ACS (Asia Classification Society)

Rules for

Classification of Vessels

(2014)

Part 5

Special Class Notations

Rules for Classification of Vessels

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Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Ro-ro cargo ship.

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in other parts of the Rules, as applicable, and with the requirements of this Chapter, which are specific to ro-ro cargo ships.

Section 2 Hull and Stability

1 General

1.1 Application

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

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

1.2 Definitions

1.2.1 Ro-ro cargo spaces

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

2 Stability

2.1 Damage stability requirements for ship where additional class notation SDS is required

2.1.1 General

A ro-ro cargo ship equal to or greater than 80 m in length where additional class notation SDS is required is to comply with the subdivision and damage stability criteria in Pt III, Ch 4, App 3.

3 Structure design principles

3.1 General

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

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

3.2 Hull structure

3.2.1 Framing

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

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

4 Design loads

4.1 Wheeled loads

4.1.1 The wheeled loads induced by vehicles are defined in Pt III, Ch 2, Sec 3.

5 Hull girder strength

5.1 Basic criteria

5.1.1 Strength deck

In addition to the requirements in Pt III, the contribution of the hull structures up to the strength deck to the longitudinal strength is to be assessed through a finite element analysis of the whole ship in the following cases:

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

6 Hull scantlings

6.1 Plating

6.1.1 Minimum net thicknesses

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

$t = 2.1 + 0.013\ L\ k^{1/2} + 4.5\ s$

where:

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

6.1.2 Plating under wheeled loads

The net thickness of plate panels subjected to wheeled loads is to fulfill the applicable requirements.

6.2 Ordinary stiffeners

6.2.1 Ordinary stiffeners under wheeled loads

The strength checks of ordinary stiffeners subjected to wheeled loads are to be carried out in accordance with the applicable requirements.

6.3 Primary supporting members

6.3.1 Primary supporting members under wheeled loads

The strength checks of primary supporting members subjected to wheeled loads are to be carried out in accordance with the applicable requirements.

7 Other structures

7.1 Bow doors and inner doors

7.1.1 The requirements applicable to bow doors and inner doors are defined in Pt III, Ch2 Sec16.

7.2 Side doors and stern doors

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

7.2.2 The requirements applicable to side doors and stern doors are defined in Pt III, Ch2 Sec1.

7.2.3 The requirements in 7.2.4 to 7.2.7 apply to doors in the boundary of ro-ro spaces as defined in 1.2.1, through which such spaces may be flooded.

Where no part of the door is below the uppermost waterline and the area of the door opening is not greater than 6 m2, the requirements in 7.2.4 to 7.2.7 need not be applied.

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

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

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

The power supply for the indicator system is to be independent of the power supply for operating and closing the doors and is to be provided with a backup power supply.

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

7.2.6 The indication panel on the navigation bridge is to be equipped with a mode selection function ـِ harbor / sea voyageپ so arranged that an audible alarm is given if the vessel leaves harbor with the doors not closed and with any of the securing devices not in the correct position.

7.2.7 A water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the inner door.

7.3 Movable decks and inner ramps

7.3.1 The requirements applicable to movable decks and inner ramps are defined in Pt III, Ch2, Sec16.

Section 3 Machinery and Systems

1 Scuppers and sanitary discharges

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

1.1.1 Prevention of build-up of free surfaces

In cargo spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion and fitted with a fixed pressure water-spraying fire-extinguishing system, the drainage arrangement is to be such as to prevent the build-up of free surfaces. If this is not possible, the adverse effect upon stability of the added weight and free surface of water is to be taken into account to the extent deemed necessary by the Society in its approval of the stability information.

1.1.2 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.

Section 4 Electrical Installations

1 General

1.1 Applicable requirements

1.1.1 In addition to the relevant requirements of Pt IV, Ch2 and those contained in this Section, electrical installations in spaces intended for the carriage of motor vehicles with fuel in their tanks for their propulsion are to comply with those of Part IV, Ch 4.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt IV, Sec1, the following is to be submitted for approval:

a) plan of hazardous areas

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

Table 1.1: Electrical equipment permitted in closed ro-ro cargo spaces

Hazardous area	Spaces		Electrical equipment
	No.	Description	
Zone 1	1	Closed ro-ro cargo spaces except areas under item 3	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category ِibپ not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and acceptable to the appropriate authority d) certified flameproof Ex(d) e) certified pressurized Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: ٍ a non-metallic impervious sheath in combination with braiding or other metallic covering ٍ copper or stainless steel sheath (for mineral-insulated cables only)
Zone 1	2	Exhaust ventilation ducts	As stated under item 1
Zone 2	3	On condition that the ventilation system is so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least 10 air changes per hour whenever vehicles are on board: ٍ areas above a height of 450mm from the deck ٍ areas above a height of 450mm from each platform for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward ٍ areas above platforms for vehicles, if fitted, with openings of sufficient size permitting penetration of petrol gases downward	a) any type that may be considered for zone 1 b) tested specially for zone 2 (e.g. type ِnپprotection) c) pressurized, and acceptable to the appropriate authority d) encapsulated, and acceptable to the appropriate authority e) the type which ensures the absence of sparks and arcs and of ِhot spotsپduring its normal operation (minimum class of protection IP55) f) cables sheathed with at least a non-metallic external impervious sheath

1.3 Safety characteristics

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

2 Installation

2.1 Installations in closed ro-ro cargo spaces

2.1.1 Except as provided for in 2.1.2, electrical equipment is to be of a certified safe type as stated in Pt IV, Ch2 and electrical cables are to be as stated in Pt IV, Ch2, Sec9.

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

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

2.1.4 The requirements in this item are summarized in Tab 1.1.

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

2.2.1 The provisions of 2.1 apply.

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

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

3 Type approved components

3.1

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

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

Chapter 2 Container Ships

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Container ship, as defined in Pt I, Ch 1, Sec 3.

1.1.2 Ships assigned with the additional service feature equipped for carriage of containers are to comply with the applicable requirements of this Chapter.

1.1.3 Ships dealt with in this Chapter are to comply with the requirements stipulated in other parts of the Rules, as applicable, and with the requirements of this Chapter, which are specific to container ships.

Section 2 Hull and Stability

1 General

1.1 Application

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

Typical midship sections are shown in Fig 1.1 and Fig 1.2.

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

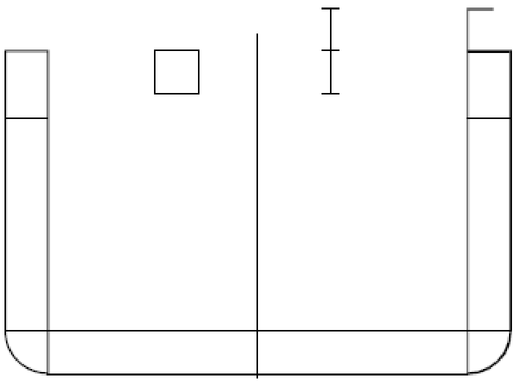


Figure 1.1: Container ship of double side skin construction

Figure 1.2: Container ship of single side skin construction

2 Stability

2.1 Intact stability

2.1.1 General

The stability for the loading conditions defined in Pt III, Ch 4, App 2 is to be in compliance with the requirements of Pt III, Ch 4, Sec 2.

2.1.2 Additional criteria

In addition to 2.1.1, the initial metacentric height is to be equal to or greater than 0.20 m.

2.1.3 Alternative criteria for ships greater than 100 m in length

For ships greater than 100 m in length, the Society may apply the following criteria instead of those in Pt III, Ch 4, Sec 2:

- the area under the righting lever curve (GZ curve), in m.rad, is to be not less than 0.009/C up to an angle of heel of 30°, and not less than 0.016/C up to 40° or the angle of flooding if this angle is less than 40°
- the area under the righting lever curve (GZ curve), in m.rad, between the angles of heel of 30° and 40° or between 30° and if , if this angle is less than 40°, is to be not less than 0.006/C
- the righting lever GZ, in m, is to be at least 0.033/C at an angle of heel equal to or greater than 30°
- the maximum righting lever GZ, in m, is to be at least 0.042/C
- the total area under the righting lever curve (GZ curve), in m.rad, up to the angle of flooding if is not to be less than 0.029/C

where:

C: Coefficient defined by:

$$C=\sqrt{T/KG}\sqrt{100/L}\left(C_B/C_W\right)^2\ TD/B_m^2$$

T: Mean draught, in m

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

C_B : Block coefficient

C_W : Waterplane coefficient

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

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

h : Mean height, in m, of hatch coamings within L/4 forward and aft from amidships (see Fig 2.1)

b : Mean width, in m, of hatch coamings within L/4 forward and aft from amidships (see Fig 2.1)

B_m, B_D : Breadths, in m, defined in Fig 2.1

l_H : Length, in m, of each hatch coaming within L/4 forward and aft from amidships (see Fig 2.2).

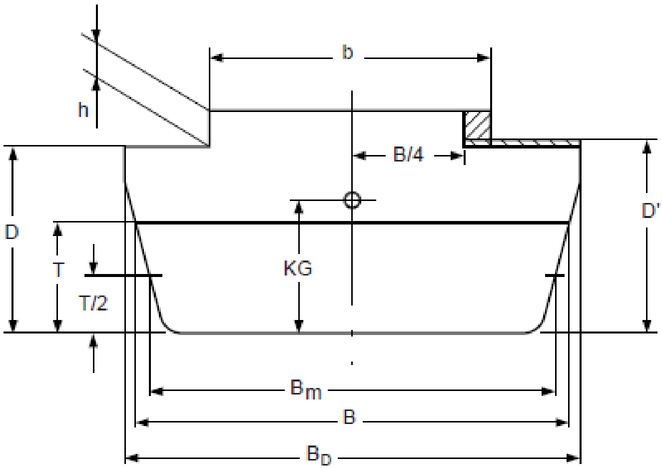


Figure 2.1: Definition of dimensions

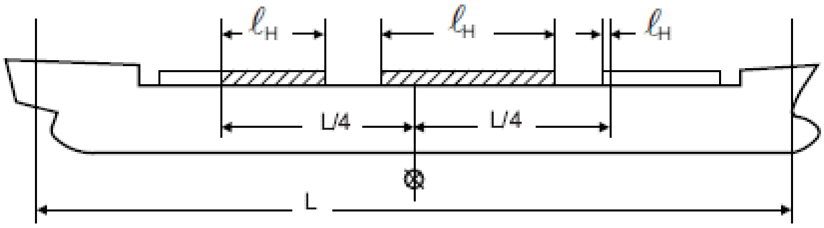


Figure 2.2: Definition of dimensions

2.1.4 Additional requirements for open top container ships

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

- for the intact condition described in 2.1.5 with the assumptions in 2.1.6, the stability of the ship is to comply with the survival criteria of Pt III, Ch 4, App 3: the factor of survival s_i is to be equal to one.

2.1.5 Loading condition for open top container ships

The ship is at the load line corresponding to the minimum freeboard assigned to the ship and, in addition, all the open holds are completely filled with water, with a permeability of 0.70 for container holds, to the level of the top of the hatch side or hatch coaming or, in the case of a ship fitted with cargo hold freeing ports, to the level of those ports.

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

2.1.6 Assumptions for the stability calculation for open top container ships

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

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

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

2.2 Damage stability requirements for ships where the additional class notation SDS has been required

2.2.1 General

Any type of container ship with a length equal to or greater than 80 m is to comply with the subdivision and damage stability criteria of Pt III, Ch 4, App 3.

For open top container ships, the coaming of the open top holds is to be considered as a downflooding area.

3 Structure design principles

3.1 Materials

3.1.1 Steels for hull structure

The material classes required for the strength deck plating, the sheerstrake and the torsion box girder structure within 0.4L amidships are to be maintained in way of the entire cargo hold region.

3.2 Strength principles

3.2.1 General

Local reinforcements of the hull structure are to be provided under container corners and in way of 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. When the additional class notation LASHING is granted, these forces may be determined by the Society.

3.2.2 Structural continuity

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

3.3 Bottom structure

3.3.1 Floor and girder spacing

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

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

3.3.2 Reinforcements in way of cell guides

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

3.4 Side structure

3.4.1 Framing arrangement

The topside torsion box girders are to be longitudinally framed.

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

3.5 Deck structure

3.5.1 Longitudinal girders between hatchways

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

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

3.5.2 Cross decks

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

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

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

Transverse deck strips between hatches are to be suitably overlapped at ends. It is necessary to ascertain that the forces induced by the strips may be transmitted to the web frame (see Fig 3.1).

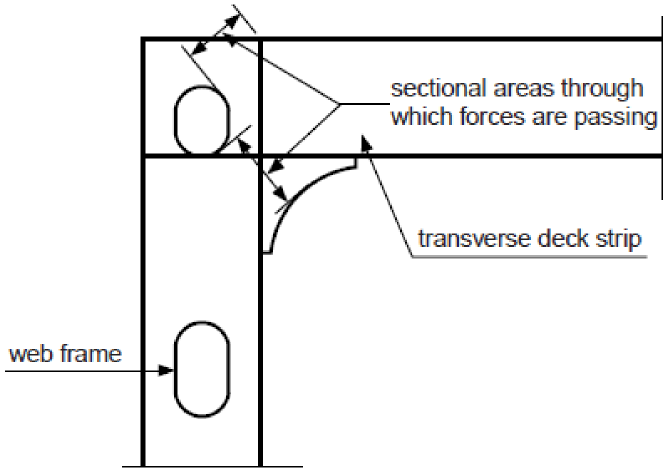


Figure 3.1: Transverse deck strip between hatches

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

Where longitudinal deck girders between hatchways intersect cross decks, the connection between their face plates is generally to be as shown in Fig 3.2. If necessary, the girder height is to be gradually modified.

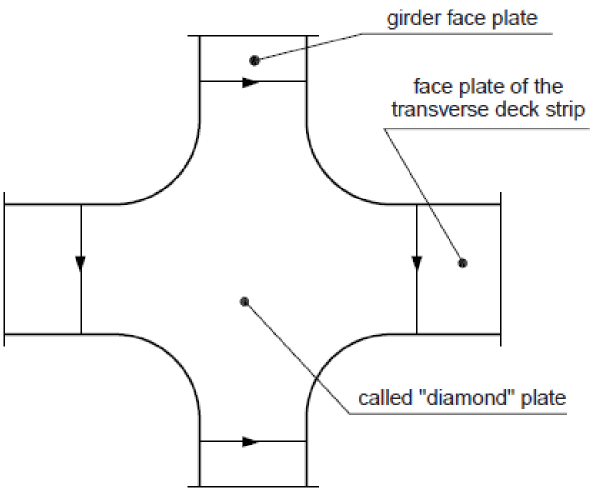


Figure 3.2: Connection of longitudinal girders between hatchways with face plates of cross decks

3.5.4 Deck and hatch cover reinforcements

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

3.6 Bulkhead structure

3.6.1 Transverse box structures in way of transverse watertight bulkheads

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

3.6.2 Primary supporting members

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

3.6.3 Reinforcements in way of cell guides

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

4 Design loads

4.1 Hull girder loads

4.1.1 Still water loads

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

$M_{SW,T} = 31.4\ F_T\ S\ T\ B$

where:

F_T : Distribution factor defined in Tab 4.1 as a function of the x co-ordinate of the hull transverse section with respect to the reference co-ordinate system of the ship

S : Number of container stacks over the breadth B

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

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

Table 4.1: Distribution factor FT

Hull transverse section location	Distribution factor F_T
0 □x <0.5 L	x / L
0.5 L □x < L	(1-x/L)

4.2 Forces on containers

4.2.1 Still water and inertial forces

The still water and inertial forces applied to one container located at the level ـiپ are to be obtained, in kN, as specified in Tab 4.2.

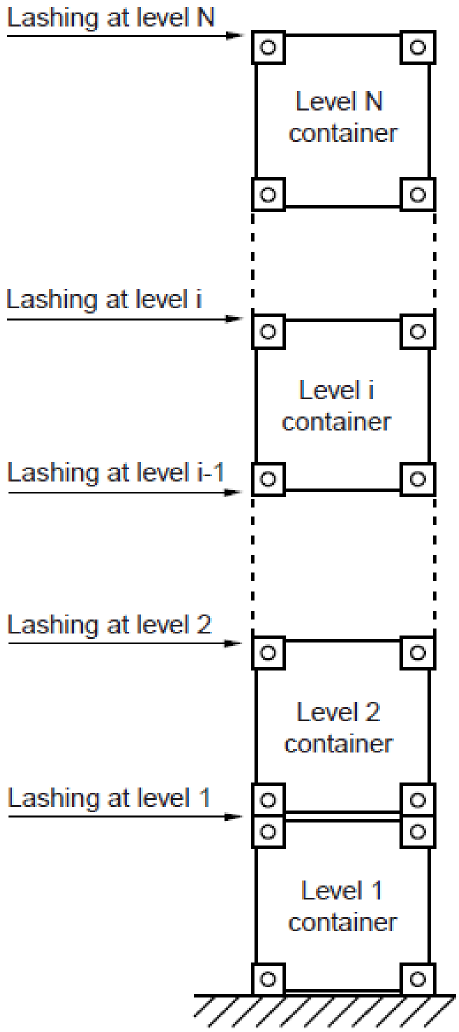


Figure 4.1: Containers level in a stack

Table 4.2: Container at level ﺑiﭘStill water and inertial forces

Ship condition	Load case	Still water force F_S and inertial force F_W , in kN
Still water		$F_{S,i} = M_i g$
Upright (positive heave motion)	ﺑaﭘ	No inertial force
	ﺑbﭘ	$F_{W,X,i} = M_i\ a_{X1}$ in x direction $F_{W,Z,i} = M_i\ a_{Z1}$ in z direction
Inclined (negative roll angle)	ﺑcﭘ	$F_{W,Y,i} = M_i\ C_{FA}\ a_{Y2}$ in y direction
	ﺑdﭘ	$F_{W,Z,i} = M_i\ C_{FA}\ a_{Z2}$ in z direction

Note 1:

g: Gravity acceleration, in m/s2: g = 9.81 m/s2

Mi : Mass, in t, of the container considered at the level ﺑiﭘ

CFA : Combination factor, to be taken equal to:

- CFA = 0.7 for load case “c”
- CFA = 1.0 for load case “d”

aX1, aZ1 : Accelerations, in m/s2, determined at the container's centre of gravity for the upright ship condition as specified in Table 4.3

aY2, aZ2 : Accelerations, in m/s2, determined at the container's centre of gravity for the inclined ship condition as specified in Table 4.3

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

- 0.14 times the weight of a loaded container, in the case of steel containers
- 0.08 times the weight of a loaded container, in the case of aluminum containers.

Table 4.3: Reference values of the accelerations aX, aY and aZ

Direction	Upright ship condition	Inclined ship condition
X – Longitudinal a_{X1} and a_{X2} in m/s^2	$a_{x1} = \sqrt{a_{SU}^2 + [A_P g + \alpha_P (z - T_1)]^2}$	$a_{x2} = 0$
Y – Transverse a_{Y1} and a_{Y2} in m/s^2	$a_{Y1} = 0$	$a_{Y2} = \sqrt{a_{SW}^2 + [A_R g + \alpha_R (z - T_1)]^2 + a_Y^2 K_X L^2}$
Z – Vertical a_{Z1} and a_{Z2} in m/s^2	$a_{Y2} = \sqrt{a_H^2 + \alpha_P^2 K_X L^2}$	$a_{Z2} = \sqrt{0.25 a_H^2 + \alpha_R^2 Y^2}$

Note 1: $K_X = 1.2(X/L)^2 - 1.1(X/L) + 0.2$ without being taken less than 0,018

T1 : Draught, in m

aSU , aSW and aH : Surge, Sway and Heave acceleration, in m/s2, respectively

α_R, α_P and α_Y : Roll, Pitch and Yaw acceleration, in rad/s2, respectively

AR : Roll amplitude, in rad

AP : Pitch amplitude, in rad

4.2.2 Wind forces applied to one container

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

- in x direction:

$F_{x,wind,i} = 1.2 h_C b_C$

- in y direction:

$F_{y,wind,i} = 1.2\ h_C l_C$

where:

h_C : Height, in m, of a container

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

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

In the case of juxtaposed and connected stacks of different heights, the wind forces are to be distributed taking into account the number of stacks at the level considered (see example in Fig 4.2).

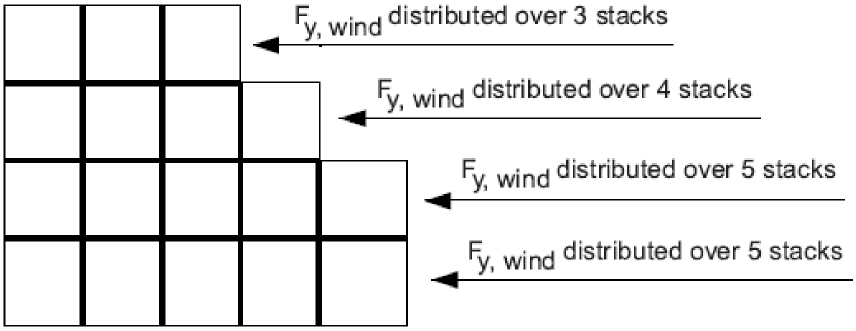


Figure 4.2: Distribution of wind forces in the case of stacks of different heights

4.2.3 Stacks of containers

The still water, inertial and wind forces, to be considered as being applied at the centre of gravity of the stack, and those transmitted at the corners of such stack are to be obtained, in kN, as specified in Tab 4.4.

4.2.4 Effect of cell guides

Where cell guides support the containers stowed in holds, the values of $R_{W,1}$ and $R_{W,2}$ calculated according to 4.2.3 for inclined ship condition, may be assumed to be not greater than ($F_{W,Z}$ / 4 + 160), provided that arrangements of cell guides and horizontal transverse cross-ties, according to 7.2, ensure the blocking of the corners of containers.

Any other arrangement may be accepted, to the Societyِs satisfaction.

4.3 Loading conditions for primary structure analysis

4.3.1 The following loading conditions are to be considered in the analysis of the primary structure:

- full container load and scantling draught T
- ballast condition and ballast draught corresponding to this condition in the loading manual
- partial loading conditions given in the loading manual.

Table 4.4: Containers - Still water, inertial and wind forces

Ship condition	Load case	Still water force F_S and inertial and wind force F_W, in kN, acting on each container stack	Vertical still water force RS and inertial and wind force R_W, in kN, transmitted at the corners of each container stack
Still water condition Upright condition (see Fig 4.3)		$F_S = \sum_{i=1}^{N} F_{S,i}$	$R_S = F_S / 4$
	ﺑaپ	No inertial forces	No inertial forces
	ﺑbپ	ﭘ in x direction $F_{W,X} = \sum_{i=1}^{N} (F_{W,X,i} + F_{X,Wind,i})$ ﭘ in z direction $F_{W,Z} = \sum_{i=1}^{N} F_{W,Z,i}$	$R_{W,1} = \frac{F_{W,Z}}{4} + \frac{N_C h_C F_{W,X}}{4 l_C}$ $R_{W,2} = \frac{F_{W,Z}}{4} - \frac{N_C h_C F_{W,X}}{4 l_C}$
Inclined condition (negative roll angle) (see Fig 4.4)	ﺑcپand ﺑdپ	ﭘ in y direction $F_{W,Y} = \sum_{i=1}^{N} (F_{W,Y,i} + F_{Y,Wind,i})$ ﭘ in z direction $F_{W,Z} = \sum_{i=1}^{N} F_{W,Z,i}$	$R_{W,1} = \frac{F_{W,Z}}{4} + \frac{N_C h_C F_{W,X}}{4 b_C}$ $R_{W,2} = \frac{F_{W,Z}}{4} - \frac{N_C h_C F_{W,X}}{4 b_C}$

Note 1:

N: Number of containers per stack

hC : Height, in m, of a container

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

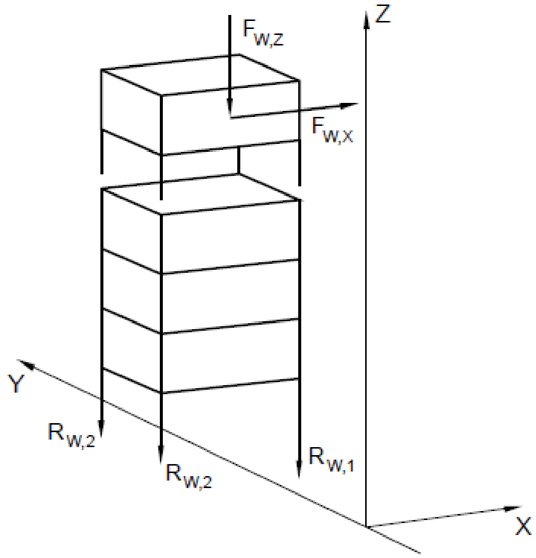


Figure 4.3: Inertial and wind forces Upright ship condition

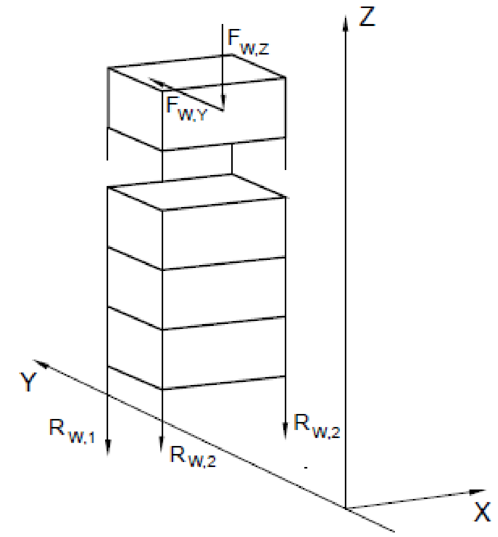


Figure 4.4: Inertial and wind forces Inclined ship condition

5 Hull scantlings

5.1 Plating

5.1.1 Thickness of the strake below the sheerstrake

The thickness of the strake below the sheerstrake is not to be less than 0.7 times that of the sheerstrake.

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

The thickness of the strake below the upper strake of torsion box girders is not to be less than 0.7 times that of the upper strake.

5.2 Primary supporting members

5.2.1 Scantlings of primary supporting members of ships greater than 150 m in length are to be analyzed.

6 Other structure

6.1 Non-weathertight hatch covers above superstructure deck

6.1.1 Non-weathertight hatch covers may be fitted to hatchways located on weather decks which are at least two standard heights of superstructure above an actual freeboard deck or an assumed freeboard deck from which a freeboard can be calculated which will result in a draught not less than that corresponding to the freeboard actually assigned. Where any part of a hatchway is forward of a point located one quarter of the ship's load line length (0.25 L_{LL}) from the forward perpendicular, that hatchway is to be located on a weather deck at least three standard heights of superstructure above the actual or assumed freeboard deck.

The assumed freeboard deck is used only for the purpose of measuring the height of the deck on which the hatchways are situated and may be an imaginary, or virtual deck and in this case is not to be used for the actual assignment of freeboard.

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

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

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

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

6.1.5 Scantlings of the hatch cover panels are to be equivalent to those for weathertight covers and in accordance with the applicable requirements.

7 Fixed cell guides

7.1 General

7.1.1 Containers may be secured within fixed cell guides, permanently connected by welding to the hull structure, which prevent horizontal sliding and tipping (see Fig 7.1).

7.1.2 When containers are secured by fixed cell guides, the scantlings of such cell guides and supports are to be approved and checked using the criteria in 7.2 and 7.3.

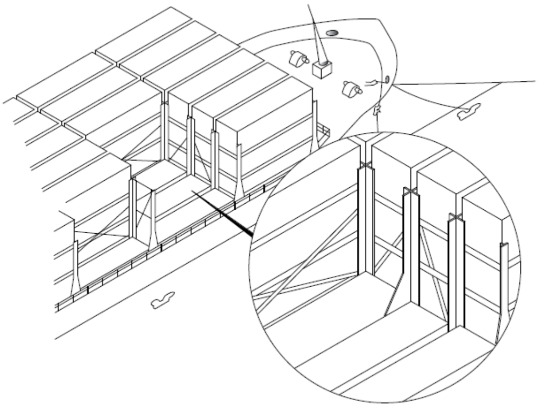


Figure 7.1: Containers within fixed cell guides

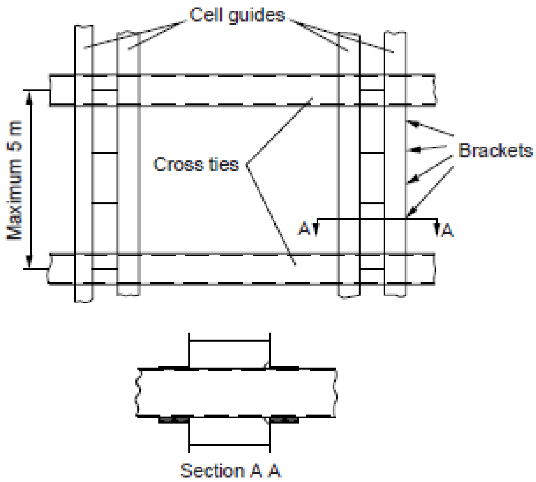


Figure 7.2: Typical structure of cell guides

7.2 Arrangement of fixed cell guides

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

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

In general, the spacing between cross-ties connecting the guides may not exceed 5 metres, and their position is to coincide as nearly as possible with that of the container corners (see Fig 7.2).

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.

7.2.3 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.

7.3 Strength criteria

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

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

where Q is the material factor, defined in Pt III, Ch 2, Sec1.

8 Fixed cargo securing devices

8.1 Documentation to be submitted

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

8.1.2 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.

9 Construction and testing

9.1 Special structural details

9.1.1 The specific requirements for ships with the service notation container ship are to be complied with.

Section 3 Machinery

1 Open top container ships

1.1 The bilge system and fire-extinguishing arrangements of open top container ships are to comply with the relevant requirements of IMO MSC/Circ.608/rev.1 بInterim guidelines for open top container shipsپ

Chapter 3 Dry Bulk Cargo Carriers

Section 1 General

1 Application, definitions, class notations and documentation

1.1 Application

1.1.1 The requirements of this chapter apply in general to all bulk carriers except those vessels mentioned in 1.1.2 below. The requirements are supplementary to those given for the assignment of main character of class.

1.1.2 The IACS common structural rules (CSR), for bulk carriers are to be applied to hull structures of seagoing self propelled bulk carriers of unrestricted service and having a length L of 90 m and above, which are constructed generally with single deck, double bottom, hopper side tanks and topside tanks and with single or double skin construction in cargo area, excluding ore and combination carriers.

1.1.3 The requirements of SOLAS Chapter XII, i.e. additional safety measures for bulk carriers, apply to bulk carriers of "single side skin construction" and of ﺑdouble side skin constructionﭘ

1.2 Definitions

1.2.1 Bulk carrier means a ship which is intended primarily to carry dry cargo in bulk, including such types as ore carriers and combination carriers.

1.2.2 ﺑBulk carrier of single side skin constructionﭘmeans a bulk carrier in which:

a) any part of a cargo hold is bounded by the side shell; or

b) where one or more cargo holds are bounded by a double side skin, the width of which is less than 760 mm in bulk carriers constructed before 1 January, 2000 and less than 1000 mm in bulk carriers constructed on or after 1 January, 2000 but before 1 July, 2006, the distance being measured perpendicular to the side shell. Such ships include combination carriers in which any part of a cargo hold is bounded by the side shell.

1.2.3 ﺑBulk carriers of double side skin constructionﭘmeans a bulk carrier in which all cargo holds are bounded by a double-side skin, other than as defined in b) above.

1.2.4 ﺑDouble side skinﭘmeans a configuration where each ship side is constructed by the side shell and longitudinal bulkhead connecting the double bottom and the deck. Hopper side tanks and top-side tanks may, where fitted, be integral parts of the double side skin construction. Double side skin construction is to comply with the requirements of 8.

1.3 Class notations

1.3.1 In general, bulk carriers built in compliance with the above requirements, as applicable, will be eligible to be assigned one of the following class notations, depending on their design cargo density and cargo distribution:

BC-C,

BC-B,

BC-A, "hold(s) ... (to be specified) ... may be empty",

The descriptive notation "no MP" will be assigned when the vessel has not been designed for loading and unloading in multiple ports in accordance with the conditions specified in 2.

The descriptive notation "Maximum cargo density [t/m^3]" will be assigned along with notations BC-B and BC-A when the maximum cargo density is less than 3.0 [t/m^3].

1.3.2 The notation BC-C implies that the vessel is designed to carry bulk cargoes of cargo density less than 1.0 [t/m^3].

1.3.3 The notation BC-B implies that the vessel is designed to carry bulk cargoes of cargo density 1.0 [t/m^3] and above with all cargo holds loaded. In addition, this notation implies that the requirements for class notation BC-C are also satisfied.

1.3.4 The notation BC-A implies that the vessel is designed to carry dry bulk cargoes of cargo density 1.0 [t/m^3] and above with specified holds empty. In addition, this notation implies that the requirements for class notation BC-B are also satisfied.

1.3.5 When the IACS Common Structural Rules (CSR) are applied as mentioned in 1.1.2 above, the vessel will be eligible to be assigned class notation ιCSRب

1.3.6 Assignment of class notation ESP (Enhanced Survey Program) is mandatory for bulk carriers of single or double skin construction, with a double bottom, hopper side tanks and topside tanks fitted below the upper deck and for ore carriers having two longitudinal bulkheads and a double bottom throughout the cargo region and intended primarily to carry ore cargoes in the centre hold only. Typical cross sections of such bulk carriers and ore carriers are given in Fig.1.a and Fig.1.b respectively. Class notation ιESPبmay be assigned to other types of bulk carriers, when required by the Administration.

1.3.7 Ore carriers built in compliance with the above mentioned requirements, as applicable, will be eligible to be assigned class notation "ORE CARRIER, ESP".

Fig.1.a, Typical midship section of bulk carrier

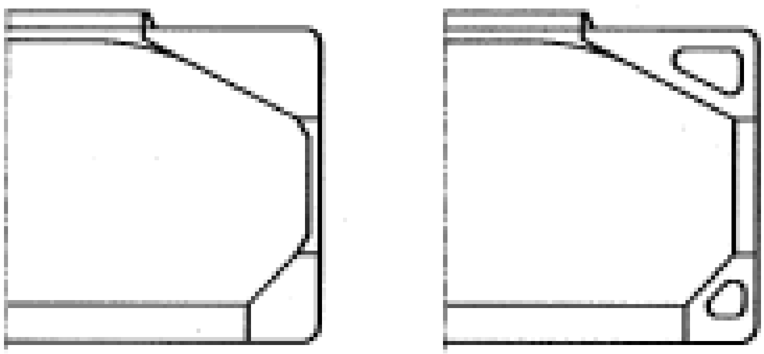
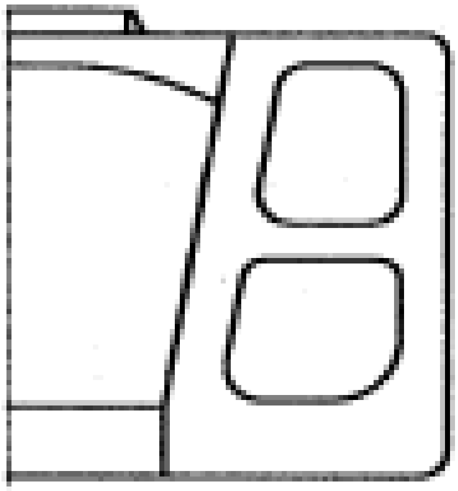


Fig.1.b, Typical midship section of ore carrier



1.4 Documentation

1.4.1 The following additional documents are to be submitted for approval, as applicable:

a) Plan showing the cross sections taken at mid-length of each hold and the hold capacities upto the top of hatch coaming.

b) Maximum allowable and minimum required mass of cargo and double bottom contents of each hold as a function of the draught at mid-hold position.

c) Design values of maximum density of bulk cargo to be carried in each hold when the cargo is filled upto top of the hatch coaming. Corresponding angles of repose to be indicated.

d) Details of all (mandatory and other envisaged) homogeneous and/or nonhomogeneous loading conditions giving various combinations of filling levels in holds, combinations of empty and loaded holds including possible part loading/unloading conditions in the homogeneous mode and loading conditions where two adjacent holds are loaded fully with adjacent holds empty (block loading). In ballast conditions where water ballast is intended to be carried in holds, details of filling levels are to be included. Calculations of still water bending moments and shear forces in these conditions are to be submitted along with the limiting values to be included in the loading manual and the loading instrument. The design loading conditions to be included in the loading manual as a minimum for assignment of the various class notations are indicated in 2.

e) Where applicable, calculations of still water bending moments and shear forces in flooded conditions, as detailed in sec2, 2.2 to 2.6.

f) Typical cargo loading/unloading sequences and sequences for change of ballast at sea as indicated in 2.1(h) and (i) respectively.

2 Design loading conditions to be considered for the assignment of class notations BC-A, BC-B, BC-C

2.1 Loading conditions (ship)

The following loading conditions, subdivided into departure and arrival conditions, are to be considered, as appropriate.

Partial filling of ballast tanks is not acceptable in the design conditions unless compliance with relevant requirements is demonstrated by investigation of the necessary additional loading conditions.

a) Alternate light and heavy cargo loading conditions at moulded summer loadline draught (T_S) where applicable;

b) Homogeneous light and heavy cargo loading conditions at draught (T_S)

c) Ballast conditions.

Note: For vessels having ballast holds adjacent to topside wing, hopper and double bottom tanks, it shall be strengthwise acceptable that the ballast holds are filled when the topside wing, hopper and double bottom tanks are empty.

d) Short voyage conditions where the vessel is to be loaded to draught (T_S) but with limited amount of bunkers;

e) Multiple port loading/unloading conditions;

f) Block loading conditions;

g) Deck cargo conditions, where applicable;

h) Typical loading/unloading sequences as detailed in 3.4;

i) Typical sequences for change of ballast at sea, where applicable.

For the assignment of various class notations indicated in 1.3.1, the design loading conditions shown in Table 2.1 are mandatory.

Other loading conditions, which may be envisaged, are also to be investigated.

In actual operations, the ship may be loaded differently from the loading conditions mentioned above, provided limitations on longitudinal and local strength as defined in the loading manual and loading instrument onboard are not exceeded and the applicable stability requirements are complied with.

2.2 Loading conditions (individual cargo holds) The loading conditions to be considered for the evaluation of strength of any individual cargo hold/s and the net load on the double bottom structure in way of the cargo hold for assignment of various class notations are given in Table 2.2.

Table 2.1: Design loading conditions (Ship)

Notation	Loading Conditions
CARGO LOADING CONDITIONS (See Note a)	
BC-C	(1D), (1A), (4D), (4A), (5D), (5A)
BC-B	(1D), (1A), (2D), (2A), (4D), (4A), (5D), (5A)
BC-A	(1D), (1A), (2D), (2A), (3D), (3A), (4D), (4A), (5D), (5A)
(1D)	Departure condition at draught 'T' with 100% consumables and all ballast tanks empty. Cargo assumed to be homogeneously loaded with all cargo holds 100% full including hatchways. uniform cargo density=(total cargo deadweight/total cargo hold capacity) t/m^3
(1A)	Arrival condition corresponding to (1D), with 10% consumables.
(2D)	Departure condition at draught 'T' with 100% consumables and all ballast tanks empty. Cargo assumed to be homogeneously loaded with a uniform filling rate (cargo mass / cubic capacity) in each cargo hold. Uniform cargo density = 3 [t/m^3], unless the descriptive notation specifies lesser density (See 1.5).
(2A)	Arrival condition corresponding to (2D), with 10% consumables.
(3D)	Departure condition at draught 'T' with 100% consumables and all ballast tanks empty. Specified holds empty. Cargo assumed to be loaded with uniform filling rate (Cargo mass / cubic capacity) [t/m^3] in each of the remaining cargo holds. Uniform cargo density = 3.0 [t/m^3], unless the descriptive notation specifies lesser density (See 1.5).
(3A)	Arrival condition corresponding to (3D), with 10% consumables.
NORMAL BALLAST CONDITIONS (See Notes a, b, c)	
(4D)	Ballast departure with 100% consumables, all ballast tanks 100% full, any cargo hold adapted for the carriage of water ballast is empty.
(4A)	Ballast arrival condition corresponding to (4D) with 10% consumables.
(5D)	Ballast departure with 100% consumables. Any cargo hold adapted for the carriage of water ballast is empty. The following conditions are to be satisfied in conditions (5D) and (5A): i) The propeller is to be fully immersed. ii) The trim is to be by stern, but not greater than 0.015L. iii) Strength of bottom structure forward is adequate against slamming, at the lightest forward draught. If any ballast tank is partially filled, compliance as required by 2.1 is to be demonstrated.
(5A)	Ballast arrival condition corresponding to (5D) with 10% consumables.
HEAVY BALLAST CONDITIONS (See Notes a, b, c, d)	
(6D)	Ballast departure with 100% consumables and all ballast tanks 100% full. One cargo hold adapted and designated for the carriage of water ballast at sea, if any, is to be 100% full.
(6A)	Ballast arrival corresponding to (6D) with 10% consumables.
(7D)	Ballast departure with 100% consumables. At least one cargo hold adapted for the carriage of water ballast at sea, if any, is to be full. The following conditions are to be satisfied for (7D) and (7A): i) The propeller immersion is to be such that I/D_p □0.6 where: I = distance from propeller centre line to the water line D_p = propeller diameter. ii) The trim is to be by stern and not to exceed 0.015L. iii) The moulded forward draught is not to be less than the smaller of 0.03L or 8m. If any ballast tank is partially filled, compliance as required by 2.1 is to be demonstrated.
(7A)	Ballast arrival corresponding to (7D) with 10% consumables.

Notes:

(a) '100% consumables' means bunker tanks not less than 95% full and other consumables 100%.

(b) All bulk carriers are to have ballast tanks of sufficient capacity and so disposed as to fulfill the conditions mentioned in the respective ballast conditions.

(c) In the assessment of propeller immersion and trim, the draughts at the forward and after perpendiculars may be used.

(d) Where more than one hold is adapted and designated for the carriage of water ballast at sea, it will not be required that two or more holds be assumed 100% full simultaneously in the longitudinal strength assessment, unless such conditions are expected in the heavy ballast condition. Unless each hold is individually investigated, the designated heavy ballast hold and any/all restrictions for the use of other ballast hold(s) are to be indicated in the loading manual.

