requirements stated under Sec 2, D., as far as applicable.

2. Vessel arrangements

2.1 Sheathing

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 BKI on a case-by-case basis.

2.3 Drainage of ro-ro 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 Ro-ro cargo spaces

3.1.1 Design loads

The wheeled loads induced by vehicles are defined in Rules for Hull - Inland Waterways (Part 2, Vol.II), Sec 3, C.6.6.

3.1.2 The scantlings of ro-ro cargo spaces are to be in compliance with Sec 2, C.4.

3.2 Movable decks and inner ramps

The requirements applicable to movable decks and inner ramps are defined in Rules for Hull - Inland Waterways(Part 2, Vol.II), Sec 6, F.1.

3.3 External ramps

The requirements applicable to external ramps are defined in Rules for Hull - Inland Waterways(Part 2, Vol.II), Sec 6, F.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 ship, the electrical equipment is to be of a certified safe type as stated in Rules for Machinery Installation, Inland Waterways (Part 2, Vol.III , Sec 2, A. 1.4.6 and to have minimum explosion group IIA and temperature class T3.

Electrical equipment is to be as stated in Rules for Machinery Installation, Inland Waterways (Part 2, Vol.III , Sec 2, A.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 Rules for Machinery Installation, Inland Waterways(Part 2, Vol.III , Sec 2, A.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 Rules for Machinery Installation, Inland Waterways (Part 2, Vol.III , Sec 2, A.1.4.6 and to have minimum explosion group IIA and tempera¬ture class T3.

F. Stability

1. Symbols

L = Rule length [m] defined in Rules for Hull - Inland Waterways(Part 2, Vol.II), Sec 1, A.1.

L_{WL} = length of the hull [m] measured at the maximum draught

B = breadth [m] [m] defined in Rules for Hull - Inland Waterways(Part 2, Vol.II) , Sec 1, A.1.

H = depth [m] [m] defined in Rules for Hull - Inland Waterways(Part 2, Vol.II) , Sec 1, A.1.

T = draught [m] [m] defined in Rules for Hull - Inland Waterways(Part 2, Vol.II) , Sec 1, A.1.

A = displacement of the laden ship [t]

v = maximum speed of the ship in relation to the water [m/s]

KG = height [m] of the centre of gravity above base line

n = navigation coefficient defined in Rules for Hull-Inland Waterways(Part 2, Vol.II),Sec 3,B.

= $0,85 \cdot H_W$

H_W = significant wave height [m]

Cb = block coefficient

2. General

2.1 Application

Ships complying with the requirements of this Section are eligible for the assignment of one of the following additional class Notations, as defined in BKI Rules for Classification and Surveys (Part 2, Vol.I), Sec 2, B.9.4:

- Intact stability
- Damage stability

2.2 Definitions

2.2.1 Plane of maximum draught

Plane of maximum draught is the water plane corresponding to the maximum draught at which the ship is authorized to navigate.

2.2.2 Bulkhead deck

Bulkhead deck is the deck up to which the required watertight bulkheads are carried and from which the freeboard is measured.

2.2.3 Freeboard (f)

Freeboard is the distance between the plane of maximum draught and a parallel plane passing through the lowest point of the gunwale or, in the absence of a gunwale, the lowest point of the upper edge of the ship's side.

2.2.4 Residual freeboard

Residual freeboard is the vertical clearance available, in the event of the ship heeling over, between the water level and the upper surface of the deck at the lowest point of the immersed side or, if there is no deck, the lowest point of the upper surface of the ship's side shell.

2.2.5 Safety clearance

Safety clearance is the distance between the plane of maximum draught and the parallel plane passing through the lowest point above which the ship is no longer deemed to be watertight.

2.2.6 Residual safety clearance

Residual safety clearance is the vertical clearance available, in the event of the ship heeling over, between the water level and the lowest point of the immersed side, beyond which the ship is no longer regarded as watertight.

2.2.7 Weathertight

Weathertight is the term used to describe a closure or structure which prevents water from penetrating into the ship under any service conditions. Weathertight designates structural elements or devices which are so designed that the penetration of water into the inside of the ship is prevented:

– for one minute when they are subjected to a pressure corresponding to a 1 m head of water, or
– for ten minutes when they are exposed to the action of a jet of water with a minimum pressure of 1 bar in all directions over their entire area

Following constructions are regarded as weathertight:

– weathertight doors complying with ISO 6042
– ventilation flaps complying with ISO 5778
– airpipe heads of automatic type and of approved design

Weathertightness shall be proven by hose tests or equivalent tests accepted by BKI before installing.

2.2.8 Watertight

Watertight designates structural elements or devices which meet all the conditions stated for weathertightness and also remain tight at the anticipated internal and external pressure.

Watertightness should be proven by workshop testing and where applicable by type approvals in combination with construction drawings (e.g. watertight sliding doors, cable penetrations through watertight bulkheads).