Table 2.2: Design loading conditions (individual cargo holds)

Notation	Loading conditions
BC-C	(a), (b), (c), (d), (e), (f), (g), (k), (l), (m)
BC-B	(a), (b), (c), (d), (e), (f), (g), (k), (l), (m)
BC-A	(a), (b), (c), (d), (e), (f), (g), (h), (i), (j), (k), (l), (m)
Note: Wherever notation "no MP" is assigned, along with any of the above class notations, the conditions (d), (e), (f) and (g) need not be applied.	
Description of loading conditions: (a) At draught 'T': - Cargo mass M_{Full} in cargo hold - Fuel oil tanks in double bottom in way of cargo hold are 100% full. - Ballast water tanks in double bottom in way of cargo hold are empty	
(b) At draught 'T': - Cargo mass 50% of M_H in cargo hold - All double bottom tanks in way of cargo hold are empty	
(c) At the deepest ballast draught: - Cargo hold empty - All double bottom tanks in way of cargo hold are empty	
(d) At 67% of draught 'T': - Cargo mass MFull in cargo hold - Full oil tanks in double bottom in way of cargo hold are 100% full - Ballast water tanks in double bottom in way of cargo hold are empty	
(e) At 83% of draught 'T': - Cargo hold empty - All double bottom tanks in way of cargo hold are empty	
(f) At 67% of draught 'T': - Two adjacent cargo holds with cargo mass M_{Full} in each hold - Fuel oil tanks in double bottom in way of cargo hold are 100% full - Ballast water tanks in double bottom in way of cargo hold are empty (Note : Conditions in which one hold is filled with cargo (M_{full}) and the adjacent hold filled with water ballast, is also to be considered, if applicable)	

(g) At 75% of draught 'T': - Any two adjacent cargo holds are empty - All double bottom tanks in way of the cargo hold are empty
(h) At draught 'T': - Cargo holds which are intended to be empty are empty - All double bottom tanks in way of empty cargo hold are also empty
(i) At draught 'T': - Cargo mass (M_{HD} + 10% of M_H) in cargo holds which are intended to be loaded with higher density cargo - Fuel oil tanks in double bottom in way of cargo hold are 100% full - Ballast water tanks in double bottom in way of cargo hold are empty (Note : in operation the maximum allowable cargo mass is to be limited to M_{HD})
(j) Where any two adjacent cargo holds are loaded with next holds empty, in any loading condition, the following loads to be considered in each hold: At draught 'T': - Cargo mass in cargo hold = maximum cargo load in the above loading condition + 10% M_H - Fuel oil tanks in double bottom in way of the cargo hold are 100% full. - Ballast water tanks in double bottom in way of the cargo hold are empty (Note : In operation the maximum allowable mass is to be limited to the maximum cargo hold according to the loading conditions)
(k) For cargo holds designed as ballast water holds, at any heavy ballast draught: - Ballast hold filled with water ballast upto the top of hatch coaming - All double bottom tanks in way of the ballast hold are 100% full
(l) In harbour conditions at 67% of draught 'T': ☐Maximum allowable seagoing mass in any cargo hold
(m) In harbour conditions at 67% of draught 'T': - Two adjacent cargo holds with cargo mass M_{Full} in each hold - Fuel oil double bottom tanks in way of cargo hold are 100% full - Ballast water double bottom tanks in way of cargo hold are empty

Definitions

MH = the actual cargo mass in a cargo hold corresponding to a homogeneously loaded condition at draught 'T'

MFull = Cargo mass in a cargo hold filled to the top of hatch coaming at virtual density, where virtual density

= (MH/hold cubic capacity) [t/m3]

virtual density is not to be taken less than 1.0 [t/m3].

MHD = the maximum cargo mass allowed to be carried in a cargo hold according to design loading conditions with specified hold empty.

3 Loading guidance information - additional requirements

3.1 Bulk carriers, ore carriers and combination carriers of length 150 m and above, are to comply with the following in addition to the general requirements and in 2 above.

i) The loading manual is to contain the additional information as per 3.2 and also include additional loading conditions given in 3.3; and

ii) The computer-based loading instrument is to have additional capabilities as per 3.4 and its approval is to subjected to the additional conditions of approval given in 3.5.

3.2 Loading manual shall contain complete information with respect to:

a) The loading conditions on which the design of the ship has been based, including permissible limits of still water bending moments and shear forces;

b) The results of the calculations of still water bending moments, shear forces and where applicable, limitations due to torsional loads;

c) Where the longitudinal strength in flooded condition is required to be checked according to sec2, 2.2, envelope results and permissible limits of still water bending moments and shear forces in the hold flooded condition;

d) The cargo hold(s) or combination of cargo holds that might be empty at full draught. If no cargo hold is allowed to be empty at full draught, this is to be clearly stated in the loading manual;

e) Hold mass curves:

Based on the design loading criteria for local strength as given in (a) to (m) of Table 2.2, hold mass curves are to be included in the loading manual and the loading instrument, showing maximum allowable and minimum required mass in single holds, as well as for any two adjacent holds as a function of draught, in seagoing condition as well as during loading and unloading in harbour.

The following principles are too be used for plotting the hold-mass curves:

i) At draughts other than those specified in the design loading conditions above, the maximum allowable and minimum required mass are to be obtained by accounting for the change in buoyancy in way of the hold.

Table 3.1: Guidance for maximum permissible and minimum required cargo mass in individual cargo holds: (see Table 2.2 for details of loading conditions)

Class notation	Type of loading	Maximum mass loading condition	Minimum mass loading condition
BC-A	Loaded hold alternate loading	(i)	least of (b) or (e)
BC-A [no MP]	-do-	(i)	(b)
BC-A	Empty hold alternate loading	(d)	hold empty
BC-A [no MP]	-do-	(a)	hold empty
BC-B	loaded hold homogeneous loading	(d)	least of (b) or (e)
BC-B [no MP]	-do-	(a)	(b)
BC-C	-do-	(d)	least of (b) or (e)
BC-C [no MP]	-do-	(a)	(b)

ii) At any draught less than 0.67T in harbor conditions, the maximum allowable mass in harbour need not be less than:-

Maximum allowable mass in seagoing condition +15% of the maximum allowable mass at maximum draught in seagoing condition.

However, the maximum allowable mass in harbour at any lower draught is not to exceed the maximum mass allowed at the maximum changed in seagoing condition.

iii) The minimum required mass at any lower draught in harbour need not be more than:-

Minimum required mass in seagoing condition minus 15% of maximum allowable mass at maximum draught in seagoing condition.

The maximum permissible and minimum required cargo mass in holds for the various class notations are generally determined by the design loading conditions as shown in Table 1.3.2.

f) Maximum allowable tank top loading together with specifications of the nature of the cargo for cargoes other than bulk cargoes;

g) Maximum allowable load on deck and hatch covers. If the vessel is not approved to carry load on the deck or hatch covers, this is to be clearly stated in the loading manual;

h) The maximum rate of ballast change together with the advice that a load plan is to be agreed with the terminal on the basis of the achievable rates of change of ballast.

3.3 All loading conditions mentioned in 2.1 are to be included in the Loading Manual.

3.4 Typical loading/unloading sequences are to be prepared, considering the various intermediate stages from commencement to completion of the loading/unloading operation relevant to all envisaged loading conditions including the following:

- alternate light and heavy cargo load condition,
- homogeneous light and heavy cargo load condition,
- short voyage condition where the ship is loaded to maximum draught but with limited bunkers,
- multiple port loading/unloading condition,
- deck cargo condition,
- block loading.

The loading/unloading sequences may be port specific or typical.

The sequence is to be built up step by step from commencement of cargo loading to reaching full deadweight capacity. Each time the loading equipment changes position to a new hold defines a step. Each step is to be documented and submitted. In addition to longitudinal strength, the local strength of each hold is to be considered.

For each loading condition a summary of all steps is to be included. This summary is to highlight the essential information for each step such as:

- How much cargo is filled in each hold during the step.
- How much ballast is discharged from each ballast tank during the step.

– The maximum still water bending moment and shear at the end of the step.

– The ship's trim and draught at the end of the step.

3.5 The digital loading instrument shall also be capable of ascertaining, as applicable, the following:

– The mass of cargo and double bottom contents in way of each hold as a function of the draught at mid-hold position;

– The mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds;

– Where the longitudinal strength in flooded condition is required to be checked according to sec2, 2.2, the still water bending moment and shear forces in the hold flooded conditions are within permissible values.

3.6 The approval of loading instrument is to be based on the following additional conditions, as applicable:

a) Acceptance of hull girder bending moment limits for all read-out points.

b) Acceptance of hull girder shear force limits for all read-out points.

c) Acceptance of limits for mass of cargo and double bottom contents of each hold as a function of draught.

Acceptance of limits for mass of cargo and double bottom contents in any two adjacent holds as a function of draught.

4 Design loads in cargo holds

4.1 Definitions

$\square_f$ = value of maximum density of bulk cargo to be carried in the hold under consideration when cargo is filled upto the top of hatch coaming in any loading condition.

Note : Unless the ship is designed to carry, in non-homogeneous conditions, only iron ore or cargo of density equal to or more than 1.78 [t/m^3], the maximum mass of cargo allowed to be carried in a cargo hold in any loading condition, shall also be considered to fill that hold upto the top of hatch coaming.

$\square_H$ = The density of cargo in a heavy bulk cargo loading condition.

h_c = Height from the load point to be actual cargo surface corresponding to the required cargo volume (max. heavy bulk cargo mass/$\square_H$) and the angle of repose of the cargo.

H = height m, from the load point to the top of hatch coaming.

M_h = maximum cargo mass [tonnes], to be carried in the hold under consideration when carrying heavy bulk cargo of density $\square_h$ [t/m^3].

h_c = height m, from the load point to the actual cargo surface corresponding to the cargo volume (M_h/$\square_H$) [m^3] in the hold and the angle of repose.

$\square$ = angle of repose of bulk cargo in degrees, generally not to be taken greater than that given in Table 4.1:

Table 4.1: Characteristics of select bulk cargoes

Bulk cargo	Angle of repose maximum [degrees]	Permeability μ minimum	Bulk density ρ_c t/m^3
Iron ore	35	0.3	3.0
Cement	25	0.3	1.3
Coal	20	0.3	0.9
Grain	20	0.5	0.8

4.2 In intact conditions, pressure at a load point on inner bottom and sloping or vertical bulkheads due to dry bulk cargo is to be taken as:

$\rho_c = C \cdot q\,(g_o + 0.5\,a_v)\,10^{-3}$ [N/mm^2]

where,

C = 1.0 for inner bottom

$= Tan^2(45 - \phi/2)$ for vertical bulkheads

$= Sin^2\alpha \cdot Tan^2(45 - \phi/2) + Cos^2\alpha$ for sloping bulkheads

α = angle of sloping bulkhead with the horizontal plane, [degrees]

$q = \rho_f \cdot H$ [t/m^2], or

$= \rho_H \cdot h_c$ [t/m^2]; whichever is greater.

$g_o = 9.81$ [m/s^2]

a_v = vertical acceleration [m/s^2]

4.3 The design loads for hold-flooded conditions, when required, are to be taken as per Table 4.2 and Fig. 4.1.

In this context, the flooded waterline is to be considered at a distance d_f m measured vertically above the baseline with the ship in upright position.

d_f is taken as follows:

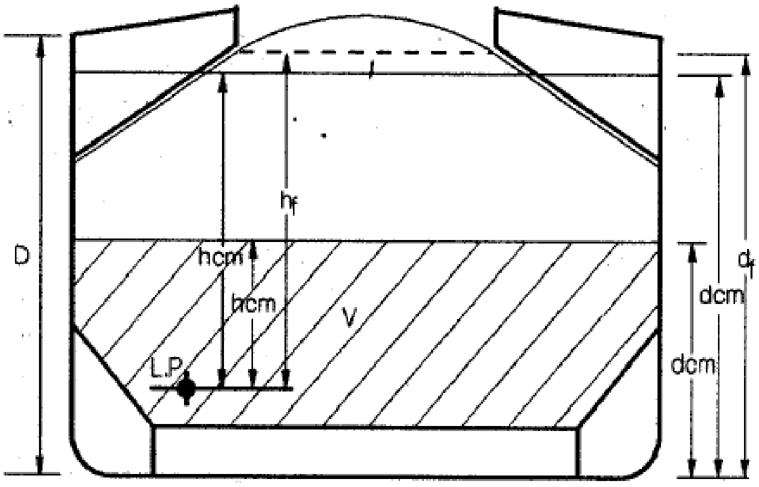
a) For bulk carriers in general

- D in m for the foremost hold and for the transverse bulkhead between the two foremost holds
- 0.9D in m for other holds and for other transverse bulkheads.

b) For bulk carriers which have been assigned type B-0 freeboard and are of DWT < 50,000 [tonnes]

- 0.95D m for the foremost hold and for the transverse bulkhead between the two foremost holds
- 0.85D m for the other holds and for other transverse bulkheads.

4.4 Where the ship is to carry cargoes having bulk density less than 1.78 [t/m3], in nonhomogeneous condition, the distance df in (a) and (b) above may be reduced by 0.05D.



V=Volume of cargo L.P.=Load Point

Fig.4.1: Definition of d_f, h_f, d_{cm}, h_{cm}

Table 4.2: Design loads on bulkheads in flooded conditions (See Note 1)

Condition		Pressure, $p_{c,f}$ at a load point on sloping or vertical bulkheads [N/mm^2]	Total force, on a corrugation [kN]
I.	Flooding of a hold already loaded with bulk cargo		
	a) When the flooded waterline is above the mean plane of cargo in hold surface i.e. when d_f □d_1	i) for load points located above the mean plane of cargo surface $p_{c,f} = 0.01\ h_f$	$F_{c,f}$ = 0.5s[0.01(d_f -d_{cm})^2 +{0.01(d_f □d_{cm}) + ($p_{c,f}$)$_{le}$}(d_{cm} □d_{le})]
		ii) for load points located below the mean plane of cargo surface in hold $p_{c,f}$ = 0.01 h_f + [g_o . □ -10(1-□)]h_{cm} C10^{-3}	
	b) When the flooded waterline is below the mean plane of cargo surfaces in a hold i.e. when $d_f < d_1$	i)for load points located above the flooded waterline $p_{c,f}$ = □ g_o h_{cm} C10^{-3}	$F_{c,f}$ = 0.5s[□ g_oC(d_{cm} -d_f)^2 10^{-3}+ { □ g_oC(d_{cm} -d_f)10^{-3} + ($p_{c,f}$)$_{le}$}(d_f -d_{le})]
		ii) for load points located below the flooded waterline $p_{c,f}$ = 0.01 h_f + [g_o □ h_{cm} -10(1-□)h $_f$] C10^{-3}	
II.	Flooding of an empty hold	$p_f = 0.01\ h_f$	F_f = 0.005 s (d_f -d_{le})^2
III.	Hold (loaded with bulk cargo) adjacent to the flooded hold 3	For calculation of the resultant loads in flooded conditions in homogeneous mode as per sec 2, 10.7	
		p_c= □ g_o h_{cm} C10^{-3}	F_c =0.5□ g_osC(d_{cm} ٮ d_{le})^2$10^{-3}$

f = as defined in 1.4.3 and where applicable, reduced as per 4.4

□c = density [t/m^3] of the bulk cargo in the hold. Unless the ship is designed to carry, in non-homogeneous conditions, only iron ore or cargo of bulk density equal to or greater than 1.78 [t/m^3], the maximum mass of cargo which may be carried in the hold shall also be considered to fill that hold up to the top of hatch coaming. Also see Table 4.1.

h_f = distance m from the load point to the flooded waterline

h_{cm} = distance m from the load point to the mean plane of cargo surface

□= permeability of the bulk cargo considered, also see Table 4.1

d_{cm} = distance of mean plane of cargo surface from base line m see Fig. 4.1

d_{le} = distance of lower end of bulkhead, from base line m

= sum of height of the double bottom 'h_{DB}' and the mean height of lower stool 'h_{LS}'

s = corrugation spacing mm, S_1 as indicated in sec 2, Fig. 9.1

Note 1: Most severe combinations of cargo induced loads and flooding loads are to be determined and used. See sec2, 10.4.

5 Requirements for the fitting of a forecastle for bulk carriers, ore carriers and combination carriers

5.1 All vessels with any of the following class notations are to be fitted with an enclosed forecastle on the freeboard deck as detailed in sec 1, 5.2:

ıBC-Aپ ıBC-Bپ ıBC-Cپ ıORE CARRIERپ ıORE OR OIL CARRIERپ ıOIL OR BULK CARRIERپ

5.2 The forecastle is to be located on the freeboard deck with its aft bulkhead fitted in way or aft of the collision bulkhead as shown in Fig.5.1.

However, if this requirement hinders hatch cover operation, the aft bulkhead of the forecastle may be fitted forward of the forward bulkhead of the foremost cargo hold provided the forecastle length is not less than 7% of ship length abaft the forward perpendicular where the ship length and forward perpendicular are defined in the International Convention on Load Line 1966 and its Protocol 1988.

The forecastle height H_F above the main deck is to be not less than:

- the standard height of a superstructure as specified in the International Convention on Load Line 1966 and its Protocol of 1988, or
- Hc + 0.5 in m, where Hc is the height of the forward transverse hatch coaming of the foremost cargo hold

whichever is the greater.

5.3 Reduced horizontal loading on the forward transverse hatch coaming and hatch cover of the foremost cargo hold due to the shielding effect provided by the forecastle, can be considered only when for all points of the aft edge of the forecastle deck:

$$l_F \leq 5\sqrt{H_F - H_C}$$

where,

l_F, H_F and H_c are as shown in Fig.5.1.

5.4 A breakwater is not to be fitted on the forecastle deck with the purpose of protecting the hatch coaming or hatch covers. If fitted for other purposes, it is to be located such that its upper edge at centre line is not less than H_B /tan 20°forward of the aft edge of the forecastle deck, where H_B is the height of the breakwater above the forecastle (See Fig. 5.1).

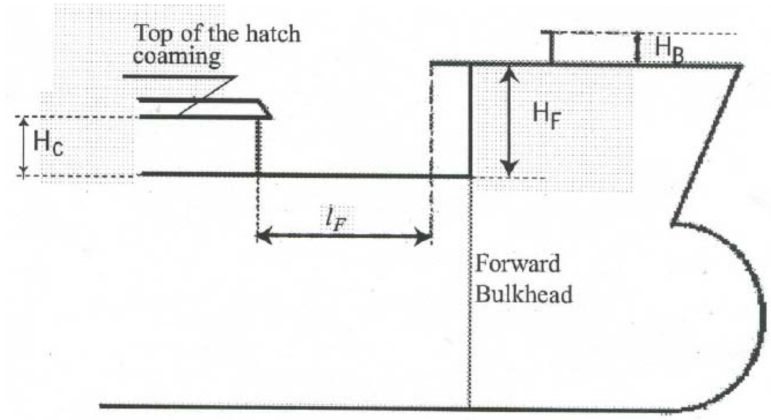


Fig. 5.1:

6 Arrangements for access in the cargo area and forward spaces

6.1 The requirements in 6 and 7 apply to bulk carriers of single or double side skin construction, with double bottom, hopper side tanks and top side tanks fitted below the upper deck, ore carriers and combinations carriers of 20,000 gross tonnage and over.

6.2 Each space is to be provided with a means of access to enable, throughout the life of the ship, overall and close-up inspections and thickness measurements of the ship's structures. Such means of access are to comply with the requirements of the Technical provisions for means of access for inspections, specified in 7.

Where a permanent means of access may be susceptible to damage during normal cargo loading and unloading operations or where it is impracticable to fit permanent means of access, the provision of movable or portable means of access, as specified in 7 may be considered, provided that the means of attaching, rigging, suspending or supporting the portable means of access forms a permanent part of the ship's structure. All portable equipment may be capable of being readily erected or deployed by ship's personnel.

6.3 The construction and materials of all means of access and their attachment to the ship's structure are to be approved by ACS.

6.4 Access to cargo holds, cofferdams, ballast tanks and other spaces in the cargo area is to be direct from the open deck and such as to ensure their complete inspection. Access to double bottom spaces or to forward ballast tanks may be from a pipe tunnel, cargo hold, double hull space or similar compartment not intended for the carriage of hazardous cargoes. Access to a double side skin spaces may be from a topside tank or double bottom tank.

6.5 Tanks and subdivisions of tanks, having a length of 35 m or more are to be fitted with at least two access hatchways and ladders, as far apart as practicable. Tanks less than 35 m in length are to be served by at least one access hatchway and ladder. When a tank is subdivided by one or more swash bulkheads or similar obstructions which do not allow ready means of access to the other parts of the tank, at least two hatchways and ladders are to be fitted.

6.6 Each cargo hold is to be provided with at least two means of access as far apart as practicable. In general, these accesses should be arranged diagonally, for example one access near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side.

6.7 For access through horizontal openings, hatches or manholes, the dimensions are to be sufficient to allow a person wearing a selfcontained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space.

6.8 A ship's means of access to carry out overall and close-up inspections and thickness measurements is to be described in a Ship Structure Access Manual which is to consist of two parts.

The first part should include the following for each space:

a) plans showing the means of access to the space, with appropriate technical specifications and dimensions;

b) plans showing the means of access within each space to enable an overall inspection to be carried out, with appropriate technical specifications and dimensions. The plans are to indicate from where each area in the space can be inspected;

c) plans showing the means of access within the space to enable close-up inspection to be carried out, with appropriate technical specifications and dimensions. The plans are to indicate the positions of critical structural areas, whether the means of access is permanent or portable and from where each area can be inspected. Critical structural areas are to be identified by advanced calculation techniques for structural strength and fatigue performance, and service history of similar ships;

d) instructions for regularly inspecting and maintaining the structural strength of all means of access and means of attachment, taking into account any corrosive atmosphere that may be within the space;

e) instructions for safety guidance when rafting is used for close-up inspections and thickness measurements;

f) instructions for the rigging and use of any portable means of access in a safe manner;

g) an inventory of all portable means of access; and

The second part of the Ship Structure Access Manual is to contain a form of record of periodical inspections and maintenance, and change of inventory of portable equipment due to additions or replacement after construction.

The format of this part is to be approved at the time of construction of the ship. The manual is to include a re-approval procedure for any changes to the permanent, portable or movable means of access.

The Ship Structure Access Manual is to be approved by ACS and an updated copy including all revisions / re-approvals is to be kept onboard.

7 Technical provisions for means of access for inspections

7.1 Definitions: For the purpose of these technical provisions, the following definitions apply:

a) Rung means the step of vertical ladder or step on the vertical surface.

b) Tread means the step of inclined ladder, or step for the vertical access opening.

c) Flight of an inclined ladder means the actual stringer length of an inclined ladder.

For vertical ladders, it is the distance between the platforms.

d) Stringer means:

i) the frame of a ladder; or

ii) the stiffened horizontal plating structure fitted on side shell, transverse bulkheads and/or longitudinal bulkheads in the space.

For the purpose of ballast tanks of less than 5 m width forming double side spaces, the horizontal plating structure is credited as a stringer and a longitudinal permanent means of access, if it provides a continuous passage of 600 mm or more in width past frames or stiffeners on the side shell or longitudinal bulkhead. Openings in stringer plating utilized as permanent means of access are to be arranged with guard rails or grid covers to provide safe passage on the stringer or safe access to each transverse web.

e) Vertical ladder means a ladder of which the inclined angle is 70° and over up to 90°. A vertical ladder is not to be skewed by more than 2°.

f) Overhead obstructions mean the deck or stringer structure including stiffeners above the means of access.

g) Distance below deck head means the distance below the plating.

h) Cross deck means the transverse area which is located inboard of the line of hatch openings of the main deck and between adjacent transverse hatch coamings.

7.2 Structural members subject to the close-up inspections and thickness measurements of the shipۑs structure referred to in Pt I, except those in double bottom spaces, are to be provided with a permanent means of access to the extent as specified in Table 7.1 and Table 7.2, as applicable. For wing ballast tanks of ore carriers, approved alternative methods such as rafting may be used in combination with the fitted permanent means of access, provided that the structure allows for its safe and effective use.

7.3 Permanent means of access should as far as possible be integral to the structure of the ships, thus ensuring that they are robust and at the same time contributing to the overall strength of the structure of the ship.

7.4 Elevated passageways forming sections of a permanent means of access, where fitted, is to have a minimum clear width of 600 mm, except for going around vertical webs where the minimum clear width may be reduced to 450 mm and have guard rails over the open side/

sides of their entire length. Sloping structures that are sloped 5 degree or more from horizontal plane, providing part of the access is to be of a non-skid construction. Non-skid construction is to be such that the surface on which the personnel walks provides sufficient friction to the sole of boots even when the surface is wet and covered with thin sediment.

Guard rails are to be 1000 mm in height and consist of a rail and an intermediate bar at a height of 500 mm. They are to be of substantial construction ensuring adequate design strength as well as residual strength during service life.

Stanchions are to be not more than 3 m apart. Discontinuous handrails are allowed provided the gap does not exceed 50 mm. The distance between adjacent stanchions across the handrail gaps is to be not more than 350 mm.

Durability of passage ways and guard rails are to be ensured by corrosion protection and inspection and maintenance during services.

Fire resistant materials are to be used for all means of access.

7.5 Access to permanent means of access and vertical openings from the ship's bottom is to be provided by means of easily accessible passageways, ladders or treads. Treads are to be provided with lateral support for the foot.

Where the rungs of ladders are fitted against a vertical surface, the distance from the centre of the rungs to the surface is to be at least 150 mm. Where vertical manholes are fitted higher than 600 mm above the walking level, access is to be facilitated by means of treads and hand grips with platform landings on both sides. In such cases, it is to be demonstrated that an injured person can be easily evacuated.

Table 7.1: Means of access to ballast tanks in bulk carriers*

Ballast tanks
1. Top side tanks
1.1 For each topside tank of which the height is 6 m and over, one longitudinal continuous permanent means of access shall be provided along the side shell webs and installed at a minimum of 1.6 m to a maximum of 3 m below deck with a vertical access ladder in the vicinity of each access to that tank.
1.2 If no access holes are provided through the transverse webs within 600 mm of the tank base and the web frame rings have a web height greater than 1 m in way of side shell and sloping plating, then stop rings/grab rails shall be provided to allow safe access over each transverse web frame ring.
1.3 Three permanent means of access, fitted at the end bay and middle bay of each tank, shall be provided spanning from tank base up to the intersection of the sloping plate with the hatch side girder.
The existing longitudinal structure, if fitted on the sloping plate in the space may be used as part of this means of access. If the longitudinal structures on the sloping plate are fitted outside of the tank a means of access is to be provided.
1.4 For topside tanks of which the height is less than 6 m, alternative means as defined in7.10 of the technical provisions or a portable means may be utilized in lieu of the permanent means of access.

Bilge hopper tanks 1.5 For each bilge hopper tank of which the height is 6 m and over, one longitudinal continuous permanent means of access shall be provided along the side shell webs and installed at a minimum of 1.2 m below the top of the clear opening of the web ring with a vertical access ladder in the vicinity of each access to the tank. Note: The height of a bilge hopper tank located outside of the parallel part of vessel is to be taken as the maximum of the clear vertical distance measured from the bottom plating to the hopper plating of the tank. 1.5.1 An access ladder between the longitudinal continuous permanent means of access and the bottom of the space shall be provided at each end of the tank. 1.5.2 Alternatively, the longitudinal continuous permanent means of access can be located through the upper web plating above the clear opening of the web ring, at a minimum of 1.6 m below the deck head, when this arrangement facilitates more suitable inspection of identified structurally critical areas. An enlarged longitudinal frame of at least 600 mm clear width can be used for the purpose of the walkway. 1.5.3 For double side skin bulk carriers the longitudinal continuous permanent means of access may be installed within 6 m from the knuckle point of the bilge, if used in combination with alternative methods to gain access to the knuckle point. 1.6 If no access holes are provided through the transverse ring webs within 600 mm of the tank base and the web frame rings have a web height greater than 1 m in way of side shell and tank base, then step rungs/grab rails are to be provided to allow safe access over each transverse web frame ring. 1.7 For bilge hopper tanks of which the height is less than 6 m, alternative means as defined in 7.10 or a portable means may be utilized in lieu of the permanent means of access. It is to be demonstrated that such means of access can be deployed and made readily available in the areas where needed.
Double skin side tanks 1.8 Permanent means of access is to be provided in accordance with the applicable sections of Ch.4, Tables 4.1 and 4.2.
Fore peak tanks 1.9 For fore peak tanks with a depth of 6 m or more at the centre line of the collision bulkhead, a suitable means of access shall be provided for access to critical areas such as the underdeck structure, stringers, collision bulkhead and side shell structure. 1.9.1 Stringers of less than 6 m in vertical distance from the deck head or a stringer immediately above are considered to provide suitable access in combination with portable means of access. 1.9.2 In case the vertical distance between the deck head and stringers, stringers or the lowest stringer and the tank bottom is 6 m or more, alternative means of access as defined in 7.10 is to be provided.

* For ore carriers, permanent means of access shall be provided in accordance with the applicable sections of Tables 7.1 and 7.2 and Ch.4, Tables 4.1 and 4.2.

Table 1.7.2b: Means of access to cargo holds of bulk carriers*

Cargo holds 1. Access to underdeck structure 1.1 Permanent means of access is to be fitted to provide access to the overhead structure at both sides of the cross deck and in the vicinity of the centerline. Each means of access is to be accessible from the cargo hold access mentioned in 1.6.6 or directly from the main deck and installed at a minimum of 1.6 m to a maximum of 3 m below the deck. Means of access is to be provided to the cross deck structures of the foremost and aftermost part of the cargo hold. 1.2 An athwartship permanent means of access fitted on the transverse bulkhead at a minimum 1.6 m to a maximum 3 m below the cross-deck head is accepted as equivalent to1.1 1.3 Access to the permanent means of access to overhead structure of the cross deck may also be via the upper stool. 1.4 Ships having transverse bulkheads with full upper stools (extending between top side tanks and upto the hatch end beam) with access from the main deck which allows monitoring of all framing and plates from inside, do not require permanent means of access of the cross deck. 1.5 Special attention is to be paid to the structural strength where any access opening is provided in the main deck or cross deck. The requirements for access to cross deck structure are also applicable to ore carriers. 1.6 Alternatively, movable means of access may be utilized for access to the overhead structure of cross deck if its vertical distance is 17 m or less above the tank top. This movable means of access need not be necessarily be carried on board the vessel, but is to be made available when required.
Access to vertical structures 1.7 Permanent means of vertical access shall be provided in all cargo holds and built into the structure to allow for an inspection of a minimum of 25% of the total number of hold frames port and starboard equally distributed throughout the hold including at each end in way of transverse bulkheads. But in no circumstance shall this arrangement be less than 3 permanent means of vertical access fitted to each side (fore and aft ends of hold and mid-span). Permanent means of vertical access fitted between two adjacent hold frames is counted for an access for the inspection of both hold frames. A means of portable access may be used to gain access over the sloping plating of lower hopper ballast tanks.
1.8 In addition, portable or movable means of access are to be utilized for access to the remaining hold frames upto their upper brackets and transverse bulkheads. 1.9 Portable or movable means of access may be utilized for access to hold frames upto their upper bracket in place of the permanent means required in 1.6. These means of access are to be carried on board the ship and readily available for use. 1.10 The width of vertical ladders for access to hold frames is to be at least 300 mm, measured between stringers. 1.11 A single vertical ladder over 6 m in length is acceptable for the inspection of the hold side frames in a single skin construction. 1.12 For double side skin construction no vertical ladders for the inspection of the cargo hold surfaces are required. Inspection of this structure should be provided from within the double hull space.

* For ore carriers, permanent means of access shall be provided in accordance with the applicable sections of Tables 7.1 and 7.2 and Ch.4, Tables 4.1 and 4.2.

7.6 Permanent inclined ladders are to be inclined at an angle of less than 70°. There are to be no obstructions within 750 mm of the face of the inclined ladder, except that in way of an opening this clearance may be reduced to 600 mm. The clearance distances are to be measured perpendicular to the face of the ladder. Resting platforms of adequate dimensions are to be provided normally at a maximum of 6 m vertical height. Requirements for resting platforms are to be similar to that of elevated passageways.

Ladders and handrails are to be constructed of steel or equivalent material of adequate strength and stiffness and securely attached to the structure by stays. The method of support and length of stay are to be such that vibration is reduced to a practical minimum. In cargo holds, ladders are to be designed and arranged so that cargo handling difficulties are not increased and the risk of damage from cargo handling gear is minimized.

7.7 The width of inclined ladders between stringers are not to be less than 400 mm in general. However, the width of inclined ladders for access to a cargo hold is to be at least 450 m. The treads are to be equally spaced at a distance apart, measured vertically, of between 200 mm and 300 mm. When steel is used, the treads are to be formed of two square bars of not less than 22 mm by 22 mm in section, fitted to form a horizontal step with the edges pointing upward. The treads are to be carried through the side stringers and attached thereto by double continuous welding. All inclined ladders are to be provided with two course handrails of substantial construction on both sides, fitted at a convenient distance above the treads. Vertical height of handrails is not to be less than 890 mm from the center of the step.

7.8 For vertical ladders or spiral ladders, the width and construction should be in accordance with accepted international or national standards.

The width of vertical ladders is to be not less than 350 mm and the vertical distance between the rungs is to be between 250 mm and 350 mm. The minimum climbing clearance in width is to be 600mm other than for ladders between hold frames.

The vertical ladders are to be secured at intervals not exceeding 2.5 m apart to prevent vibration.

7.9 No free-standing portable ladder is to be more than 5 m long. Mechanical devices such as hooks for securing the upper end of a ladder is considered as an appropriate securing device if movement fore/ aft and sideways can be prevented at the upper end of the ladder.

7.10 Alternative means of access include, but are not limited to such devices as:

a) hydraulic arm fitted with a stable base;

b) wire lift platform;

c) staging;

d) rafting;

e) robot arm or remotely operated vehicle (ROV);

f) portable ladders (ladders more than 5 m long shall only be utilized if fitted with a mechanical device to secure the upper end of the ladder);

g) other means of access, approved by and acceptable to ACS.

Means for safe operation and rigging of such equipment to and from and within these spaces are to be clearly described in the Ship Structure Access Manual.

7.11 For access through horizontal openings, hatches or manholes, the minimum clear opening is not to be less than 600 mm x 600 mm, which may have corner radii of not more than 100 mm. Where a larger corner sections is desired to reduce the stress level around the opening, the size of the opening is to be suitably increased to ensure the required size of clear opening e.g. 600 mm x 800 mm opening with 300 mm corner radius is acceptable.

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

Access hatch coamings having a height greater than 900 mm shall also have steps on the outside in conjunction with the ladder.

7.12 For access through vertical openings, or manholes, in swash bulkheads, floors, girders and web frames providing passage through the length and breadth of the space, the minimum opening is to be not less than 600 mm x 800 mm at a height of not more than 600 mm from the passage unless gratings or other foot holds are provided.

The opening of 600 mm x 800 mm may have corner radii of 300 mm. An opening of 600 mm in height x 800 mm in width may be accepted as access opening in vertical structures where it is not desirable to make large opening considering structural strength aspects, such as in girders and floors in double bottom tanks.

Subject to verification of easy evacuation of injured person on a stretcher, a vertical opening 850mm x 620 mm as shown in Fig.1.7.12 is considered as an acceptable alternative to the opening of 600 mm width x 800 mm height with corner radii of 300 mm.

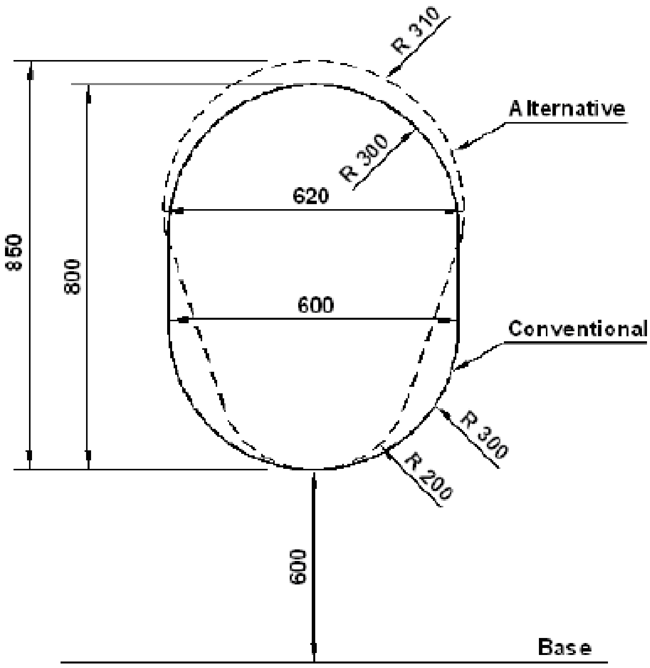


Fig. 7.1: Access opening in vertical structure

7.13 Access ladders to cargo holds and other spaces are to be as follows:

a) Where the vertical distance between the upper surface of adjacent decks or between deck and the bottom of the cargo space is not more than 6 m, either a vertical ladder or an inclined ladder or a combination of both.

b) Where the vertical distance between the upper surface of adjacent decks or between deck and the bottom of the cargo space is more than 6 m, an inclined ladder or series of inclined ladders at one end of the cargo hold, except the uppermost 2.5 m of a cargo space measured clear of overhead obstructions and the lowest 6 m may have vertical ladders, provided that the vertical extent of the inclined ladder or ladders connecting the vertical ladders is not less than 2.5 m.

The second means of access at the other end of the cargo hold may be formed of a series of staggered vertical ladders, which should comprise of one or more ladders linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder. Adjacent sections of ladder should be laterally offset from each other by at least the width of the ladder. The uppermost entrance section of the ladder directly exposed to a cargo hold should be vertical for a distance of 2.5 m measured clear of overhead obstructions and connected to a ladder-linking platform.

c) A vertical ladder may be used as a means of access to topside tanks, where the vertical distance is 6 m or less between the deck and the longitudinal means of access in the tank or the stringer or the bottom of the space immediately below the entrance.

The uppermost entrance section from deck of the vertical ladder of the tank should be vertical for a distance of 2.5 m measured clear of the overhead obstructions and comprises a ladder linking platform unless landing on the longitudinal means of access, the stringer or the bottom within the vertical distance. The platform is to be displaced to one side of a vertical ladder.

d) Unless allowed in c) above, an inclined ladder or combination of ladders should be used for access to a tank or a space where the vertical distance is greater than 6 m between the deck and a stringer immediately below the entrance, between stringers, or between the deck or a stringer and the bottom of the space immediately below the entrance.

In such cases the uppermost entrance section from deck of the ladder should be vertical for a distance of 2.5 m clear of the overhead obstructions and connected to a landing platform and continued with an inclined ladder. The flights of inclined ladders are not be more than 9 m in actual length and the vertical height is not normally be more than 6 m. The lowermost section of the ladders may be vertical for a vertical distance of not less than 2.5 m.

e) In double side skin spaces of less than 2.5 m width, the access to the space may be by means of vertical ladders that comprise of one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder.

Adjacent sections of ladder should be laterally offset from each other by at least the width of the ladder.

f) A spiral ladder is considered acceptable as an alternative for inclined ladders. In this case the spiral ladder may be continued in the uppermost 2.5 m and the change over to vertical ladder is not required.

g) The uppermost entrance section from deck of the vertical ladder providing access to a tank is to be vertical for a distance of 2.5 m measured clear of the overhead obstructions and comprise a ladder linking platform, displaced to one side of a vertical ladder. The vertical ladder can be between 1.6 m and 3 m below deck structure if it lands on a longitudinal or athwartship permanent means of access fitted within that range.

8 General requirements for double side skin construction

8.1 Bulk carriers of 150 m in length and above are to comply with the following in all areas of double side skin construction.

a) Primary stiffening structures of the double side skin shall not be placed inside the cargo hold space.

b) Subject to the provisions below, the distance between the outer shell and the inner shell at any transverse section shall not be less than 1000 mm. This distance is to be measured perpendicular to the outer shell from the top of the double bottom to the main deck, as indicated in Fig.8.1. The distance is to be maintained throughout the whole double-side skin construction.

The double side skin construction shall be such as to allow access for inspection as provided in regulation 6 and 7:

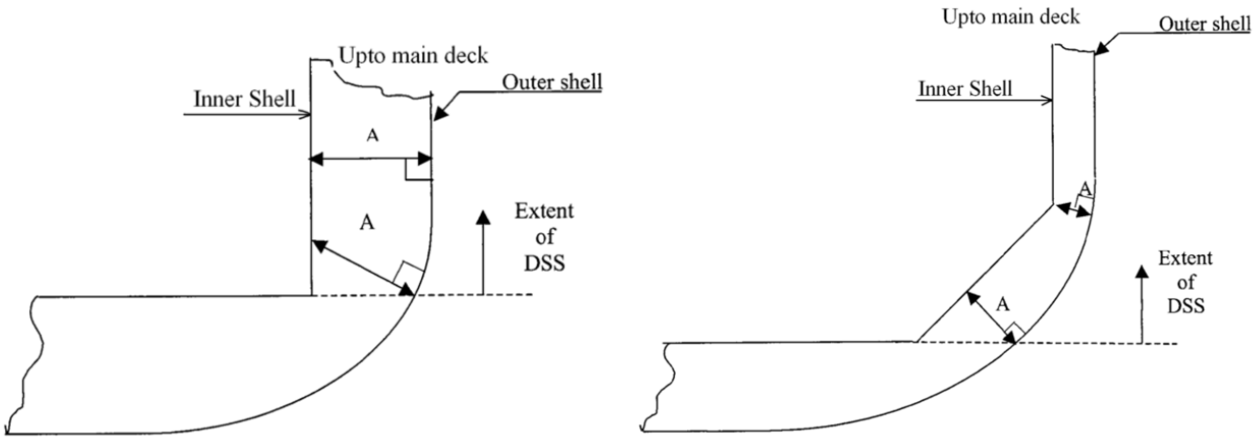
i) The clearances below need not be maintained in way of cross ties, upper and lower end brackets of transverse framing or end brackets of longitudinal framing.

ii) The minimum width of the clear passage through the double side skin space in way of obstructions such as piping or vertical ladders shall not be less than 600 mm.

iii) Where the inner and/or outer skins are transversely framed, the minimum clearance between the inner surfaces of the frames shall not be less than 600 mm.

iv) Where the inner and outer skins are longitudinally framed, the minimum clearance between the inner surfaces of the frames shall not be less than 800 mm. Outside the parallel part of the cargo hold length, this clearance may be reduced where necessitated by the structural configuration but in no case shall be less than 600 mm.

v) The minimum clearance referred to above shall be the shortest distance measured between assumed lines connecting the inner surfaces of the frames on the inner and outer skins.



The value of A shall not be less than 1000 mm

Fig. 8.1: Distance between inner and outer shell in way of double-side skin

Section 2 Bulk Carriers

1 Hull arrangement

1.1 Within the cargo region, longitudinal stiffening system, in general, is to be adopted for the double bottom, strength deck outside line of openings and in the hopper and topside tanks. Proposals for transverse framing on sloping bulkheads and side shell within the hopper side tanks and top side tanks will be specially considered.

1.2 In the hopper side tanks and top side tanks, tank end bulkheads or wash bulkheads are to be provided in line with the main hold bulkheads.

2 Longitudinal strength

2.1 The longitudinal strength in intact condition is to be in accordance with the requirements given in Pt III and sec 1, 2.1 for the class notation as applicable.

The loading conditions given in sec 1, 2.1 for the appropriate class notation are also to be considered for the longitudinal strength evaluation.

2.2 Bulk carriers of the following configurations are to have sufficient strength to withstand flooding of each cargo hold in all cargo loading and ballast conditions:

a) Single side skin bulk carriers of length equal to or more than 150 m and designed to carry bulk cargoes having a density of 1000 kg/m3 and above.

b) Double side skin bulk carriers of length equal to or more than 150 m in which any part of the longitudinal bulkhead is located within B/5 or 11.5 m whichever is less, inboard from the shipڍ side at right angle to the centre line at the assigned summer load line, designed to carry bulk cargoes having a density of 1000 kg/m3 and above.

2.3 The longitudinal strength calculations in the flooded conditions are to be investigated for each of the seagoing cargo and ballast loading conditions specified in 2.1 and the still water bending moment and shear forces determined.

Intermediate conditions of loading encountered during ballast water exchange need not be considered. Each cargo hold is to be considered individually flooded upto the equilibrium waterline.

2.4 For intact and flooded conditions featuring uneven distribution of cargo loading (e.g. loading conditions with empty holds or ballast conditions with ballast in cargo holds), shear force correction is to be applied.

2.5 Calculation of the quantity of ingressed water due to flooding of the hold is to be based on the following assumptions:

c) The permeability of empty cargo spaces and the volume left in cargo spaces above any cargo is to be taken as 0.95.

ii) Appropriate permeability and bulk density is to be used for the cargo carried, See sec1, Table 3.1. In this context, the permeability means the ratio of the volume of the voids within the cargo mass to the volume occupied by the cargo. For packed cargo conditions, the permeability is to be assessed based on the actual cargo weight.

2.6 The hull girder section modulus and shear strength requirements for the flooded conditions at any location are to be calculated in a way similar to that for intact conditions considering the following:

- Maximum stillwater bending moment and shear force values in flooded conditions, at the section under consideration.
- The wave bending moment and wave shear force values for the flooded condition are to be assumed equal to 80% of the most probable maximum lifetime values.
- The structure is assumed to remain fully effective in resisting the applied loading.

2.7 The buckling strength of the structure participating in longitudinal strength is to comply with the requirements given in Pt III, Ch2, App 4.

3 Bottom structure - Scantlings and arrangements

3.1 The scantlings and arrangements are, in general, to be as per Pt III, Ch2, sec 4, except as given below.

3.2 For bulk carriers with notation BC-B or BC-A and for all ships in way of cargo hold(s) designated for ballast, the spacing of plate floors in the double bottom is generally not to exceed 2.5 m.

3.3 The inner bottom plating is to be based on the design loads given in sec 1, 4.2 for intact conditions and 4.3 for hold flooded conditions.

The permissible stress for hold flooded conditions is to be as per Table 3.1 using the value of f_B based on still water bending moment and wave bending moment in flooded conditions as given in 2.6.

For bulk carriers with notation BC-B or BC-A, the thickness of inner bottom plating between the hopper or side tanks is not to be less than:

$$t = (9.0 + 0.03L)\sqrt{k} + t_c \quad \text{mm}$$

where, k is the material factor, L need not be taken as greater than 200 m and t_c is the corrosion allowance.

Table 3.1: Allowable bending stress (□) for bottom, bilge and inner bottom plating [N/mm^2]

		Single Bottom	Double Bottom	
Region	Framing	Bottom and bilge	Bottom and bilge	Inner bottom 1)
0.4L amidships	Transverse	($175-120f_B$)/k max. 120/k	($170-120f_B$)/k max. 120/k	($200-110f_B$)/k max. 160/k
	Longitudinal	($185-100f_B$)/k max. 120/k	($180-100f_B$)/k max. 120/k	($220-100f_B$)/k max. 160/k
Within 0.1L from ends				
Elsewhere	To be obtained by linear interpolation between allowable values at regions specified above			

Note : 1) In way of hold tanks amidships intended for ballast or cargo oil the value of allowable bending stress is to be reduced by 10/k [N/mm^2]

f_B = Rule midship section modulus / Actual midship section modulus provided at bottom.

3.4 The section modulus of inner bottom longitudinals is to be based on the design loads given in sec 1, 4.2 for intact conditions and sec 1, 4.3 for hold flooded conditions. For bulk carriers with 'notations BC-A or BC-B the section modulus of both the bottom and inner bottom longitudinal (except in hopper side tanks) for intact conditions is to be obtained as per the following formula using permissible bending stress 'σ' value given below:

$SM = (spl^2 10^3)/(12\sigma)$

p = applicable design pressure for bottom longitudinals and inner bottom longitudinals

l = span of longitudinals in m, measured between the plate floors

s = stiffener spacing, mm.

For bottom longitudinals in way of empty holds

$\sigma = (230 - 135\ f_{BH} - 0.7\ \sigma_{DBB})/k$ N/mm^2

For bottom longitudinals in way of loaded holds

$\sigma = (230 - 135\ f_{BS} - 0.7\ \sigma_{DBB})/k$ N/mm^2

For inner bottom longitudinals

$\sigma = (230 - 135\ f_{BH} \cdot f_z - 0.7\ \sigma_{DBI})/k$ N/mm^2

where,

$f_z = z/z_n$

z_n = vertical distance in m, from the neutral axis of the hull girder to the base line.

z = vertical distance in m, from the neutral axis of hull girder to the free flange of the stiffener or girder

f_{BS}, f_{BH} = f_B as defined above but based on sagging and hogging values of (M_s + M_w) respectively, for the intact loading condition and location under consideration.

σ_{DBB}, σ_{DBI} = longitudinal stress in double bottom at middle of the hold found by direct analysis, at outer bottom plating and inner bottom plating respectively. For preliminary design consideration, σ_{DBB} and σ_{DBI} may be taken as:

= 60 N/mm^2 in general

= 80 N/mm^2, for ore loaded holds between adjacent empty holds.

The requirements for section modulus of inner bottom longitudinals for hold flooded conditions is to be similarly calculated. However, the permissible stress is to be obtained using the value of f_B based on M_{SW} and M_W in flooded conditions as per 2.6.

Appropriate corrosion tolerance for the section modulus should be considered.

3.5 Structural details in way of double bottom tank and hopper tank knuckle is to be given special attention during design/fabrication.

In all dry holds where the double bottom tank and hopper tank knuckle is of radiused construction and the floor spacing is 2.5 m or greater, brackets as shown in Fig. 3.1 are to be arranged mid-length between floors in way of the intersection. The brackets are to be attached to the adjacent inner bottom and hopper longitudinals. The thickness of the brackets is to be in accordance with requirements but need not exceed 15 mm.

In way of floodable holds, two intermediate brackets as shown in Fig. 3.1, are to be provided in all cases where the hopper to double bottom knuckle is radiused and one such intermediate bracket is to be provided where the double bottom tank and hopper tank knuckle is of welded construction.

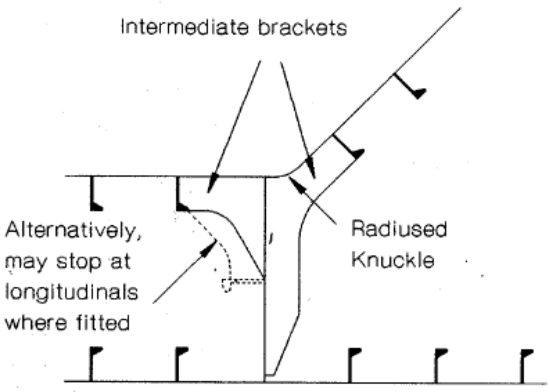


Fig. 3.5: Intermediate brackets at hopper / inner bottom interface

3.6 The connections at the knuckle are to be as follows:

a) Where of welded construction, the corner scallops in floors and transverses are to be omitted, or closed by welded collars where arranged for purposes of construction. In such cases, to ensure satisfactory welding of the collars, the radius of the scallops should not be less than 150 mm. See Fig. 3.2(a). Alternatively, the scallop may be retained on the hopper tank side, provided gusset plates are arranged in line with the inner bottom plating. See Fig. 3.2(b)

b) Where of radiused construction, the corner scallops are to be omitted, and full penetration welding arranged locally for the connection to the inner bottom plating. The centre of the flange at the knuckle is not to be greater than 70 mm from the side girder, See Fig. 3.2(c).

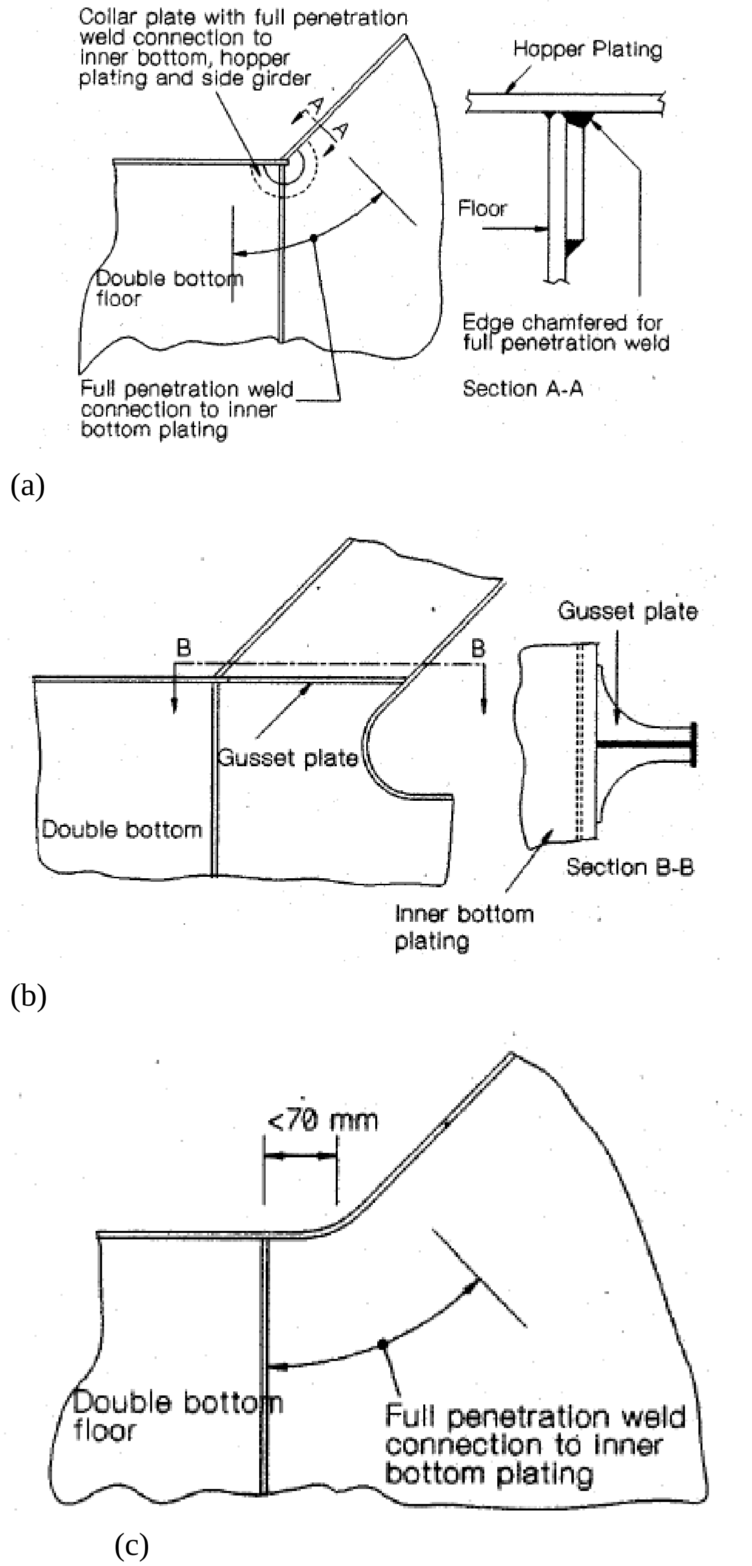


Fig. 3.6: Connection of intersection of inner bottom and hopper

4 Bottom structure - allowable hold loading considering hold flooding

4.1 These requirements apply to those bulk carriers which are required to be considered flooded for the hull girder longitudinal strength investigation in flooded conditions, as per 2.2.

The loading in each hold is not to exceed the allowable hold loading in flooded condition, which is to be calculated as per 4.6, using the loads given in 4.2 and the shear capacity of the double bottom obtained as per 4.3, 4.4 and 4.5.

In no case is the allowable hold loading, considering flooding, to be taken greater than the design hold loading in intact condition.

4.2 The loads to be considered as acting on the double bottom are those given by the external sea pressures and the combination of the cargo loads with those induced by the flooding of the hold to which the double bottom belongs.

The flooding head h_f is the distance, m, measured vertically with the ship in the upright position, from the inner bottom to the flooded waterline as defined in 1.4.3 alone, i.e. without applying 1.4.4.

The most severe combinations of cargo induced loads and flooding loads are to be used, depending on the loading conditions included in the loading manual:

- homogeneous loading conditions;
- non homogeneous loading conditions;
- packed cargo conditions (such as steel mill products).

For each loading condition, the maximum bulk cargo density to be carried is to be considered in calculating the allowable hold loading limit.

4.3 The shear capacity C in kN of the double bottom is defined as the sum of the shear strength at each end of:

- all floors adjacent to both hoppers, less one half of the strength of the two floors adjacent to each stool (or transverse bulkhead if no stool is fitted) (See Fig. 4.1).
- all double bottom girders adjacent to both stools (or transverse bulkheads if no stool is fitted).

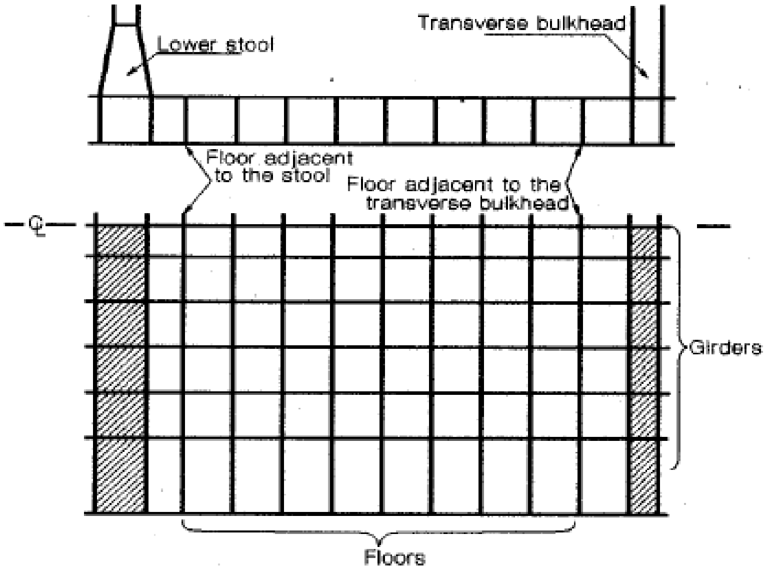


Fig. 4.1: Members contribution to shear capacity of double bottom

Where, in the end holds, girders or floors run out and are not directly attached to the boundary stool or hopper girder, their strength is to be evaluated for the one end only.

It may be noted that the floors and girders to be considered are those inside the hold boundaries formed by the hoppers and stools (or transverse bulkheads if no stool is fitted). The hopper side girders and the floors directly below the connection of the bulkhead stools (or transverse bulkheads if no stool is fitted) to the inner bottom are not to be included.

When the geometry and/or the structural arrangement of the double bottom are such as to make the above assumptions inadequate, the shear capacity C of double bottom will be specially considered.

In calculating the shear strength, the net thickness of floors and girders is to be used.

The net thickness, $t_{net} = t - 2.5$ mm

where,

t = thickness mm, of floors and girders.

4.4 The floor shear strength in way of the floor panel adjacent to hoppers Sf1 and the floor shear strength in way of the openings in the outmost bay (i.e. that bay which is closer to hopper) Sf2 are given by:

$$S_{f1} = A_f \frac{\tau_a}{\eta_1} 10^{-3} \quad \text{kN}$$

$$S_{f2} = A_{fh} \frac{\tau_a}{\eta_2} 10^{-3} \text{ kN}$$

where,

A_f = sectional area in mm^2, of the floor panel adjacent to hoppers;

A_{fh} = net sectional area in mm^2, of the floor panels in way of the openings in the outmost bay (i.e. that bay which is closer to hopper);

τ_a = allowable shear stress in N/mm^2

$$= 162\sigma_Y^{0.6}\left(t/s\right)^{0.8} \text{ or } \sigma_Y/\sqrt{3}$$

whichever is lesser.

For floors adjacent to the stools or transverse bulkheads, τ_a may be taken as $\sigma_Y/\sqrt{3}$.

σ_y = minimum upper yield stress N/mm^2, of the material;

s = spacing of stiffening members mm, of panel under consideration;

η_1 = 1.10

η_2 = 1.20

η_2 may be reduced to 1.10 where adequate reinforcements are fitted in way of the openings in floors.

4.5 The girder shear strength in way of the girder panel adjacent to stools (or transverse bulkheads, if no stool is fitted), Sg1 and the girder shear strength in way of the largest opening in the outmost bay (i.e. that bay which is closer to stool, or transverse bulkhead, if no stool is fitted) Sg2 are given by:

$$S_{g1} = A_g \frac{\tau_a}{\eta_1} 10^{-3} \quad \text{kN}$$

$$S_{g2} = A_{gh} \frac{\tau_a}{\eta_2} 10^{-3} \quad \text{kN}$$

where,

A_g = minimum sectional area in mm^2, of the girder panel adjacent to stools (or transverse bulkheads, if no stool is fitted).

A_{gh} = net sectional area, mm^2, of the girder panel in way of the largest opening in the outmost bay (i.e. that bay which is closer to stool, or transverse bulkhead, if no stool is fitted).

τ_a = allowable shear stress, N/mm^2, as given in 4.4.

η_1 = 1.10

η_2 = 1.15

η_2 may be reduced to 1.10 where adequate reinforcements are fitted in way of the openings in girders.

4.6 The allowable hold loading 'W', is given by:

W = ρ_c . V / F in tones

where,

F = 1.1 in general 1.05 for steel mill products

ρ_c = maximum applicable value of bulk cargo density, t/m^3, (See 4.2)

= cargo density for steel products.

V = volume, m^3, of the hold under consideration upto a level, h_1 measured vertically above the inner bottom

$$h_1 = \frac{X}{\rho_c g_0} \text{ m}$$

X = the lesser of X_1 and X_2 for bulk cargoes

= X_1 for steel products

X_1 and X_2 are given below:

$$X_1 = \frac{Z + \rho g_0 (E - h_f)}{1 - \rho(1-\mu)/\rho_c}$$

$$X_2 = Z + \rho\ g_o\ (E - hf\ .\ \mu)$$

E = d_f - 0.1D

d_f = as given in sec1, 4.3.

μ = cargo permeability as per sec1, Table 4.1, however, need not be taken greater than 0.3.

For steel mill products, μ = 0.

Z = $\frac{C_h}{A_{DB,h}}$ or $\frac{C_e}{A_{DB,e}}$ whichever is lesser.

where,

C_h = The shear capacity of the double bottom, kN, considering, for each floor, the lesser of the shear strengths S_{f1} and S_{f2} and, for each girder, the lesser of the shear strengths S_{g1} and S_{g2}. (See 4.3, 4.4 and 4.5).

Ce = The shear capacity of the double bottom, kN, considering, for each floor, the shear strength Sf1 and for each girder, the lesser of the shear strengths Sg1 and Sg2. (See 4.3, 4.4 and 4.5).

$$A_{DB,h} = \sum_{i=1}^{i=n} S_i B_{DB,i}$$

$$A_{DB,e} = \sum_{i=1}^{i=n} S_i (B_{DB} - s_l)$$

n = number of floors between stools (or transverse bulkheads, if no stool is fitted)

S_i = mean spacing of i^{th} floor in m

$B_{DB,i} = (B_{DB} - s_l)$ - for floors whose shear strength is given by S_{f1} i.e. floors without openings in the outmost bay

= $B_{DB,h}$ - for floors whose shear strength is given by S_{f2} i.e. floors with openings in the outmost bay

B_{DB} = breadth of double bottom, m, between hoppers (See Fig. 4.2)

$B_{DB,h}$ = distance m between the two openings considered (See Fig.4.2)

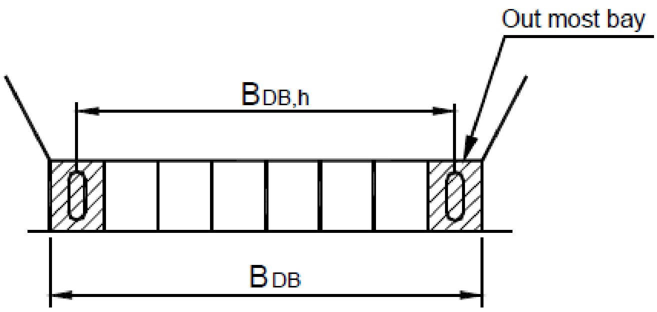


Fig.4.2: Definition of B_{DB} and $B_{DB,h}$

s_l = spacing m, of double bottom longitudinals adjacent to hoppers.

5 Side structure

5.1 The requirements given in this section apply to the side structures of cargo holds bounded by the side shell only of all bulk carriers which are contracted for construction on or after 1 July 1998.

5.2 The thickness of the side shell plating located between the hopper and topside tanks is to be not less than:

$t = \sqrt{L}$ mm

5.3 The thickness of web of main frames situated within cargo and ballast holds, except in the foremost hold, is not to be less than:

$t = (7.0 + 0.03L)$ mm

where, L need not be taken as greater than 200 m.

In foremost hold, the frame web thickness is to be at least 15% greater than that given above.

The thickness of the main frame lower bracket is to be 2 mm greater than the minimum frame web thickness. In no case the thickness of the main frame lower brackets and upper brackets is to be less than that provided for main frame web.

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

The frame face plate is to be curved (not knuckled) at the connection with the end brackets. The radius of curvature, 'r', is not to be less than:

$r = 0.4 b_f^2 / t_f$ mm

where,

b_f and t_f are the width of the face plate and thickness of the brackets in mm, respectively.

The face plate, is to be sniped at the end.

In ships of length less than 190 m, frames when made of ordinary mild steel, may be asymmetric and fitted with separate brackets.

The face plate or flange of the bracket is to be sniped at both ends. Brackets are to be arranged with soft toes.

The web depth to thickness ratio of frames is not to exceed the following values:

$60\sqrt{Q}$ for symmetric sections

$50\sqrt{Q}$ for asymmetric sections

where,

Q = material factor for the side frame.

In case of asymmetric sections, the breadth of the face plate or flange is not to exceed $10\sqrt{Q}$ times its thickness.

5.5 In way of the foremost hold, side frames of asymmetric section are to be effectively supported by tripping brackets as shown in Fig. 5.1.

5.6 The scantlings of hold side frames immediately adjacent to the collision bulkhead are to be suitably increased in order to prevent excessive deformation imposed on the shell plating. As an alternative, at least two supporting structures are to be fitted which align with forepeak stringers or flats as shown in Fig. 5.2.

5.7 The dimensions of the lower and upper brackets are not to be smaller than those shown in Fig. 5.3.

The section modulus of the frame and bracket or integral bracket and associated shell plating, at the locations marked 'Zb' in Fig. 5.3, is not to be less than twice the section modulus required for the frame in midspan area.

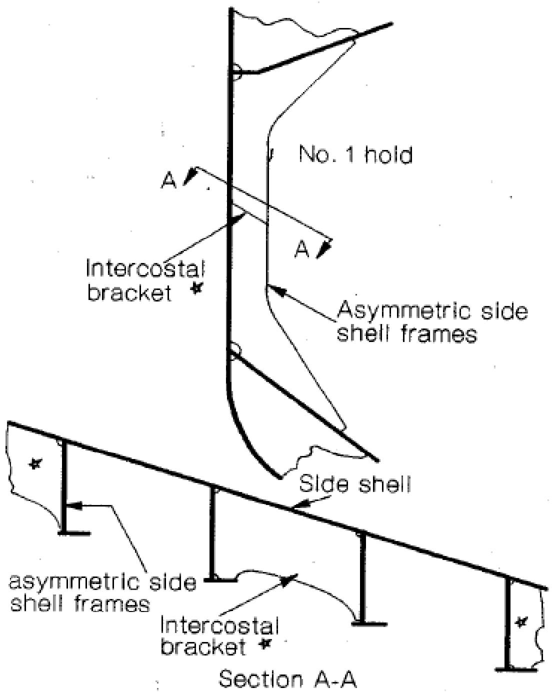


Fig. 5.1 Typical arrangement of inter coastal brackets supporting asymmetric side shell frames in foremost hold

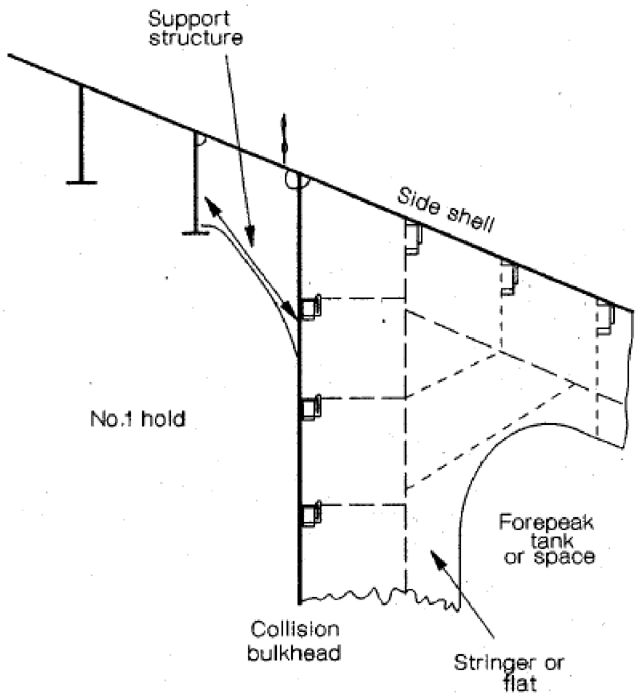


Fig. 5.2 Hold frame supporting structures aft of collision bulkhead

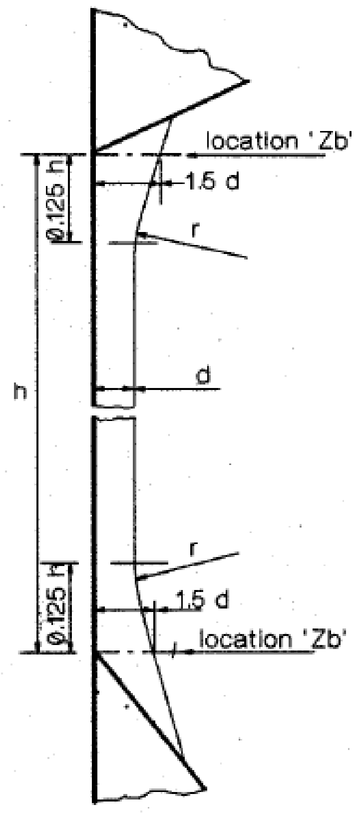


Fig. 5.3Minimum dimensions of end brackets

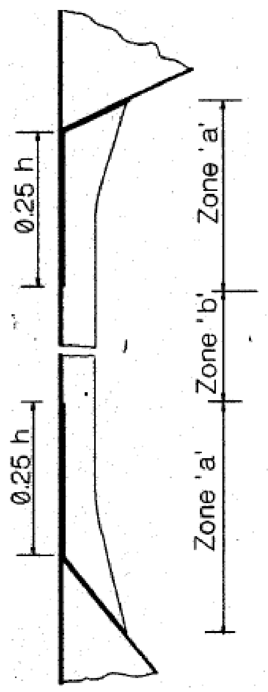


Fig. 5.4 Definition of zones ιa̦andιb̦for welding

5.8 Double continuous welding is to be adopted for the connections of frames and brackets to side shell, hopper and upper wing tank plating and web to face plates. For this purpose, the weld factor is to be not less than:

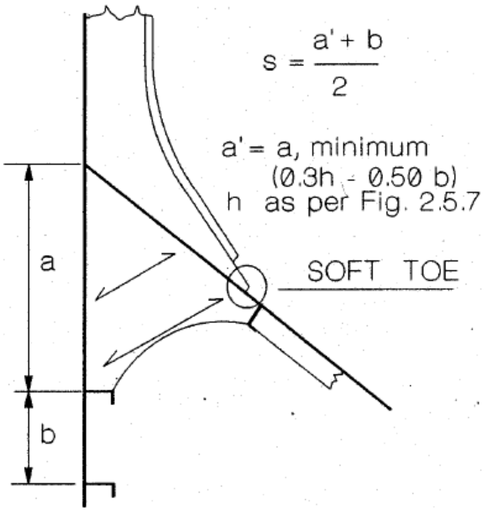
0.44 in zone 'a' and

0.4 in zone 'b'

See Fig. 5.4 for extent of zone 'a' and 'b'.

Where the hull form is such that an effective fillet weld can not be made, edge preparation of the web of frame and bracket may be required, in order to ensure the required efficiency of the weld connection.

5.9 At upper and lower end of frames, supporting brackets are to be arranged inside hopper and topside tanks, in line with the main frame brackets to provide adequate resistance to the rotation and displacement of the joint.



aج a, minimum
(0.3h ث0.50b)
h as per Fig. 5.3

Fig. 5.9: Detail in way of end brackets

The thickness of the supporting brackets is generally to be the same as that of the main frame bracket.

Where the toe of the hold frame bracket is situated on or in close proximity of the first longitudinal on the hopper or topside tank sloping bulkhead from the side shell, the supporting brackets are to be extended to the next longitudinal. This extension is to be obtained by enlarging the supporting bracket or by fitting an intercostal flat bar stiffener of same depth as that of the longitudinal.

In all cases, the section modules of the side longitudinals and sloping bulkhead longitudinal which are connected to the supporting brackets are to be determined using the spacing 's' as shown in Fig. 5.9 and span taken between transverses.

6 Hopper side tank structure

6.1 Scantlings of sloped bulkhead plating and stiffening is to be as per Pt III, ch2, sec 9, based on the actual spacing of stiffeners; and dry bulk cargo loading given in Sec.1, 4 or as for a deep tank, whichever is higher.

6.2 Transverses supporting longitudinals are to be arranged in line with double bottom floors.

7 Topside tank structure

7.1 The scantlings of sloped bulkhead plating and stiffening is to be as per Pt III, ch2, based on actual spacing of stiffeners and loading corresponding to sec1, 4 or as for a deep tank, whichever is higher.

7.2 Where the sloping bulkhead stiffeners are fitted on the hold side of the bulkhead, suitable arrangement to prevent tripping are to be provided.

7.3 Transverses supporting longitudinals are generally to be spaced not more than 3.6 m apart. They are also to be arranged in line with hatch end beams.

8 Deck structure

8.1 The deck within the line of hatchway openings is preferably to be stiffened transversely or alternatively the arrangements are to be such as to provide adequate buckling strength to resist athwartships forces acting on ship's sides.

8.2 In case of large bulk carriers with narrow deck strips between hatchways and for vessels of class notation BC-A the cross deck scantlings will be specially considered.

8.3 Where the difference between the thickness of plating inside and outside the line of hatchway openings exceeds 12 mm, a transitional plate of thickness equivalent to the mean of the adjacent plate thicknesses is to be fitted.

9 Corrugated bulkheads - Construction

9.1 Where bulkheads are of corrugated construction, the angle of corrugation (i.e. of webs with the plane of bulkheads) is not to be less than 55, See Fig. 9.1.

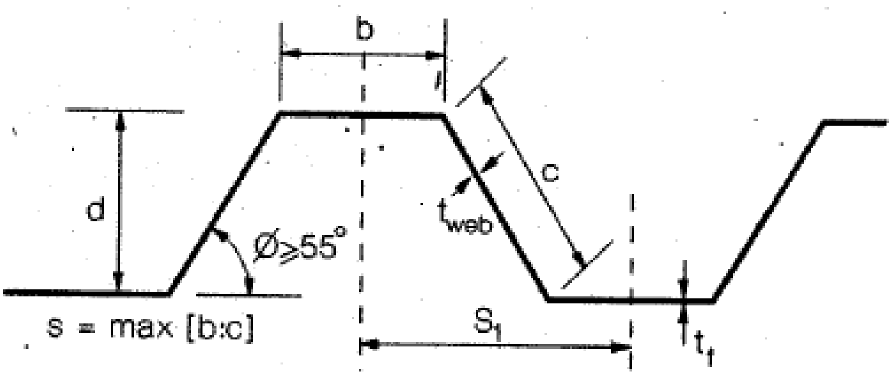


Fig. 9.1: Corrugated bulkhead

9.2 For ships of length 190 m and above, vertically corrugated transverse bulkheads are to be fitted with a lower stool and generally with an upper stool below deck.

For smaller ships, corrugated bulkheads may extend from inner bottom to deck. However, where a lower and/or upper stool is fitted in smaller ships, the requirements of 9.4 and/or 9.5 are to be complied with, as applicable.

9.3 Where no stool is fitted at bottom, supporting floors are to be provided in line with corrugation flanges. Corrugated bulkhead plating is to be connected to the inner bottom plating by full penetration welds. The plating of supporting floors is to be connected to the inner bottom by either full penetration or deep penetration welds as per Fig. 9.2. The thickness and material specification of the supporting floors are to be at least equal to those provided for the corrugation flanges.

Additionally, the cut-outs for connections of the inner bottom longitudinals to double bottom floors are to be closed by collar plates. The supporting floors are to be connected to each other by means of shear plates.

Where no stool is fitted at deck, two transverse reinforced beams are to be fitted in line with the corrugation flanges.

9.4 The lower stool, where fitted, is generally to have a height equal to 3 times the depth of corrugation 'd'. The thickness and material specification of the stool top plate and the stool side plates within the depth equal to the corrugation flange width from the stool top should not to be less than the flange plate thickness and material specification required to meet the bulkhead stiffness requirement at the lower end of corrugation.

The distance of the edge of the stool top plate to the surface of the corrugation flange is to be in accordance with Fig. 9.3.

The sloping stool side plating is to align with the corrugation flanges. Knuckles on stool side plating are not permitted.

The scantlings of the stool side plating and stiffeners are not to be less than those required

for plane transverse bulkhead using corresponding ballast or cargo flooded pressure.

The stool side vertical stiffeners are to be bracketed at the top and bottom ends. The lower end brackets are to align with the inner bottom longitudinals.

The stool bottom is to be arranged in line with the double bottom floors and should have a width not less than 2.5 times the width of the top plate. These supporting floors are to have thickness and material properties not less than that of the lower strake of the bottom stool. Cutouts for the connection of inner bottom longitudinals to these double bottom floors are to be closed by collar plates.

Diaphragms are to be fitted in line with longitudinal girders of the double bottom for effective support of the bulkhead. Scallops in the brackets and diaphragms in way of the top and bottom connections to the top plate and the double bottom floors/girders are to be avoided.

Where corrugations are cut at the bottom stool, corrugated bulkhead plating is to be connected to the stool top plate by full penetration welds.

The stool side plating is to be connected to the stool top plate and the inner bottom plating by either full penetration or deep penetration welds as per Fig. 9.2. The supporting floors are to be connected to the inner bottom by either full penetration or deep penetration welds as per Fig. 9.2.

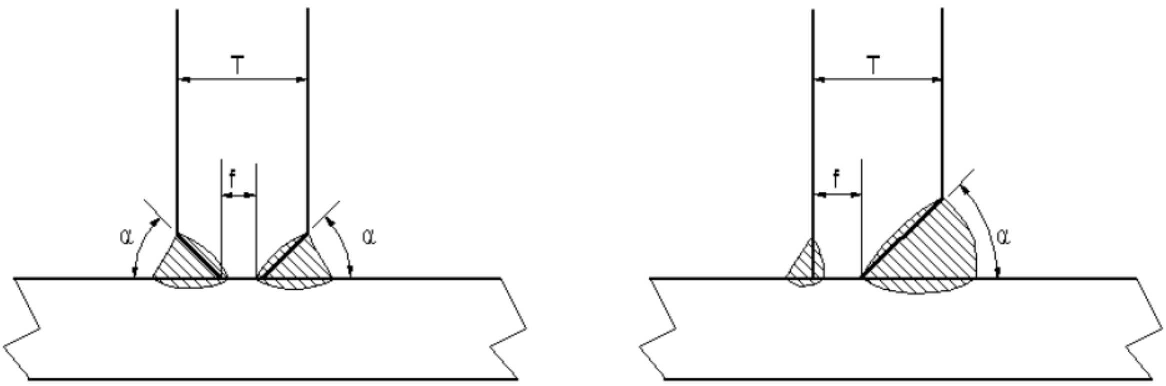
9.5 The upper stool, where fitted, is to have a height, measured at the hatch side girder, equal to 2 to 3 times the depth of corrugations.

Rectangular stools are generally to have a height of 2 times the depth of corrugation. The upper stool is to be adequately supported by girders or deep brackets between the adjacent hatch-end beams.

The width of the stool bottom plate should generally be the same as that of the lower stool top plate. The stool top of non-rectangular stools are to have widths not less than 2 times the depth of corrugations. The thickness and material of the stool bottom plate is to be the same as that of the bulkhead plating below. The thickness of the lower portion of the stool side plating is to be not less than 80% of that required for upper part of the corrugated bulkhead plating, where same material is used.

The thickness of stool side plating and the section modulus of its stiffeners are to be not less than those required for plane transverse bulkheads and stiffening using corresponding ballast or cargo flooded pressure. The stool side stiffeners are to be attached to brackets at upper and lower end of the stool.

Diaphragms are to be fitted inside the stool in line with and effectively attached to longitudinal deck girders extending to the hatch end coaming for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connection to the stool bottom plate are to be avoided.



Root face (f): 3 mm to T/3 mm

Groove angle (a): 40 to 60

Fig. 9.2

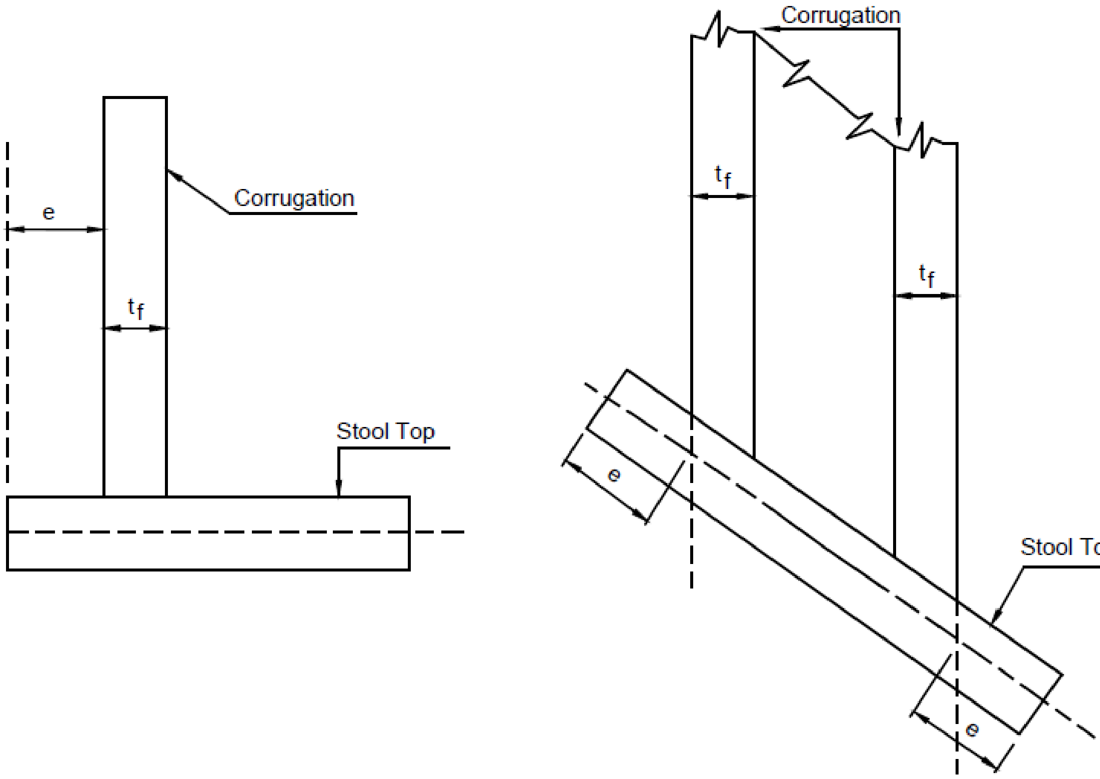


Fig. 9.3 Permitted distance, e, from edge of stool top plate to surface of corrugation flange

10 Corrugated bulkheads - Strength

10.1 The scantlings of bulkheads are to be as per Pt3, ch2, sec9, taking into account the dry bulk cargo loading given in sec1, 4.2 and, where applicable as per 10.3, the loading in cargo hold flooded condition as given in sec1, 4.3.

10.2 In way of ballast holds, the scantlings of bulkhead are not to be less than those required for a deep tank.

10.3 The following requirements apply to vertically corrugated transverse watertight bulkheads bounding those cargo holds which are required to be considered flooded for the hull girder longitudinal strength investigation in flooded conditions, as per 2.2.

10.4 The loads to be considered as acting on the bulkheads are those given by the combination of the cargo loads with those induced by the flooding of one hold adjacent to the bulkhead under examination. In any case, the pressure due to the flooding water alone is also to be considered.

The most severe combinations of cargo induced loads and flooding loads are to be used for the check of the scantlings of each bulkheads, depending on the loading conditions (homogeneous and non-homogeneous included in the loading manual).

Individual flooding of both loaded and empty holds is to be considered.

Non homogeneous part loading conditions associated with multiport loading and unloading operations for homogeneous loading conditions need not be considered.

10.5 In this context, homogeneous loading condition means a loading condition in which the ratio between the highest and the lowest filling ratio, evaluated for each hold and corrected for differences in cargo densities, if any, does not exceed 1.20.

10.6 Holds carrying packed cargoes are to be considered as empty holds for this application.

Unless the ship is intended to carry, in nonhomogeneous conditions, only iron ore or cargo having bulk density equal or greater than 1.78 [t/m3], the maximum mass of cargo which may be carried in the hold shall also be considered to fill that hold upto the upper deck level at centreline.

10.7 At each point of the bulkhead structure, the resultant pressure p and the resultant force F, to be considered for the scantlings of the bulkhead, is given in Table 10.1:

Table 10.1: Resultant pressures and forces

Loading condition	p in N/mm^2	F in kN
Homogeneous	p_{cF} - 0.8 p_c; Minimum p_f	$F_{c,f}$ - 0.8 F_c; Minimum F_f
Non-homogeneous	p_{cF}	$F_{c,f}$
Empty hold, flooded	p_f	F_f

where, pressures $p_{c,f}$, p_c, p_f and forces $F_{c,f}$, F_c and F_f are given in sec1 Table 4.2 and sec1, Fig 4.1.

10.8 The design bending moment M, kN-m, for the bulkhead corrugations is given by:

$M = F.l/8$

where,

F = resultant force, kN, as per 10.7.

l = span of the corrugation, m, See Fig. 10.1 (a), (b) and (c).

The shear force Fs, kN, at the lower end of the bulkhead corrugations is given by:

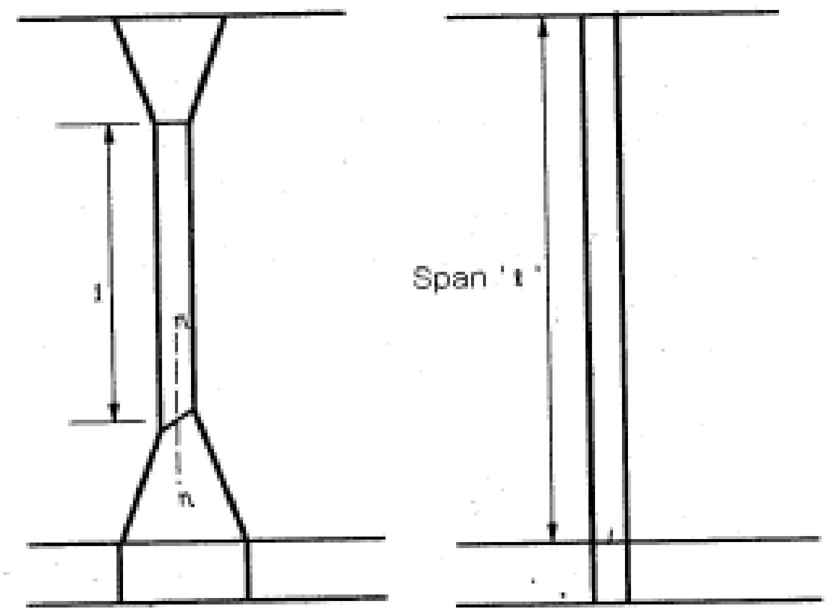
Fs = 0.8 F

10.9 For the purpose of the calculations, the shedder plates can be considered effective provided they:

- are not knuckled;
- are attached to the corrugations and the top of the lower stool by one side penetration welds or equivalent;
- have with a minimum slope of 45 and their lower edge is in line with the stool side plating;
- have thicknesses not less than 75% of that of the corrugation flange;
- material properties are at least equal to that of the corrugation flanges.