2.3 Documents to be submitted and to be used on board

2.3.1 Documents to be given on board

The following information is to be given on board of the ship and has to be prepared in a clear and understandable form, as a working document for the master.

- general description of the ship

- general arrangement and capacity plans indicating the assigned use of compartments and spaces (cargo, passenger, stores, accommodation, etc.)

- a sketch indicating the position of the draught marks referred to the ship's perpendiculars

- hydrostatic curves or tables corresponding to the design trim, and, if significant trim angles are foreseen during the normal operation of the ship, curves or tables corresponding to such range of trim are to be introduced

- cross curves or tables of stability calculated on a free trimming basis, for the ranges of displace-ment and trim anticipated in normal operating conditions, with indication of the volumes which have been considered buoyant

- tank sounding tables or curves showing capaci¬ties, centres of gravity, and free surface data for each tank

- light ship data from the inclining test, including light ship displacement, centre of gravity co-ordinates, place and date of the inclining test, as well as BKI approval details specified in the inclining test report. It is suggested that a copy of the approved test report be included

Where the above-mentioned information is derived from a sister ship, the reference to this sister ship is to be clearly indicated, and a copy of the approved inclining test report relevant to this sister ship is to be included

- standard loading conditions and examples for developing other acceptable loading conditions using the information contained in the trim and stability booklet

- intact stability results (total displacement and its centre of gravity co-ordinates, draughts at per-pendiculars, GM, GM corrected for free surfaces effect, GZ values and curve, criteria reporting a comparison between the actual and the required values) are to be available for each of the above-mentioned operating conditions

- information on loading restrictions (maximum allowable load on double bottom, maximum specific gravity allowed in liquid cargo tanks, maximum filling level or percentage in liquid cargo tanks, possibilities for alternate loading of liquid cargo tanks, maximum KG or minimum GM curve or table which can be used to determine compliance with the applicable intact and damage stability criteria), when applicable

- information about openings (location, tightness, means of closure), pipes or other progressive flooding sources

- information concerning the use of any special cross-flooding fittings with descriptions of damage conditions which may require cross- flooding, when applicable

- damage control plan (in case a damage stability calculation is required) showing the watertight subdivision used for damage stability calcula¬tion, giving guidance on how to reduce a heeling angel resulting from water ingress, and showing all closing devices to be kept closed while sailing.

2.3.2 Documents to be submitted for examination

All information/documents mentioned under 2.3.1, to be given on board, and a lines plan respectively a hull definition such as offset table. BKI may require further necessary guidance for the safe operation of the ship.

2.4 Basic data for the stability calculation

2.4.1 Definitions

– Light ship

The light ship is a ship complete in all respects, but without consumables, stores, cargo, and crew and effects, owners' supply and without liquids on board except for machinery and piping fluids, such as lubricants and hydraulics, which are at operating levels.

– Inclining test

The inclining test is a procedure which involves moving a series of known weights, normally in the transverse direction, and then measuring the resulting change in the equilibrium heel angle of the ship. By using this information and applying basic naval architecture principles, the vessel's vertical centre of gravity (VCG or KG) is determined.

2.4.2 The light ship displacement and the location of the centre of gravity shall be determined either by means of an inclining experiment (see H.) or by detailed mass and moment calculation. In this latter case the light weight of the ship shall be checked by means of a light weight test with a tolerance limit of about 5 % between the mass determined by calculation and the displacement determined by the draught readings. The weight and centre of gravity calculation has to be submitted before the light weight survey will be performed.

2.5 Effects of free surfaces of liquids in tanks

2.5.1 For all loading conditions, the initial meta-centric height and the righting lever curve are to be corrected for the effect of free surfaces of liquids in tanks.

2.5.2 Free surface effects are to be considered for any filling level of the tank. Free surface effects need not be considered where a tank is nominally full.

3. Tankers

3.1 General

3.1.1 Application

3.1.2 The following requirements apply to tankers which have been requested to receive the additional class Notation **Intact stability**.

3.1.3 The centre longitudinal bulkhead may be dispensed with only if sufficient stability is guaranteed.

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 ships 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 2.5.