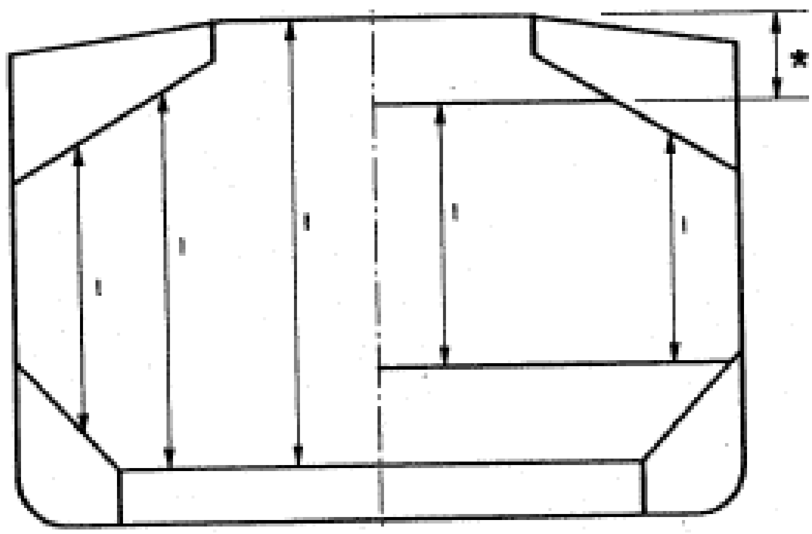
10.10 For the purpose of the calculations, gusset plates can be considered effective provided they:

- act together with effective shedder plates
- have a height not less than half of the flange width
- are fitted in line with the stool side plating
- are generally welded to the top of the lower stool by full penetration welds, and to the corrugations and shedder plates by one side penetration welds or equivalent
- have thickness and material properties at least equal to those of the flanges.



n=neutral axis of the corrugations

(a) (b)



* For the definition of I, the internal end of the upper stool is not to be taken more than a distance from the deck at the centre line equal to

- 3 times the depth of corrugations, in general
- 2 times the depth of corrugations, for rectangular stool

Fig. 10.8: Definition of span of corrugation

10.11 The thickness of the lower part of corrugations considered in the application of 10.12 to 10.14 are to be maintained for a distance from the inner bottom (if no lower stool is fitted) or the top of the lower stool not less than 0.15l;

The thickness of the middle part of the corrugations considered in the application of 10.12, 10.13 and 10.15 are to be maintained to a distance from the deck (if no upper stool is fitted) or the bottom of the upper stool not greater than 0.3*l*;

where '*l*' is the span of the corrugation as defined in 10.8.

The section modulus of the corrugation in the remaining upper part of the bulkhead is not to be less than 75% of that required for the middle part, corrected for difference in yield stresses, if any.

10.12 The bending capacity of the corrugations is to comply with the following relationship:

$$\frac{M \cdot 10^3}{[0.5 Z_{le} (\sigma_y)_{le} + Z_m (\sigma_y)_m]} \leq 0.95$$

where,

M = bending moment, kN-m, as per 10.8

Z_{le} = section modulus, cm^3, at the lower end of corrugations, to be calculated according to 10.14; but not to be taken greater than Z'_{le}.

Z_m = section modulus, cm^3, at the mid-span of corrugations, to be calculated according to

10.15, but not to be taken greater than 1.15 times Z_{le} as defined above.

$(\sigma_y)_{le}$, $(\sigma_y)_m$ = minimum upper yield stress of the material at the lower end of corrugations and at the midspan of corrugations respectively.

$$Z'_{le} = Z_g + 10^3 (F_s h_g - 0.5 h_g^2 s_1 p_g) / \sigma_y$$

where,

Z_g = section modulus, cm^3, of the corrugations calculated, according to 10.15 in way of the upper end of shedder or gusset plates, as applicable

F_s = shear force kN as per 10.8

h_g = height in m, of shedders or gusset plates, as applicable (See Fig. 10.2 a, b, c, d & e)

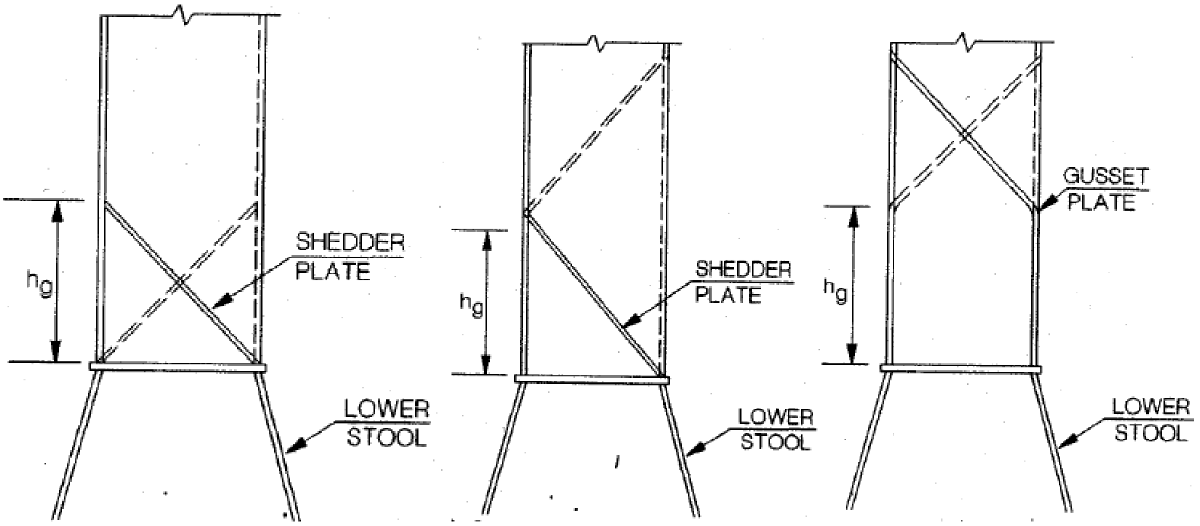
s_1 = corrugation spacing mm. See Fig. 9.1

p_g = resultant pressure in N/mm^2, as per 10.7, calculated in way of the middle of the shedders or gusset plates, as applicable.

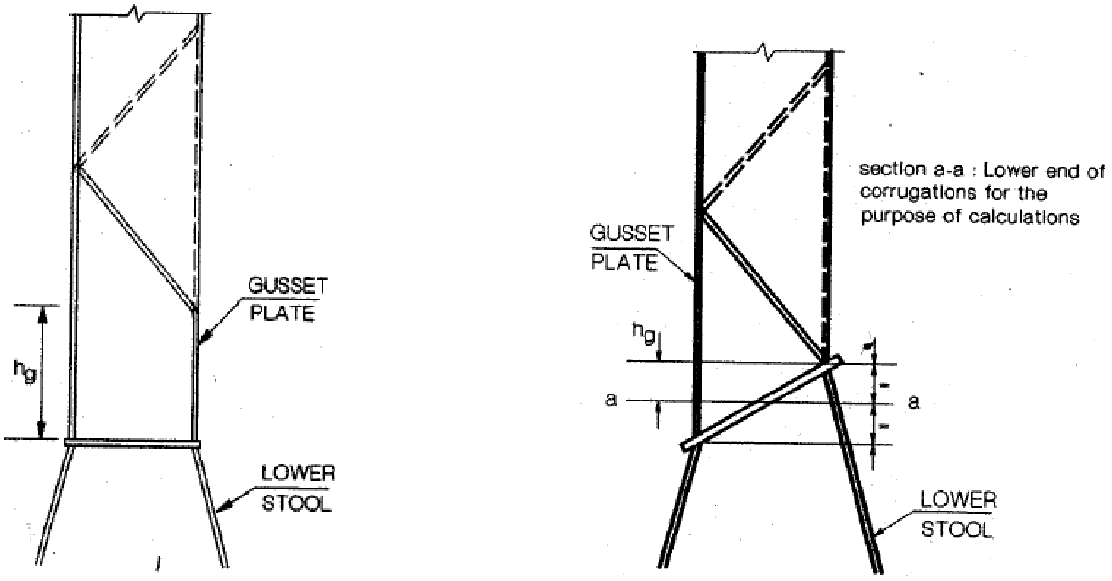
10.13 The net plate thickness to be used in the calculations of scantlings as per 10.14 to 10.17 is to be obtained by:

t_{net} = t - 3.5 mm

where, t is the actual thickness provided.



a)Symmetric shedder plate b)Asymmetric shedder plate c)Symmetric gusset / shedder plate



d) Asymmetric gusset / shedder plate e)Gusset / shedder plates with sloped stool top

Fig. 10.11: Arrangement of gusset / shedder plate

10.14 The section modulus of the lower end of corrugation is to be calculated using the net plate thicknesses and with the compression flange having an effective flange width, bef m not larger than:

$b_{ef} = C_e \cdot b$

where,

$$C_e = 2.25/\beta - 1.25/\beta^2; \quad \max = 1.0$$

$$\beta = 10^3 \frac{b}{t_f}\sqrt{\sigma_y / E}$$

t_f = net flange thickness mm.

b = width in m, of the corrugation flange. See Fig. 9.1

$□_y$ = minimum upper yield stress in N/mm^2, of the material

E = modulus of elasticity of the material in N/mm^2.

If corrugation webs are not supported by local brackets below the stool top (or below the inner bottom) in the lower part; or above the stool bottom (or in way of the upper deck) in the upper part; the section modulus is to be calculated considering the corrugation webs 30% effective.

i) Where effective shedder plates, as per 10.9 are fitted, the section modulus of corrugations at the lower end may be calculated with the area of flange plates increased by $0.0025b\sqrt{t_f t_{sh}}$ cm^2

where,

b = width mm of the corrugation flange

t_f = net flange thickness in mm

t_{sh} = net shedder plate thickness in mm; but not to be taken greater than t_f.

ii) Where effective gusset plates, as per 10.10 are fitted, the section modulus of corrugations at the lower end may be calculated with the area of flange plates increased by (7 . h_g . t_f) cm^2

where,

h_g = height of gusset plate m; but not to be taken greater than (10/7 S_{gu})

See Fig. 10.2 c, d and e.

s_{gu} = width of the gusset plates m

t_f = net flange thickness mm

iii) Where corrugation webs are welded to a sloping stool top plate which has an angle not less than 45^o with the horizontal plane, the section modulus of the corrugations may be calculated considering the corrugation webs fully effective. In case effective gusset plates are fitted, when calculating the section modulus of corrugations the area of flange plates may be increased as specified in (ii) above. No credit can be given to shedder plates only. See Fig. 10.2e.

For angles less than 45^o, the effectiveness of the web may be obtained by linear interpolation between 30% for 0o and 100% for 45^o.

10.15 The section modulus of corrugations at cross sections other than the lower end is to be calculated with the corrugation webs considered effective and the compression flange having an effective flange width, bef, as defined in 10.14.

10.16 Shear stresses □ are obtained by dividing the shear force Fs by the shear area.

When calculating the shear area, the net plate thicknesses are to be used. The shear area is to be reduced in order to account for possible nonperpendicularity between the corrugation webs and flanges. In general, the reduced shear area may be obtained by multiplying the web sectional area by (sin □), □ being the angle between the web and the flange.

Calculated shear stress is to comply with the following:

$\tau \le 0.5\,\sigma_y$

where,

σ_y = minimum upper yield stress of the material.

Shear buckling check is to be performed for the web plates at the corrugation ends, to ensure that the actual shear stress does not exceed the critical shear buckling stress, i.e.

$\tau_{cr} \ge \tau_c$

where,

τ_c = actual shear stress calculated for the web plate

τ_{cr} = the critical shear buckling stress

10.17 The bulkhead local net plate thickness t, mm, is given by:

$$t = 0.483 s \sqrt{p / \sigma_y}$$

s = plate width, in mm, to be taken equal to the width of the corrugation flange or web,

whichever is the greater. See Fig. 9.1.

p = resultant pressure, in N/mm^2, as defined in 10.7, at the bottom of each strake of plating.

σ_y = minimum upper yield stress in N/mm^2, of the material.

In all cases, the net thickness of the lowest strake is to be determined using the resultant pressure at the top of the lower stool, or at the inner bottom, if no lower stool is fitted or at the top of shedders, if shedder or gusset/shedder plates are fitted.

For built-up corrugation bulkheads, when the thicknesses of the flange and web are different, the net thickness requirements are to be calculated as per the above formula using the respective width of web or flange. In addition the net thickness of the wider plating is to be not less than:

$$t = \sqrt{0.462 s^2 p / \sigma_y - t_a^2} \qquad \text{mm}$$

where,

t_a = net thickness of the adjacent plating mm.

10.18 The design of local details is to be adequate for the purpose of transferring the corrugated bulkhead forces and moments to the boundary structures, in particular, the double bottom and cross-deck structures.

The thickness and stiffening of effective gusset and shedder plates, are to be based on loads as per 10.4, see also 10.5 and 10.6.

11 Protective coatings for cargo hold spaces

11.1 All internal and external surfaces of hatch coamings and hatch covers and all internal surfaces of the cargo holds, excluding the flat tank top areas and the hopper tank sloping plating extending upwards upto approximately 300 mm below the side shell frame and brackets, are to have an efficient protective coating (epoxy or equivalent) applied in accordance with the manufacturers recommendations.

11.2 In the selection of coating, due consideration is to be given by the Owner to intended cargo conditions expected in service.

12 Damage stability requirements

12.1 Bulk carriers of single side skin construction and of length 150 m and above designed to carry solid bulk cargoes having a density of 1.0 tonnes per cubic metre and above, the keels of which are laid or are at a similar stage of construction on or after 1 July, 1999 shall, when loaded to the summer load line, be able to withstand flooding of any one cargo hold in all loading conditions and remain afloat in a satisfactory condition of equilibrium, as specified in 12.4.

12.2 Bulk carriers of single side skin construction, in the foremost cargo hold and of length 150 m and above carrying solid bulk cargoes having a density of 1.78 tonnes per cubic metre and above, the keels of which are laid or are at a similar stage of construction before 1 July 1999 shall, when loaded to the summer loadline, be able to withstand flooding of the foremost cargo hold in all loading conditions and remain afloat in a satisfactory condition of equilibrium, as specified in 12.4. This requirement shall be complied with in accordance with the schedule given for compliance with IMO standards for scantlings of transverse bulkhead between the two foremost cargo holds and allowable hold loading for the foremost cargo hold.

12.3 Bulk carriers of double side skin construction and of length 150 m and above in which any part of the longitudinal bulkhead is located within B/5 or 11.5 m, whichever is less, inboard from the shipۑ side at right angle to the centerline at the assigned summer load line, designed to carry solid bulk cargoes having a density of 1000 in kg/m3 and above, shall be able to withstand when loaded to the summer load line, flooding of any one cargo hold in all loading conditions and remain afloat in a satisfactory condition of equilibrium as specified in 12.4.

12.4 Subject to the provisions of 12.7 below, the condition of equilibrium after flooding shall satisfy the condition of equilibrium laid down in the annex to resolution A.320(IX) ت Regulation equivalent to Regulation 27 of the International Convention on Load Lines, 1966, as amended by Resolution A.514(13). The assumed flooding need only take into account flooding of the cargo hold space. The permeability of a loaded hold shall be assumed as 0.9 and the permeability of an empty hold shall be assumed as 0.95, unless a permeability relevant to a particular cargo is assumed for the volume of a flooded hold occupied by cargo and a permeability of 0.95 is assumed for the remaining empty volume of the hold.

12.5 Bulk carriers contracted before 1 July, 1998 which have been assigned a reduced freeboard in compliance with regulation 27(7) of the International Convention on Load Lines, 1966, may be considered as complying with the requirements of 12.2.

12.6 Bulk carriers which have been assigned a reduced freeboard in compliance with the provisions of paragraph (8) of the regulation equivalent to regulation 27 of the International Convention on Load Lines, 1966, adopted by resolution A.320(IX), as amended by resolution A.514(13), may be considered as complying with the requirements of 12.1, 12.2 or 12.3, as appropriate.

12.7 On bulk carriers which have been assigned reduced freeboard in compliance with the provisions of regulation 27(8) set out in Annex B of the Protocol of 1988 relating to the International Convention on Load Lines, 1966, the condition of equilibrium after flooding shall satisfy the relevant provisions of that Protocol.

13 Hold, ballast and dry space water level detectors

13.1 All bulk carriers are to be fitted with water level detectors as indicated in a), b) and c) below:

a) In each cargo hold, giving audible and visual alarms, one when the water level above the inner bottom in any hold reaches a height of 0.5 m and another at a height not less than 15% of the depth of the cargo hold but not more than 2 m.

If bulk carriers are exempted by the Administration from the compliance of SOLAS Chapter XII Reg.4.2 and 6 according to the provisions of SOLAS Chapter XII Reg.9, then only one alarm at a water level of not less than 15% of the depth of the cargo hold but not more than 2m needs to be provided.

The water level detectors are to be fitted in the aft end of the cargo holds.

For cargo holds which are used for water ballast, an alarm overriding device is to be installed.

The visual alarms are to clearly discriminate between the two different water levels detected in each hold.

b) In any ballast tank forward of the collision bulkhead giving an audible and visual alarm when the liquid in the tank reaches a level not exceeding 10% of the tank capacity. An alarm overriding device is to be installed for activation when the tank is in use; and

c) In any dry or void space other than a chain cable locker, any part of which extends forward of the foremost cargo hold, giving an audible and visual alarm at a water level of 0.1 m above the deck. Such alarms need not be provided in enclosed spaces if the volume of the space does not exceed 0.1% of the ship's maximum displacement volume.

The audible and visual alarms described in a), b) and c) above are to be located on the navigation bridge. The water level detectors are to be of approved type.

14 De-watering of forward spaces

14.1 On bulk carriers, the means for draining and pumping ballast tanks forward of the collision bulkhead and bilges of dry spaces any part of which extends forward of the foremost cargo hold, is to be capable of being brought into operation from a readily accessible enclosed space, the location of which is accessible from the navigation bridge or propulsion machinery control position without traversing exposed freeboard or superstructure decks.

In this context, an enclosed space accessible via an under deck passage, a pipe trunk or other similar means of access is not considered as a "readily accessible enclosed space".

14.2 Where pipes serving tanks or bilges pierce the collision bulkhead, valve operation by means of remotely operated actuators may be accepted, as an alternative to the valve control, provided that the location of such valve controls complies with 14.1.

14.3 Where the piping arrangements for dewatering closed dry spaces are connected to the piping arrangements for the drainage of water ballast tanks, two non-return valves located in accessible positions, are to be provided to prevent the ingress of water into dry spaces from those intended for the carriage of water ballast. One of these non-return valves is to be fitted with shut-off isolation arrangement capable of being controlled from the same readily accessible enclosed space specified in 14.1.

14.4 The failure of either control system power or actuator power is not to alter the valve position.

14.5 Positive indication is to be provided at the remote control station to show that the valve is fully open or closed.

14.6 The dewatering arrangements are to be such that any accumulated water can be drained directly by a pump or educator.

14.7 When the dewatering arrangements are in operation, other systems essential for the safety of the ship including fire-fighting and bilge systems are to remain available and ready for immediate use. The systems for normal operation of electric power supplies, propulsion and steering should not be affected by the operation of the dewatering systems. It must also be possible to immediately start fire pumps and have a ready available supply of fire-fighting water and to be able to configure and use bilge system for any compartment when the dewatering system is in operation.

14.8 Bilge wells are to be provided with gratings or strainers that will prevent blockage of the dewatering system with debris.

14.9 The enclosures of electrical equipment for the dewatering system installed in any of the forward dry spaces are to provide protection to IPX8 standard as defined in IEC Publication 60529 for a water head equal to the height of the space in which the electrical equipment is installed for a time duration of at least 24 hours.

14.10 The requirements given in 14.1 to 14.9 are not applicable to the enclosed spaces whose volume does not exceed 0.1% of the ship's maximum displacement volume and to the chain locker.

15 Dewatering capacity

15.1 The dewatering system for ballast tanks located forward of the collision bulkhead and for bilges of dry spaces any part of which extends forward of the foremost cargo hold is to be designed to remove water from the forward spaces at a rate of not less than 320A in m^3/h, where A is the cross-sectional area in m^2 of the largest air pipe or ventilator pipe connected from the exposed deck to a closed forward space that is required to be dewatered by these arrangements.

Section 3 Ore Carriers

1 Hull arrangement

1.1 The vessel is to have two effective longitudinal bulkheads and a double bottom in way of the cargo holds. It is assumed that only spaces between the longitudinal bulkheads are used as cargo holds. A double bottom is to be fitted in way of the cargo holds.

1.2 The bottom and deck outside the line of openings are to be longitudinally framed. The side shell and longitudinal bulkheads also, in general, are to be longitudinally framed. Inside line of openings, the deck is generally to be transversely stiffened.

2 Longitudinal strength

2.1 The longitudinal strength requirements as detailed in Pt III, ch2 sec 1 are to be complied with.

3 Bottom structure

3.1 The scantlings and arrangements are in general, to be as per Pt III, ch2, sec 4 except as given below.

3.2 Spacing of floors in the double bottom in centre hold is not to exceed 2.5 m or 0.01L whichever is greater. Additional side girders are to be provided below the centre hold so that the spacing of longitudinal girders generally does not exceed 3.6 m.

3.3 The spacing of bottom transverses in the wing tanks is not to exceed the greater of 0.02L or 3.6 m.

3.4 The thickness of inner bottom plating in cargo holds is to be based on the design loads given in sec1, 4.2, however not to be less than

$$t = (9.0 + 0.012s)\sqrt{k} + t_c \quad \text{mm}$$

where, k is the material factor and t_c is the corrosion allowance.

4 Wing tank structure

4.1 In wing tanks, primary bottom structure is to be so arranged as to maintain structural continuity of the hold double bottom structure in the transverse direction.

4.2 The inner bottom plating is to be extended into the wing tank in the form of a horizontal gusset plate. The gusset plates are to be of sufficient width to provide effective scarfing of the inner bottom into the wing tank structure.

4.3 At locations where bottom transverses are not provided in line with plate floors in the hold double bottom, substantial brackets are to be arranged in line with such plate floors. These brackets are to extend transversely over at least three longitudinal spaces and vertically well above the inner bottom level.

4.4 In the wing tanks, bulkheads are to be arranged in line with the centre hold bulkheads so that continuity of transverse strength is maintained.

4.5 All watertight and non-watertight bulkheads in wing tanks are to be suitably reinforced in way of double bottom scarfing arrangements and also at the ends of centre hold deck transverses. Openings in wing tank bulkheads are to be kept clear of these areas.

5 Deck structure

5.1 The arrangement and scantlings of deck plating inside line of ore hatchways are to be in accordance with the requirements for bulk carriers given in Sec.2, 8.

5.2 When the hatch coamings are situated inboard of the longitudinal bulkhead, the portion of the deck between the two is to be suitably supported by longitudinals.

6 Additional requirements for ore carriers with narrow wing tanks

6.1 For ore carriers of 150 m in length and above, in which any part of longitudinal bulkhead is located within B/5 or 11.5 m, whichever less, inboard from ship side at right angle to the centerline at the assigned summer load line, are to comply with the following additional requirements given in 6.2 to 6.6.

6.2 The longitudinal strength in the hold flooded condition is to comply with the requirements given in 2.3 to 2.7.

6.3 The thickness of the inner bottom plating and the section modulus of inner bottom longitudinals are to comply with the requirements given in 3.3 and 3.4 respectively.

6.4 The shear capacity of the double bottom is to comply with the requirements of 4.3 to 4.5.

6.5 The thickness longitudinal bulkhead plating and stiffeners are to be in accordance with Pt III, ch2, using the design loads in hold flooded conditions.

6.6 The construction and strength of transverse corrugated bulkheads is to be as per 2.9 and 2.10 respectively.

Section 4 Direct Strength Calculations

1 General

1.1 Direct strength calculations are required in cases where simplified formulations are not able to take into account special stress distributions, boundary conditions or structural arrangements with sufficient accuracy.

1.2 The scantlings of the double bottom and transverse bulkhead structures in cargo region and top wing tank/deck structures over long holds, obtained from simplified formulae may have to be increased based on the results of the direct strength calculations.

1.3 The computer programs used are to take into account the effects of bending, shear, axial and torsional deformations.

1.4 For deep girders, bulkhead panels, bracket zones etc. FEM or equivalent methods are to be applied. For systems consisting of slender girders, calculations may be based on beam theory.

In case of corrugated bulkheads, the dimension of the elements used to model the corrugations may be the width of the flange, the first row of elements from the top of the stool is to have an aspect ratio equal to 1 and for the other elements, the aspect ratio is not to exceed 3;

1.5 The calculations are to reflect the structural response of 2 or 3-dimensional structure considered, with due attention to the boundary conditions. The minimum longitudinal extent of the model is to be half the hold length on either side of the transverse bulkhead and transversely, the model is to extend over a minimum of half the ship breadth.

1.6 The calculations are to be carried out using net thicknesses obtained after deduction of applicable corrosion additions specified in 4.3 and 10.13 and those in Pt III, ch2.

2 Load cases and design loads

2.1 The calculations are to be carried out for realistic intact and flooded conditions which cause most severe loading on double bottom, bulkhead and top side structures.

The ship and individual hold loading conditions specified in sec1, 2 are also to be considered for the evaluation of strength.

2.2 The following cases are generally to be included:

a) Ballast in ballast hold with adjacent holds empty, at minimum ballast draught ت with respect to double bottom, transverse bulkhead and top wing tank/ship side strength.

b) Ballast in top wing tank - with respect to top wing tank strength in the upright and heeled conditions, where angle of heel is to be taken equal to half the angle of roll.

c) Heavy ore cargo in hold, hold considered flooded with adjacent hold empty ت with respect to double bottom of the loaded and adjacent empty holds and transverse bulkhead in between.

d) Maximum cargo in the hold filled upto the top of hatch coaming, hold considered flooded - with respect of transverse bulkhead structure.

e) Specified cargo on deck and external sea pressure on deck (in particular forward holds) with respect to deck and top wing tank structure.

2.3 Normally, harbour conditions need not be considered provided the minimum draught in harbour with cargo hold filled, is not less than two thirds of the draught in the associated approved seagoing condition.

2.4 The internal pressures on transverse bulkheads and inner bottom are to be taken as per Sec.1.4. The external sea pressures are to be taken based on the draught at midhold.

3 Allowable stresses

3.1 The values of allowable stresses given below are subject to satisfactory buckling strength as per Pt.III, ch2, App 4 for bulkhead corrugations.

3.2 In the double bottom structures the combined longitudinal stress 'σ_{LC}', is not to exceed 230/k inN/mm^2.

$\sigma_{LC} = \sigma_L + \sigma_{DB} + \sigma_g$ in N/mm^2

σ_L = hull girder bending stress based on total bending moment (M_s + M_w) as given in Pt.III, Ch.2 (hogging and sagging) as relevant.

σ_{DB} = stress in the double bottom structure at base line inner bottom level or at flanges of the longitudinals as relevant.

σ_g = local bending stress due to lateral pressure, in the flanges of bottom or inner bottom longitudinal under consideration in N/mm^2.

3.3 In case of transverse bulkhead girders or corrugations, the following stress values are not to be exceeded in intact conditions:

For bulkheads of ballast holds:

Bending or axial stress	σ = 160/k in N/mm^2
Shear stress	τ = 100/k in N/mm^2
Equivalent stress	$\sigma_e = \sqrt{(\sigma^2 + 3\tau^2)} = 180/k$

For bulkheads of cargo holds:

Bending or axial stress	σ = 210/k in N/mm^2
Shear stress	τ = 115/k in N/mm^2
Equivalent stress	$\sigma_e = 225/k$

Chapter 4 Oil Tankers and Fls Tankers

Section 1 General

1 General

1.1 Application

1.1.1 Service notation ﺑOil tankerﭖ

a) The requirements of this Chapter apply to ships having the service notation oil tanker, as defined in Pt I. They also apply to ships having the additional service feature flash point > 60°C and asphalt carrier, taking into account the specific provisions given in the different Sections.

Note 1: The specific provisions referred to in a) above do not apply to ships intended for the carriage of bulk cargoes at a temperature above the flash point of the product carried.

b) Departures from these requirements are given for ships that have the service notation oil tanker, flash point > 60°C and are intended only for the carriage of bulk cargoes:

ﭽ at a temperature below and not within 15°C of their flash point, or

ﭽ having a flash point above 100°C.

c) Sec 4, 8 provides additional requirements for ships having the service notation oil tanker, asphalt carrier.

d) The list of substances the carriage in bulk of which is covered by the service notations oil tanker, oil tanker, flash point > 60°C and oil tanker, asphalt carrier is given in App 3, Tab 1.

1.1.2 Service notation FLS tanker

a) The requirements of this Chapter apply to ships having the service notation FLS tanker, as defined in Pt I, Ch 1. They also apply to ships having the additional service feature FLS tanker, flash point > 60°C, taking into account the specific provisions given in Sec 4.

Note 1: The specific provisions referred to in a) above do not apply to ships intended for the carriage of bulk cargoes at a temperature above the flash point of the product carried.

b) Sec 4, [9] provides additional requirements for ships having the service notations FLS tanker and FLS tanker, flash point > 60°C in the case of carriage of pollution category Z products.

c) The list of substances the carriage in bulk of which is covered by the service notations FLS tanker and FLS tanker, flash point > 60°C is given in App 4.

Note 2: The service notation FLS tanker does not cover cargoes containing 10% of benzene or more. Ships carrying such cargoes are to comply with the relevant requirements of Chemical Tankers, Chapter 5.

Note 3: Where the provisions of this Chapter applicable to the service notation oil tanker and those applicable to the service notation FLS tanker are simultaneously complied with, a ship

may be granted both service notations oil tanker - FLS tanker or oil tanker - FLS tanker, flash point > 60°C, as applicable.

1.2 Definitions

1.2.1 Cargo area

The cargo area is that part of the ship that contains cargo tanks as well as slop tanks, cargo pump rooms including pump rooms, cofferdams, ballast or void spaces adjacent to cargo tanks or slop tanks as well as deck areas throughout the entire length and breadth of the part of the ship above these spaces.

When independent tanks are installed in hold spaces, the cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space are excluded from the cargo area.

1.2.2 Cargo pump room

Cargo pump room is a space containing pumps and their accessories for the handling of products covered by the service notation granted to the ship.

1.2.3 Cargo service spaces

Cargo service spaces are spaces within the cargo area used for workshops, lockers and storerooms of more than 2 m^2 in area, intended for cargo handling equipment.

1.2.4 Clean ballast

Clean ballast means the ballast in a tank which since oil was last carried therein, has been so cleaned that the effluent therefrom if it were discharged from a ship which is stationary

into clean calm water on a clear day would not produce visible traces of oil on the surface of the water or on adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

If the ballast is discharged through an oil discharge monitoring and control system approved by the Society, evidence based on such a system to the effect that the oil content of the effluent did not exceed 15 parts per million is to be determinative that the ballast was clean, notwithstanding the presence of visible traces.

1.2.5 Cofferdam

For the purpose of Sec 2, 2, a cofferdam is an isolating space between two adjacent steel bulkheads or decks. It is to meet the following criteria:

a) the minimum distance between the two bulkheads or decks is to be sufficient for safe access and inspection.

b) in order to meet the single failure principle, in the particular case when a corner-to-corner situation occurs, this principle may be met by welding a diagonal plate across the corner.

1.2.6 Crude oil

Crude oil is any oil occurring naturally in the earth whether or not treated to render it suitable for transportation and includes:

a) crude oil from which certain distillate fractions have been removed, and

b) crude oil to which certain distillate fractions may have been added.

1.2.7 Crude oil tanker

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

1.2.8 Hold space

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

1.2.9 Fuel oil

Fuel oil means any oil used as fuel in connection with the propulsion and auxiliary machinery of the ship on which such oil is carried.

1.2.10 Non-sparking fan

A fan is considered as non-sparking if in either normal or abnormal conditions it is unlikely to produce sparks. For this purpose, the following criteria are to be met:

a) Design criteria

1) The air gap between the impeller and the casing is to be not less than 1/10 of the shaft diameter in way of the impeller bearing and in any case not less than 2 mm, but need not exceed 13 mm

2) Protective screens with square mesh of not more than 13 mm are to be fitted to the inlet and outlet of ventilation ducts to prevent objects entering the fan housing.

b) Materials

1) The impeller and the housing in way of the impeller are to be made of spark-proof materials which are recognised as such by means of an appropriate test to the satisfaction of the Society

2) Electrostatic charges, both in the rotating body and the casing, are to be prevented by the use of antistatic materials. Furthermore, the installation on board of ventilation units is to be such as to ensure their safe bonding to the hull

3) Tests may not be required for fans having the following material combinations:

- impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity
- impellers and housings of non-ferrous materials
- impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous material is fitted in way of the impeller

- any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm design tip clearance.

4) The following impeller and housing combinations are considered as sparking and therefore are not permitted:

- impellers of an aluminium alloy or a magnesium alloy and a ferrous housing, regardless of tip clearance
- housings made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
- any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

5) Complete fans are to be type-tested in accordance with either the Society's requirements or national or international standards accepted by the Society.

1.2.11 Oil-like substances

Oil-like substances are those substances listed in App 3, Tab 2.

1.2.12 Oil mixture

Oil mixture means a mixture with any oil content.

1.2.13 Product carrier

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

1.2.14 Pump room

Pump room is a space, located in the cargo area, containing pumps and their accessories for the handling of ballast and fuel oil, or cargoes other than those covered by the service notation granted to the ship.

1.2.15 Segregated ballast

Segregated ballast means the ballast water introduced into a tank which is completely separated from the cargo oil and fuel oil system and which is permanently allocated to the carriage of ballast or to the carriage of ballast or cargoes other than oil or noxious substances as variously defined in this chapter and chapter 5.

1.2.16 Slop tank

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

1.2.17 Void space

Void space is an enclosed space in the cargo area external to a cargo tank, except for a hold space, ballast space, fuel oil tank, cargo pump room, pump room, or any space normally used by personnel.

Section 2 Ship Arrangement

Symbols

L_{LL} : Load line length, in m.

1 General

1.1 Application

1.1.1 Except otherwise specified, the requirements of this Section apply to the ships having one of the following service notations:

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

1.1.2 The requirements of this Section apply to ships having a propelling machinery located at the aft part of the ship. Ships with other arrangements are to be specially considered by the Society.

1.2 Documents to be submitted

1.2.1 Tab 1.1 are to be submitted for approval.

Table 1.1 : Documents to be submitted

Item No	Description of the document
1	General arrangement drawing with indication of: - access and openings - capacity and size of the cargo tanks, slop tanksand ballast tanks
2	Diagram of the mechanical and natural ventilation with indication of the ventilation inlets and outlets

2 General arrangement of the ship with regard to fire prevention and crew safety

2.1 Location and separation of spaces

2.1.1 Application

a) The provisions of 2.1.2 to 2.1.5 apply only to ships having the service notations oil tanker or FLS tanker.

b) Ships having one of the following service notations:

- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier

- FLS tanker, flash point > 60°C

are to comply with the provisions of 2.1.6.

2.1.2 Cargo tank area

a) Unless expressly provided otherwise, tanks containing cargo or cargo residues are to be segregated from accommodation, service and machinery spaces, drinking water and stores for human consumption by means of a cofferdam, or any other similar compartment.

b) Fore and aft peaks are not to be used as cargo tanks.

c) Double bottom tanks adjacent to cargo tanks are not to be used as oil fuel tanks.

2.1.3 Cargo pump rooms

a) The cargo pump rooms are to be separated from the other spaces of the ship by oiltight bulkheads and are not to have, in particular, any direct communications with the machinery spaces.

b) Where glazed ports are provided on the bulkhead separating the cargo pump room from the machinery compartment, they are to satisfy the following conditions:

- they are to be efficiently protected from mechanical damage
- strong covers are to be permanently secured on the machinery compartment side
- glazed ports are to be so constructed that glass and sealing are not impaired by the working of the ship
- the glazed ports are to be so constructed as to maintain the structural integrity and the bulkheads resistance to fire and smoke.

2.1.4 Machinery spaces

Machinery spaces are to be positioned aft of cargo tanks and slop tanks; they are also to be situated aft of cargo pump rooms and cofferdams, but not necessarily aft of the fuel oil bunker tanks. Any machinery space is to be isolated from cargo tanks and slop tanks by cofferdams, cargo pump rooms, fuel oil bunker tanks or ballast tanks. Pump rooms containing pumps and their accessories for ballasting those spaces situated adjacent to cargo tanks and slop tanks and pumps for fuel oil transfer are to be considered as equivalent to a cargo pump room within the context of Article 2, provided that such pump rooms have the same safety standard as that required for cargo pump rooms. However, the lower portion of the pump room may be recessed into machinery spaces of category A to accommodate pumps, provided that the deck head of the recess is in general not more than one third of the moulded depth above the keel, except that in the case of ships of not more than 25000 tonnes deadweight, where it can be demonstrated that for reasons of access and satisfactory piping arrangements this is impracticable, the Society may permit a recess in excess of such height, but not exceeding one half of the moulded depth above the keel.

2.1.5 Accommodation spaces, service spaces and control stations

a) Accommodation spaces, main cargo control stations, control stations and service spaces (excluding isolated cargo handling gear lockers) are to be positioned aft of cargo tanks, slop tanks, and spaces which isolate cargo or slop tanks from machinery spaces but not necessarily aft of the fuel oil bunker tanks and ballast tanks, but be arranged in such a way that a single failure of a deck or bulkhead not permit the entry of gas or fumes from the cargo tanks into an accommodation space, main cargo control stations, control station, or service spaces. Arecess provided in accordance with 2.1.4 need not be taken into account when the position of these spaces is being determined.

b) However, where deemed necessary, the Society may permit accommodation spaces, main cargo control stations, control stations, and service spaces forward of the cargo tanks, slop tanks and spaces which isolate cargo and slop tanks from machinery spaces, but not necessarily forward of fuel oil bunker tanks or ballast tanks.

Machinery spaces, other than those of category A, may be permitted forward of the cargo tanks and slop tanks provided they are isolated from the cargo tanks and slop tanks by cofferdams, cargo pump rooms, fuel oil bunker tanks or ballast tanks. All of the above spaces are to be subject to an equivalent standard of safety and appropriate availability of fire-extinguishing arrangements being provided to the satisfaction of the Society. Accommodation spaces, main cargo control spaces, control stations and service spaces are to be arranged in such a way that a single failure of a deck or bulkhead not permit the entry of gas or fumes from the cargo tanks into such spaces. In addition, where deemed necessary for the safety or navigation of the ship, the Society may permit machinery spaces containing internal combustion machinery not being main propulsion machinery having an output greater than 375 kW to be located forward of the cargo area provided the arrangements are in accordance with the provisions of this paragraph.

c) Where the fitting of a navigation position above the cargo area is shown to be necessary, it is to be for navigation purposes only and it is to be separated from the cargo tank deck by means of an open space with a height of at least 2 m. The fire protection of such navigation position is to be in addition as required for control spaces in Sec 6 and other provisions, as applicable, of this Chapter.

d) Means be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by provision of a permanent continuous coaming of a height of at least 300 mm, extending from side to side. Special consideration be given to the arrangements associated with stern loading.

Note 1: The provisions of paragraph d) above also apply to bow and stern cargo loading stations.

e) Exterior boundaries of superstructures and deckhouses enclosing accommodation and including any overhanging decks which support such accommodation, is to be constructed of steel and insulated to A-60 standard for the whole of the portions which face the cargo area and on the outward sides for a distance of 3 m from the end boundary facing the cargo area. The distance of 3 m is to be measured horizontally and parallel to the middle line of the ship from the boundary which faces the cargo area at each deck level. In the case of the sides of those superstructures and deckhouses, such insulation is to be carried up to the underside of the deck of the navigation bridge.

Note 2: Service spaces and control stations (except the wheelhouse) located in superstructures and deckhouses enclosing accommodation are to comply with the provisions of item e).

f) The location and arrangement of the room where foods are cooked are to be selected such as to minimize the risk of fire.

2.1.6 Case of ships having the service notations oil tanker, flash point > 60°C, oil tanker, asphalt carrier or FLS tanker, flash point > 60°C

On ships having one of the following service notations:

- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier
- FLS tanker, flash point > 60°C,

the location and separation of spaces is not required to comply with requirements 2.1.2 to 2.1.5.

However, the following provisions are to be complied with:

a) Tanks containing cargo or cargo residues are to be segregated from accommodation, service and machinery spaces, tanks containing drinking water and stores for human consumption by means of a cofferdam or similar space.

b) Double bottom tanks adjacent to cargo tanks are not to be used as fuel oil tanks.

c) Means are to be provided to keep deck spills away from accommodation and service areas.

2.2 Access and openings

2.2.1 Application

a) Ships with the service notation oil tanker ESP of less than 500 gross tonnage, and ships with the service notation oil tanker or FLS tanker are to comply with the provisions of 2.2.2 to 2.2.6.

b) Ships having one of the following service notations:

- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier
- FLS tanker, flash point > 60°C

are to comply with the provisions of 2.2.7.

c) Ships with the service notation oil tanker ESP of 500 gross tonnage and over, are to comply with the provisions of 2.2.2, 2.2.4, 2.2.5 and 2.2.6 and with the International Convention for the Safety of Life at Sea, 1974, as amended, Chapter II-1, Part A-1, Regulation 3- 6, for details and arrangements of openings and attachments to the hull structure.

2.2.2 Access and openings to accommodation spaces, service spaces, control stations and machinery spaces

a) Except as permitted in paragraph b), access doors, air inlets and openings to accommodation spaces, service spaces, control stations and machinery spaces are not to face the cargo area. They are to be located on the transverse bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse at a distance of at least 4% of the length of the ship but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area. This distance need not exceed 5 m.

b) The Society may permit access doors in boundary bulkheads facing the cargo area or within the 5 m limits specified in paragraph a), to main cargo control stations and to such service spaces used as provision rooms, store-rooms and lockers, provided they do not give access directly or indirectly to any other space containing or providing for accommodation, control stations or service spaces such as galleys, pantries or workshops, or similar spaces containing sources of vapour ignition. The boundary of such a space is to be insulated to بA-60پclass standard, with the exception of the boundary facing the cargo area. Bolted plates for the removal of machinery may be fitted within the limits specified in paragraph a). Wheelhouse doors and windows may be located within the limits specified in paragraph a) so long as they are designed to ensure that the wheelhouse can be made rapidly and efficiently gas tight and vapour tight.

Note 1: An access to a deck foam system room (including the foam tank and the control station) can be permitted within the limits mentioned in paragraph a), provided that the conditions listed in paragraph b) are satisfied and that the door is located flush with the bulkhead.

Note 2: The navigating bridge door and windows are to be tested for gas tightness. If a water hose test is applied, the following test conditions are deemed acceptable by the Society:

- nozzle diameter: minimum 12 mm
- water pressure just before the nozzle: not less than 2 bar,
- distance between the nozzle and the doors or windows: maximum 1,5 m.

c) Windows and sidescuttles facing the cargo area and on the side of the superstructures and deckhouses within the limits specified in paragraph a) are to be of the fixed (non-opening) type. Such windows and sidescuttles, except whellhouse windows, are to be constructed to بA-60پclass standard.

d) Air intakes and air outlets of machinery spaces are to be located as far aft as practicable and, in any case, outside the limits stated in a) above.

e) Where the ship is designed for bow or stern loading and unloading, entrance, air inlets and openings to accommodation, service and machinery spaces and control stations are not to face the cargo shore connection location of bow or stern loading or unloading arrangements.

They are to be located on the outboard side of the superstructure or deckhouse at a distance of at least 4% of the length of the ship but not less than 3 m from the end of the deckhouse facing the cargo shore connection location of the bow or stern loading and unloading arrangements. This distance, however, need not exceed 5 m.

Sidescuttles facing the shore connection location and on the sides of the superstructure or deckhouse within the distance mentioned above are to be of the fixed (non-opening) type. In addition, during the use of the bow or stern loading and unloading arrangements, all doors, ports and other openings on the corresponding superstructure or deckhouse side are to be kept closed.

Note 3: Where, in the case of small ships, compliance with the provisions of paragraph e) is not possible, the Society may permit departures.

2.2.3 Access to spaces in the cargo area

a) Access to cofferdams, ballast tanks, cargo tanks and other compartments in the cargo area is to be direct from the open deck and such as to ensure their complete inspection. Access to double bottom compartments may be through a cargo pump room, pump room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

Safe access to cofferdams, ballast tanks, cargo tanks and other compartments in the cargo area is to be direct from the open deck and such as to ensure their complete inspection. Safe access to double bottom compartments or to forward ballast tanks may be from a pumproom,

deep cofferdam, pipe tunnel, double hull compartment or similar compartment not intended for the carriage of oil or hazardous cargoes.

Note 1: Access manholes to forward gas dangerous spaces are permitted from an enclosed gas-safe space provided that:

- their closing means are gastight and
- a warning plate is provided in their vicinity to indicate that the opening of the manholes is only permitted after checking that there is no flammable gas inside the compartment in question.

Note 2: Unless other additional arrangements provided to facilitate their access are considered satisfactory by the Society, the double bottom tanks are to be provided with at least two separate means of access complying with a) above.

b) For access through horizontal openings, hatches or manholes, the dimensions are to be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also provide a clear opening to facilitate the hoisting of an injured person from the bottom of the compartment. The minimum clear opening is to be not less than 600 mm x 600 mm.

c) For access through vertical openings, or manholes, in swash bulkheads, floors, girders and web frames providing passage through the length and breadth of the compartment, the minimum opening is to be not less than 600 mm x 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other foot holds are provided.

d) For oil tankers of less than 5000 t deadweight smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

For oil tankers of less than 5,000 tonnes deadweight, the Society may approve, in special circumstances, smaller dimensions for the openings referred to in paragraphs a) and b), if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

e) Access ladders of cargo tanks are to be fitted with handrails and to be securely attached to the tank structure.

They are not to be fitted vertically, unless justified by the size of the tanks. Rest platforms are to be provided at suitable intervals of not more than 10 m.

2.2.4 Access to the pipe tunnels

a) The pipe tunnels in the double bottom are to comply with the following requirements:

1) they are not to communicate with the engine room,

2) provision is to be made for at least two exits to the open deck arranged at a maximum distance from each other. One of these exits fitted with a watertight closure may lead to the cargo pump room.

b) Where there is permanent access from a pipe tunnel to the main pump room, a watertight door is to be fitted complying with the requirements of Pt III, Ch 2 and in addition with the following:

1) in addition to the bridge operation, the watertight door is to be capable of being manually closed from outside the main pump room entrance,

2) the watertight door is to be kept closed during normal operations of the ship except when access to the pipe tunnel is required.

Note 1: A notice is to be affixed to the door to the effect that it may not be left open.

2.2.5 Access to the forecastle spaces

Access to the forecastle spaces containing sources of ignition may be permitted through doors facing cargo area provided the doors are located outside hazardous areas as defined in Sec 5.

2.2.6 Access to the bow

Every tanker is to be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means of access are to be approved by the Society.

Note 1: The Society accepts means of access complying with the Guidelines for safe access to tanker bows adopted by the Marine Safety Committee of IMO by Resolution MSC.62(67).

2.2.7 Case of ships having the service notations oil tanker, flash point > 60°C, oil tanker, asphalt carrier or FLS tanker, flash point > 60°C

On ships having one of the following service notations:

- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier

- FLS tanker, flash point > 60°C,

the access and openings are not required to comply with the provisions of 2.2.2. However, the access doors, air inlets and openings to accommodation spaces, service spaces and control stations are not to face the cargo area.

2.3 Ventilation

2.3.1 Application

a) The requirements of 2.3.2 to 2.3.5 apply only to ships having the service notations oil tanker or FLS tanker.

b) Ships having one of the following service notations:

- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier
- FLS tanker, flash point > 60°C

are to comply with the provisions of 2.3.6.

2.3.2 General

a) Enclosed spaces within the cargo area are to be provided with efficient means of ventilation. Unless otherwise specified, portable means are permitted for that purpose. Ventilation fans are to be of non sparking construction according to Sec 1, 1.3.10.

b) Ventilation inlets and outlets, especially for machinery spaces, are to be situated as far aft as practicable. Due consideration in this regard is to be given when the ship is equipped to load or discharge at the stern. Sources of ignition such as electrical equipment are to be so arranged as to avoid an explosion hazard.

2.3.3 Ventilation of cargo pump rooms

a) Ventilation exhaust ducts are to discharge upwards in locations at least 3 m from any ventilation intake and opening to gas safe spaces.

b) Ventilation intakes are to be so arranged as to minimize the possibility of recycling hazardous vapours from ventilation discharge openings.

c) The ventilation ducts are not to be led through gas safe spaces, cargo tanks or slop tanks.

d) See also Sec 4, 3.5.1.

2.3.4 Ventilation of other pump rooms

a) Ventilation of pump rooms containing:

- ballast pumps serving spaces adjacent to cargo or slop tanks
- oil fuel pumps is to comply with paragraphs a) to c) of 2.3.3 and a) of Sec 4, 3.5.1.

b) The ventilation intakes of the pump rooms referred to in a) are to be located at a distance of not less than 3 m from the ventilation outlets of cargo pump rooms.

2.3.5 Ventilation of double hull and double bottom spaces

Double hull and double bottom spaces are to be fitted with suitable connections for the supply of air.

2.3.6 Case of ships having the service notations oil tanker, flash point > 60°C, oil tanker, asphalt carrier or FLS tanker, flash point > 60°C

On ships having one of the following service notations:

- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier
- FLS tanker, flash point > 60°C,

the ventilation is not required to comply with requirements 2.3.2 to 2.3.5. However, the following provisions apply:

a) Where the ship is intended only for the carriage of cargo with flashpoint above 100°C:

- spaces located within the cargo area are to be efficiently ventilated
- portable means of ventilation are permitted except for the cargo pump room, which is to be mechanically ventilated.

b) Where the ship is intended for the carriage of cargo with flashpoint of 100°C or below:

- spaces located within the cargo area are to be efficiently ventilated. Portable means of ventilation are permitted
- ventilation of the cargo pump room is to comply with 2.3.3.

3 General arrangement of the ship with regard to pollution prevention

3.1 Application

3.1.1 Service notations

The requirements of the present Article apply only to ships having one of the following notations:

- oil tanker
- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier.

3.1.2 Tonnage

Unless otherwise specified, the requirements of the present Article apply only to ships of 150 tons gross tonnage and above.

3.2 Protection of the cargo tank length in the event of grounding or collision

3.2.1 Application

The requirements of the present sub-article apply to ships of 600 tons deadweight and above.

3.2.2 General

a) The design and construction of oil tankers is to pay due regard to the general safety aspects including the need for maintenance and inspections of wing and double bottom tanks or spaces.

b) Oil is not to be carried in any space extending forward of a collision bulkhead located in accordance with Pt III, Ch 2. An oil tanker that is not required to have a collision bulkhead in accordance with that regulation is not to carry oil in any space extending forward of the transverse plane perpendicular to the centreline that is located as if it were a collision bulkhead located in accordance with that regulation.

3.2.3 Case of ships of 5000 tons deadweight and above

On oil tankers of 5000 tons deadweight and above, the entire cargo tank length is to be protected by ballast tanks or spaces other than cargo and fuel oil tanks as follows:

a) Wing tanks or spaces

Wing tanks or spaces are to extend either for the full depth of the shipۥs side or from the top of the double bottom to the uppermost deck, disregarding a rounded gunwale where fitted. They are to be arranged such that the cargo tanks are located inboard of the moulded line

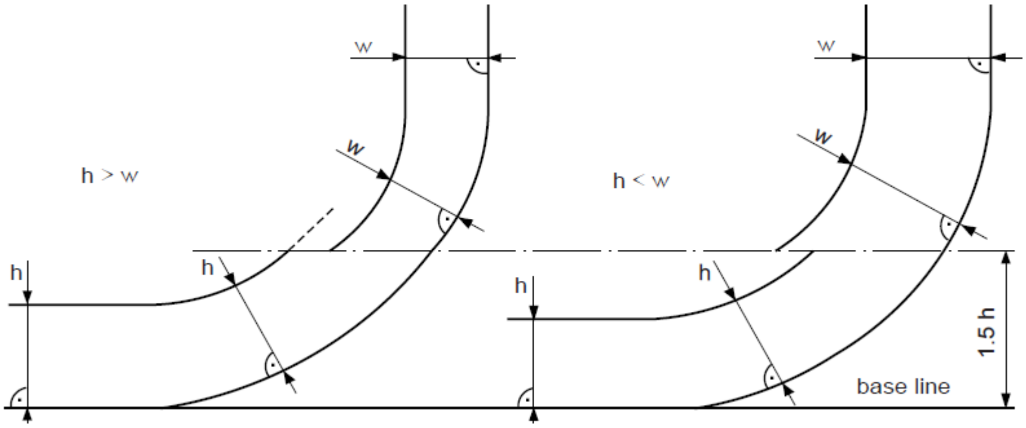
of the side shell plating, nowhere less than the distance *w* which, as shown in Fig 3.1 is measured at any cross-section at right angles to the side shell, as specified below:

w = 0.5+DW/20000 in m

or w = 2,0 m, whichever is the lesser.

The minimum value of w = 1,0 m.

Figure 3.1 : Cargo tank boundary lines



b) Double bottom tanks or spaces

At any cross-section, the depth of each double bottom tank or compartment is to be such that the distance *h* between the bottom of the cargo tanks and the moulded line of the bottom shell plating measured at right angles to the bottom shell plating, as shown in Fig 3.1 is not less than specified below:

- B/15 (m), or
- 2,0 m, whichever is the lesser.

The minimum value of h = 1.0 m.

Note 1: Double bottom tanks or spaces as required by the above paragraph may be dispensed with, provided that the design of the tanker is such that the cargo and vapour pressure exerted

on the bottom shell plating forming a single boundary between the cargo and the sea does not exceed the external hydrostatic water pressure, as expressed by the following formula:

$$f\, h_c\, \rho_c\, g + 100\,\Delta_p \leq d_n\, \rho_s\, g$$

where:

h_c : Height of cargo in contact with the bottom shell plating, in metres

ρ_c : Maximum cargo density, in t/m^3

d_n : Minimum operating draught under any expected loading conditions, in metres

ρ_s : Density of seawater, in t/m^3

Δ_p : Maximum set pressure of pressure/vacuum valve provided for the cargo tanks, in bars

f : Safety factor = 1.1

g : Standard acceleration of gravity (9.81 m/s^2).

Any horizontal partition necessary to fulfil the above requirements are to be located at a height of not less than B/6 or 6 m, whichever is the lesser, but not more than 0.6D, above the baseline where D is the moulded depth amidships.

The location of wing tanks or spaces is to be as defined in paragraph a) above except that, below a level 1.5h above the baseline where h is as defined above, the cargo tank boundary line may be vertical down to the bottom plating, as shown in Fig 3.2.

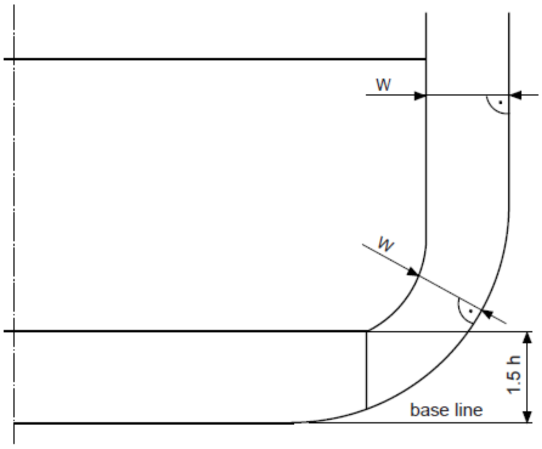
c) Turn of the bilge area or at locations without a clearly defined turn of the bilge

Where the distance h and w are different, the distance w is to have preference at levels exceeding 1.5h above baseline as shown in Fig 3.1.

d) Aggregate capacity of the ballast tanks

On crude oil tankers of 20000 t deadweight and above and product carriers of 30000 t deadweight and above, the aggregate capacity of wing tanks, double bottom tanks, forepeak tanks and afterpeak tanks is to be not less than the capacity of segregated ballast tanks necessary to meet the requirements of 3.3.2. Wing tanks or compartments and double bottom tanks used to meet the requirements of 3.3.2 are to be located as uniformly as practicable along the cargo tank length. Additional segregated ballast capacity provided for reducing longitudinal hull girder bending stress, trim, etc., may be located anywhere within the ship.

Figure 3.2 : Cargo tank boundary lines



Note 2: In calculating the aggregate capacity under paragraph d) above, the following is to be taken into account:

- the capacity of engine-room ballast tanks is to be excluded from the aggregate capacity of ballast tanks,
- the capacity of ballast tanks located inboard of double hull is to be excluded from the aggregate capacity of ballast tanks,
- spaces such as void spaces located in the double hull within the cargo tank length is to be included in the aggregate capacity of ballast tanks.

e) Suction wells in cargo tanks may protube into the double bottom below the boundary line defined by the distance h provided that such wells are as small as practicable and the distance between the well bottom and bottom shell plating is not less than 0.5h.

f) Ballast and cargo piping is to comply with the provisions of Sec 4, 2.3.7 and 3.4.1.

Note 3: Other methods of design and construction of oil tankers may also be accepted as alternatives to the requirements prescribed in items a) to f), provided that such methods ensure at least the same level of protection against oil pollution in the event of collision or stranding and are approved in principle by the Society.

The Society will accept the methods of design and construction described in IMO Resolution MEPC.66(37).

3.2.4 Case of ships of less than 5000 tons deadweight

Oil tankers of less than 5000 tons deadweight are to:

a) at least be fitted with double bottom tanks or spaces having such a depth that the distance h specified in 3.2.3 b) complies with the following:

$h = B/15$ (m)

with a minimum value of $h = 0.76$ m;

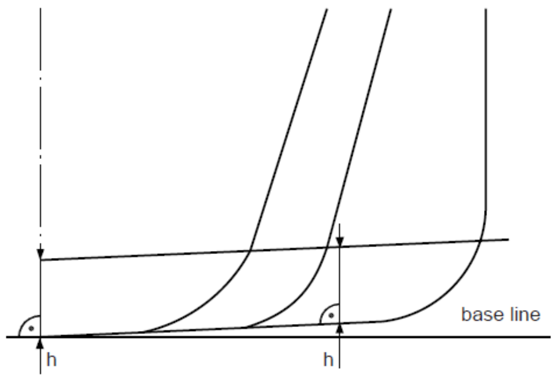
in the turn of the bilge area and at locations without a clearly defined turn of bilge, the cargo tank boundary line is to run parallel to the line of the midship flat bottom as shown in Fig 3.3; and

b) be provided with cargo tanks so arranged that the capacity of each cargo tank does not exceed 700 m3 unless wing tanks or spaces are arranged in accordance with 3.2.3 a) complying with the following:

w=0.4+2.4DW/20000 in m

with a minimum value of w = 0.76 m.

Figure 3.3 : Cargo tank boundary lines



3.3 Segregation of oil and water ballast

3.3.1 General

a) In oil tankers of 150 tons gross tonnage and above, no ballast water is to be carried in any oil fuel tank.

b) Every crude oil tanker of 20000 tons deadweight and above and every product carrier of 30000 tons deadweight and above are to be provided with segregated ballast tanks and are to comply with requirements 3.3.2 and 3.3.3.

3.3.2 Capacity of the segregated ballast tanks

The capacity of the segregated ballast tanks is to be so determined that the ship may operate safely on ballast voyages without recourse to the use of cargo tanks for water ballast. In all cases, however, the capacity of segregated ballast tanks is to be at least such that, in any ballast condition at any part of the voyage, including the conditions consisting of lightweight plus segregated ballast only, the ship's draughts and trim can meet each of the following requirements:

a) the moulded draught amidships, dm in metres (without taking into account any ship's deformation) is to be not less than:

$d_m = 2.0 + 0.02\ L_{LL}$

b) the draughts at the forward and after perpendicular are to correspond to those determined by the draught amidships dm as specified above, in association with the trim by the stern of not greater than 0.015 LLL , and

c) in any case the draught at the after perpendicular is to be not less than that which is necessary to obtain full immersion of the propeller(s).

Refer also to paragraph d) of 3.2.3.

Note 1: In case of oil tankers less than 150 metres in length, the above formulae may be replaced by those set out in Appendix I to the Unified Interpretations of Annex I of MARPOL 73/78.

3.3.3 Carriage of ballast water in cargo tanks

a) In no case is ballast water to be carried in cargo tanks, except:

1) on those rare voyages when weather conditions are so severe that, in the opinion of the Master, it is necessary to carry additional ballast water in cargo tanks for the safety of the ship, and

2) in exceptional cases where the particular character of the operation of an oil tanker renders it necessary to carry ballast water in excess of the quantity required under 3.3.3, provided that such operation of the oil tanker falls under the category of exceptional cases.

Note 1: Exceptional cases are defined in the Unified Interpretations of Annex I of MARPOL 73/78

Such additional ballast water is to be processed and discharged in compliance with regulation 34 of Annex I of MARPOL 73/78 and an entry is to be made in the Oil Record Book Part II referred to in regulation 36 of that Annex.

b) In the case of crude oil tankers, the additional ballast permitted in paragraph a) above is to be carried in cargo tanks only if such tanks have been crude oil washed in accordance with 3.5 before departure from an oil unloading port or terminal.

3.4 Accidental oil outflow performance

3.4.1 Oil tankers are to comply with the requirements of the Regulation 25 of Annex I to Marpol Convention, as amended.

3.5 Cleaning of cargo tanks

3.5.1 General

a) Adequate means are to be provided for cleaning the cargo tanks.

Note 1: This provision does not apply to ships of less than 150 tons gross tonnage provided the conditions stated in 3.6.1 are fulfilled.

b) Every crude oil tanker of 20000 tons deadweight and above is to be fitted with a cargo tank cleaning system using crude oil washing complying with the following requirements. Unless such oil tanker carries crude oil which is not suitable for crude oil washing, the oil tanker is to operate the system in accordance with those requirements.

The crude oil washing installation and associated equipment and arrangements are to comply with the requirements of App 2.

3.5.2 Ballasting of cargo tanks

With respect to the ballasting of cargo tanks, sufficient cargo tanks are to be crude oil washed prior to each ballast voyage in order that, taking into account the tanker's trading pattern and expected weather conditions, ballast water is put only into cargo tanks which have been crude oil washed.

3.5.3 Operations and Equipment Manual

Every oil tanker operating with crude oil washing systems is to be provided with an Operations and Equipment Manual detailing the system and equipment and specifying operational procedures. Such a Manual is to be to the satisfaction of the Society and is to contain all the information set out in App 2. If an alteration affecting the crude oil washing system is made, the Operating and Equipment Manual is to be revised accordingly.

3.6 Retention of oil on board - Slop tanks

3.6.1 Application

a) The provisions of requirements 3.6.2 to 3.6.4 do not apply to ships of less than 150 tons gross tonnage for which the control of discharge of oil under Sec 4, 5.2.1 is to be effected by the retention of oil on board with subsequent discharge of all contaminated washings to reception facilities, unless adequate arrangements are made to ensure that any effluent which is allowed to be discharged into the sea is effectively monitored to ensure that the provisions of Sec 4, 5.2.1.

Note 1: The provisions of requirements 3.6.2 to 3.6.4 may be waived for any oil tanker which engages exclusively on both voyages of 72 hours or less in duration and within 50 miles from the nearest land, provided that the oil tanker is engaged exclusively in trades between ports or terminals within a State Party to MARPOL 73/78 Convention. Any such waiver is to be subject to the requirements that the oil tanker is to retain on board all oily mixtures for subsequent discharge to reception facilities and to the determination by the Administration that facilities available to receive such oily mixtures are adequate.

b) The provisions of Sec 4, 5 are also to be complied with.

3.6.2 General

a) Adequate means are to be provided for transferring the dirty ballast residue and tank washings from the cargo tanks into a slop tank approved by the Society.

b) Arrangements are to be provided to transfer the oily waste into a slop tank or combination of slop tanks in such a way that any effluent discharged into the sea comply with the provisions of Sec 4, 5.2.

3.6.3 Capacity of slop tanks

The arrangement of the slop tank or combination of slop tanks is to have a capacity necessary to retain the slop generated by tank washings, oil residues and dirty ballast residues.

The total capacity of the slop tank or tanks is not to be less than 3% of the oil carrying capacity of the ship, except that the Society may accept:

a) 2% for oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without the introduction of additional water into the system

b) 2% where segregated ballast tanks are provided in accordance with 3.3, or where a cargo tank cleaning system using crude oil washing is fitted in accordance with 3.5. This capacity may be further reduced to 1.5% for oil tankers where the tank washing arrangements are such that once the slop tank or tanks are charged with washing water, this water is sufficient for tank washing and, where applicable, for providing the driving fluid for eductors, without introduction of additional water into the system.

Oil tankers of 70 000 tons deadweight and above are to be fitted with at least two slop tanks.

3.6.4 Design of slop tanks

Slop tanks are to be so designed particularly in respect of the position of inlets, outlets, baffles or weirs where fitted, so as to avoid excessive turbulence and entrainment of oil or emulsion with the water.

3.7 Deck spills

3.7.1 Means are to be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by providing a permanent continuous coaming of a suitable height extending from side to side.

Where gutter bars are installed on the weather decks of oil tankers in way of cargo manifolds and are extended aft as far as the aft bulkhead of superstructures for the purpose of containing cargo spills on deck during loading and discharge operations, the free surface effects caused by containment of a cargo spill during liquid transfer operations or of boarding seas while underway are to be considered with respect to the vessel's available margin of positive initial stability (GMo).

Where the gutter bars installed are higher than 300 mm, they are to be treated as bulwarks with freeing ports arranged and provided with effective closures for use during loading and discharge operations. Attached closures are to be arranged in such a way that jamming is prevented while at sea, enabling the freeing ports to remain effective.

On ships without deck camber, or where the height of the installed gutter bars exceeds the camber, and for oil tankers having cargo tanks exceeding 60% of the vessel's maximum beam amidships regardless of gutter bar height, gutter bars may not be accepted without an assessment of the initial stability (GMo) for compliance with the relevant intact stability requirements taking into account the free surface effect caused by liquids contained by the gutter bars.

3.8 Pump-room bottom protection

3.8.1 This Article is applicable to oil tankers of 5000 tons deadweight and above.

3.8.2 The pump-room is to be provided with a double bottom such that at any cross-section the depth of each double bottom tank or space is to be such that the distance *h* between the bottom of the pump-room and the ship's base line measured at right angles to the ship's base line is to be not less than the lesser of:

- $h = B/15$ m
- $h = 2$ m

without being taken less than 1 m.

3.8.3 In case of pump rooms whose bottom plate is located above the base line by at least the minimum height required in 3.8.2 (e.g. gondola stern designs), there is no need for a double bottom construction in way of the pump-room.

3.8.4 Ballast pumps are to be provided with suitable arrangements to ensure efficient suction from double bottom tanks.

3.8.5 Notwithstanding the provisions of 3.8.2 and 3.8.3, where the flooding of the pump-room would not render the ballast or cargo pumping system inoperative, a double bottom need not be fitted.

Section 3 Hull and Stability

Symbols

L_{LL} : Load line length, in m

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

k : Material factor for steel,

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

to:

- $E = 2.06\ 10^5\ N/mm^2$ for steels in general
- $E = 1.95\ 10^5\ N/mm^2$ for stainless steels.

1 Stability

1.1 Application

1.1.1 The requirements in 1.2.2 and 1.3 apply only to ships with the service notation oil tanker ESP.

1.2 Intact stability

1.2.1 General

The stability of the ship for the loading conditions in Pt III, Ch 4, App 2, 1.2.6 is to be in compliance with the requirements in Pt III, Ch 4, Sec 2. In addition, the requirements in 1.2.2 are to be complied with.

1.2.2 Liquid transfer operations

Ships with certain internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling,

the design of oil tankers of 5000 t deadweight and above is to be such that the following criteria are complied with:

a) The intact stability criteria reported in b) is to be complied with for the worst possible condition of loading and ballasting as defined in c), consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.

b) The initial metacentric height GMo, in m, corrected for free surface measured at 0° heel, is to be not less than 0.15. For the purpose of calculating GMo, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.

c) The vessel is to be loaded with:

- all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank

- cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value
- full departure consumable
- 1% of the total water ballast capacity.The maximum free surface moment is to be assumed in all ballast tanks.

1.3 Damage stability for ships where the additional class notation SDS is required

1.3.1 General

Every oil tanker is to comply with the subdivision and damage stability criteria as specified in 1.3.8, after the assumed side or bottom damage as specified in 1.3.2, for the standard of damage described in 1.3.3, and for any operating draught reflecting actual partial or full load conditions consistent with trim and strength of the ship as well as specific gravities of the cargo.

The actual partial or full load conditions to be considered are those specified in Pt III, Ch 4, App 2, 1.2.6, but ballast conditions where the oil tanker is not carrying oil in cargo tanks, excluding any oil residues, are not to be considered.

1.3.2 Damage dimensions

The assumed extent of damage is to be as defined in Tab 1.1.

The transverse extent of damage is measured inboard the ship side at right angles to the centreline at the level of the summer load line.

Table 1 : Extent of damage

Damage		Longitudinal extent	Transverse extent	Vertical extent
Side		l_C = 1/3 $(L_{LL})^{2/3}$or14.5m (1)	t_C = B/5 or 11.5 m (1)	v_C= without limit
Bottom	For 0.3 L_{LL} from the forward perpendicular	l_S = 1/3 $(L_{LL})^{2/3}$ or14.5m (1)	t_S = B/6 or 10 m (1)	v_S = B/15 or 6m (1)
	any other part	*ls* = 1/3 $(L_{LL})^{2/3}$ or 5m (1)	t_S = B/6 or 5 m (1)	v_S = B/15 or 6m (1)

For the purpose of determining the extent of assumed damage, suction wells may be neglected, provided such wells are not excessive in areas and extend below the tank for a minimum distance and in no case more than half the height of the double bottom.

The vertical extent of damage is measured from the moulded line of the bottom shell plating at centreline.

If any damage of a lesser extent than the maximum extent of damage specified in Tab 1.1 would result in a more severe condition, such damage is to be considered.

1.3.3 Standard of damage

The damage in 1.3.2 is to be applied to all conceivable locations along the length of the ship, according to Tab 1.2.

Table 1.2 : Standard of damage

Shipۥs length,in m	Damage anywhere in shipۥs length	Damage between transverse bulkheads	Machinery space flooded
L_{LL} □100	No	Yes (1) (2)	No
100 < L_{LL} □150	No	Yes (1)	No
150 < L_{LL} □225	Yes	No	Yes, alone
L_{LL} > 225	Yes	No	Yes

(1) Machinery space not flooded.

(2) Exemptions from the requirements of 1.3.8 may be accepted by the Society on a case-by-case basis.

1.3.4 Calculation method

The metacentric heights (GM), the stability levers (GZ) and the centre of gravity positions (KG) for judging the final survival conditions are to be calculated by the constant displacement method (lost buoyancy).

1.3.5 Flooding assumptions

The requirements of 1.3.8 are to be confirmed by calculations which take into consideration the design characteristics of the ship, the arrangements, configuration and contents of the damaged compartments and the distribution, specific gravities and free surface effect of liquids.

Where the damage involving transverse bulkheads is envisaged as specified in 1.3.3, transverse watertight bulkheads are to be spaced at least at a distance equal to the longitudinal

extent of assumed damage specified in 1.3.2 in order to be considered effective. Where transverse bulkheads are spaced at a lesser distance, one or more of these bulkheads within such extent of damage is to be assumed as non-existent for the purpose of determining flooded compartments.

Where the damage between adjacent transverse watertight bulkheads is envisaged as specified in 1.3.3, no main transverse bulkhead bounding side tanks or double bottom tanks is to be assumed damaged, unless:

- the spacing of the adjacent bulkheads is less than the longitudinal extent of assumed damage specified in 1.3.2 or,
- there is a step or a recess in a transverse bulkhead of more than 3.05 metres in length, located within the extent of penetration of assumed damage. The step formed by the after peak bulkhead and after peak tank top is not to be regarded as a step.

1.3.6 Progressive flooding

If pipes, ducts or tunnels are situated within the assumed extent of damage penetration as defined in 1.3.2, arrangements are to be made so that progressive flooding cannot thereby extend to compartments other than those assumed to be floodable in the calculation for each case of damage.

1.3.7 Permeabilities

The specific gravity of cargoes carried, as well as any outflow of liquid from damaged compartments, are to be taken into account for any empty or partially filled tank.

The permeability of compartments assumed to be damaged are to be as indicated in Tab 1.3.

Table 1.3 : Permeability

Compartments	Permeability
Appropriate for stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Void compartments	0.95
Intended for consumable liquids	0 to 0.95 (1)
Intended for other liquids	0 to 0.95 (1)

(1) The permeability of partially filled compartments is to be consistent with the amount of liquid carried in the compartment.

1.3.8 Survival requirements

Oil tankers are to be regarded as complying with the damage stability criteria if the requirements of 1.3.9 and 1.3.10 are met.

1.3.9 Final stage of flooding

a) The final waterline, taking into account sinkage, heel and trim, is to be below the lower edge of any opening through which progressive flooding may take place. The progressive flooding is to be considered in accordance with Pt III, Ch 4, Sec 3, 3.3.

b) The angle of heel due to unsymmetrical flooding may not exceed 25°, except that this angle may be increased up to 30° if no deck edge immersion occurs.

c) The stability is to be investigated and may be regarded as sufficient if the righting lever curve has at least a range of 20° beyond the position of equilibrium in association with a maximum residual righting lever, in m, of at least 0.1 within the 20° range; the area, in m.rad, under the curve within this range is to be not less than 0.0175.

1.3.10 Intermediate stage of flooding

The Society is to be satisfied that the stability is sufficient during the intermediate stages of flooding. To this end the Society applies the same criteria relevant to the final stage of flooding also during the intermediate stages of flooding.

1.3.11 Bottom raking damage

This requirement applies to oil tankers of 20000 t deadweight and above.

The damage assumptions relative to the bottom damage prescribed in 1.3.2 are to be supplemented by the assumed bottom raking damage of Tab 1.4.

The requirements of 1.3.8 are to be complied with for the assumed bottom raking damage.

Table 1.4 : Bottom damage extent

Deadweight	Longitudinal extent	Transverse extent	Vertical extent
< 75000 t	0.4 L_{LL} (1)	B/3	(2)
□75000 t	0.6 L_{LL} (1)	B/3	(2)

(1) Measured from the forward perpendicular.

(2) Breach of the outer hull.

1.3.12 Equalisation arrangements

Equalisation arrangements requiring mechanical aids such as valves or cross levelling pipes, if fitted, may not be considered for the purpose of reducing an angle of heel or attaining the minimum range of residual stability to meet the requirements of 1.3.9 and sufficient residual stability is to be maintained during all stages where equalisation is used.

Compartments which are linked by ducts of a large crosssectional area may be considered to be common.

1.3.13 Information to the Master

The Master of every oil tanker is to be supplied in an approved form with:

- information relative to loading and distribution of cargo necessary to ensure compliance with the requirements relative to stability, and
- data on the ability of the ship to comply with damage stability criteria as determined in 1.3.8 including the effect of relaxation that may have been allowed as specified in Tab 1.2.

2 Structure design principles

2.1 Framing arrangement

2.1.1 In general, within the cargo tank region of ships of more than 90 m in length, the bottom, the inner bottom and the deck are to be longitudinally framed.

Different framing arrangements are to be considered by the Society on a case-by-case basis, provided that they are supported by direct calculations.

2.2 Bulkhead structural arrangement

2.2.1 General

Transverse bulkheads may be either plane or corrugated.

2.2.2 Corrugated bulkheads

For ships of less than 120 m in length, vertically corrugated transverse or longitudinal bulkheads may be connected to the double bottom and deck plating.

For ships equal to or greater than 120 m in length, lower and upper stools are to be fitted.

3 Design loads

3.1 Hull girder loads

3.1.1 Still water loads

In addition to the requirements in Pt III, Ch 2, Sec 1, 2.2.2, still water loads are to be calculated for the following loading conditions, subdivided into departure and arrival conditions as appropriate:

- homogeneous loading conditions (excluding tanks intended exclusively for segregated ballast tanks) at maximum draft
- partial loading conditions
- any specified non-homogeneous loading condition
- light and heavy ballast conditions
- mid-voyage conditions relating to tank cleaning or other operations where, at the Society's discretion, these differ significantly from the ballast conditions.

3.2 Local loads

3.2.1 Bottom impact pressure

For oil tankers of 20000 t deadweight and above and product carriers of 30000 t deadweight and above, the draught T_F, to be considered in the calculation of the bottom impact pressure according to the following formula, is that calculated by using the segregated ballast tanks only.

The bottom impact pressure p_{BI} is to be obtained, in kN/m^2, from the following formula:

$p_{BI} = 62\ C_1\ C_{SL}\ L^{0.6}$ if $L \le 135$

$p_{BI} = (1510 - 2.5\ L)\ C_1\ C_{SL}$ if $L > 135$

where:

$C_1 = (119 - 2300\ T_F/L)/(78 + 1800\ T_F/L)$ without being taken greater than 1.0

T_F : Draught

C_{SL} : Longitudinal distribution factor, taken equal to:

$C_{SL} = 0$ for $x \le x_1$

$C_{SL} = (x - x_1)/(x_2 - x_1)$ for $x_1 < x < x_2$

$C_{SL} = 1$ for $x \ge x_2$

$x_1 = (0.55 + L/2000)\ L$

$x_2 = (0.35 + 0.5C_B + L/3000)L$ with $0.6 \le C_B \le 0.85$

3.2.2 Cargo mass density

In the absence of more precise values, a cargo mass density of 0.9 t/m^3 is to be considered for calculating the internal pressures and forces in cargo tanks.

3.2.3 Partial filling

The carriage of cargoes with a mass density above the one considered for the design of the cargo tanks may be allowed with partly filled tanks under the specific conditions approved by the rules. The classification certificate or the annex to this certificate is to mention these conditions of carriage.

3.2.4 Overpressure due to cargo filling operations

For ships having the additional service feature asphalt carrier, the overproduce which may occurred under loading/ unloading operations are to be considered, if any. In such a case, the diagram of the pressures in loading/unloading conditions is to be given by the Designer.

4 Hull scantlings

4.1 Plating

4.1.1 Minimum net thicknesses

The net thickness of the strength deck and bulkhead plating is to be not less than the values given in Tab 4.1.

Table 4.1 : Minimum net thickness of the strength deck and bulkhead plating

Plating	Minimum net thickness, in mm
Strength deck	$(5.5 + 0.02\,L)\,k^{1/2}$ for $L < 200$ $(8 + 0.0085\,L)\,k^{1/2}$ for $L \geq 200$
Tank bulkhead	$L^{1/3}\,k^{1/6} + 4.5\,s$ for $L < 275$ $1.5\,k^{1/2} + 8.2 + s$ for $L \geq 275$
Watertight bulkhead	$0.85\,L^{1/3}\,k^{1/6} + 4.5\,s$ for $L < 275$ $1.5\,k^{1/2} + 7.5 + s$ for $L \geq 275$
Wash bulkhead	$0.8 + 0.013\,L\,k^{1/2} + 4.5s$ for $L < 275$ $3.0\,k^{1/2} + 4.5 + s$ for $L \geq 275$

Note 1:

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

4.2 Ordinary stiffeners

4.2.1 Minimum net thicknesses

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

$t_{MIN} = 0.75\,L^{1/3}\,k^{1/6} + 4.5\,s$ for $L < 275$ m

$t_{MIN} = 1.5\,k^{1/2} + 7.0 + s$ for $L \geq 275$ m

where s is the spacing, in m, of ordinary stiffeners.

4.3 Primary supporting members

4.3.1 Minimum net thicknesses

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

$t_{MIN} = 1.45\ L^{1/3}\ k^{1/6}$

4.3.2 Loading conditions for the analyses of primary supporting members

The still water and wave loads are to be calculated for the most severe loading conditions as given in the loading manual, with a view to maximising the stresses in the longitudinal structure and primary supporting members.

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

- Fig 4.1 for ships less than 200 m in length
- Fig 4.2 and Fig 4.3 for ships equal to or greater than 200 m in length.

4.3.3 Strength check of floors of cargo tank structure with hopper tank analysed through a three dimensional beam model

Where the cargo tank structure with hopper tank is analysed through a three dimensional beam model, to be carried out according to App 1, the net shear sectional area of floors within 0.1 *l* from the floor ends (see Fig 4.4 for the definition of *l*) is to be not less than the value obtained, in cm^2, from the following formula:

$A_{sh}=20(\gamma_R\ \gamma_m F_s)/(R_y)$

where:

F_s : Shear force, in kN, in the floors at the ends of *l*, obtained from the structural analysis

γ_R : Resistance partial safety factor:

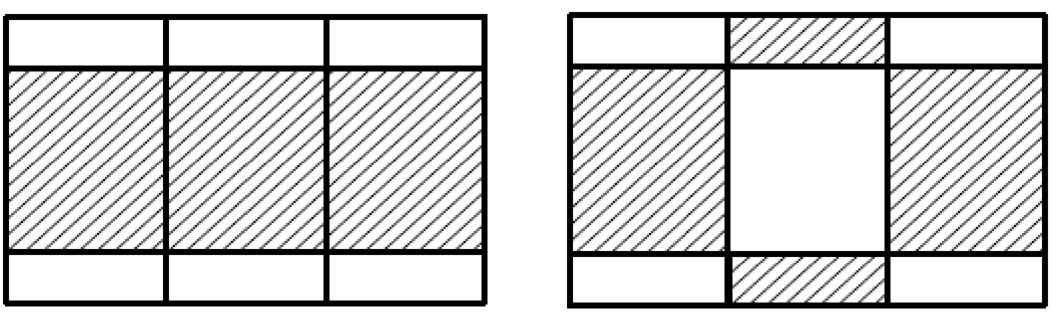
$\gamma_R = 1.2$

γ_m : Material partial safety factor:

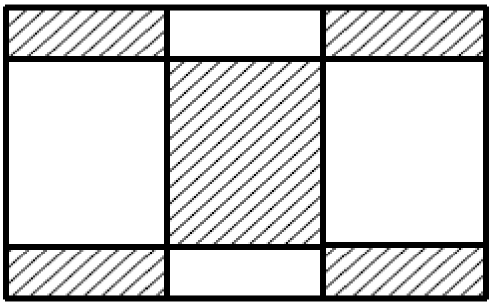
$\gamma_m = 1.02$

Figure 4.1 : Loading conditions for ships less than 200 m in length

Homogeneous loading condition at draught T   Non homogeneous loading condition at draught T



Partial loading condition at draught equal to 0.5D



Light ballast condition at the relevant draught

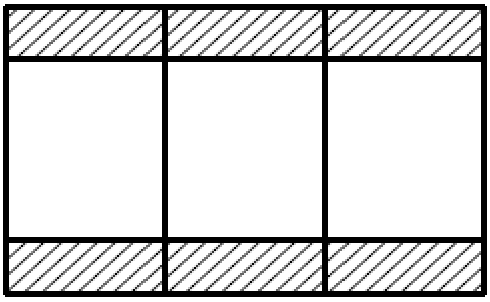
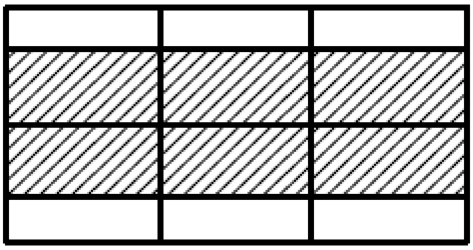
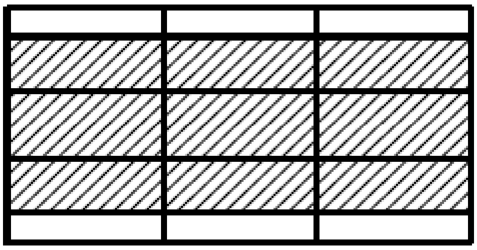


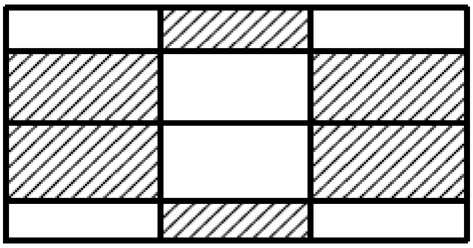
Figure 4.2 : Loading conditions for ships equal to or greater than 200 m in length

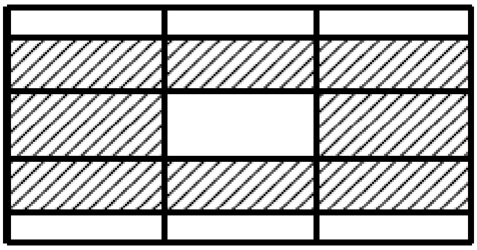
Homogeneous loading conditions at draught T



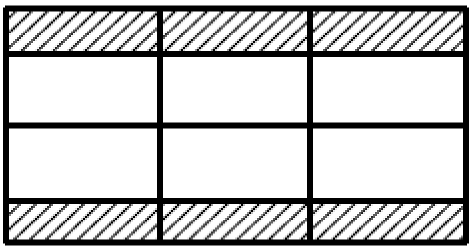


Non homogeneous loading conditions at draught T





Light ballast conditions at the relevant draught



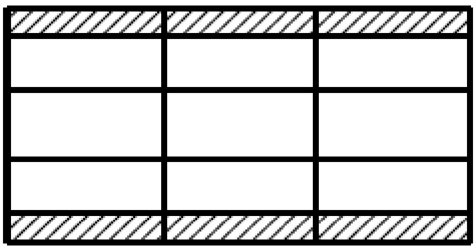
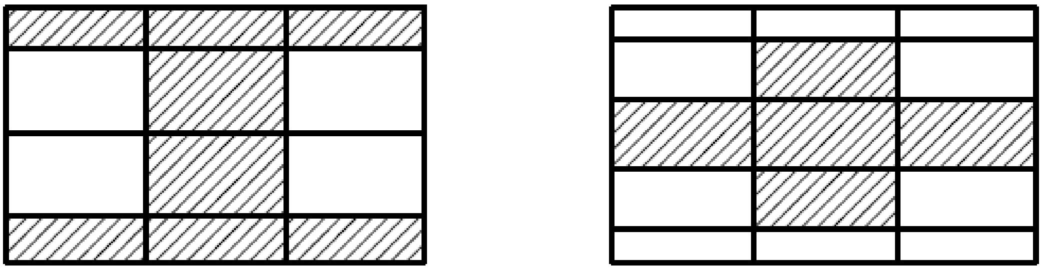
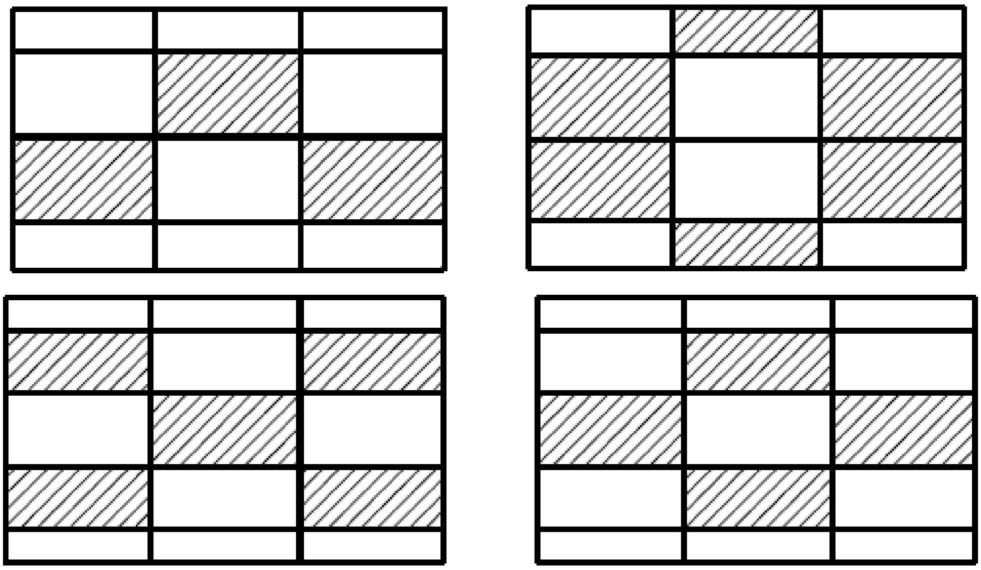


Figure 4.3 : Loading conditions for ships equal to or greater than 200 m in length

Partial loading condition at draught equal to 0.5D



Partial loading condition at draught equal to 0.4D



Heavy ballast conditions(where applicable) at the relevant draught

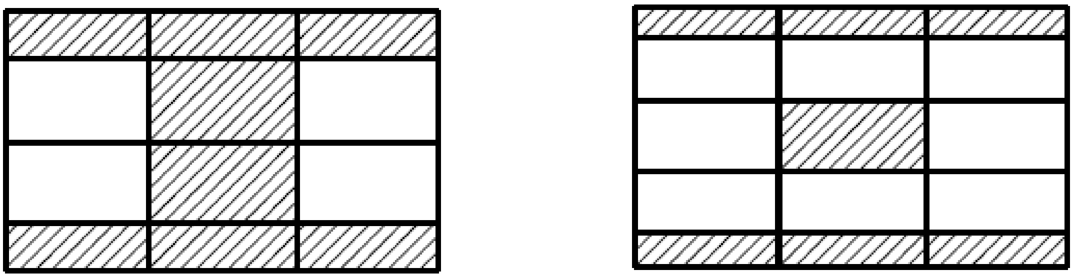
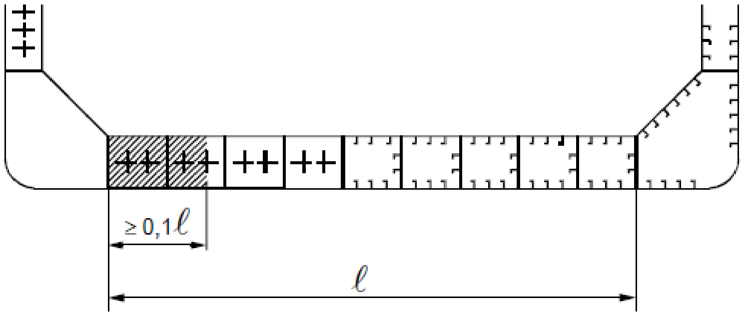


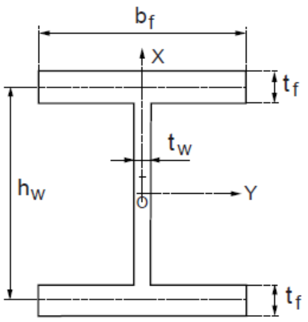
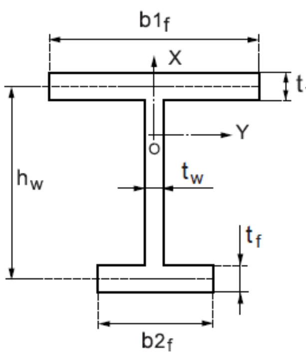
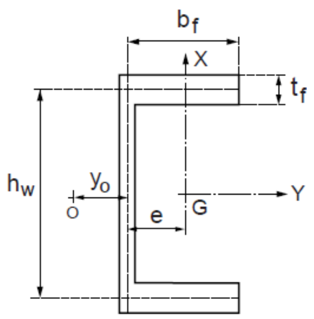
Figure 4.4 : End area of floors



4.3.4 Strength checks of cross-ties analysed through a three dimensional beam model

a) Cross-ties analysed through three dimensional beam model analyses are to be considered, in the most general case, as being subjected to axial forces and bending moments around the neutral axis perpendicular to the cross-tie web. This axis is identified as the y axis, while the x axis is that in the web plane (see Figures in Tab 4.2).