4. Container ships

4.1 General

4.1.1 Application

The following requirements apply to container ships 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 ship by means of rails or turnbuckles and its position cannot alter during the voyage. 4.1.3. In case of ships 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 ship'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 ship'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 [m] resulting from the centrifugal force caused by the ship turning shall be determined in accordance with the following formula:

$$h_{KZ} = 0.04 \cdot \frac{v^2}{L_{WL}} \cdot \left(KG - \frac{T}{2}\right)$$

KG = height [m] of centre of gravity of the loaded ship above its base

v = maximum speed of the ship [m/s]

4.2.3 The heeling lever [m] resulting from the wind thrust is to be determined in accordance with the following formula:

$$h_{KW} = P_{WD} \cdot \frac{A_W}{\Delta} \cdot \left(l_W - \frac{T}{2}\right)$$

P_{WD} = specific wind pressure [t/m^2]:

– for IN(0) and IN(0,6) : P_{WD} = 0,025

– for IN(1,2) and IN(2) : P_{WD} = 0,04·n

A_W = side surface above the water of the loaded ship [m^2]

ℓ_W = height [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 [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:

$$h_{KFO} = \frac{0.015}{\Delta} \cdot \sum b.l\left(b - 0{,}55 \cdot \sqrt{b}\right)$$

b = width of hold or section of the hold in question [m]

ℓ = length of hold or section of the hold in question [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 ship 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.

$KG \leq KG_Z$

KG = effective height [m] of ship centre of gravity above its base

KG_Z = maximum permissible height [m] of the loaded ship's centre of gravity above its base, given by the formula:

$$= \frac{KM + \frac{B_{WL}}{2.F} \cdot \left(Z_Z \cdot \frac{T_m}{2} - h_{KW} - h_{KFO}\right)}{\frac{B_{WL}}{2.F} . Z_Z + 1}$$

Or

$$KG_Z = KM - 1$$

Whichever is the lesser,

$$B_{WL} / 2 \cdot F > 11{,}5$$

KM = height of the metacentre above the base [m]

If no curve diagram is available the value of KM may be determined, for example, via the following approximation formulae:

– ships in the form of a pontoon

$$= \frac{B_{WL}^2}{\left(12{,}5 - 1{,}2 . \frac{T_m}{D}\right) . T_m} + \frac{T_m}{2}$$

– other ships

$$= \frac{B_{WL}^2}{\left(12{,}7 - 1{,}2 . \frac{T_m}{D}\right) . T_m} + \frac{T_m}{2}$$

F = effective freeboard at 0,5 · L

BWL = ship waterline breadth [m]

Tm = average draught [m]

Z_Z = parameter for the centrifugal force resulting from turning:

$$= 0{,}04 . \frac{v^2}{L_{WL}}$$

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 ship 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 ship, wind thrust and free surfaces of water.

4.3.2 The heeling moments resulting from the wind thrust, centrifugal force due to the ship'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 ship carrying secured containers shall be considered to be adequate if the effective KG does not exceed the KGZ resulting from the formula that has been calculated for the different displacements resulting from the possible height variations.

$$KG \le KG_Z$$

KG = effective height [m] of ship centre of gravity above base line

KG_Z = maximum admissible height [m] of ship centre of gravity above its base line, given by:

$$= \frac{KM - KM_1 + KM_2}{0{,}75 . \frac{B_{WL}}{F^*} . Z_Z + 1}$$

Or

$$KG_Z = KM - 0{,}5$$

whichever is the lesser,

$$KM_1 = \frac{1 - i}{2 \cdot \nabla} \cdot \left(1 - 1{,}5 . \frac{F}{F^*}\right) \ge 0$$

$$KM_2 = 0{,}75 . \frac{B_{WL}}{F^*} . \left(Z_Z . \frac{T_m}{2} - h_{KW} - h_{KFO}\right)$$

$B_{WL} / F^* \ge 6{,}6$

F^* = ideal freeboard [m]

= MIN (F_1^*, F_2^*)

F_1^* = $D^* - T_m$

$$F_2^* = \frac{a . B_{WL}}{2 . b}$$

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 ship's normal position [m]

b = distance of the same opening as above from the centre of the ship [m]

D* = ideal depth [m]:

$$= D^* + \frac{q}{0{,}9.L.B_{WL}}$$

q = sum of the volumes [m3] 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 ship shall not be taken into account.

∇ = displacement of the ship at Tm [m^3]

i = transverse moment of inertia [m^4] of water- line parallel to the base, at height [m] equal to:

h = Tm + 2 · F* / 3

I = transverse moment of inertia [m^4] of water- line Tm

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:

– ships in the form of a pontoon:

$$= \frac{\nabla.B_{WL}^2}{\left(12{,}5 - \frac{T_m}{D}\right).T_m}$$

– other ships:

$$= \frac{\nabla.B_{WL}^2}{\left(12{,}5 - 1{,}2.\frac{T_m}{D}\right).T_m}$$

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 ships exceeding 110 m in length and to ships intended for the carriage of dangerous goods according to Sec 3, D.

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 ship's light weight 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 light weight of the ship 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 ship.
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 with¬out limit

b) Extent of bottom damage:
- longitudinal extent: at least 0,10 · L
- transverse extent: 3,00 m
- vertical extent: from base line to 0,39 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 ship remains afloat after flooding two or more adjacent compartments in the longitudinal direction.

For the main engine room only a 1-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 Table 4.3 may be assumed.