Table 4.2 : Calculation of cross-tie geometric properties

Cross-tie profile	e	y_0	J	I_w
T symmetrical 	0	0	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f h_w^2 b_f^3}{24}$
T non-symmetrical 	0	0	$\frac{1}{3}\left[(b_1 + b_2)t_f^3 + h_w t_w^3\right]$	$\frac{t_f h_w^2 b1_f^3 b2_f^3}{12(b1_f^3 + b2_f^3)}$
Non-symmetrical 	$\frac{b^2 t_f}{h t_w + 2bt_f}$	$\frac{3b_f^2 t_f}{6b_f t_f + h_w t_w}$	$\frac{1}{3}(2b_f t_f^3 + h_w t_w^3)$	$\frac{t_f b_f^3 h^2}{12} \frac{3b_f t_f + 2h_w t_w}{6b_f t_f + h_w t_w}$

The axial force may be either tensile or compression.

Depending on this, two types of checks are to be carried out, according to b) or c), respectively.

b) Strength check of cross-ties subjected to axial tensile forces and bending moments.

The net scantlings of cross-ties are to comply with the following formula:

$10\, F_T/A_{ct} + 10^3\, M/w_{yy} \le R_y/(\gamma_R\, \gamma_m)$

where:

F_T : Axial tensile force, in kN, in the cross-ties, obtained from the structural analysis

A_{ct} : Net sectional area, in cm^2, of the cross-tie

M : Max ($|M_1|$, $|M_2|$)

M_1, M_2 : Algebraic bending moments, in kN.m,around the y axis at the ends of the cross-tie,

obtained from the structural analysis

w_{yy} : Net section modulus, in cm^3, of the cross-tie about the y axis

γ_R : Resistance partial safety factor: $\gamma_R = 1.02$

γ_m : Material partial safety factor: $\gamma_m = 1.02$

c) Strength check of cross-ties subjected to axial compressive forces and bending moments.

The net scantlings of cross-ties are to comply with the following formulae:

$10\, F_c(1/A_{ct} + \Phi e/w_{xx}) \le R_y/(\gamma_R\, \gamma_m)$

$10\, F_c/A_{ct} + 10^3\, M_{max}/w_{yy} \le R_y/(\gamma_R\, \gamma_m)$

where:

F_C : Axial compressive force, in kN, in the crossties, obtained from the structural analysis

A_{ct} : Net cross-sectional area, in cm^2, of the cross-tie

$\Phi = 1/(1 - F_c/F_{EX})$

F_{EX} : Euler load, in kN, for buckling around the x axis:

$F_{EX} = (\pi^2 E\, I_{XX})/(10^5 l^2)$

I_{xx} : Net moment of inertia, in cm^4, of the crosstie about the x axis

l : Span, in m, of the cross-tie

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 4.2

for various types of profiles

w_{ww} : Net section modulus, in cm^3, of the cross-tie about the x axis

M_{max} : Max ($|M_0|$, $|M_1|$, $|M_2|$)

$$M_0 = \frac{\sqrt{1+t^2}\,(M_1 + M_2)}{2\cos(u)};\quad t = \frac{1}{\tan(u)}\left(\frac{M_2 - M_1}{M_2 + M_1}\right);\quad u = \frac{\pi}{2}\sqrt{\frac{F_c}{F_{EY}}}$$

F_{EY} : Euler load, in kN, for buckling around the y axis:

$$F_{EY} = \frac{\pi^2 E I_{YY}}{10^5 l^2}$$

I_{yy} : Net moment of inertia, in cm^4, of the crosstie about the y axis

M_1,M_2 : Algebraic bending moments, in kN.m, around the y axis at the ends of the cross-tie,

obtained from the structural analysis

w_{yy} : Net section modulus, in cm^3, of the cross-tie about the y axis

γ_R : Resistance partial safety factor: γ_R = 1.02

γ_m : Material partial safety factor: γ_m = 1.02

4.3.5 Strength checks of cross-ties analysed through a three dimensional finite element model

a) In addition to the requirements for yielding and buckling, the net scantlings of cross-ties

subjected to compression axial stresses are to comply with the following formula:

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

where:

σ: Compressive stress, in N/mm^2, obtained from a three dimensional finite element analysis, based on fine mesh modelling

σ_c : Critical stress, in N/mm^2, defined in b)

γ_R : Resistance partial safety factor: γ_R = 1,02

γ_m : Material partial safety factor: γ_m = 1,02

b) The critical buckling stress of cross-ties is to be obtained, in N/mm^2, from the following formulae:

$\sigma_c = \sigma_E$ for $\sigma_E \le 0.5R_Y$

$\sigma_c = R_Y(1- 0.25R_Y/\sigma_E)$ for $\sigma_E > 0.5R_Y$

where:

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

σ_{E1} : Euler flexural buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E1} = \frac{\pi^2 E I}{10^4 A_{ct} l^2}$$

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

I_{xx} : Net moment of inertia, in cm^4, of the crosstie about the x axis defined in 4.3.4 a)

I_{yy} : Net moment of inertia, in cm^4, of the crosstie about the y axis defined in 4.3.4 a)

A_{ct} : Net cross-sectional area, in cm^2, of the cross-tie

l : Span, in m, of the cross-tie

σ_{E2} : Euler torsional buckling stress, to be obtained, in N/mm^2, from the following formula:

$$\sigma_{E2} = \frac{\pi^2 E I_W}{10^4 I_0 l^2} + 0.41 EJ / I_0$$

I_w : Net sectorial moment of inertia, in cm^6, of the cross-tie, specified in Tab 4.2 for various

types of profiles

I_o : Net polar moment of inertia, in cm^4, of the cross-tie:

$I_o = I_{xx} + I_{yy} + A_{ct} (y_o + e)^2$

y_o : Distance, in cm, from the centre of torsion to the web of the cross-tie, specified in Tab 4.2 for various types of profiles

e : Distance, in cm, from the centre of gravity to the web of the cross-tie, specified in Tab 4.2

for various types of profiles,

J : St. Venantی net moment of inertia, in cm^4, of the cross-tie, specified in Tab 6 for various

types of profiles.

4.4 Strength check with respect to stresses due to the temperature gradient

4.4.1 Direct calculations of stresses induced in the hull structures by the temperature gradient are to be performed for ships intended to carry cargoes at temperatures exceeding 90°C. In these calculations, the water temperature is to be assumed equal to 0°C.

The calculations are to be submitted to the Society for review.

4.4.2 The stresses induced in the hull structures by the temperature gradient are to comply with the yielding checking criteria.

5 Other structures

5.1 Machinery space

5.1.1 Extension of the hull structures within the machinery space

Longitudinal bulkheads carried through cofferdams are to continue within the machinery space and are to be used preferably as longitudinal bulkheads for liquid cargo tanks.

In any case, such extension is to be compatible with the shape of the structures of the double bottom, deck and platforms of the machinery space.

5.2 Opening arrangement

5.2.1 Tanks covers

Covers fitted on all cargo tank openings are to be of sturdy construction, and to ensure tightness for hydrocarbon and water.

Aluminium is not permitted for the construction of tank covers. The use of reinforced fibreglass covers is to be specially examined by the Society.

For the protection of cargo tanks carrying crude oil and petroleum products having a flash point not exceeding 60°C, materials readily rendered ineffective by heat are not to be used for tank opening covers so as to prevent the spread of fire to the cargo.

6 Hull outfitting

6.1 Equipment

6.1.1 Emergency towing arrangements

The specific requirements in Pt III, Ch 5, 4 for ships with the service notation oil tanker ESP or FLS tanker and of 20000 t deadweight and above are to be complied with.

7 Protection of hull metallic structures

7.1 Protection by aluminium coatings

7.1.1 The use of aluminium coatings is prohibited in cargo tanks, the cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

7.2 Material and coatings of tanks

7.2.1 The resistance of materials and coatings and their compatibility with intended cargoes are the responsibility of the builder or owner. All supporting documents are, however, to be given to the Society to allow the issue of the list of cargoes annexed to the classification certificate.

Copy of the charts of coating and/or material resistance issued by the manufacturers is to be kept on board. These documents are to indicate the possible restrictions relative to their use.

8 Cathodic protection of tanks

8.1 General

8.1.1 Internal structures in spaces intended to carry liquids may be provided with cathodic protection.

Cathodic protection may be fitted in addition to the required corrosion protective coating, if any.

8.1.2 Details concerning the type of anodes used and their location and attachment to the structure are to be submitted to the Society for approval.

8.2 Anodes

8.2.1 Magnesium or magnesium alloy anodes are not permitted in oil cargo tanks and tanks adjacent to cargo tanks.

8.2.2 Aluminium anodes are only permitted in cargo tanks and tanks adjacent to cargo tanks in locations where the potential energy does not exceed 28 kg m. The height of the anode is to be measured from the bottom of the tank to the centre of the anode, and its weight is to be taken as the weight of the anode as fitted, including the fitting devices and inserts.

However, where aluminium anodes are located on horizontal surfaces such as bulkhead girders and stringers not less than 1 m wide and fitted with an upstanding flange or face flat projecting not less than 75 mm above the horizontal surface, the height of the anode may be measured from this surface.

Aluminium anodes are not to be located under tank hatches or washing holes, unless protected by the adjacent structure.

8.2.3 There is no restriction on the positioning of zinc anodes.

8.2.4 Anodes are to have steel cores and are to be declared by the Manufacturer as being sufficiently rigid to avoid resonance in the anode support and designed so that they retain the anode even when it is wasted.

8.2.5 The steel inserts are to be attached to the structure by means of a continuous weld. Alternatively, they may be attached to separate supports by bolting, provided a minimummof two bolts with lock nuts are used. However, other mechanical means of clamping may be accepted.

8.2.6 The supports at each end of an anode may not be attached to separate items which are likely to move independently.

8.2.7 Where anode inserts or supports are welded to the structure, they are to be arranged by the Shipyard so that the welds are clear of stress peaks.

8.2.8 As a general rule, the requirements 8.2.1 to 8.2.7 apply also to spaces or compartments adjacent to cargo or slop tanks.

8.3 Impressed current systems

8.3.1 Impressed current cathodic protections are not accepted in cargo or slop tanks, unless specially authorized by the Society.

9 Construction and testing

9.1 Welding and weld connections

9.1.1 For all the members, the web is to be connected to the face plate by means of continuous fillet welding.

It is recommended to use continuous fillet welding to connect the web to its associated shell plating. The throat thickness of such a welding is not to be less than the value specified in the rule.

Discontinuous welds are not allowed for primary members perpendicular to ordinary stiffeners.

For longitudinals, scallop welding can be accepted as for primary members parallel to longitudinals, especially in small ships.

Scallop welding can be accepted for some members.

Where scallop fillet is used, the scallops are to be avoided:

- in way of the connecting brackets and at least more than 200 mm beyond the beginning of the bracket
- more than 200 mm about on either side of the connection of the ordinary stiffeners to the primary stiffeners
- on bottom transverses, shell stringers and longitudinal bulkhead stringers
- on the lower half of side shell and longitudinal bulkhead transverses, and on the web frames of transverse bulkheads.

9.1.2 The welding factors for some hull structural connections are specified in Tab 9.1. These welding factors are to be used, in lieu of the corresponding factors specified in Pt III, to calculate the throat thickness of fillet weld T connections.

For the connections of Tab 9.1, continuous fillet welding is to be adopted.

9.1.3 For ships of more than 250 m in length, throat thicknesses of fillet welds for transverse web frames and horizontal stringers on transverse bulkheads are to be reinforced as

shown in Fig 9.1 and Fig 9.2.

The length, in m, of reinforcement is not to be less than the greater of the following values:

- l = 2s
- l = 1.2

where s is the spacing, in m, of the ordinary stiffeners.

9.1.4 The minimum throat thickness of continuous fillet welding or of scallop welding is not to be less than 4 mm for assemblies of high tensile steel.

9.2 Special structural details

9.2.1 The specific requirements in Pt III for ships with the service notation oil tanker ESP are to be complied with.

Table 9.1 : Welding factor wF

Hull area	Connection		Welding factor w_F
	of	to	
Double bottom in way of cargo tanks	girders	bottom and inner bottom plating	0.35
		floors (interrupted girders)	0.35
	floors	bottom and inner bottom plating	0.35
		inner bottom in way of bulkheads or their lower stools	0.45
		girders (interrupted floors)	0.35
Bulkheads (1)	ordinary stiffeners	bulkhead plating	0.35

(1) Not required to be applied to ships with the additional service feature flash point > 60oC.

Figure 9.1: Reinforcement of throat thickness for ships greater than 250 m

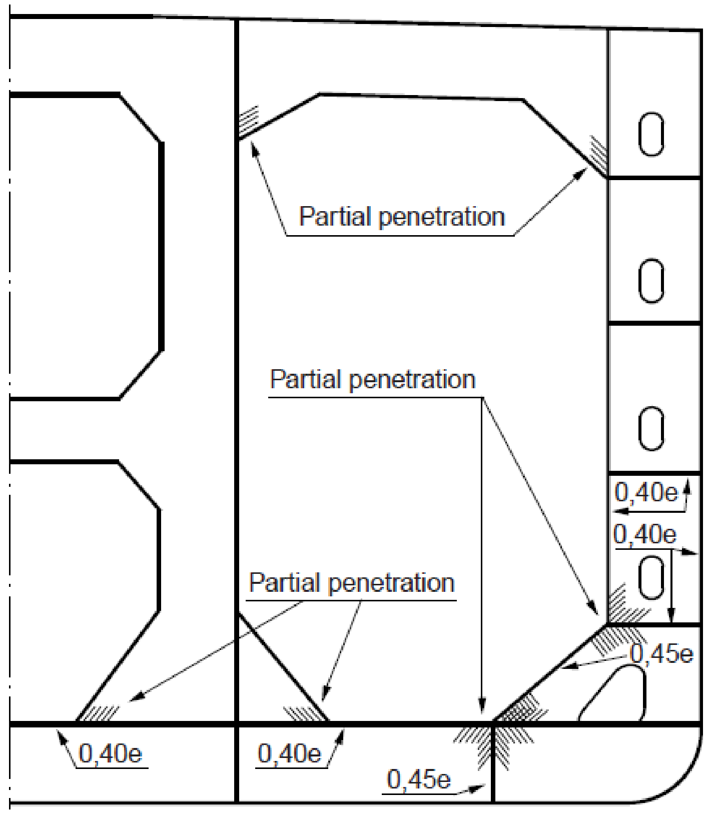
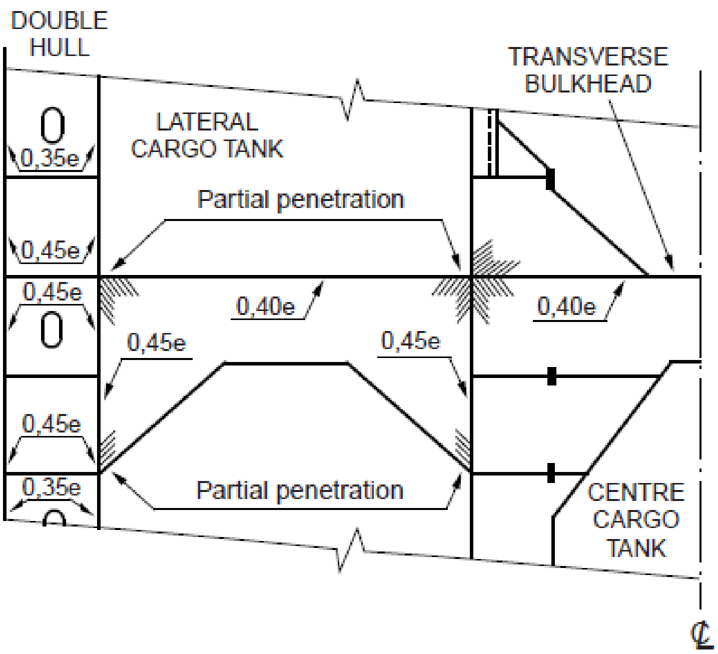


Figure 9.2: Reinforcement of throat thickness for ships greater than 250 m



Section 4 Machinery and Cargo Systems

1 General

1.1 Application

1.1.1 Relaxations applying to certain service notations

Articles 2 to 7 provide requirements that apply to ships having the service notation oil tanker and, where indicated in the relevant notes, the relaxations which may be accepted for ships of less than 500 gross tonnage and for ships having the following service notations:

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

Such relaxations are summarised in Tab 1.1.

1.1.2 Additional requirements

Additional requirements are provided in:

- 8 for ships having the service notation oil tanker, asphalt carrier
- 9 for ships intended to carry substances of pollution category Z.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1.2 are to be submitted for approval.

1.3 Abbreviations

1.3.1 The following abbreviations are used in this Section.

F_P : Flash point, in °C.

2 Piping systems other than cargo piping system

2.1 General

2.1.1 Materials

a) Materials are to comply with the provisions of Pt IV, Ch 1, Sec 11.

b) Spheroidal graphite cast iron may be accepted for bilge and ballast piping within double bottom or cargo tanks.

c) Grey cast iron may be accepted for ballast lines within cargo tanks, except for ballast lines to forward tanks through cargo tanks.

2.1.2 Independence of piping systems

a) Bilge, ballast and scupper systems serving spaces located within the cargo area:

- are to be independent from any piping system serving spaces located outside the cargo area
- are not to lead outside the cargo area.

b) Fuel oil systems are to:

- be independent from the cargo piping system
- have no connections with pipelines serving cargo or slop tanks.

2.1.3 Passage through cargo tanks and slop tanks

a) Unless otherwise specified, bilge, ballast and fuel oil systems serving spaces located outside the cargo area are not to pass through cargo tanks or slop tanks. They may pass through ballast tanks or void spaces located within the cargo area.

b) Where expressly permitted, ballast pipes passing through cargo tanks are to fulfil the following provisions:

- they are to have welded or heavy flanged joints the number of which is kept to a minimum
- they are to be of extra-reinforced wall thickness as per Pt IV, Ch 1, Sec 11, Tab 2.2
- they are to be adequately supported and protected against mechanical damage.

c) Where required by 3.4.5, lines of piping which run through cargo tanks are to be fitted with closing devices.

2.1.4 Pumps forward of cargo tank area

One or more driven pumps are to be fitted, in a suitable space forward of cargo tanks, for bilge, ballast and, where relevant, fuel oil services.

Note 1: On ships of less than 500 gross tonnage, such pumps may be omitted provided that the above services are ensured by means of equivalent arrangements, subject to the approval of the Society.

2.2 Bilge system

2.2.1 Bilge pumps

a) At least one bilge pump is to be provided for draining the spaces located within the cargo area. Cargo pumps or stripping pumps may be used for this purpose.

b) Bilge pumps serving spaces located within the cargo area are to be located in the cargo pump room or in another suitable space within the cargo area.

Table 1.1 : Possible relaxations according to service notation

Subject	Reference to the Rules	Service notation or other feature of the ship to which relaxations apply	Relaxations
Driven pumps for bilge, ballast,etc.	2.1.4	< 500 GRT	equivalent arrangements accepted
Drainage of cofferdams	2.2.5	< 500 GRT	hand pumps permitted
Ballast pumps	2.3.2	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	Shaft misalignment compensation, gastightness of the shaft gland and temperature sensors are not required
Air and sounding pipes of spaces other than cargo tanks	2.4	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	NA (1)
Cargo pumps	3.2.3 3.2.4 3.2.5	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	Shaft misalignment compensation, gas-tightness of the shaft gland and temperature sensors are not required
Generation of static electricity	3.4.4	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	NA (1)
Bow or stern cargo loading and unloading arrangement	3.4.5	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	NA (1)
Cargo tank venting	4.2	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	See Tab 4.1
Cargo tank purging/gas-freeing	4.3	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	NA (1)
Tank level gauging	4.4	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	See Tab 4.1
Tank washing	4.6	• FLS tanker • FLS tanker, flash point > 60°C	NA (1)
Retention of oil on board	5.2	• oil tanker, flash point > 60°C • oil tanker, asphalt carrier • FLS tanker, flash point > 60°C	NA (1)
Oil discharge monitoring and control system	5.3	• oil tanker, less than 150 gross tonnage • oil tanker, flash point > 60°C, and less than 150 gross tonnage • oil tanker, asphalt carrier • FLS tanker • FLS tanker, flash point > 60°C	NA (1)
Oil contaminated water discharge arrangements	5.4	• FLS tanker • FLS tanker, flash point > 60°C	NA (1)
Survey of pollution prevention equipment	6.3.2	• FLS tanker • FLS tanker, flash point > 60°C	NA (1)

(1) NA means that the requirements referred to in the second column of the table are not applicable.

Table 1.2 : Documents to be submitted

Item No.	Description of the document (1)
1	General layout of cargo pump room with details of: • bulkhead penetrations • gas detection system • other alarms and safety arrangements
2	Diagram of cargo piping system
3	Diagram of the cargo tank venting system with: • indication of the outlet position • details of the pressure/vacuum valves and flame arrestors • details of the draining arrangements, if any
4	Diagram of the cargo tank level gauging system with overfill safety arrangements
5	Diagram of the cargo tank cleaning system
6	Diagram of the bilge and ballast systems serving the spaces located in the cargo area
7	Diagram of the cargo heating systems
8	Diagram of inert gas system with details of the inert gas plant
9	Diagram of gas measurement system for double hull and double bottom spaces

(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems

2.2.2 Draining of spaces located outside the cargo area

For bilge draining of spaces located outside the cargo area, refer to Pt IV, Ch 1, Sec 11, 6.

Note 1: Where the bilge pumps are designed to pump from the machinery space only, the internal diameter d, in mm, of the bilge main may be less than that required in Pt IV, Ch 1, Sec 11, 6.8.1 but it is not to be less than that obtained from the following formula:

$$d = 35 + \sqrt{L_0 (B + D)}$$

where:

L_0 : Length of the engine room, in m

B : Breadth of the ship, in m

D : Moulded depth of the ship to the bulkhead deck, in m.

In any case, the internal section of the bilge main is not to be less than twice that of the bilge suction pipes determined from Pt IV, Ch 1, Sec 11, 6.8.3.

Attention is drawn to the requirements stated in Part IV, Chapter 4 as regards the diameter to be adopted for the determination of fire pump capacity.

2.2.3 Draining of pump rooms

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

Note 1: On tankers of less than 500 gross tonnage, the pump rooms may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

b) Cargo pumps or stripping pumps may be used for draining cargo pump rooms provided that:

- a screw-down non-return valve is fitted on the bilge suctions, and
- a remote control valve is fitted between the pump suction and the bilge distribution box.

c) Bilge pipe diameter is not to be less than 50 mm.

d) The bilge system of cargo pump rooms is to be capable of being controlled from outside.

e) A high level alarm is to be provided. Refer to item d) of 3.5.2.

2.2.4 Draining of tunnels and pump rooms other than cargo pump rooms

Arrangements are to be provided to drain tunnels and pump rooms other than cargo pump rooms. Cargo pumps may be used for this service under the provisions of 2.2.3, item b).

2.2.5 Draining of cofferdams located at the fore and aft ends of the cargo spaces

a) When they are not intended to be filled with water ballast, cofferdams located at the fore and aft ends of the cargo spaces are to be fitted with drainage arrangements.

b) Aft cofferdams adjacent to the cargo pump room may be drained by a cargo pump in accordance with the provisions of 2.2.3, items b) and c), or by bilge ejectors.

c) Cofferdams located at the fore end of the cargo spaces may be drained by the bilge or ballast pumps required in 2.1.4, or by bilge ejectors.

d) Drainage of the after cofferdam from the engine room bilge system is not permitted.

Note 1: On tankers of less than 500 gross tonnage, cofferdams may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

2.2.6 Drainage of other cofferdams and void spaces located within the cargo area

Other cofferdams and void spaces located within the cargo area and not intended to be filled with water ballast are to be fitted with suitable means of drainage.

2.3 Ballast system

2.3.1 General

a) Every crude oil tanker of 20 000 tons deadweight and above and every product carrier of 30 000 tons deadweight and above is to be provided with segregated ballast tanks.

b) Except where expressly permitted, ballast systems serving segregated ballast tanks are to be completely separated from the cargo oil and fuel oil systems.

c) In oil tankers of 150 gross tonnage and above, no ballast water is normally to be carried in any fuel oil tank; see Pt IV, Ch 1, Sec 11, 7.1.3.

d) In:

- crude oil tankers of 20 000 tons deadweight and above
- product carriers of 30 000 tons deadweight and above,

no ballast water is to be carried in cargo tanks, except in exceptional cases.

2.3.2 Ballast pumps

a) Ballast pumps are to be located in the cargo pump room, or a similar space within the cargo area not containing any source of ignition.

b) Where installed in the cargo pump room, ballast pumps are to comply with the applicable provisions of 3.2.3.

Note 1: The above provisions do not apply to tankers having one of the following service notations:

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

2.3.3 Pumping arrangements for ballast tanks within the cargo area

a) Ballast systems serving segregated ballast in the cargo area are to be entirely located within the cargo area and are not to be connected to other piping systems.

b) Segregated ballast tanks located within the cargo area are to be served by two different means. At least one of these means is to be a pump or an eductor used exclusively for dealing with ballast.

2.3.4 Pumping arrangement for cofferdams located at the fore and aft ends of the cargo spaces

Where they are intended to be filled with water ballast, the cofferdams located at the fore and aft ends of the cargo spaces may be emptied by a ballast pump located inside the machinery compartment or the forward space mentioned in 2.1.4, whichever is the case, provided that:

- the suction is directly connected to the pump and not to a piping system serving machinery spaces
- the delivery is directly connected to the ship side.

2.3.5 Emergency discharge of segregated ballast

Provisions may be made for emergency discharge of the segregated ballast by means of a connection to a cargo pump through a detachable spool piece provided that:

- non-return valves are fitted on the segregated ballast connections to prevent the passage of oil to the ballast tank, and
- shut-off valves are fitted to shut off the cargo and ballast lines before the spool piece is removed.

The detachable spool piece is to be placed in a conspicuous position in the pump room and a permanent warning notice restricting its use is to be permanently displayed adjacent to it.

2.3.6 Carriage of ballast water in cargo tanks

a) Provisions are to be made for filling cargo tanks with sea water, where permitted. Such ballast water is to be processed and discharged using the equipment referred to in 5.

b) The sea water inlets and overboard discharges serving cargo tanks for the purpose of a) are not to have any connection with the ballast system of segregated ballast tanks.

c) Cargo pumps may be used for pumping ballast water to or from the cargo tanks, provided two shut-off valves are fitted to isolate the cargo piping system from the sea inlets and overboard discharges.

d) Ballast pumps serving segregated ballast tanks may be used for filling the cargo tanks with sea water provided that the connection is made on the top of the tanks and consists of a detachable spool piece and a screw-down non-return valve to avoid siphon effects.

2.3.7 Ballast pipes passing through tanks

a) In oil tankers of 600 tons deadweight and above, ballast piping is not to pass through cargo tanks except in the case of short lengths of piping complying with 2.1.3, item b).

b) Sliding type couplings are not to be used for expansion purposes where ballast lines pass through cargo tanks.

Expansion bends only are permitted.

2.3.8 Fore peak ballast system on oil tankers

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

- the tank is considered as hazardous
- the vent pipe openings are located on open deck 3 m away from sources of ignition
- means are provided, on the open deck, to allow measurement of flammable gas concentrations within the tank by a suitable portable instrument
- the access to the fore peak tank and sounding arrangements are direct from open deck. In case the fore peak tank is separated by cofferdams from the cargo tanks, an access through a gas tight bolted manhole located in an enclosed space may be accepted. In that case, a warming sign is to be provided at the manhole stating that the tank may only be opened after it has been proven to be gas free or the electrical equipment which is not electrically safe in the enclosed space is isolated.

2.4 Air and sounding pipes of spaces other than cargo tanks

2.4.1 Application

The provisions of 2.4 do not apply to ships having one of the following service notations:

- oil tanker, flash point > 60°C

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

2.4.2 General

The air and sounding pipes fitted to the following spaces:

- cofferdams located at the fore and aft ends of the cargo spaces
- tanks and cofferdams located within the cargo area and not intended for cargo are to be led to the open.

2.4.3 Air pipes

The air pipes referred to in 2.4.2 are to be arranged as per Pt IV, Ch 1, Sec 11, 9 and are to be fitted with easily removable flame screens at their outlets.

2.4.4 Passage through cargo tanks

In oil tankers of 600 tons deadweight and above, the air and sounding pipes referred to in 2.4.2 are not to pass through cargo tanks except in the following cases:

- short lengths of piping serving ballast tanks
- lines serving double bottom tanks located within the cargo area, except in the case of oil tankers of 5 000 tons deadweight and above where the provisions of 2.1.3, item b) are complied with.

2.5 Scupper pipes

2.5.1 Scupper pipes are not to pass through cargo tanks except, where this is impracticable, in the case of short lengths of piping complying with the following provisions:

- they are of steel
- they have only welded or heavy flanged joints the number of which is kept to a minimum
- they are of substantial wall thickness as per Pt IV, Ch 1, Sec 11, Tab 8.2, column 1.

2.6 Heating systems intended for cargo

2.6.1 General

a) Heating systems intended for cargo are to comply with the relevant requirements of Pt IV, Ch 1, Sec 11.

b) No part of the heating system is normally to exceed 220°C.

c) Blind flanges or similar devices are to be provided on the heating circuits fitted to tanks carrying cargoes which are not to be heated.

d) Heating systems are to be so designed that the pressure maintained in the heating circuits is higher than that exerted by the cargo oil. This need not be applied to heating circuits which are not in service provided they are drained and blanked-off.

e) Isolating valves are to be provided at the inlet and outlet connections of the tank heating circuits. Arrangements are to be made to allow manual adjustment of the flow.

f) Heating pipes and coils inside tanks are to be built of a material suitable for the heated fluid and of reinforced thickness as per Pt IV, Ch 1, Sec 11, Tab 2.2. They are to have welded connections only.

2.6.2 Steam heating

To reduce the risk of liquid or gaseous cargo returns inside the engine or boiler rooms, steam heating systems of cargo tanks are to satisfy either of the following provisions:

- they are to be independent of other ship services, except cargo heating or cooling systems, and are not to enter machinery spaces, or
- they are to be provided with an observation tank on the water return system located within the cargo area. However, this tank may be placed inside the engine room in a well-ventilated position remote from boilers and other sources of ignition. Its air pipe is to be led to the open and fitted with a flame arrester.

2.6.3 Hot water heating

Hot water systems serving cargo tanks are to be independent of other systems. They are not to enter machinery spaces unless the expansion tank is fitted with:

- means for detection of flammable vapours
- a vent pipe led to the open and provided with a flame arrester.

2.6.4 Thermal oil heating

Thermal oil heating systems serving cargo tanks are to be arranged by means of a separate secondary system, located completely within the cargo area. However, a single circuit system may be accepted provided that:

- the system is so arranged as to ensure a positive pressure in the coil of at least 3 m water column above the static head of the cargo when the circulating pump is not in operation
- means are provided in the expansion tank for detection of flammable cargo vapours. Portable equipment may be accepted.
- valves for the individual heating coils are provided with a locking arrangement to ensure that the coils are under static pressure at all times.

3 Cargo pumping and piping systems

3.1 General

3.1.1 A complete system of pumps and piping is to be fitted for handling the cargo oil. Except where expressly permitted, and namely for the bow and stern cargo loading and unloading stations, this system is not to extend outside the cargo area and is to be independent of any other piping system on board.

3.2 Cargo pumping system

3.2.1 Number and location of cargo pumps

a) Each cargo tank is to be served by at least two separate fixed means of discharging and stripping.

However, for tanks fitted with an individual submerged pump, the second means may be portable.

b) Cargo pumps are to be located:

- in a dedicated pump room, or
- on deck, or
- when designed for this purpose, within the cargo tanks.

3.2.2 Use of cargo pumps

a) Except where expressly permitted in 2.2 and 2.3, cargo pumps are to be used exclusively for handling the liquid cargo and are not to have any connections to compartments other than cargo tanks.

b) Subject to their performance, cargo pumps may be used for tank stripping.

c) Cargo pumps may be used, where necessary, for the washing of cargo tanks.

3.2.3 Cargo pumps drive

a) Prime movers of cargo pumps are not to be located in the cargo area, except in the following cases:

- steam driven machine supplied with steam having a temperature not exceeding 220°C
- hydraulic motors
- electric motors in accordance with Sec 5, 2.

b) Pumps with a submerged electric motor are not permitted in cargo tanks.

c) Where cargo pumps are driven by a machine which is located outside the cargo pump room, the provisions of item a) of 3.5.2 are to be complied with.

3.2.4 Design of cargo pumps

a) Materials of cargo pumps are to be suitable for the products carried.

b) The delivery side of cargo pumps is to be fitted with relief valves discharging back to the suction side of the pumps (bypass) in closed circuit. Such relief valves may be omitted in the case of centrifugal pumps with a maximum delivery pressure not exceeding the design pressure of the piping, with the delivery valve closed.

c) Pump casings are to be fitted with temperature sensing devices; see Tab 3.1.

Note 1: The provisions of item c) above do not apply to ships having one of the following service notations:

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

3.2.5 Monitoring of cargo pumps

Cargo pumps are to be monitored as required in Tab 3.1.

3.2.6 Control of cargo pumps

Cargo pumps are to be capable of being stopped from:

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

3.3 Cargo piping design

3.3.1 General

a) Unless otherwise specified, cargo piping is to be designed and constructed according to the requirements of Pt IV, Ch 1, Sec 11 applicable to piping systems of:

- class III, in the case of ships having the service notation oil tanker
- class II, in the case of ships having the service notation FLS tanker, with the exception of cargo pipes and accessories having an open end or situated inside cargo tanks, for which class III may be accepted.

b) For tests, refer to 6.

Table 3.1 : Monitoring of cargo pumps

Equipment, parameter	Alarm (1)	Indication (2)	Comments
pump, discharge pressure		L	- on the pump (3), or - next to the unloading control station
pump casing, temperature (4)	H (4)		visual and audible, in cargo control room or pump control station
bearings, temperature (4)	H (4)		visual and audible, in cargo control room or pump control station
bulkhead shaft gland, temperature (4)	H (4)		visual and audible, in cargo control room or pump control station

(1) H = high

(2) L = low

(3) and next to the driving machine if located in a separate compartment

(4) not required for tankers having one of the following service notations:

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

3.3.2 Materials

a) For the protection of cargo tanks carrying crude oil and petroleum products having a flash point not exceeding 60°C, materials readily rendered ineffective by heat are not to be used for valves, fittings, cargo vent piping and cargo piping so as to prevent the spread of fire to the cargo.

b) Cargo piping is, in general, to be made of steel or cast iron.

c) Valves, couplings and other end fittings of cargo pipe lines for connection to hoses are to be of steel or other suitable ductile material.

d) Spheroidal graphite cast iron may be used for cargo oil

piping within the double bottom or cargo tanks.

e) Grey cast iron may be accepted for cargo oil lines:

- within cargo tanks, and
- on the weather deck for pressure up to 1.6 Mpa.

It is not to be used for manifolds and their valves of fittings connected to cargo handling hoses.

f) Plastic pipes may be used in the conditions specified in Pt IV, Ch 1, App 1. Arrangements are to be made to avoid the generation of static electricity.

3.3.3 Connection of cargo pipe lengths

Cargo pipe lengths may be connected either by means of welded joints or, unless otherwise specified, by means of flange connections.

3.3.4 Expansion joints

a) Where necessary, cargo piping is to be fitted with expansion joints or bends.

b) Expansion joints including bellows are to be of a type approved by the Society.

c) Expansion joints made of non-metallic material may be accepted only inside tanks and provided they are:

- of an approved type
- designed to withstand the maximum internal and external pressure
- electrically conductive.

d) In ships having the service notation oil tanker, sliding type couplings are not to be used for expansion purposes where lines for cargo oil pass through tanks for segregated ballast.

e) In ships having the service notation FLS tanker, slip joints are not to be used for cargo piping systems with the exception of pipe sections inside cargo tanks served by such sections.

3.3.5 Valves with remote control

a) Valves with remote control are to comply with Pt IV, Ch 1, Sec 11, 2.7.3.

b) Submerged valves are to be remote controlled. In the case of a hydraulic remote control system, control boxes are to be provided outside the tank, in order to permit the emergency control of valves.

c) Valve actuators located inside cargo tanks are not to be operated by means of compressed air.

3.3.6 Cargo hoses

a) Cargo hoses are to be of a type approved by the Society for the intended conditions of use.

b) Hoses subject to tank pressure or pump discharge pressure are to be designed for a bursting pressure not less than 5 times the maximum pressure under cargo transfer conditions.

c) Unless bonding arrangements complying with Section 6 are provided, the ohmic electrical resistance of cargo hoses is not to exceed 10^6 □.

3.4 Cargo piping arrangement and installation

3.4.1 Cargo pipes passing through tanks or compartments

a) Cargo piping is not to pass through tanks or compartments located outside the cargo area.

b) Cargo piping and similar piping to cargo tanks is not to pass through ballast tanks except in the case of short lengths of piping complying with 2.1.3, item b).

c) Cargo piping may pass through vertical fuel oil tanks adjacent to cargo tanks on condition that the provisions of 2.1.3, item b) are complied with.

d) Cargo piping passing through cargo tanks is to comply with the provisions of 3.4.5.

3.4.2 Cargo piping passing through bulkheads

Cargo piping passing through bulkheads is to be so arranged as to preclude excessive stresses at the bulkhead.

Bolted flanges are not to be used in the bulkhead.

3.4.3 Valves

a) Stop valves are to be provided to isolate each tank.

b) A stop valve is to be fitted at each end of the cargo manifold.

c) When a cargo pump in the cargo pump room serves more than one cargo tank, a stop valve is to be fitted in the cargo pump room on the line leading to each tank.

d) Main cargo oil valves located in the cargo pump roombelow the floor gratings are to be remote controlledfrom a position above the floor.

e) Valves are also to be provided where required by 3.4.4 and 3.4.5.

3.4.4 Prevention of the generation of static electricity

a) In order to avoid the generation of static electricity, the loading pipes are to be led as low as practicable in the tank.

b) Cargo pipe sections and their accessories are to be electrically bonded together and to the ship's hull.

Note 1: The provisions of 3.4.4 do not apply to ships having one of the following service notations:

- oil tanker / flash point > 60°C

- oil tanker / asphalt carrier
- FLS tanker, flash point > 60°C.

3.4.5 Bow or stern cargo loading and unloading arrangements

Where the ship is arranged for loading and unloading outside the cargo area, the following provisions are to be complied with:

a) the piping outside the cargo area is to be fitted with a shut-off valve at its connection with the piping system within the cargo area and separating means such as blank flanges or removable spool pieces are to be provided when the piping is not in use, irrespective of the

number and type of valves in the line

b) the shore connection is to be fitted with a shut-off valve and a blank flange

c) pipe connections outside the cargo area are to be of welded type only

d) arrangements are made to allow the piping outside the cargo area to be efficiently drained and purged.

Note 1: The provisions of 3.4.5 do not apply to ships having one of the following service notations:

- oil tanker / flash point > 60°C
- oil tanker / asphalt carrier
- FLS tanker, flash point > 60°C.

3.4.6 Draining of cargo pumps and oil lines

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

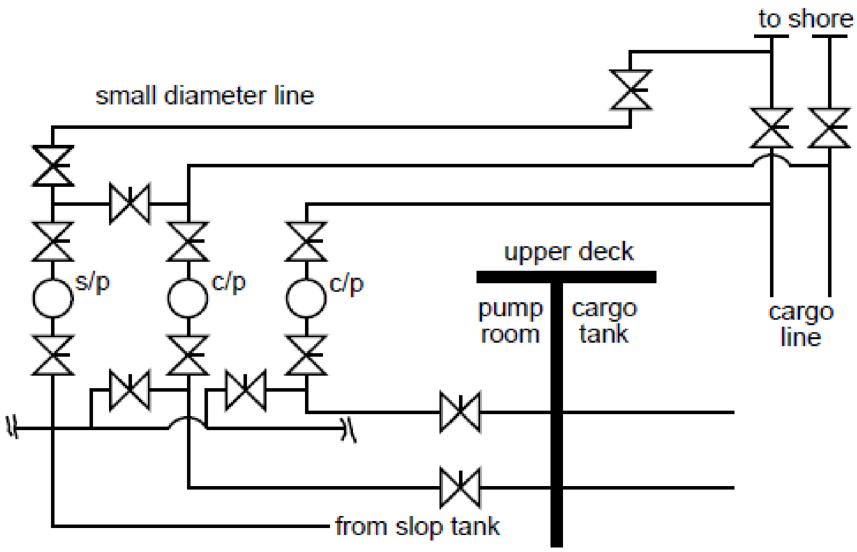
a) it is to be equipped with oil piping so designed and installed that oil retention in the lines is minimised, and

b) means are to be provided to drain all cargo pumps and all oil lines at the completion of cargo discharge, where necessary by connection to a stripping device. The line and pump drainings are to be capable of being discharged both ashore and to a cargo tank or slop tank.