If a calculation proves that the average permeability of any compartment is lower, the calcu¬lated value may be used.

e) At the final stage of flooding, the lower edge of any non-watertight opening (e.g. doors, win-dows, access hatches) shall, at the final stage of flooding, be not less than 100 mm above the damaged waterline.

Table 4.3 Permeability values [%]

Spaces	μ
Engine and service 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 ship 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, see Fig. 4.2:

a) At the final stage of flooding a safety clearance of not less than 100 mm remains and the angle of heel of the ship does not exceed 5°; or

b) The positive 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 open¬ings and in any event up to an angle of heel equal to 10° (see Fig. 4.2). 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 ships carrying dangerous goods, calculations in accordance with the procedure for damage stability specified in Section 3 or ADN, Part 9, shall produce a positive result.

4.4.6 When cross- or down-flooding openings are provided for reduction of unsymmetrical flooding, the time for equalization 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 ship, 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

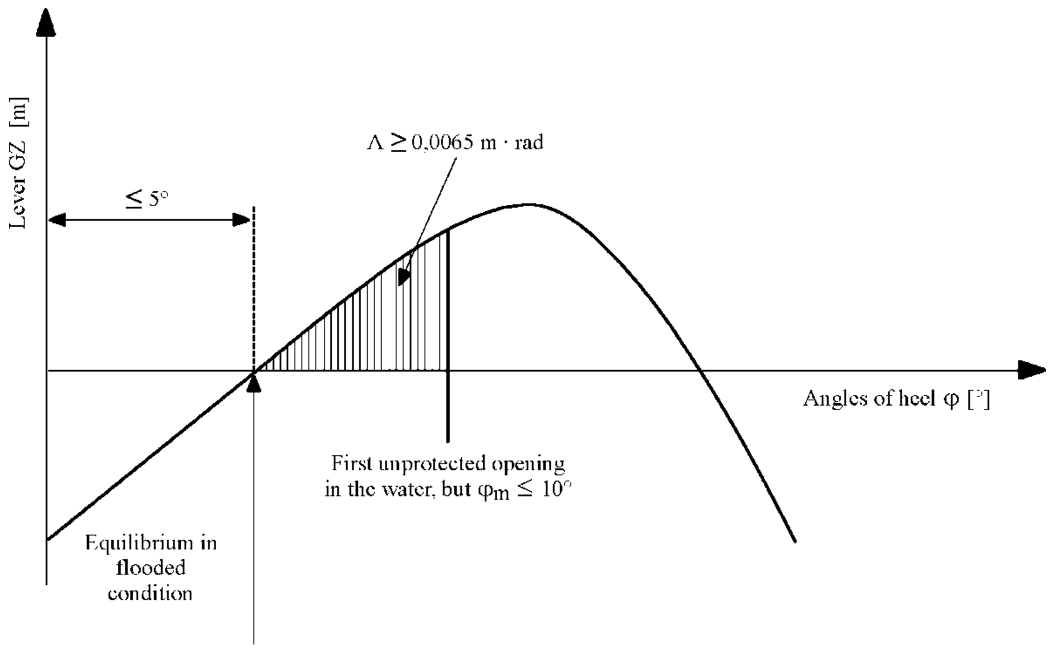


Fig. 4.2 Container ships: proof of damage stability

5.2 Load assumptions

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/m3
- very wet sands: 2,0 t/m3
- soil, on average: 1,8 t/m3
- mixture of sand and water in the ducts: 1,3 t/m3

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 5.3.11.
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 [tm] shall be calculated in accordance with the following formula:

$$M_w = c \cdot P_{WD} \cdot A_w \cdot (\ell_w + T / 2)$$

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 [t/m2]:

- for IN(0) and IN(0,6) : PWD = 0,025
- for IN(1,2) and IN(2) : PWD = 0,04 · n

AW = side surface area of the floating installation[m2]

ℓw = distance [m] of centre of gravity of area Aw, from draught mark

5.3.6 Turning circle induced moment

For self-propelled ships, the moment resulting from the turning of the ship [tm] is to be determined by the following formula:

$$M_T = \frac{0{,}045 . C_B . v^2 . \Delta}{L_{wl}} . \left(KG - \frac{T}{2}\right)$$

KG = height [m] of the centre of gravity above base line

5.3.7 Cross-current induced moment

The moment resulting from the cross-current shall 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 clear surfaces occupied by liquids

The moment [tm] due to clear surfaces occupied by liquids is to be determined in accordance with the following formula:

$$M_{FO} = 0{,}015 \cdot \sum b.l \cdot \left(b - 0{,}55 . \sqrt{b}\right)$$

b = width of the free surface or width of the free surface section considered [m]

ℓ = length of the free surface or length of the free surface section considered [m]

5.3.10 Moment due to inertia forces

The moment resulting from the inertia forces shall be taken into account if the movements of the load and the working gear are likely to affect its stability.

5.3.11 Moment due to other mechanical equipment

The moment due to other mechanical equipment is to be defined by the designer.

5.3.12 The righting moments [tm] for floating installations with vertical side walls may be calculated via the formula:

$$M_a = \Delta \cdot GM \cdot \sin\varphi$$

GM = metacentric height [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

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 [m] of at least:

$$h = 0{,}30 - 0{,}28 \cdot \varphi_n$$

φn = list angle [rad] 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° < φn < 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 open¬ings
- 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 [m] is at least:

h = 0,20 - 0,23 · φn

φ_n = list angle [rad] 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 ship 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 confirma¬tion of stability

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.

6. Ships carrying bulk dry cargo

6.1 General

6.1.1 Application

The following requirements apply to bulk dry cargo carriers which have been requested to receive the additional class Notation **Intact stability**.

6.2 Heeling moments

6.2.1 Wind pressure induced moment

The moment [tm] due to lateral wind pressure is to be determined by the following formula:

$$M_W = P_W \cdot A_W \cdot (\ell_W + T / 2)$$

P_W = specific wind pressure [kN/m^2]:

- for IN(0) and IN(0,6): P_W = 0,025
- for IN(1,2) and IN(2): P_W = 0,04·n A_W = lateral area above water [m^2]

ℓ_W = distance [m] of centre of gravity of area Aw, from draught mark

6.2.2 Centrifugal force induced moment

The turning circle moment [tm] is to be determined by the following formula:

$$M_T = \frac{0{,}045 \cdot v^2 \cdot \Delta}{L_{WL}} \cdot \left(KG - \frac{T}{2}\right)$$

KG = height [m] of centre of gravity above base line

6.2.3 Cargo shift induced moment

For bulk dry cargo likely to redistribute itself if the ship lists to an inclination greater than its angle of repose, such as grain or cement, the cargo shifting induced moment is to be taken into account.

The value of this moment is to be determined in rela¬tion with the hold or compartment geometry, assuming an angle to the horizontal of the resulting cargo surface after shifting of 12°.

6.3 Intact stability

The intact stability characteristics of any ship carrying bulk dry cargo (see Fig. 4.3), are to be shown to meet, throughout the voyage, at least the following criteria after taking into account the total heeling moment (as defined under 6.2):

a) The angle of heel φ1 is to be not greater than 12°.

b) In the statical stability diagram, the residual area between the heeling arm curve and the righting arm curve up to the angle of heel φ2 is in all conditions of loading to be not less than 0,0065 m·rad.

φ_2 = angle of heel of maximum difference between the ordinates of the heeling arm curve and the righting arm curve, or 27° or the angle of flooding, whichever is the least.

6.4 Additional requirement

6.4.1 For bulk dry cargo likely to redistribute itself if the ship lists to an inclination greater than its angle of repose, such as grain or cement, requirements 6.4.2 to 6.4.4 are to be additionally complied with.

6.4.2 Trimming

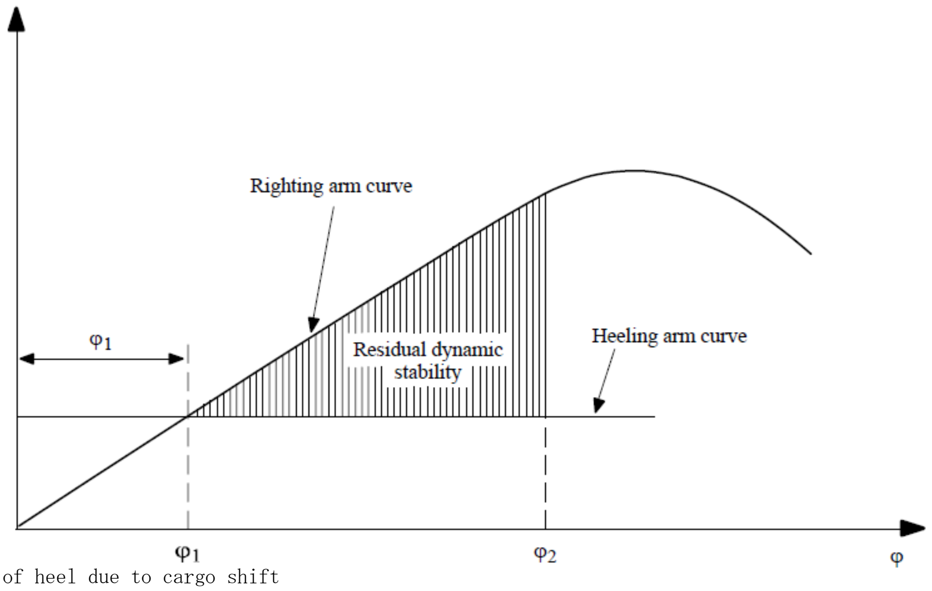
All necessary and reasonable trimming is to be performed to level all free cargo surfaces and minimize the effect of cargo shifting.