For discharge ashore, a special small diameter line having a cross-sectional area not exceeding 10% of the main cargo discharge line is to be provided and is to be connected on the downstream side of the tankerي deck manifold valves, both port and starboard, when the cargo is being discharged; see Fig 3.1.

For oil tankers fitted with a crude oil washing system, refer also to App 2, 2.4.5.

Figure 3.1 : Connection of small diameter line to the manifold valve



3.4.7 Cleaning and gas-freeing

a) The cargo piping system is to be so designed and arranged as to permit its efficient cleaning and gas-freeing.

b) Requirements for inert gas systems are given in Sec 6, 5.

3.5 Arrangement of cargo pump rooms

3.5.1 Pump room ventilation

In addition to the provisions of Sec 2, 2.3.3, the ventilation of the cargo pump room is to comply with the following provisions:

a) Cargo pump rooms are to be mechanically ventilated and discharges from exhaust fans are to be led to a safe place on the open deck. The ventilation of these rooms is to have sufficient capacity to minimize the possibility of accumulation of flammable vapours. The number of

changes of air is to be at least 20 per hour, based upon the gross volume of the space. The air ducts are to be arranged so that all of the space is effectively ventilated.

The ventilation is to be of the suction type using fans of the non-sparking type.

b) The ventilation ducts are to be so arranged that their suction is just above the transverse floor plates or bottom longitudinals in the vicinity of bilges.

c) An emergency intake located about 2.20 m above the pump room lower grating is to be provided. It is to be fitted with a damper capable of being opened or closed from the exposed main deck and lower grating level.

Ventilation through the emergency intake is to be effective when the lower intakes are sealed off due to flooding in the bilges.

d) The foregoing exhaust system is in association with open grating floor plates to allow the free flow of air.

e) Arrangements involving a specific ratio of areas of upper emergency and lower main ventilator openings, which can be shown to result in at least the required 20 air changes per hour through the lower inlets, can be adopted without the use of dampers. When the lower access inlets are closed then at least 15 air changes per hour should be obtained through the upper inlets.

3.5.2 Measures to prevent explosions

The provisions of 3.5.2 do not apply to ships having one of the following service notations:

- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier
- FLS tanker, flash point > 60°C,

except where the cargo is carried at a temperature above 15°C from the flash point.

a) Where cargo pumps, ballast pumps and stripping pumps are driven by a machine which is located outside the cargo pump room, the following arrangements are to be made:

1) drive shafts are to be fitted with flexible couplings or other means suitable to compensate for any misalignment

2) the shaft bulkhead or deck penetration is to be fitted with a gas-tight gland of a type approved by the Society. The gland is to be efficiently lubricated from outside the pump room and so designed as to prevent overheating. The seal parts of the gland are to be of material that cannot initiate sparks.

3) Temperature sensing devices are to be fitted for bulkhead shaft glands, bearings and pump casings.

b) To discourage personnel from entering the cargo pump room when the ventilation is not in operation, the lighting in the cargo pump room is to be interlocked with ventilation such that ventilation is to be in operation to energise the lighting.

Failure of the ventilation system is not to cause the lighting to go out. Emergency lighting, if fitted, is not to beinterlocked.

c) A system for continuously monitoring the concentration of hydrocarbon gases is to be fitted. Sampling points or detector heads are to be located in suitable positions in order that potentially dangerous leakages are readily detected. Sequential sampling is acceptable as long as it is dedicated for the pump room only, including exhaust ducts, and the sampling time is reasonably short. Suitable positions may be the exhaust ventilation duct and lower parts of the pump room above floor plates. The system is to raise an alarm if the concentration of hydrocarbon gases exceeds 10 per cent of the lower flammable limit (LFL). The alarm signals (visual and audible) are to be provided in the cargo control room and on the

navigation bridge.

d) High liquid level in the bilges is to activate an audible and visual alarm in the cargo control room and on the navigation bridge.

4 Cargo tanks and fittings

4.1 Application

4.1.1

a) The provisions of Article 4 apply to cargo tanks and slop tanks.

b) The provisions of Article 4 apply for the various service notations in accordance with Tab 4.1.

Table 4.1 : Requirements applicable to cargo tanks according to the service notations

Reference of item	Subject	Service notations to which the item applies	Substitutive requirements for service notations to which the item does not apply
4.2	tank venting	• oil tanker • FLS tanker	• The relevant provisions of Pt IV, Ch 1, Sec 11, 9 and 11are to be complied with. • Tank venting systems are to open to the atmosphere at a height of at least 760 mm above the weather deck (1). • Tanks may be fitted with venting systems of the open type provided with a flame screen (2).
4.3	Tank purging /gas-freeing	• oil tanker • FLS tanker	No requirement
4.4	tank level gauging	• oil tanker • FLS tanker	• The relevant provisions of Pt IV, Ch 1, Sec 11, 9 and 11 are to be complied with. • Tanks may be fitted with gauging systems of the open type, such as a hand sounding pipe or other portable gauging devices.
4.5	protection against tank overload	• oil tanker • oil tanker, flash point >60°C • oil tanker, asphalt carrier • FLS tanker • FLS tanker, flash point > 60°C	
4.6	tank washing	• oil tanker • oil tanker, flash point > 60°C • oil tanker, asphalt carrier	

(1) For ships having the notation oil tanker, flash point > 60°C and carrying bulk cargoes at a temperature exceeding flash point - 15°C, this height is to be increased to 2,4 m.

(2) For ships having the notation oil tanker, flash point > 60°C and carrying bulk cargoes with flash point > 100°C, the flame screen may be omitted.

4.2 Cargo tank venting

4.2.1 Principle

Cargo tanks are to be provided with venting systems entirely distinct from the air pipes of the other compartments of the ship. The arrangements and position of openings in the cargo tank deck from which emission of flammable vapours can occur are to be such as to minimise the possibility of flammable vapours being admitted to enclosed spaces containing a source of ignition, or collecting in the vicinity of deck machinery and equipment which may constitute an ignition hazard.

4.2.2 Design of venting arrangements

The venting arrangements are to be so designed and operated as to ensure that neither pressure nor vacuum in cargo tanks exceeds design parameters and be such as to provide for:

a) the flow of the small volumes of vapour, air or inert gas mixtures caused by thermal variations in a cargo tank in all cases through pressure/vacuum valves, and

b) the passage of large volumes of vapour, air or inert gas mixtures during cargo loading and ballasting, or during discharging,

c) a secondary means of allowing full flow relief of vapour, air or inert gas mixtures to prevent overpressure or underpressure in the event of failure of the arrangements in b).

Alternatively, pressure sensors may be fitted in each tank protected by the arrangement required in b), with a monitoring system in the ship's cargo control room or the position from which cargo operations are normally carried out. Such monitoring equipment is also to provide an alarm facility which is activated by detection of overpressure or underpressure conditions within a tank.

Note 1: A pressure / vacuum valve fitted on the inert gas main may be utilised as the required secondary means of venting. Where the venting arrangements are of the free flow type and the masthead isolation valve is closed for the unloading condition, the inert gas system will serve as the primary underpressure protection with the pressure / vacuum breaker serving as the secondary means.

4.2.3 Combination of venting arrangements

a) The venting arrangements in each cargo tank may be independent or combined with other cargo tanks and may be incorporated into the inert gas piping.

b) Where the arrangements are combined with other cargo tanks, either stop valves or other acceptable means are to be provided to isolate each cargo tank. Where stop valves are fitted, they are to be provided with locking arrangements which are to be under the control of the responsible ship's officer. There is to be a clear visual indication of the operational status of the valves or other acceptable means. Where tanks have been isolated, it is to be ensured that relevant isolating valves are opened before cargo loading or ballasting or discharging of those tanks is commenced. Any isolation must continue to permit the flow caused by thermal variations in a cargo tank in accordance with 4.2.2.

Note 1: Inadvertent closure or mechanical failure of the isolation valves need not be considered in establishing the secondary means of venting cargo tanks required in 4.2.2.

c) If cargo loading and ballasting or discharging of a cargo tank or cargo tank group is intended, which is isolated from a common venting system, that cargo tank or cargo tank group is to be fitted with a means for overpressure or underpressure protection as required in 4.2.2.

4.2.4 Arrangement of vent lines

The venting arrangements are to be connected to the top of each cargo tank and are to be self-draining to the cargo tanks under all normal conditions of trim and list of the ship.

Where it may not be possible to provide self-draining lines, permanent arrangements are to be provided to drain the vent lines to a cargo tank.

Plugs or equivalent means are to be provided on the lines after the safety relief valves.

4.2.5 Openings for pressure release

Openings for pressure release required by 4.2.2 are to:

a) have as great a height as is practicable above the cargo tank deck to obtain maximum dispersal of flammable vapours but in no case less than 2 m above the cargo tank deck,

b) be arranged at the furthest distance practicable but not less than 5 m from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery and equipment which may constitute an ignition hazard.

Note 1: The provisions of item a) are not applicable to the pressure / vacuum valve fitted on the inert gas main (see 4.2.2, 4.2.2, Note 1) provided its settings are above those of the venting arrangements required by items a) and b) of 4.2.2.

Note 2: Anchor windlass and chain locker openings constitute an ignition hazard. They are to be located at the distances required by b) above.

4.2.6 Pressure/vacuum valves

a) Pressure/vacuum valves are to be set at a positive pressure not exceeding 0.021 N/mm^2 and at a negative pressure not exceeding 0.007 N/mm^2.

Note 1: Higher setting values not exceeding 0.07 N/mm^2 may be accepted in positive pressure if the scantlings of the tanks are appropriate.

b) Pressure/vacuum valves required by 4.2.2 may be provided with a bypass when they are located in a vent main or masthead riser. Where such an arrangement is provided, there are to be suitable indicators to show whether the bypass is open or closed.

c) Pressure/vacuum valves are to be of a type approved by the Society in accordance with App 1.

d) Pressure/vacuum valves are to be readily accessible.

e) Pressure/vacuum valves are to be provided with a manual opening device so that valves can be locked on open position. Locking means on closed position are not permitted.

4.2.7 Vent outlets

Vent outlets for cargo loading, discharging and ballasting required by 4.2.2 are to:

a) permit:

- the free flow of vapour mixtures, or
- the throttling of the discharge of the vapour mixtures to achieve a velocity of not less than 30 m/s,

b) be so arranged that the vapour mixture is discharged vertically upwards,

c) where the method is by free flow of vapour mixtures, be such that the outlet is not less than 6 m above the cargo tank deck or fore and aft gangway if situated within 4 m of the gangway and located not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery and equipment which may constitute an ignition hazard,

d) where the method is by high velocity discharge, be located at a height not less than 2 m above the cargo tank deck and not less than 10 m measured horizontally from the nearest air intakes and openings to enclosed spaces containing a source of ignition and from deck machinery which may constitute an ignition hazard.

These outlets are to be provided with high velocity devices of a type approved by the Society,

e) be designed on the basis of the maximum designed loading rate multiplied by a factor of at least 1.25 to take account of gas evolution, in order to prevent the pressure in any cargo tank from exceeding the design pressure.

The Master is to be provided with information regarding the maximum permissible loading rate for each cargo tank and in the case of combined venting systems, for each group of cargo tanks.

Note 1: The height requirements of items c) and d) above are not applicable to the pressure / vacuum valve fitted on the inert gas main (see 4.2.2, 4.2.2, Note 1) provided its settings are above those of the venting arrangements required by items a) and b) of 4.2.2.

Note 2: Anchor windlass and chain locker openings constitute an ignition hazard. They are to be located at the distances required by c) and d) above.

4.2.8 High velocity valves

a) High velocity valves are to be readily accessible.

b) High velocity valves not required to be fitted with flame arresters (see 4.2.9) are not to be capable of being locked on open position.

4.2.9 Prevention of the passage of flame into the tanks

a) The venting system is to be provided with devices to prevent the passage of flame into the cargo tanks. The design, testing and locating of these devices are to comply with App 1.

Note 1: The above requirement is not applicable to the pressure / vacuum valve fitted on the inert gas main (see 4.2.2, 4.2.2 Note 1) provided its settings are above those of the venting arrangements required by items a) and b) of 4.2.2.

b) A flame arresting device integral to the venting system may be accepted.

c) Flame screens and flame arresters are to be designed for easy overhauling and cleaning.

4.2.10 Prevention of liquid rising in the venting system

a) Provisions are to be made to prevent liquid rising in the venting system; refer to 4.5.

b) Cargo tanks gas venting systems are not to be used for overflow purposes.

c) Spill valves are not considered equivalent to an overflow system.

4.2.11 Additional provisions for ships fitted with an inert gas system

a) On ships fitted with an inert gas system, one or more pressure/vacuum-breaking devices are to be provided to prevent the cargo tanks from being subject to:

1) a positive pressure in excess of the test pressure of the cargo tank if the cargo were to be loaded at the maximum rated capacity and all other outlets are left shut, and

2) a negative pressure in excess of 700 mm water gauge if cargo were to be discharged at the maximum rated capacity of the cargo pumps and the inert gas blowers were to fail.

Such devices are to be installed on the inert gas main unless they are installed in the venting system required by 4.2.1 or on individual cargo tanks.

b) The location and design of the devices referred to in paragraph a) above are to be in accordance with requirements 4.2.1 to 4.2.10.

4.3 Cargo tank inerting, purging and/or gasfreeing

4.3.1 General

a) Arrangements are to be made for purging and/or gasfreeing of cargo tanks. The arrangements are to be such as to minimise the hazards due to the dispersal of flammable vapours in the atmosphere and to flammable mixtures in a cargo tank. Accordingly, the provisions of 4.3.2 and 4.3.3, as applicable, are to be complied with.

b) The arrangements for inerting, purging or gas-freeing of empty tanks as required in Sec 6, 5.3.2 are to be to the satisfaction of the Society and are to be such that the accumulation of hydrocarbon vapours in pockets formed by the internal structural members in a tank is minimized.

c) Ventilation/gas-freeing lines between fans and cargo tanks are to be fitted with means, such as detachable spool pieces, to prevent any back-flow of hydrocarbon gases through the fans when they are not used.

d) Discharge outlets are to be located at least 10 m measured horizontally from the nearest air intake and openings to enclosed spaces with a source of ignition and from deck machinery equipment which may constitute an ignition hazard.

4.3.2 Ships provided with an inert gas system

The following provisions apply to ships provided with an inert gas system:

a) On individual cargo tanks the gas outlet pipe, if fitted, is to be positioned as far as practicable from the inert gas / air inlet and in accordance with 4.2. The inlet of such outlet pipes may be located either at the deck level or at not more than 1 m above the bottom of the tank.

b) The cross-sectional area of such gas outlet pipe referred to in a) above is to be such that an exit velocity of at least 20 m/s can be maintained when any three tanks are being simultaneously supplied with inert gas. Their outlets are to extend not less than 2 m above deck level.

c) Each gas outlet referred to in b) above is to be fitted with suitable blanking arrangements.

d) The arrangement of inert gas and cargo piping systems is to comply with the provisions of Sec 6, 5.4.7, item f).

e) The cargo tanks are first to be purged in accordance with the provisions of a) to d) above until the concentration of hydrocarbon vapours in the cargo tanks has been reduced to less than 2% by volume. Thereafter, gas-freeing may take place at the cargo tank deck level.

4.3.3 Ships not provided with an inert gas system

When the ship is not provided with an inert gas system, the operation is to be such that the flammable vapour is discharged initially:

a) through the vent outlets as specified in 4.2.7, or

b) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 30 m/s maintained during the gas-freeing operation, or

c) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 20 m/s and which are protected by suitable devices to prevent the passage of flame.

When the flammable vapour concentration at the outlet has been reduced to 30% of the lower flammable limit, gasfreeing may thereafter be continued at cargo tank deck level.

4.4 Cargo tank level gauging systems

4.4.1 General

a) Each cargo or slop tank is to be fitted with a level gauging system indicating the liquid level along the entire height of the tank. Unless otherwise specified, the gauge may be portable or fixed with local reading.

b) Gauging devices and their remote reading systems are to be type approved.

c) Ullage openings and other gauging devices likely to release cargo vapour to the atmosphere are not to be arranged in enclosed spaces.

4.4.2 Definitions

a) A “restricted gauging device” means a device which penetrates the tank and which, when in use, permits a small quantity of vapour or liquid to be exposed to the atmosphere. When not in use, the device is completely closed. Examples are sounding pipes.

b) A “closed gauging device” means a device which is separated from the tank atmosphere and keeps tank contents from being released. It may:

- penetrate the tank, such as float-type systems, electric probe, magnetic probe or protected sight glass,
- not penetrate the tank, such as ultrasonic or radar devices.

c) An “indirect gauging device” means a device which determines the level of liquid, for instance by means of weighing or pipe flow meter.

4.4.3 Tankers fitted with an inert gas system

a) In tankers fitted with an inert gas system, the gauging devices are to be of the closed type.

b) Use of indirect gauging devices will be given special consideration.

4.4.4 Tankers not fitted with an inert gas system

a) In tankers not fitted with an inert gas system, the gauging devices are to be of the closed or restricted types.

Ullage openings may be used only as a reserve sounding means and are to be fitted with a watertight closing appliance.

b) Where restricted gauging devices are used, provisions are to be made to:

- avoid dangerous escape of liquid or vapour under pressure when using the device
- relieve the pressure in the tank before the device is operated.

c) Where used, sounding pipes are to be fitted with a self-closing blanking device.

4.5 Protection against tank overfilling

4.5.1 General

a) Provisions are to be made to guard against liquid rising in the venting system of cargo or slop tanks to a height which would exceed the design head of the tanks. This is to be accomplished by high level alarms or overflow control systems or other equivalent means, together with gauging devices and cargo tank filling procedures.

Note 1: For ships having the service notation FLS tanker, only high level alarms are permitted.

b) Sufficient ullage is to be left at the end of tank filling to permit free expansion of liquid during carriage.

c) High level alarms, overflow control systems and other means referred to in a) are to be independent of the gauging systems referred to in 4.4.

4.5.2 High level alarms

a) High level alarms are to be type approved.

b) High level alarms are to give an audible and visual signal at the control station, where provided.

4.5.3 Other protection systems

a) Where the tank level gauging systems, cargo and ballast pump control systems and valve control systems are centralised in a single location, the provisions of 4.5.1 may be complied with by the fitting of a level gauge for the indication of the end of loading, in addition to that

required for each tank under 4.4. The readings of both gauges for each tank are to be as near as possible to each other and so arranged that any discrepancy between them can be easily detected.

b) Where a tank can be filled only from other tanks, the provisions of 4.5.1 are considered as complied with.

4.6 Tank washing systems

4.6.1 General

a) Adequate means are to be provided for cleaning the cargo tanks.

b) Every crude oil tanker of 20 000 tons deadweight and above is to be fitted with a cargo tank cleaning system using crude oil washing and complying with App 2.

c) Crude oil washing systems fitted on oil tankers other than crude oil tankers of 20 000 tons deadweight or above are to comply with the provisions of App 2 related to safety.

4.6.2 Washing machines

a) Tank washing machines are to be of a type approved by the Society.

b) Washing machines are to be made of steel or other electricity conducting materials with a limited propensity to produce sparks on contact.

4.6.3 Washing pipes

a) Washing pipes are to be built, fitted, inspected and tested in accordance with the applicable requirements of Pt C, Ch 1, Sec 10, depending on the kind of washing fluid, water or crude oil.

b) Crude oil washing pipes are also to satisfy the requirements of Article 3.3.

4.6.4 Use of crude oil washing machines for water washing operations

Crude oil washing machines may be connected to water washing pipes, provided that isolating arrangements, such as a valve and a detachable pipe section, are fitted to isolate water pipes.

4.6.5 Installation of washing systems

a) Tank cleaning openings are not to be arranged in enclosed spaces.

b) The complete installation is to be permanently earthed to the hull.

5 Prevention of pollution by cargo oil

5.1 General

5.1.1 Application

a) Unless otherwise specified, the provisions of 5.3 apply only to ships having the service notations oil tanker or oil tanker, flash point > 60°C and of 150 gross tonnage and above.

b) The provisions of Sec 2, 3.6 are to be complied with.

5.1.2 Provisions for oil tankers of less than 150 gross tonnage

The control of discharge for ships having the service notations oil tanker or oil tanker, flash point > 60°C and of less than 150 tons gross tonnage is to be effected by the retention of oil on board with subsequent discharge of all contaminated washings to reception facilities unless adequate arrangements are made to ensure that the discharge of any effluent which is allowed to be discharged into the sea is effectively monitored to ensure that the total quantity of oil discharged into the sea does not exceed 1/30 000 of the total quantity of the particular cargo of which the residue formed a part.

5.1.3 Exemptions

a) The provisions of 5.3 may be waived in the following cases:

- oil tankers which engage exclusively on both voyages of 72 hours or less in duration and within 50 miles from the nearest land, provided that the oil tanker is engaged exclusively in trades between ports or terminals within a State Party to MARPOL 73/78 Convention. Any such waiver is to be subject to the requirements that the oil tanker is to retain on board all oily mixtures for subsequent discharge to reception facilities and to the determination by the Administration that facilities available to receive such oily mixtures are adequate,
- oil tankers carrying products which through their physical properties inhibit effective product /water separation and monitoring, for which the control of discharge is to be effected by the retention of residues on board with discharge of all contaminated washings to reception facilities.

b) Where, in the view of the Society, the equipment referred to in 5.3.1 and 5.3.2 is not obtainable for the monitoring of discharge of oil refined products (white oils), compliance with such requirements may be waived provided that discharge is performed only in compliance with the applicable procedures.

5.2 Discharge into the sea of cargo oil or oily mixtures

5.2.1 Any discharge into the sea of cargo oil or oily mixtures is to be prohibited except when all the following conditions are satisfied:

a) the tanker is not within a special area,

Note 1: Special areas are defined in MARPOL Annex I, regulation (9).

b) the tanker is more than 50 nautical miles from the nearest land.

c) the tanker is proceeding on route.

d) the instantaneous rate of discharge of oil content does not exceed 30 litres per nautical mile.

e) the total quantity of oil discharged into the sea does not exceed 1/30000 of the total quantity of the particular cargo of which the residue formed a part.

f) the tanker has in operation an oil discharge and monitoring system complying with the provisions of 5.3 and a slop tank arrangement as required by Sec 2, 3.6.

5.2.2 The provisions of 5.2.1 are not to apply to the discharge of segregated ballast.

5.2.3 The cargo oil residues which cannot be discharged into the sea in compliance with 5.2.1 above are to be retained on board or discharged to reception facilities.

5.3 Oil discharge monitoring and control system

5.3.1 General

a) An oil discharge monitoring and control system is to be fitted.

b) A manually operated alternative method is to be provided.

5.3.2 Design of the discharge monitoring and control system

a) The discharge monitoring and control system is to be of a type approved in compliance with the provisions of IMO Resolution A.586(14).

b) The discharge monitoring and control system is to be fitted with a recording device to provide a continuous record of the discharge in litres per nautical mile and total quantity discharged, or the oil content and rate of discharge. This record is to be identifiable as regards time and date.

c) The oil discharge monitoring and control system is to come into operation when there is any discharge of effluent into the sea and is to be such as will ensure that any discharge of oily mixture is automatically stopped when the instantaneous rate of discharge of oil content exceeds 30 litres per nautical mile.

d) Any failure of the monitoring and control system is to stop the discharge.

5.3.3 Oil/water interface detectors

Effective oil/water interface detectors approved by the Society are to be provided for a rapid and accurate determination of the oil/water interface in slop tanks and are to be available for use in other tanks where the separation of oil and water is effected and from which it is intended to discharge effluent directly to the sea.

5.4 Pumping, piping and discharge arrangements

5.4.1 Discharge manifold

In every oil tanker, a discharge manifold for connection to reception facilities for the discharge of dirty ballast water or oil contaminated water is to be located on the open deck on both sides of the ship.

5.4.2 Discharge pipelines

In every oil tanker, pipelines for the discharge of ballast water or oil contaminated water from cargo tank areas to the sea, where permitted, are to be led to the open deck or to the ship side above the waterline in the deepest ballast condition, except that:

a) segregated ballast and clean ballast may be discharged below the waterline:

- in ports or at offshore terminals, or
- at sea by gravity,

provided that the surface of the ballast water has been examined immediately before the discharge to ensure that no contamination with oil has taken place.

b) on every oil tanker at sea, dirty ballast water or oil contaminated water from tanks in the cargo area, other than slop tanks, may be discharged by gravity below the waterline, provided that sufficient time has elapsed in order to allow oil/water separation to have taken place and the water ballast has been examined immediately before the discharge with an oil/water interface detector referred to in 5.3.3, in order to ensure that the height of the interface is such that the discharge does not involve any increased risk of harm to the marine environment.

5.4.3 Discharge stopping

Means are to be provided for stopping the discharge into the sea of ballast water or oil contaminated water from cargo tank areas, other than those discharges below the waterline permitted under 5.4.2, from a position on the upper deck or above located so that the manifold in use referred to in 5.4.1 and the discharge to the sea from the pipelines referred to in 5.4.2 may be visually observed.

Means for stopping the discharge need not be provided at the observation position if a positive communication system such as a telephone or radio system is provided between the observation position and the discharge control position.

6 Certification, inspection and testing

6.1 Application

6.1.1 The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt IV, Ch 1, Sec 11, 20 for piping systems.

6.2 Workshop tests

6.2.1 Tests for materials

Where required in Tab 6.1, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt IV, Ch 1, Sec 11, 20.3.2.

6.2.2 Inspection of welded joints

Where required in Tab 6.1, welded joints are to be subjected to the examinations specified in Pt IV, Ch 1, Sec 11, 3.6 for class II pipes.

6.2.3 Hydrostatic testing

a) Where required in Tab 6.1, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt IV, Ch 1, Sec 11, 20.4.

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt IV, Ch 1, Sec 11, 20.4.

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

6.2.4 Tightness tests

Tightness of the following devices is to be checked:

- gas-tight penetration glands
- cargo tank P/V and high velocity valves.

Note 1: These tests may be carried out in the workshops or on board.

6.2.5 Check of the safety valves setting

The setting pressure of the pressure/vacuum valves is to be checked in particular with regard to 4.2.6.

6.2.6 Summarising table

Inspections and tests required for cargo piping and other equipment fitted in the cargo area are summarised in Tab 6.1.

6.3 Shipboard tests

6.3.1 Pressure test

a) After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

b) The piping system used in crude oil washing systems is to be submitted to hydrostatic tests in accordance with App 2, 3.2.1.

6.3.2 Survey of pollution prevention equipment

Every ship having the service notations oil tanker or oil tanker, flash point > 60°C and of 150 gross tonnage and above is to be subjected to an initial survey before the ship is put in service, to ensure that the equipment, systems, fittings, arrangements and materials fully comply with the relevant provisions of 4.6 and 5.

7 Steering gear

7.1 General

7.1.1 In addition to the provisions of Pt IV, Ch 1, Sec 12, the steering gear of ships having the service notation oil tanker or FLS tanker and of 10000 gross tonnage and above is to comply with the requirements of 7.

7.2 Design of the steering gear

7.2.1 Every tanker of 10 000 gross tonnage and upwards is, subject to the provisions of 7.3, to comply with the following:

a) the main steering gear is to be so arranged that in the event of loss of steering capability due to a single failure in any part of one of the power actuating systems of the main steering gear, excluding the tiller, quadrant or components serving the same purpose, or seizure of the rudder actuators, steering capability is to be regained in not more than 45 s after the loss of one power actuating system.

b) the main steering gear is to comprise either:

1) two independent and separate power actuating systems, each capable of meeting the requirements of Pt IV, Ch 1, Sec 12; or

2) at least two identical power actuating systems which, acting simultaneously in normal operation, are to be capable of meeting the requirements of Pt IV, Ch 1, Sec 12. Where necessary to comply with this requirement, interconnection of hydraulic power actuating systems is to be provided. Loss of hydraulic fluid from one system is to be capable of being detected and the defective system automatically isolated so that the other actuating system or systems remain(s) fully operational

c) steering gear other than that of the hydraulic type is to achieve equivalent standards.

Table 6.1 : Inspection and testing at works

No	Item	Tests for materials		Inspections and tests for the products			References to the Rules
		Y/N (1)	Type of material certificate (2)	during manufacturing (1)	after completion (1) (3)	Type of product certificate (2)	
1	pipes, valves and fittings of class II (see 3.3.1)	Y	• C where ND > 100mm • W where ND □100mm	Y (4)	Y	C	6.2.1 6.2.1 6.2.2 6.2.3
2	expansion joints and cargo hoses	Y (5)	W	N	Y	C	6.2.1 6.2.3
3	cargo pumps	Y	C	Y (6)	Y	C	SeeNote(6) 6.2.3
4	gas-tight penetration glands	N		N	Y	C	6.2.3 6.2.4
5	cargo tank P/V and high velocity valves	Y	C	Y	Y	C	6.2.1 6.2.2 6.2.3 6.2.4
6	flame arresters	N		N	Y	C	See note(3)
7	Oil discharge monitoring and control system	N			Y (7)	C	See note(3)
8	Oil/water interface detector	N			Y (7)	C	See note(3)

(1) Y = required, N = not required.

(2) C = class certificate, W = works certificate.

(3) includes the checking of the rule characteristics according to the approved drawings.

(4) only in the case of welded construction.

(5) if metallic.

(6) inspection during manufacturing is to be carried out according to a program approved by the Society.

(7) may also be carried out on board.

7.3 Alternative design for ships of less than 100 000 tonnes deadweight

7.3.1 General

For tankers of 10 000 gross tonnage and upwards, but of less than 100 000 tons deadweight, solutions other than those set out in 7.2, which need not apply the single failure criterion to the rudder actuator or actuators, may be permitted provided that an equivalent safety standard is achieved and that:

a) following loss of steering capability due to a single failure of any part of the piping system or in one of the power units, steering capability is regained within 45 s; and

b) where the steering gear includes only a single rudder actuator, special consideration is given to stress analysis for the design including fatigue analysis and fracture mechanics analysis, as appropriate, to the material used, to the installation of sealing arrangements and to testing and inspection and to the provision of effective maintenance.

7.3.2 Materials

Parts subject to internal hydraulic pressure or transmitting mechanical forces to the rudder stock are to be made of duly tested ductile materials complying with recognized standards. Materials for pressure retaining components are to be in accordance with recognised pressure vessel standards.

These materials are not to have an elongation of less than 12% or a tensile strength in excess of 650 N/mm^2.

7.3.3 Design

a) Design pressure

The design pressure is assumed to be at least equal to the greater of the following:

1) 1.25 times the maximum working pressure to be expected under the operating conditions required in Pt IV, Ch 12

2) the relief valve setting.

b) Analysis

1) the manufacturers of rudder actuators are to submit detailed calculations showing the suitability of the design for the intended service

2) a detailed stress analysis of the pressure retaining parts of the actuator is to be carried out to determine the stress at the design pressure

3) where considered necessary because of the design complexity or manufacturing procedures, a fatigue analysis and fracture mechanics analysis may be required. In connection with the analyses, all foreseen dynamic loads are to be taken into account.

Experimental stress analysis may be required in addition to, or in lieu of, theoretical calculations depending on the complexity of the design.

c) Allowable stresses

For the purpose of determining the general scantlings of parts of rudder actuators subject to internal hydraulic pressure, the allowable stresses are not to exceed:

- $\sigma_m \le f$
- $\sigma_l \le 1.5\ f$
- $\sigma_b \le 1.5\ f$
- $\sigma_l + \sigma_b \le 1.5\ f$
- $\sigma_m + \sigma_b \le 1.5\ f$

where:

σ_m : Equivalent primary general membrane stress

σ_l : Equivalent primary local membrane stress

σ_b : Equivalent primary bending stress

f : the lesser of σ_B/A or σ_y/B

σ_B : Specified minimum tensile strength of material at ambient temperature

σ_y: Specified minimum yield stress or 0.2% proof stress of material at ambient temperature

A : Equal to:

- 4.0 for steel
- 4.6 for cast steel
- 5.8 for nodular cast iron

B : Equal to:

- 2.0 for steel
- 2.3 for cast steel
- 3.5 for nodular cast iron

d) Burst test

1) Pressure retaining parts not requiring fatigue analysis and fracture mechanics analysis may be accepted on the basis of a certified burst test at the discretion of the Society and the detailed stress analysis required by 7.3.3, item b), need not be provided.

2) The minimum bursting pressure is to be calculated as follows:

$P_b = PA\,\square_{Ba} / \square_B$

where:

P_b : Minimum bursting pressure

P : Design pressure as defined in 7.3.3, item a)

A : As from 7.3.3, item c)

$\square_{Ba}$: Actual tensile strength

$\square_B$: Tensile strength as defined in 7.3.3, item c).

7.3.4 Construction details

a) General

The construction is to be such as to minimise the local concentration of stress.

b) Welds

1) The welding details and welding procedures are to be approved.

2) All welded joints within the pressure boundary of a rudder actuator or connecting parts transmitting mechanical loads are to be full penetration type or of equivalent strength.

c) Oil seals

1) Oil seals between non-moving parts, forming part of the external pressure boundary, are to be of the metal upon metal type or of an equivalent type.

2) Oil seals between moving parts, forming part of the external pressure boundary, are to be duplicated, so that the failure of one seal does not render the actuator inoperative. Alternative arrangements providing equivalent protection against leakage may be accepted at the discretion of the Society.

d) Isolating valves

Isolating valves are to be fitted at the connection of pipes to the actuator, and are to be directly mounted on the actuator.

e) Relief valves

Relief valves for protecting the rudder actuator against overpressure as required in Pt IV, Ch 1, Sec 12 are to comply with the following:

1) the setting pressure is not to be less than 1.25 times the maximum working pressure expected under operating conditions required in Pt IV, Ch 1, Sec 12

2) the minimum discharge capacity of the relief valves is not to be less than the total capacity of all pumps which provide power for the actuator, increased by 10 per cent. Under such conditions, the rise in pressure is not to exceed 10 per cent of the setting pressure.

In this regard, due consideration is to be given to extreme foreseen ambient conditions in respect of oil viscosity.

7.3.5 Inspection and testing

a) Non-destructive testing

The rudder actuator is to be subjected to suitable and complete non-destructive testing to detect both surface flaws and volumetric flaws. The procedure and acceptance criteria for non-destructive testing is to be in accordance with requirements of recognised standards.

If found necessary, fracture mechanics analysis may be used for determining maximum allowable flaw size.

b) Other testing

1) Tests, including hydrostatic tests, of all pressure parts at 1.5 times the design pressure are to. be carried out.

2) When installed on board the ship, the rudder actuator is to be subjected to a hydrostatic test and a running test.

8 Additional requirements for ships having the additional service feature asphalt carrier

8.1 Application

8.1.1 The provisions of this Article apply, in addition to those contained in Articles 1 to 7 above, to oil tankers having the additional service feature asphalt carrier.

8.2 Additional requirements

8.2.1 Heating systems

a) Cargo tanks intended for the carriage of asphalt solutions are to be equipped with a heating system capable of preserving the asphalt solutions in their liquid state.

Valves are to be fitted on the heating system inlet and outlet.

b) Cargo piping and associated fittings outside tanks are to be provided with suitable heating devices. For heating of piping and fittings, refer to 2.6.

8.2.2 Thermometers

Each tank is to be equipped with at least two thermometers in order to ascertain the temperature of the asphalt solution.

8.2.3 Insulation

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

9 Specific requirements for ships having the notations “FLS tanker” or “FLS tanker, flash point > 60°C”

9.1 Application

9.1.1 The provisions of this Article, derived from Appendix II of the MARPOL 73/78 Convention, are related to the prevention of pollution by noxious liquid substances. They apply as follows:

a) Where the ship is granted only the service notation FLS tanker or FLS tanker, flash point > 60°C, these provisions replace those of 5 related to the prevention of pollution by cargo oil.

b) Where the ship is granted both service notations oil tanker-FLS tanker, or oil tanker-FLS tanker, flash point > 60°C, these provisions are additional to those of 5.

9.2 Design requirements

9.2.1 General

The requirements of 9.2 apply to ships carrying category Z substances.

9.2.2 Underwater discharge

The underwater discharge outlet arrangement is to be such that the residue/water mixture discharged into the sea will not pass through the ship's boundary layer. To this end, when the discharge is made normal to the ship's shell plating, the minimum diameter of the discharge outlet is governed by the following equation:

$D=Q_D/5L$

where:

D : Minimum diameter of the discharge outlet, in m

L : Distance from the forward perpendicular to the discharge outlet, in m

Q_D : the maximum rate selected at which the ship may discharge a residue/water mixture through the outlet, in m^3/h.

When the discharge is directed at an angle to the ship's shell plating, the above relationship is to be modified by substituting for Q_D the component of Q_D which is normal to the ship's shell plating.

9.2.3 Ventilation equipment

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

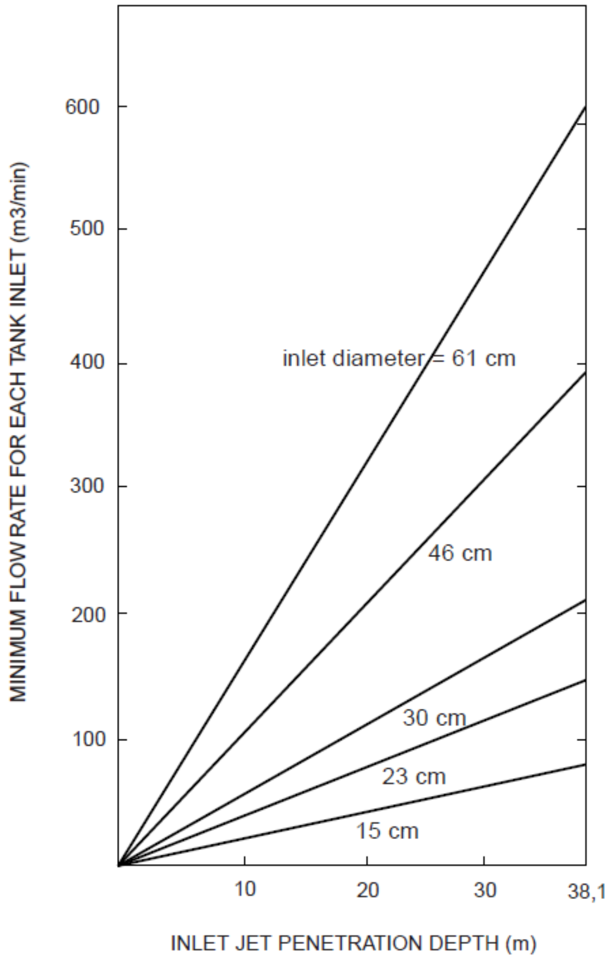
Note 1: Ventilation procedures may be applied only to those substances having a vapour pressure greater than 5 x 103 Pa at 20°C.

b) The ventilation equipment is to be capable of producing an air jet which can reach the tank bottom. Fig 9.1 may be used to evaluate the adequacy of ventilation equipment used for ventilating a tank of given depth.

c) The ventilation equipment is to be placed in the tank opening closest to the tank sump or suction point.

d) When practicable, the ventilation equipment is to be positioned so that the air jet is directed at the tank sump or suction point and impingement of the air jet on tank structural members is to be avoided as far as possible.

Figure 9.1 : Minimum flow rate as a function of jet penetration depth



Jet penetration depth is to be compared against tank height.

Section 5 Electrical Installations

1 General

1.1 Application

1.1.1 The requirements in this Section apply, in addition to those contained in Part IV, Chapter 2 to ships with the service notation oil tanker or FLS tanker.

1.1.2 The design is to be in accordance with IEC publication 60092-502.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt IV, Ch 2, the following are to be submitted for approval:

a) plan of hazardous areas

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

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 The following systems of generation and distribution of electrical energy are acceptable:

a) direct current:

- two-wire insulated

b) alternating current:

- single-phase, two-wire insulated
- three-phase, three-wire insulated.

1.3.2 Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective systems

b) limited and locally earthed systems, such as starting and ignition systems of internal combustion engines, provided that any possible resulting current does not flow directly through any hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions.

1.3.3 Earthed systems without hull return are not permitted, with the following exceptions:

a) earthed intrinsically safe circuits and the following other systems to the satisfaction of the Society

b) power supplies, control circuits and instrumentation circuits in non-hazardous areas where technical or safety reasons preclude the use of a system with no connection to earth, provided the current in the hull is limited to not more than 5 A in both normal and fault conditions, or

c) limited and locally earthed systems, such as power distribution systems in galleys and laundries to be fed through isolating transformers with the secondary windings earthed, provided that any possible resulting hull current does not flow directly through any hazardous

area, or

d) alternating current power networks of 1,000 V root mean square (line to line) and over, provided that any possible resulting current does not flow directly through any hazardous area; to this end, if the distribution system is extended to areas remote from the machinery

space, isolating transformers or other adequate means are to be provided.

1.3.4 In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.4 Earth detection

1.4.1 The devices intended to continuously monitor the insulation level of all distribution systems are also to monitor all circuits, other than intrinsically safe circuits, connected to apparatus in hazardous areas or passing through such areas. An audible and visual alarm is to be given, at a manned position, in the event of an abnormally low level of insulation.

1.5 Mechanical ventilation of hazardous spaces

1.5.1 Electric motors driving fans of the ventilating systems of hazardous spaces are to be located outside the ventilation ducting.

1.5.2 At the discretion of the Society, motors driving ventilating fans may be located within the ducting provided that they are of a certified safe type and are arranged with an additional enclosure (having a degree of protection of at least IP 44) which prevents the impingement of the ducted air stream upon the motor casing.

1.5.3 The materials used for the fans and their housing are to be in compliance with Sec 1, 1.3.10.

1.5.4 Cargo pump-rooms and other enclosed spaces which contain cargo-handling equipment and similar spaces in which work is performed on the cargo should be fitted with mechanical ventilation systems, capable of being controlled from outside such spaces.

1.5.5 Provisions are to be made to ventilate the spaces defined in 1.5.4 prior to entering the compartment and operating the equipment.

1.6 Electrical installation precautions

1.6.1 Precautions against inlet of gases or vapours

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

2 Hazardous locations and types of equipment

2.1 Special requirements for oil tankers carrying flammable liquids having a flash point not exceeding 60°C and for oil tankers carrying flammable liquids having a flash point exceeding 60°C heated to a temperature within 15°C of their flash point or above their flash point

2.1.1 In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zone 0, 1 and 2 according to Pt IV, Ch 2, Sec 13. The different spaces are to be classified according to Tab 2.1.

The types of electrical equipment admitted, depending on the zone where they are installed are specified in Pt IV, Ch 2.

2.1.2 The explosion group and temperature class of electrical equipment of a certified safe type are to be at least IIA and T3 in the case of ships arranged for the carriage of crude oil or other petroleum products.

Other characteristics may be required for dangerous products other than those above.

2.1.3 A space separated by a gastight boundaries from a hazardous area may be classified as zone 0, 1, 2 or considered as non hazardous, taking into account the sources of release inside that space and its conditions of ventilation.

2.1.4 Access door and other openings are not to be provided between an area intended to be considered as nonhazardous and a hazardous area or between a space intended to be considered as zone 2 and a zone 1, except where required for operational reasons.

2.1.5 In enclosed or semi-enclosed spaces having a direct opening into any hazardous space or area, electrical installations are to comply with the requirements for the space or area to which the opening leads.

2.1.6 Where a space has an opening into an adjacent, more hazardous space or area, it may be made into a less hazardous space or non-hazardous space, taking into account the type of separation and the ventilation system.

2.1.7 A differential pressure monitoring device or a flow monitoring device, or both, are to be provided for monitoring the satisfactory functioning of pressurisation of spaces having an opening into a more hazardous zone.

In the event of loss of the protection by the over-pressure or loss of ventilation in spaces classified as zone 1 or zone 2, protective measures are to be taken.