6.4.3 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.

6.4.4 Longitudinal subdivisions

The proper precaution is to fit one or more temporary longitudinal subdivisions in the holds or compartments to minimize the possibility of shift of cargo.



φ_1 = Angle of heel due to cargo shift

Fig. 4.3 Stability curve

G. Additional Fire Rules for Passenger Ships

1. General

1.1 Application

1.1.1 Passenger ships complying with the following requirements are eligible for the assignment of the additional class Notation **Fire** as defined in Rules for Classification and Surveys – Inland waterways (Part 2, Vol.I), Section 2, B. 5.2.2

Ships are to comply with the requirements stated under Rules for Machinery Installations – Inland waterways (Part 2, Vol. III) Section1, H and Electrical Installations – Inland waterways (Part 2, Vol. IV) Section 1, D.3 as far as applicable, to passenger ships.

2. Fire integrity of bulkheads and decks

2.1 The minimum fire integrity of all bulkheads and decks shall be as shown in Table 4.4 and Table 4.5.

2.2 The following requirements shall govern the application of the tables:

- Table 4.4 shall apply to spaces without an installed sprinkler installation.
- Table 4.5 shall apply to spaces in which a sprinkler installation is provided on both sides of bulkheads and deck.

2.3 For the purpose of determining the appropriate fire integrity standard to be applied to boundaries between adjacent spaces, such spaces are classified according to their fire risk described in the following categories. The title of each category is intended to be typical rather than restrictive.

a) Control stations

wheelhouse, spaces containing the ship’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 All stairways in accommodation and service spaces are to be arranged within enclosures formed by division as stipulated in Table 4.4 and Table 4.5, with effective means of closure for all openings.

3.2 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 Table 4.4 and Table 4.5 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 4.4 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 [2]	A30	A60	A60	A60
Staircases		-	A0	A30	A60	A60	A60
Assembly stations			-	A30 / B15 [3]	A60	A60	A60
Accommodation spaces				− / B15	A60	A60	A60
Machinery spaces					A60 / A0 [4]	A60	A60
Galleys						A0	A60 / A0 [1]
Store rooms							-

[1] For divisions between galleys and refrigerating spaces or storage spaces for food is A0 sufficient.
[2] Divisions between control stations and inside embarkation areas shall be of type A0, in case of exterior embarkation areas is type B15 sufficient.
[3] Divisions between accommodation spaces and inside embarkation areas shall be of type A30, in case of exterior embarkation areas is type B15 sufficient.
[4] Divisions between space which contain machinery used for main propulsion shall be of type A60, otherwise of type A0.

Table 4.5 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						−	A0
Store rooms							−

[1] Divisions between control stations and inside embarkation areas shall be of type A0, in case of exterior embarkation areas is type B15sufficient.
[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 space which contain machinery used for main propulsion shall be of type A60, otherwise of type A0.

4. Openings in class A and B divisions

4.1 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.

4.2 Fire doors in divisions required by Table 4.4 and Table 4.5 to machinery spaces, to galleys and to staircases shall be of self-closing type.

4.3 It shall be possible for each door to be opened and closed from each side of the bulkhead by one person only.

4.4 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 Insulation materials shall be noncombustible, except insulation of pipe fittings for cold service systems.

5.2 Ceilings and linings in accommodation spaces including their substructures shall be of noncombustible material, unless the space is protected with a sprinkler installation.

5.3 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

5.4 Paints, varnishings and other finishes used on exposed interior surfaces shall not be capable of producing excessive quantities of smoke and toxic gases (see Note).

Note

Reference is made to the Fire Test Procedure Code, Annex 1, Part 2, adopted by IMO by Resolution MSC.61 (67)

5.5 Fabrics, curtains and other hanging textiles as well as upholstered furniture and bedding components (see Notes) shall be fire retardant, unless the spaces are protected with a sprinkler installation.

Notes

– *Reference is made to the Fire Test Procedure Code, Annex 1, Part 7, adopted by IMO by Resolution MSC.61(67).*

– *Reference is made to the Fire Test Procedure Code, Annex 1, Part 8, adopted by IMO by Resolution MSC.61 (67).*

– *Reference is made to the Fire Test Procedure Code, Annex 1, Part 9, adopted by IMO by Resolution MSC.61 (67).*

5.6 Furniture and fittings in public spaces, which are also assembly station, shall be made of noncombustible 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 ship 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 ships.

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 outside of the protected space.

H. Inclining Test and Light Weight Check

1. Inclining test and light weight check

1.1 General

1.1.1 General conditions of the ship

Prior to the test, BKI's Surveyor is to be satisfied of the following:

- The weather conditions are to be favourable.
- The ship is to be moored in a quiet, sheltered area free from extraneous forces, such as to allow unrestricted heeling. The ship is to be positioned in order to minimize the effects of possible wind and stream.
- The ship is to be transversely upright and hydrostatic data and sounding tables are to be available for the actual trim.
- Cranes, derrick, lifeboats and liferafts capable of inducing oscillations are to be secured.
- Main and auxiliary boilers, pipes and any other system containing liquids are to be filled.
- The bilge and the decks are to be thoroughly dried.
- Preferably, all tanks are to be empty and clean, or completely full. The number of tanks containing liquids is to be reduced to a minimum taking into account the above-mentioned trim. The shape of the tank is to be such that the free surface effect can be accurately determined and remain almost constant during the test. All cross connections are to be closed.
- The weights necessary for the inclination are to be already on board, located in the correct place.
- All work on board is suspended and crew or personnel not directly involved in the inclining test shall not be on board.
- The ship is to be as complete as possible at the time of the test. The number of weights to be removed, added or shifted is to be limited to a minimum. Temporary material, tool boxes, staging, sand, debris etc. on board is to be reduced to an absolute minimum.
- Initial heeling angle shall not be greater than 0,5° prior to the start of the inclining test.

1.1.2 Inclining weights

The total weight used is preferably to be sufficient to provide a minimum inclination of one degree and a maximum of four degrees of heel to each side. BKI may, however, accept a smaller inclination angle for large ships provided that the requirement on pendulum deflection or U-tube difference in height specified in 1.1.4 is complied with. Test weights are to be compact and of such a configuration that the VCG (vertical centre of gravity) of the weights can be accurately determined. Each weight is to be marked with an identification number and its weight. Re-certification of the test weights is to be carried out prior to the incline. A crane of sufficient capacity and reach, or some other means, shall be available during the inclining test to shift weights on the deck in an expeditious and safe manner. Water ballast is generally not acceptable as an inclining weight.

1.1.3 Water ballast as inclining weight

Where the use of solid weights to produce the inclining moment is demonstrated to be impracticable, the movement of ballast water may be permitted as an alternative method. This acceptance would be granted for a specific test only, and approval of the test procedure by BKI is required prior to the test. As a minimal prerequisite for acceptability, the following conditions are to be required:s

- Inclining tanks are to be wall-sided and free of large stringers or other internal structural members that create air pockets.
- Tanks are to be directly opposite to maintain ship's trim.
- Specific gravity of ballast water is to be measured and recorded.
- Pipelines to inclining tanks are to be full. If the vessel's piping layout is unsuitable for internal transfer, portable pumps and pipes/hoses may be used.
- Blanks shall be inserted in transverse manifolds to prevent the possibility of liquids leaking during transfer. Continuous valve control shall be maintained during the test.
- All inclining tanks shall be manually sounded before and after each shift.
- Vertical, longitudinal and transverse centres are to be calculated for each movement.
- accurate sounding/ullage tables are to be provided. The vessel's initial heel angle is to be established prior to the incline in order to produce accurate values for volumes and transverse and vertical centres of gravity for the inclining tanks at every angle of heel. The draught marks amidships (port and starboard) are to be used when establishing the initial heel angle.
- Verification of the quantity shifted may be achieved by a flowmeter or similar device.
- The time to conduct the inclining is to be evaluated. If time requirements for transfer of liquids are considered too long, water may be unacceptable because of the possibility of changing environmental conditions over long periods of time.

1.1.4 Pendulums

The use of three pendulums is recommended but a minimum of two are to be used to allow identification of bad readings at each pendulum station. However, for ships of a length equal to or less than 30 m, only one pendulum can be accepted. Each is to be located in an area protected from the wind. The pendulums are to be long enough to give a measured deflection, to each side from upright, of at least 10 cm. To ensure recordings from individual instruments, it is suggested that the pendulums shall be physically located as far apart as practical. The use of an inclinometer or U-tube is to be considered case-by-case. It is recommended that inclinometers or other measuring devices only be used in conjunction with at least one pendulum.

1.1.5 Means of communications

Efficient two-way communication is to be provided between central control and the weight handlers and between central control and each pendulum station. One person at a central control station shall have complete control over all personnel involved in the test.

1.1.6 Documentation

The person in charge of the inclining test shall have available a copy of the following plans at the time of the test:

- hydrostatic curves or hydrostatic data
- general arrangement plan of decks, holds, inner bottoms, etc.
- capacity plan showing capacities and vertical and longitudinal centres of gravity of cargo spaces, tanks, etc. When water ballast is used as inclining weights, the transverse and vertical centres of gravity for the applicable tanks, for each angle of inclination, shall be available.
- tank sounding tables
- draught mark locations

– docking drawing with keel thickness and draught mark corrections (if available)

1.1.7 Determination of the displacement

BKI's Surveyor shall carry out all the operations necessary for the accurate evaluation of the displacement of the ship at the time of the inclining test, as listed below:

- Draught mark readings are to be taken at aft, midship and forward, at starboard and port sides.
- The mean draught (average of port and starboard reading) is to be calculated for each of the locations where draught readings are taken and plotted on the ship's lines drawing or outboard profile to ensure that all readings are consistent and together define the correct waterline. The resulting plot is to yield either a straight line or a waterline which is either hogged or sagged. If inconsistent readings are obtained, the freeboards/ draughts are to be retaken.
- All double bottoms, as well as all tanks and compartments which can contain liquids, are to be checked, paying particular attention to air pockets which may accumulate due to the ship's trim and the position of air pipes, and also taking into account the provisions of 1.1.1.
- It is to be checked that the bilge is dry, and an evaluation of the liquids (not included in the light ship as defined in F.2.4.1) which cannot be pumped, remaining in the pipes, boilers, condenser, etc., is to be carried out.
- The entire ship is to be surveyed in order to identify all items which need to be added, removed or relocated to bring the ship to the light ship condition. Each item is to be clearly identified by weight and location of the centre of gravity.
- The possible solid permanent ballast is to be clearly identified and listed in the report.

1.1.8 The incline

The standard test generally employs eight distinct weight movements as shown in Fig. 4.4.

The weights are to be transversally shifted, so as not to modify the ship's trim and vertical position of the centre of gravity.

After each weight shifting, the new position of the transverse centre of gravity of the weights is to be accurately determined.

After each weight movement, the shifting distance (centre to centre) is to be measured and the heeling moment calculated by multiplying the distance by the amount of weight moved. The tangent is calculated for each pendulum by dividing the deflection by the length of the pendulum. The resultant tangents are plotted on the graph as shown in Fig. 4.5.

The pendulum deflection is to be read when the ship has reached a final position after each weight shifting. During the reading, no movements of personnel are allowed.

For ships with a length equal to or less than 30 m, six distinct weight movements may be accepted.

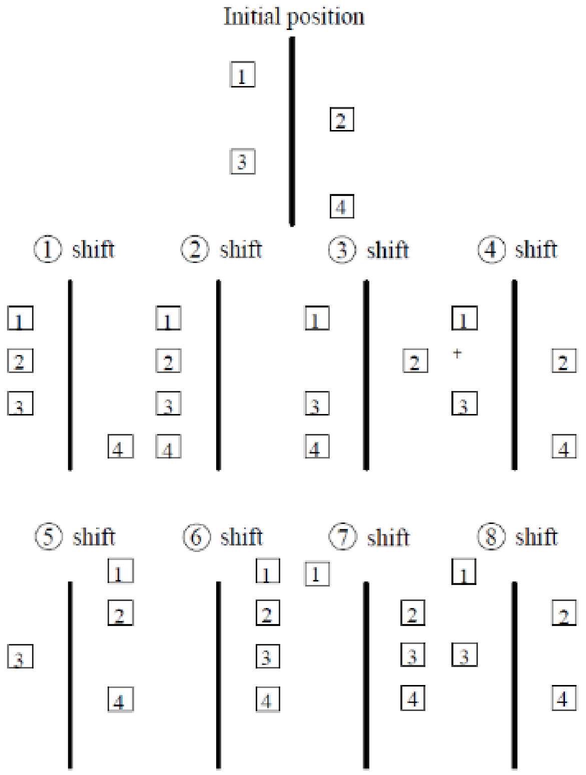


Fig. 4.4 Weight shift procedure

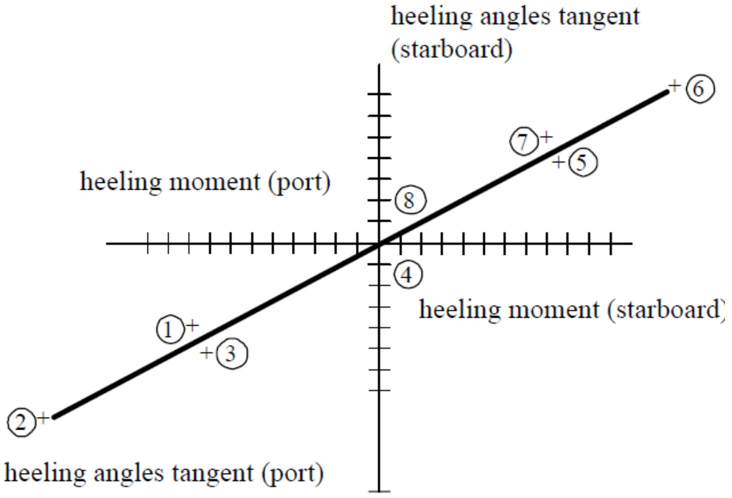


Fig. 4.5 Graph of resultant tangents