2.2 Special requirements for oil tankers carrying flammable liquids having a flash point exceeding 60°C unheated or heated to a temperature below and not within 15°C of their flash point

2.2.1 For systems of supply and earth detection, the requirements under 1.3 and 1.4 apply.

2.2.2 Cargo tanks, slop tanks, any pipe work of pressurerelief or other venting systems for cargo and slop tanks, pipes and equipment containing the cargo are to be classified as zone 2.

Table 2.1 : Space descriptions and hazardous area zones for oil tankers carrying flammable liquids having a flash point not exceeding 60°C and for oil tankers carrying flammable liquids heated to a temperature within 15°C of their flash point or above their flash point

No	Description of spaces	Hazardous area
1	The interior of cargo tanks, slop tanks, any pipework of pressure-relief or other venting systems for cargo and slop tanks, pipes and equipment containing the cargo or developing flammable gases and vapours	Zone 0
2	Void space adjacent to, above or below integral cargo tanks	Zone 1
3	Hold spaces	Zone 1
4	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks	Zone 1
5	Cargo pump rooms	Zone 1
6	Enclosed or semi-enclosed spaces, immediately above cargo tanks (for example, between decks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the Society	Zone 1
7	Spaces, other than cofferdam, adjacent to and below the top of a cargo tank (for example, trunks, passageways and hold)	Zone 1
8	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump-room ventilation outlets, and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation	Zone 1
9	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet	Zone 1
10	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5 m of cargo pump entrances, cargo pump room ventilation inlet, openings into cofferdams, or other zone 1 spaces	Zone 1
11	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck	Zone 1
12	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where structures are restricting the natural ventilation and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck	Zone 1
13	Compartments for cargo hoses	Zone 1
14	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located	Zone 1
15	Areas of 1.5 m surrounding a space of zone 1	Zone 2
16	Spaces 4 m beyond the cylinder and 4 m beyond the sphere defined in item 9	Zone 2
17	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service area and 3 m beyond these up to a height of 2,4 m above the deck	Zone 2
18	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck surrounding open or semi-enclosed spaces of zone 1	Zone 2
19	Spaces forward of the open deck areas to which reference is made in 12 and 18, below the level of the main deck, and having an opening on to the main deck or at a level less than 0,5 m above the main deck, unless: .1 the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilating system inlets and exhausts, are situated at least 5 m from the foremost cargo tank and at least 10 m measured horizontally from any cargo tank outlet or gas or vapour outlet; and .2 the spaces are mechanically ventilated	Zone 2

Section 6 Fire Protection

1 General

1.1 Application

1.1.1 Unless otherwise specified, the provisions of this Section apply to the ships having one of the following service notations:

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

1.2 Documents to be submitted

1.2.1 The documents listed in Sec 2, Tab 1.1 are to be submitted for approval in addition to chose listed in Tab 1.1.

2 General requirements

2.1 Sources of ignition

2.1.1 Dangerous zones or spaces are not to contain:

- internal combustion engines
- steam turbines and steam piping with a steam temperature in excess of 220°C
- other piping systems and heat exchangers with a fluid temperature in excess of 220°C
- any other source of ignition.

Note 1: Dangerous zones and spaces correspond to hazardous areas defined in Pt IV, Ch 2.

2.2 Electrical equipment

2.2.1 For the installation of electrical equipment, refer to Sec 5.

Table 1.1 : Documents to be submitted

Item No	Description of the document (1)
1	General arrangement drawing
2	Specification of the fire integrity of bulkheads and decks
3	Specification of the instruments for measuring oxygen and flammable vapour concentrations
4	Diagram of the pressure water system within the cargo area
5	For the foam extinguishing system within the cargo area: - diagrammatic arrangement drawing - calculation note - foam agent specification - characteristics of foam monitors and hoses
6	For the fire-extinguishing system in cargo pump rooms: - general arrangement drawing - calculation note
7	For the inert gas installation: - single-wire diagram of the installation together with the main characteristics: capacity, pressure, temperature, oxygen content, water content, - list of the components with their characteristics: pipes, scrubber, blowers, non-return devices, valves, pumps, protective devices for over-pressure and vacuum, - drawing of arrangement of installation on board, - diagram of instrumentation, alarm and safeguard systems, - specification of oxygen analyser, recorder and portable instrumentation, - operational manual containing instructions relative to the operation of the inert gas system and to safety.

(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

3 Fixed deck foam system

3.1 Application

3.1.1 Service notation oil tanker

Ships having the service notation oil tanker are to be provided with a fixed deck foam system complying with the provisions of 3.2 and 3.3 or with an equivalent fixed installation.

Note 1: To be considered equivalent, the system proposed in lieu of the deck foam system is to:

- be capable of extinguishing spill fires and also preclude ignition of spilled oil not yet ignited, and
- be capable of combating fires in ruptured tanks.

3.1.2 Service notation FLS tanker

Ships having the service notation FLS tanker are to be provided with a fixed deck foam system complying with 11.3 of the IBC Code. The type of foam to be used is specified in

App 4, Tab 2.1. Where ordinary foam is considered suitable, foam fire-extinguishing systems complying with the provisions of 3.2 and 3.3 are acceptable.

3.1.3 Service notations oil tanker, flash point > 60°C or oil tanker, asphalt carrier Ships having the service notations oil tanker, flash point > 60°C or oil tanker, asphalt carrier are to be provided with a fixed deck foam system complying with complying with the provisions of 3.2 and 3.3 or with an equivalent fixed installation. However, such a system is not required in the case of ships of less than 2000 gross tonnage.

Note 1: For the definition of بequivalent installationپ refer to 3.1.1.

3.2 System design

3.2.1 Principles

a) The arrangements for providing foam are to be capable of delivering foam to the entire cargo tank deck area as well as into any cargo tank the deck of which has been ruptured.

b) The deck foam system is to be capable of simple and rapid operation.

c) Operation of a deck foam system at its required output is to permit the simultaneous use of the minimum required number of jets of water at the required pressure from the fire main.

Note 1: A common line for fire main and deck foam line can only be accepted if it can be demonstrated that the hose nozzles can be effectively controlled by one person when supplied from the common line at a pressure needed for operation of the monitors. Additional foam concentrate is to be provided for operation of 2 nozzles for the same period of time required for the foam system.

The simultaneous use of the minimum required jets of water is to be possible on deck over the full length of the ship, in the accommodation spaces, service spaces, control stations and machinery spaces.

d) Foam from the fixed foam system is to be supplied by means of monitors and foam applicators.

Note 2: On tankers of less than 4000 tonnes deadweight, the Society may not require installation of monitors but only applicators.

e) Applicators are to be provided to ensure flexibility of action during fire-fighting operations and to cover areas screened from the monitors.

3.2.2 Foam solution - Foam concentrate

a) The rate of supply of foam solution is not to be less than the greatest of the following:

1) 0.6 l/min per square metre of cargo tanks deck area, where cargo tanks deck area means the maximum breadth of the ship multiplied by the total longitudinal extent of the cargo tank spaces,

2) 6 l/min per square metre of the horizontal sectional area of the single tank having the largest such area,

or

3) 3 l/min per square metre of the area protected by the largest monitor, such area being entirely forward of the monitor, but not less than 1250 l/min.

b) Sufficient foam concentrate is to be supplied to ensure at least 20 minutes of foam generation in tankers fitted with an inert gas installation or 30 minutes of foam generation in tankers not fitted with an inert gas installation when using solution rates stipulated in item 1 above, whichever is the greatest. The foam expansion ratio (i.e. the ratio of the volume of foam produced to the volume of the mixture of water and foam-making concentrate supplied) is not generally to exceed 12 to 1. Where systems essentially produce low expansion foam but at an expansion ratio slightly in excess of 12 to 1 the quantity of foam solution available is to be calculated as for 12 to 1 expansion ratio systems. When medium expansion ratio foam (between 50 to 1 and 150 to 1 expansion ratio) is employed, the application rate of the foam and the capacity of a monitor installation is to be to the satisfaction of the Society.

3.2.3 Monitors and foam applicators

a) At least 50 per cent of the foam solution supply rate required in paragraphs a) 1) and a) 2) of 3.2.2 is to be delivered from each monitor.

b) The capacity of any monitor is to be at least 3 l/minute of foam solution per square metre of deck area protected by that monitor, such area being entirely forward of the monitor. Such capacity is to be not less than 1250 l/minute.

c) The capacity of any applicator is to be not less than 400 l/min and the applicator throw in still air conditions is to be not less than 15 m.

Note 1: Where, in pursuance of 3.2.1, the installation of monitors is not required on tankers of less 4000 tonnes deadweight, the capacity of each applicator is to be at least 25 per cent of the foam solution supply rate required in paragraphs a) 1) and a) 2) of 3.2.2.

3.3 Arrangement and installation

3.3.1 Monitors

a) The number and position of monitors are to be such as to comply with paragraph a) of 3.2.1.

b) The distance from the monitor to the farthest extremity of the protected area forward of that monitor is not to be more than 75 per cent of the monitor throw in still air conditions.

c) A monitor and hose connection for a foam applicator are to be situated both port and starboard at the front of the poop or accommodation spaces facing the cargo tank deck.

Note 1: On tankers of less than 4000 tonnes deadweight a hose connection for a foam applicator is to be situated both port and starboard at the front of the poop or accommodation spaces facing the cargo tank deck.

3.3.2 Applicators

a) The number of foam applicators provided is to be not less than four. The number and disposition of foam main outlets are to be such that foam from at least two applicators

can be directed on to any part of the cargo tank deck area.

b) Where the ship is provided with a stern or aft cargo loading or unloading arrangement, the deck foam system is to be so arranged as to permit the protection of the shore connection by at least two foam applicators.

3.3.3 Isolation valves

Valves are be provided in the foam main, and in the fire main when this is an integral part of the deck foam system, immediately forward of any monitor position to isolate damaged sections of those mains.

3.3.4 Main control station

The main control station for the system is to be suitably located outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected.

4 Fire-extinguishing systems except deck foam system

4.1 Pressure water fire-extinguishing systems

4.1.1 The pressure water fire-fighting systems provided on ships having the service notations oil tanker, oil tanker, flash point>60°C, oil tanker, asphalt carrier, FLS tanker or FLS tanker, flash point > 60°C are subject to the provisions of Pt IV, Ch 4, Sec 6, except that:

a) The capacity of the fire pumps is to be calculated without taking into account the reduction permitted in Sec 4, 2.2.2.

b) Isolation valves are to be fitted in the fire main at poop front in a protected position and on the tank deck at intervals of not more than 40 m to preserve the integrity of the fire main system in the event of fire or explosion.

4.1.2 Attention is drawn to the provisions of paragraph c) of 3.2.1.

4.2 Fire-extinguishing systems for cargo pump rooms

4.2.1 Application

a) Cargo pump rooms of ships having the service notations oil tanker or FLS tanker are to be provided with a fixed fire-extinguishing system complying with 4.2.2.

b) Cargo pump rooms of ships having the service notations oil tanker, flash point > 60°C or oil tanker, asphalt carrier are to be provided with a fixed fire-extinguishing system complying with 4.2.2, except where the cargo is carried at a temperature below and not within 15°C of the flash point.

4.2.2 Design and arrangement of the fireextinguishing system

a) Where required by 4.2.1, each cargo pump-room is to be provided with one of the following fixed fire-extinguishing systems operated from a readily accessible position outside the pump-room. Cargo pump-rooms are to be provided with a system suitable for machinery spaces of category A.

1) Either a carbon dioxide or a halogenated hydrocarbon system complying with the provisions of Pt IV, Ch 4, Sec 13, 4 and with the following:

- the alarms giving audible warning of the release of fire-extinguishing medium are to be safe for use in a flammable cargo vapour/air mixture,
- a notice is to be exhibited at the controls stating that due to the electrostatic ignition hazard, the system is to be used only for fire extinguishing and not for inerting purposes.

2) A high-expansion foam system complying with the provisions of Pt IV, Ch 4, Sec 13, 5.1.2, provided that the foam concentrate supply is suitable for extinguishing fires involving the cargoes carried.

3) A fixed pressure water-spraying system complying with the provisions of Pt IV, Ch 4, Sec 13, 6.1.1.

b) Where the extinguishing medium used in the cargo pump-room system is also used in systems serving other spaces, the quantity of medium provided or its delivery rate need not be more than the maximum required for the largest compartment.

5 Inert gas systems

5.1 Application

5.1.1 Ships where an inert gas system is required

a) Ships having the service notations oil tanker or FLS tanker and of 20000 tonnes deadweight and upwards are to be fitted with an inert gas system complying with the provisions of this Article or with an equivalent fixed installation.

Note 1: To be considered equivalent, the system proposed in lieu of the fixed inert gas system is to:

- be capable of preventing dangerous accumulation of explosive mixtures in intact cargo tanks during normal service throughout the ballast voyage and necessary in-tank operations, and
- be so designed as to minimize the risk of ignition from the generation of static electricity by the system itself.

b) All tankers operating with a cargo tank cleaning procedure using crude oil washing are to be fitted with an inert gas system complying with the requirements of this Article.

Such system is to be provided in every cargo tank and slop tank.

5.1.2 Ships where an inert gas system is fitted but not required

Inert gas systems provided on ships where such systems are not required by 5.1.1 are to comply with the provisions of 5.5.2 .

5.2 General

5.2.1 The inert gas system referred to in 5.1 is to be designed, constructed and tested to the satisfaction of the Society.

5.2.2 Throughout this Article, the term “cargo tank” includes also slop tanks.

5.2.3 Detailed instruction manuals are to be provided on board, covering the operations, safety and maintenance requirements and occupational health hazards relevant to the inert gas system and its application to the cargo tank system. The manuals are to include guidance on procedures to be followed in the event of a fault or failure of the inert gas system.

Note 1: Refer to the Revised guidelines for inert gas systems adopted by the IMO Maritime Safety Committee at its forty-eight session in June 1983 (MSC/Circ.353).

5.3 Principles

5.3.1 The inert gas system referred to in this Chapter is to be so designed and operated as to render and maintain the atmosphere of the cargo tanks non-flammable at all times, except when such tanks are required to be gas-free. In the event that the inert gas system is unable to meet the operational requirement set out above and it has been assessed that it is impractical to effect a repair, then cargo discharge, deballasting and necessary tank cleaning are only to be resumed when the “emergency conditions” laid down in the Guidelines for Inert Gas Systems are complied with.

Note 1: Refer to the “Guidelines for Inert Gas Systems” approved by the IMO Maritime Safety Committee at its 42nd session, and subsequent amendments thereto, approved by the same Committee at its 48th and 50th sessions, which have been circulated through IMO Circulars MSC/Circ. 282, 353 and 387 respectively.

5.3.2 The system is to be capable of:

a) inerting empty cargo tanks by reducing the oxygen content of the atmosphere in each tank to a level at which combustion cannot be supported

b) maintaining the atmosphere in any part of any cargo tank with an oxygen content not exceeding 8 per cent by volume and at a positive pressure at all times in port and at sea except when it is necessary for such a tank to be gas-free

c) eliminating the need for air to enter a tank during normal operations except when it is necessary for such a tank to be gas-free

d) purging empty cargo tanks of hydrocarbon gas, so that subsequent gas-freeing operations will at no time create a flammable atmosphere within the tank.

5.3.3 The system is to be capable of delivering inert gas to the cargo tanks at a rate of at least 125 per cent of the maximum rate of discharge capacity of the ship expressed as a volume.

5.3.4 The system is to be capable of delivering inert gas with an oxygen content of not more than 5 per cent by volume in the inert gas supply main to the cargo tanks at any required rate of flow.

5.3.5 The inert gas supply may be treated flue gas from main or auxiliary boilers. The Society may accept systems using flue gases from one or more separate gas generators or other sources or any combination thereof, provided that an equivalent standard of safety is achieved. Such systems are, as far as practicable, to comply with the requirements of this Article. Systems using stored carbon dioxide are not permitted unless the Society is satisfied that the risk of ignition from generation of static electricity by the system itself is minimized.

5.3.6 The inert gas system is to be so designed that the maximum pressure which it can exert on any cargo tank will not exceed the test pressure of any cargo tank.

5.3.7 Arrangements are to be provided to enable the functioning of the inert gas plant to be stabilized before commencing cargo discharge.

5.3.8 An automatic control capable of producing suitable inert gas under all service conditions is to be fitted.

5.4 Design and arrangement of the system

5.4.1 Materials

Those parts of scrubbers, blowers, non-return devices, scrubber effluent and other drain pipes which may be subjected to corrosive action of the gases and/or liquids are to be either constructed of corrosion resistant material or lined with rubber, glass fibre epoxy resin or other equivalent coating material.

5.4.2 Inert gas supply

a) Two fuel oil pumps are to be fitted to the inert gas generator.

The Society may permit only one fuel oil pump on condition that sufficient spares for the fuel oil pump and its prime mover are carried on board to enable any failure of the fuel oil pump and its prime mover to be rectified by the shipڊ crew.

b) Flue gas isolating valves are to be fitted in the inert gas supply mains between the boiler uptakes and the gas scrubber. These valves are to be provided with indicators to show whether they are open or shut, and precautions are to be taken to maintain them gas-tight and keep the seatings clear of soot. Arrangements are be made to ensure that boiler soot blowers cannot be operated when the corresponding flue gas valve is open.

c) A gas regulating valve is to be fitted in the inert gas supply main. This valve is to be automatically controlled to close as required in paragraphs a) and b) of 5.4.11. It is also to be capable of automatically regulating the flow of inert gas to the cargo tanks unless means are provided to automatically control the speed of the inert gas blowers required in 5.4.4.

The valve referred to in the above paragraph is to be located at the forward bulkhead of the forward most gas-safe space through which the inert gas supply main passes.

Note 1: A gas-safe space is a space in which the entry of hydrocarbon gases would produce hazards with regard to flammability or toxicity.

5.4.3 Flue gas scrubber

a) A flue gas scrubber is to be fitted which will effectively cool the volume of gas specified in 5.3.3 and 5.3.4 and remove solids and sulphur combustion products.

b) The cooling water arrangements are to be that an adequate supply of water will always be available without interfering with any essential services of the ship. Provision is to be made for an alternative supply of cooling water.

c) Filters or equivalent devices are to be fitted to minimize the amount of water carried over to the inert gas blowers.

d) The scrubber is to be located aft of all cargo tanks, cargo pump-rooms and cofferdams separating these spaces from machinery spaces of category A.

5.4.4 Blowers

a) At least two blowers are to be fitted which together are to be capable of delivering to the cargo tanks the volume of gas required by 5.3.3 and 5.3.4. In the system with gas generator, the Society may permit only one blower if that system is capable of delivering the total volume of gas required by 5.3.3 and 5.3.4 to the protected cargo tanks, provided that sufficient spares for the blower and its prime mover are carried on board to enable any failure of the blower and its prime mover to be rectified by the shipی crew.

Note 1: When two blowers are provided, the total required capacity of the inert gas system is preferably to be divided equally between them, and in no case is one blower to have a capacity less than 1/3 of the total capacity required.

b) Suitable shuttoff arrangements are to be provided on the suction and discharge connections of each blower.

c) If the blowers are to be used for gas-freeing, their inlets are to be provided with blanking arrangements.

d) The blowers are be located aft of all cargo tanks, cargo pump rooms and cofferdams separating these spaces from machinery spaces of category A.

5.4.5 Means for preventing flue gas leakages

a) Special consideration is to be given to the design and location of scrubber and blowers with relevant piping and fittings in order to prevent flue gas leakages into enclosed spaces.

b) To permit safe maintenance, an additional water seal or other effective means of preventing flue gas leakage is to be fitted between the flue gas isolating valves and scrubber or incorporated in the gas entry to the scrubber.

5.4.6 Means for preventing the return of hydrocarbons

a) At least two non return devices, one of which is to be a water seal, are to be fitted in the inert gas supply main, in order to prevent the return of hydrocarbon vapour to the machinery space uptakes or to any gas-safe spaces under all normal conditions of trim, list and motion of the ship. They are to be located between the automatic valve required by paragraph c) of 5.4.2 and the aftermost connection to any cargo tank or cargo pipeline.

b) The devices referred to in paragraph a) above are to be located in the cargo area on deck.

c) The water seal referred to in paragraph a) above is to be capable of being supplied by two separate pumps, each of which is to be capable of maintaining an adequate supply at all times.

d) The arrangement of the seal and its associated fittings is to be such that it will prevent backflow of hydrocarbon vapours and will ensure the proper functioning of the seal under operating conditions.

e) Provisions are to be made to ensure that the water seal is protected against freezing, in such a way that the integrity of seal is not impaired by overheating.

f) A water loop or other approved arrangement is also to be fitted to each associated water supply and drain pipe and each venting or pressure-sensing pipe leading to gas safe spaces. Means are to be provided to prevent such loops from being emptied by vacuum.

g) The deck water seal and all loop arrangements are to be capable of preventing return of hydrocarbon vapours at a pressure equal to the test pressure of the cargo tanks.

h) The second device is to be a non-return valve or equivalent capable of preventing the return of vapours or liquids and fitted forward of the deck water seal required in paragraph a) above. It is to be provided with positive means of closure. As an alternative to positive means of closure, an additional valve having such means of closure may be provided forward of the non-return valve to isolate the deck water seal from the inert gas main to the cargo tanks.

i) As an additional safeguard against the possible leakage of hydrocarbon liquids or vapours back from the deck main, means are to be provided to permit this section of the line between the valve having positive means of closure referred to in paragraph h) above and the valve referred to in paragraph c) of 5.4.2 to be vented in a safe manner when the first of these valves is closed.

5.4.7 Inert gas piping system

a) The inert gas main may be divided into two or more branches forward of the non-return devices required by 5.4.6.

b) The inert gas supply main is to be fitted with branch piping leading to each cargo tank. Branch piping for inert gas is to be fitted with either stop valves or equivalent means of control for isolating each tank. Where stop valves are fitted, they are to be provided with locking arrangements, which are to be under the control of a responsible shipۥs officer. The control system operated is to provide positive indication of the operational status of such valves.

c) Piping systems are to be so designed as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

d) Suitable arrangements are to be provided to enable the inert gas main to be connected to an external supply of inert gas.

e) The inert gas supply main may be used for the venting of the vapours displaced from the cargo tanks during loading and ballasting. See also Sec 4, 4.2.

f) If a connection is fitted between the inert gas supply mains and the cargo piping system, arrangements are to be made to ensure an effective isolation having regard to the large pressure difference which may exist between the systems. This is to consist of two shutoff valves with an arrangement to vent the space between the valves in a safe manner or an arrangement consisting of a spool-piece with associated blanks.

The valve separating the inert gas supply main from the cargo main and which is on the cargo main side is to be a non-return valve with a positive means of closure.

5.4.8 Connection of the double hull spaces to the inert gas distribution system

On tankers required to be fitted with inert gas systems:

a) double hull spaces are to be fitted with suitable connections for the supply of inert gas,

b) where hull spaces are connected to a permanently fitted inert gas distribution system, means are to be provided to prevent hydrocarbon gases from the cargo tanks entering the double hull spaces through the system,

c) where such spaces are not permanently connected to an inert gas distribution system, appropriate means are to be provided to allow connection to the inert gas main.

5.4.9 Instrumentation

a) Indication devices

Means are to be provided for continuously indicating the temperature and pressure of the inert gas at the discharge side of the gas blowers, whenever the gas blowers are operating.

b) Indicating and recording devices

1) Instrumentation are to be fitted for continuously indicating and permanently recording, when the inert gas is being supplied:

- the pressure of the inert gas supply mains forward of the non-return devices required by paragraph a) of 5.4.6 and
- the oxygen content of the inert gas in the inert gas supply mains on the discharge side of the gas blowers.

2) The devices referred to in 1) above are to be placed in the cargo control room where provided. But where no cargo control room is provided, they are to be placed in a position easily accessible to the officer in charge of cargo operations.

3) In addition, meters are to be fitted:

- in the navigating bridge to indicate at all times the pressure referred to in the first paragraph of 1) above and the pressure in the slop tanks of combination carriers, whenever those tanks are isolated from the inert gas supply main, and
- in the machinery control room or in the machinery space to indicate the oxygen content referred to in the second paragraph of 1) above.

c) Portable instruments

Portable instruments for measuring oxygen and flammable vapour concentration are to be provided. In addition, suitable arrangement are to be made on each cargo tank such that the condition of the tank atmosphere can be determined using these portable instruments.

d) Means for instrument calibration

Suitable means are to be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments, referred to in paragraphs b) and c) above.

5.4.10 Alarms

a) For inert gas systems of both the flue gas type and the inert gas generator type, audible and visual alarms are to be provided to indicate:

1) low water pressure or low water flow rate to the flue gas scrubber as referred to in 5.4.3

2) high water level in the flue gas scrubber as referred to in 5.4.3

3) high gas temperature as referred to in paragraph a) of 5.4.9

4) failure of the inert gas blowers referred to in 5.4.4

5) oxygen content in excess of 8 per cent by volume as referred to in paragraph b) 1) of 5.4.9

6) failure of the power supply to the automatic control system for the gas regulating valve and to the indicating devices as referred to in paragraphs c) of 5.4.2 and b) 1) of 5.4.9

7) low water level in the water seal as referred to in paragraph a) of 5.4.6

8) gas pressure less than 100 mm water gauge as referred to in paragraph b) 1) of 5.4.9, and

9) high gas pressure as referred to in paragraph b) 1) of 5.4.9.

b) For inert gas systems of the inert gas generator type, additional audible and visual alarms are to be provided to indicate:

1) insufficient fuel oil supply

2) failure of the power supply to the generator

3) failure of the power supply to the automatic control systems for the generator.

c) The alarms required in paragraphs a)5), a)6) and a)8) above are to be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew.

d) In respect of paragraph a)7) above, the Society is to be satified as to the maintenance of an adequate reserve of water at all times and the integrity of the arrangements to permit the automatic formation of the water seal when the gas flow ceases. The audible and visual alarm

on the low level of water in the water seal is to operate when the inert gas is not being supplied.

e) An audible alarm system independent of that required in paragraph a)8) above or automatic shutdown of cargo pumps is to be be provided to operate on predetermined limits of low pressure in the inert gas mains being reached.

5.4.11 Safeguards

a) Automatic shutdown of the inert gas blowers and gas regulating valve is to be arranged on predetermined limits being reached in respect of paragraphs a) 1), a) 2) and a) 3) of 5.4.10.

b) Automatic shutdown of the gas regulating valve is to be arranged in respect of:

- a failure of the inert gas blowers referred to in 5.4.4,
- the power supply to the oil fired inert gas generators.

c) In respect of paragraph a)5) above, when the oxygen content of the inert gas exceeds 8% by volume, immediate action is to be taken to iumprove the gas quality.

Unless the quality of the gas improves, all cargo tank operations are to be suspended so as to avoid air being drawn into the tanks and the isolation valve referred to in paragraph h) of 5.4.6 is to be closed.

d) Arrangements are to be made to vent the inert gas from oil fired inert gas generators to the atmosphere when the inert gas produced is off-specification, e.g. during starting- up or in the event of equipment failure.

e) Automatic shut-down of the oil fuel supply to inert gas generators is to be arranged on predetermined limits being reached with respect to low water pressure or mow water flow rate to the cooling and scrubbing arrangement and with respect to high gas temperature.

5.5 Additional requirements

5.5.1 Nitrogen generator systems

a) The following requirements are specific only to the gas generator system and apply where inert gas is produced by separating air into its component gases by passing compressed air through a bundle of hollow fibres, semipermeable membranes or adsorber materials.

b) Where such systems are provided in place of the boiler flue gas or oil fired inert gas generators, the previous requirements for inert gas systems applicable to piping arrangements, alarms and instrumentation downstream of the generator are to be complied with, as far as applicable.

c) A nitrogen generator consists of a feed air treatment system and any number of membrane or adsorber modules in parallel necessary to meet the required capacity which is to be at least 125% of the maximum discharge capacity of the ship expressed as a volume.

d) The air compressor and the nitrogen generator may be installed in the engine room or in a separate compartment.

A separate compartment is to be treated as one of the "Other machinery spaces" with respect to fire protection.

e) Where a separate compartment is provided, it is to be positioned outside the cargo area and is to be fitted with an independent mechanical extraction ventilation system providing 6 air changes per hour. A low oxygen alarm is to be fitted as well. The compartment is to have

no direct access to accommodation spaces, service spaces and control stations.

f) The nitrogen generator is to be capable of delivering high purity nitrogen with O2 content not exceeding 5% by volume. The system is to be fitted with automatic means to discharge off-specification gas to the atmosphere during start-up and abnormal operation.

g) The system is to be provided with two air compressors. The total required capacity of the system is preferably to be divided equally between the two compressors, and in no case is one compressor to have a capacity less than 1/3 of the total capacity required. Only one air compressor may be accepted provided that sufficient spares for the air compressor and its prime mover are carried on board to enable their failure to be rectified by the ship's crew.

h) A feed air treatment system is to be fitted to remove free water, particles and traces of oil from the compressed air, and to preserve the specification temperature.

i) Where fitted, a nitrogen receiver/buffer tank may be installed in a dedicated compartment or in the separate compartment containing the air compressor and the generator or may be located in the cargo area. Where the nitrogen receiver/buffer tank is installed in an enclosed space, the access is to be arranged only from the open deck and the access door is to open outwards.

Permanent ventilation and alarm are to be fitted as required by e) above.

j) The oxygen-enriched air from the nitrogen generator and the nitrogen-product enriched gas from the protective devices of the nitrogen receiver are to be discharged to a safe location on the open deck.

k) In order to permit maintenance, means of isolation are to be fitted between the generator and the receiver.

l) At least two non-return devices are to be fitted in the inert gas supply main, one of which is to be of the double block and bleed arrangement. The second nonreturn device is to be equipped with positive means of closure.

Note 1: A block and bleed arrangement consisting of two shut-off valves in series with a venting valve in between may be accepted provided:

- the operation of the valve is automatically executed. Signal-s) for opening/closing is (are) to be taken from the process directly, e.g. inert gas flow or differential pressure,
- alarm for faulty operation of the valves is provided, e.g. the operation status of ﺑBlower stopﭘand ﺑsupply valve(s) openﭘis an alarm condition.

m) Instrumentation is to be provided for continuously indicating the temperature and pressure of air:

1) at the discharge side of the compressor,

2) at the entrance side of the nitrogen generator.

n) Instrumentation is to be fitted for continuously indicating and permanently recording the oxygen content of the inert gas downstream of the nitrogen generator when inert gas is being supplied.

o) The instrumentation referred to in the preceding item is to be placed in the cargo control room and in the machinery control room (or in the machinery space).

p) Audible and visual alarms are to be provided to indicate:

1) low feed-air pressure from compressor as referred to in m)1) above

2) high air temperature as referred to in m)1) above

3) high condensate level at automatic drain of water separator as referred to in item h) above

4) failure of electrical heater, if fitted

5) oxygen content in excess of that required in item f) above

6) failure of power supply to the instrumentation as referred to in item n) above.

q) Automatic shutdown of the system is to be arranged upon alarm conditions as required by items p) 1) to 5) above.

r) The alarms required by items p) 1) to 6) above are to be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew.

5.5.2 Nitrogen/inert gas systems fitted on oil tankers of less than 20 000 tonnes deadweight and for which an inert gas system is not required

Nitrogen/inert gas systems fitted on oil tankers of less than 20 000 tonnes deadweight and for which an inert gas system is not required by 5.1.1 are to comply with the following:

a) The provisions of 5.5.1 apply except paragraphs a) to c) and g).

b) Where the connections to the cargo tanks, to the hold spaces or to cargo piping are not permanent, the nonreturn devices required by item l) of 5.5.1 may be replaced by two non-return valves.

6 Equipment for measuring oxygen and flammable vapours concentration

6.1 Provisions applicable to all ships

6.1.1 All ships are to be provided with at least two portable gas detectors capable of measuring flammable vapour concentrations in air and at least two portable oxygen analysers.

6.1.2 The gas detectors required in 6.1.1 are to be of a type approved by the Society.

6.2 Additional provisions for ships having the service notation oil tanker or FLS tanker

6.2.1 Ships having the service notation oil tanker or FLS tanker are to comply with the following provisions:

a) They are to be equipped with at least one portable instrument for measuring flammable vapour concentration, together with a sufficient set of spares. Suitable means are to be provided for the calibration of such instruments.

Note 1: The above requirement is considered as being satisfied when a minimum of two instruments are provided on board.

b) Suitable portable instruments for measuring oxygen and flammable vapours concentration in double hull spaces are to be provided. In selecting these instruments, due attention is to be given to their use in combination with the fixed gas sampling line systems referred to in paragraph c).

c) Where the atmosphere in double hull spaces cannot be reliably measured using flexible gas sampling hoses, such spaces are to be fitted with permanent gas sampling lines. The configuration of such line systems are to be adapted to the design of such spaces.

d) The materials of construction and the dimensions of gas sampling lines are to be such as to prevent restriction.

Where plastic materials are used, they are to be electrically conductive.

6.3 Additional provisions for ships fitted with an inert gas system

6.3.1 In addition to the provisions of 6.1, for ships fitted with inert gas systems, at least two portable gas detectors are to be capable of measuring concentrations of flammable vapours in inerted atmosphere.

Note 1: Gas detectors are to be capable of measuring any gas content from 0 to 100% in volume.

6.4 Provisions for installation of gas analyzing units

6.4.1 The following provisions apply to gas analysing units of the sampling type located outside gas dangerous zones.

6.4.2 Gas analysing units with non-explosion proof measuring equipment may be located in areas outside cargo areas, e.g. in cargo control room, navigation bridge or engine room when mounted on the forward bulkhead provided the following requirements are observed:

a) Sampling lines are not to run through gas safe spaces, except where permitted under e).

b) The gas sampling pipes are to be equipped with flame arresters. Sample gas is to be led to the atmosphere with outlets arranged in a safe location.

c) Bulkhead penetrations of sample pipes between safe and dangerous areas are to be of approved type and have same fire integrity as the division penetrated. A manual isolating valve is to be fitted in each of the sampling lines at the bulkhead on the gas safe side.

d) The gas detection equipment including sample piping, sample pumps, solenoids, analysing units etc. is to be located in a reasonably gas tight (e.g. a fully enclosed steel cabinet with a gasketed door) which is to be monitored by its own sampling point. At gas concentrations above 30% LFL inside the steel cabinet the entire gas analysing unit is to be automatically shut down.

e) Where the cabinet cannot be arranged directly on the bulkhead, sample pipes are to be of steel or other equivalent material and without detachable connections, except for the connection points for isolating valves at the bulkhead and analysing units, and are to be routed on their shortest ways.

Appendix 1 Devices to Prevent the Passage of Flame into the Cargo Tanks

1 General

1.1 Application

1.1.1 This Appendix reproduces the text of MSC Circ. 677.

It is intended to cover the design, testing, location and maintenance of "devices to prevent the passage of flame into cargo tanks" (hereafter called "devices") of ships having the service notations oil tanker or combination carrier carrying crude oil, petroleum products having a flash point of 60°C (closed cup test) or less and a Reid vapour pressure below atmospheric pressure, and other liquids with similar fire hazard. It also applies to ships having the service notation FLS tanker carrying flammable products having such a flash point.

1.1.2 Ships having the service notations oil tanker, combination carrier or FLS tanker and fitted with an inert gas system in accordance with Sec 6, 5 are to be fitted with devices which comply with this Appendix, except that the tests specified in 4.2.3 and 4.3.3 are not required. Such devices are only to be fitted at openings unless they are tested in accordance with 4.4.

1.1.3 This Appendix is intended for devices protecting cargo tanks containing crude oil, petroleum products and flammable chemicals. In the case of the carriage of chemicals, the test media referred to in 4 can be used. However, devices for chemical tankers dedicated to the carriage of products with MESG less than 0.9 mm are to be tested with appropriate media.

Note 1: For MESG (Maximum Experimental Safe Gap) reference should be made to IEC - publication 79-1.

1.1.4 Devices are to be tested and located in accordance with this Appendix.

1.1.5 Devices are installed to protect:

a) openings designed to relieve pressure or vacuum caused by thermal variations (see Sec 4, 4.2.2, item a));

b) openings designed to relieve pressure or vacuum during cargo loading, ballasting or discharging (see Sec 4, 4.2.2, item b));

c) outlets designed for gas-freeing (see Sec 4, 4.3.3).

1.1.6 Devices are not to be capable of being bypassed or blocked open unless they are tested in the bypassed or blocked open position in accordance with 4.

1.1.7 This Appendix does not include consideration of sources of ignition such as lightning discharges, since insufficient information is available to formulate equipment recommendations.

All cargo handling, tank cleaning and ballasting operations are to be suspended on the approach of an electrical storm.

1.1.8 This Appendix is not intended to deal with the possibility of the passage of flame from one cargo tank to another on tankers with common venting systems.

1.1.9 When outlet openings of gas-freeing systems on tankers not fitted with inert gas systems are required to be protected with devices, they are to comply with this Appendix except that the tests specified in 4.2.3 and 4.3.3 are not required.

1.1.10 Certain of the tests prescribed in 4 of this Appendix are potentially hazardous, but no ttempt is made in this Appendix to specify safety requirements for these tests.

1.2 Definitions

1.2.1 Premise

For the purpose of this Appendix, the definitions given in the following paragraphs are applicable.

1.2.2 Flame arrester

A flame arrester is a device to prevent the passage of flame in accordance with a specified performance standard. Its flame arresting element is based on the principle of quenching.

1.2.3 Flame screen

A flame screen is a device utilising wire mesh to prevent the passage of unconfined flames in accordance with a specified performance standard.

1.2.4 Flame speed

The flame speed is the speed at which a flame propagates along a pipe or other system.

1.2.5 Flashback

Flashback is the transmission of a flame through a device.

1.2.6 High velocity vent

A high velocity vent is a device to prevent the passage of flame consisting of a mechanical valve which adjusts the opening available for flow in accordance with the pressure at the inlet of the valve in such a way that the efflux velocity cannot be less than 30 m/s.

1.2.7 Pressure/vacuum valve

A pressure/vacuum valve is a device designed to maintain pressure and vacuum in a closed container within preset limits.

Note 1: Pressure/vacuum valves are devices to prevent the passage of flame when designed and tested in accordance with this Appendix.

1.3 Instruction manual

1.3.1 The manufacturer is to supply a copy of the instruction manual, which is to be kept on board the tanker and which is to include:

a) installation instructions

b) operating instructions

c) maintenance requirements, including cleaning (see 2.3.3)

d) a copy of the laboratory report referred to in 4.6

e) flow test data, including flow rates under both positive and negative pressures, operating sensitivity, flow resistance and velocity.

2 Design of the devices

2.1 Principles

2.1.1 Depending on their service and location, devices are required to protect against the propagation of:

a) moving flames, and/or

b) stationary flames from pre-mixed gases after ignition of gases resulting from any cause.

2.1.2 When flammable gases from outlets ignite, the following four situations may occur:

a) at low gas velocities the flame may:

1) flashback, or

2) stabilise itself as if the outlet were a burner.

b) at high gas velocities, the flame may:

1) burn at a distance above the outlet, or

2) be blown out.

2.1.3 In order to prevent the passage of flame into a cargo tank, devices are to be capable of performing one or more of the following functions:

a) permitting the gas to pass through passages without flashback and without ignition of the gases on the protected side when the device is subjected to heating for a specified period

b) maintaining an efflux velocity in excess of the flame speed for the gas irrespective of the geometric configuration of the device and without the ignition of gases on the protected side, when the device is subjected to heating for a specified period; and

c) preventing an influx of flame when conditions of vacuum occur within the cargo tanks.

2.2 Mechanical design

2.2.1 The casing or housing of devices is to meet similar standards of strength, heat resistance and corrosion resistance as the pipe to which it is attached.

2.2.2 The design of devices is to allow for ease of inspection and removal of internal elements for replacement, cleaning or repair.

2.2.3 All flat joints of the housing are to be machined true and are to provide an adequate metal-to-metal contact.

2.2.4 Flame arrester elements are to fit in the housing in such a way that flame cannot pass between the element and the housing.

2.2.5 Resilient seals may be installed only if their design is such that if the seals are partially or completely damaged or burned, the device is still capable of effectively preventing the passage of flame.

2.2.6 Devices are to allow for efficient drainage of moisture without impairing their efficiency to prevent the passage of flame.

2.2.7 The casing, flame arrester element and gasket materials are to be capable of withstanding the highest pressure and temperature to which the device may be exposed under both normal and specified fire test conditions.

2.2.8 End-of-line devices are to be so constructed as to direct the efflux vertically upwards.

2.2.9 Fastenings essential to the operation of the device, i.e. screws, etc., are to be protected against loosening.

2.2.10 Means are to be provided to check that any valve lifts easily without remaining in the open position.

2.2.11 Devices in which the flame arresting effect is achieved by the valve function and which are not equipped with flame arrester elements (e.g. high velocity valves) are to have a width of the contact area of the valve seat of at least 5 mm.

2.2.12 Devices are to be resistant to corrosion in accordance with 4.5.1.

2.2.13 Elements, gaskets and seals are to be of material resistant to both seawater and the cargoes carried.

2.2.14 The casing of the housing is to be capable of passing a hydrostatic pressure test, as required in 4.5.2.

2.2.15 In-line devices are to be able to withstand without damage or permanent deformation the internal pressure resulting from detonation when tested in accordance with 4.4.

2.2.16 A flame arrester element is to be designed to ensure quality control of manufacture to meet the characteristics of the prototype tested, in accordance with this Appendix.

2.3 Performance

2.3.1 Devices are to be tested in accordance with 4.5 and thereafter shown to meet the test requirements of 4.2 to 4.4, as appropriate.

Note 1: End-of-line devices which are intended for exclusive use at openings of inerted cargo tanks need not be tested against endurance burning as specified in 4.2.3.

Note 2: Where end-of-line devices are fitted with cowls, weather hoods and deflectors, etc., these attachments are to be fitted for the tests described in 4.2.

Note 3: When venting to atmosphere is not performed through an end-of-line device according to 2.3.1, Note 2, or a detonation flame arrester according to 3.2.2, the in-line device is to be specifically tested with the inclusion of all pipes, tees, bends, cowls, weather hoods, etc., which may be fitted between the device and atmosphere. The testing is to consist of the flashback test in 4.2.2 and, if for the given installation it is possible for a stationary flame to rest on the device, the testing is also to include the endurance burning test in 4.2.3.

2.3.2 Performance characteristics such as the flow rates under both positive and negative pressure, operating sensitivity, flow resistance and velocity are to be demonstrated by appropriate tests.

2.3.3 Devices are to be designed and constructed to minimize the effect of fouling under normal operating conditions.

Instructions on how to determine when cleaning is required and the method of cleaning are to be provided for each device in the manufacturer's instruction manual.

2.3.4 Devices are to be capable of operating in freezing conditions and if any device is provided with heating arrangements so that its surface temperature exceeds 85°C, then it is to be tested at the highest operating temperature.

2.3.5 Devices based upon maintaining a minimum velocity are to be capable of opening in such a way that a velocity of 30 m/s is immediately initiated, maintaining an efflux velocity of at least 30 m/s at all flow rates and, when the gas flow is interrupted, closing in such a way that this minimum velocity is maintained until the valve is fully closed.

2.3.6 In the case of high velocity vents, the possibility of inadvertent detrimental hammering leading to damage and/or failure is to be considered, with a view to eliminating it.

Note 1: Hammering is intended to mean a rapid full stroke opening/ closing, not foreseen by the manufacturer during normal operations.

2.4 Flame screens

2.4.1 Flame screens are to be:

a) designed in such a manner that they cannot be inserted improperly in the opening

b) securely fitted in openings so that flames cannot circumvent the screen

c) able to meet the requirements of this Appendix. For flame screens fitted at vacuum inlets through which vapours cannot be vented, the test specified in 4.2.3 need not be complied with

d) protected against mechanical damage.

2.5 Marking of devices

2.5.1 Each device is to be permanently marked, or have a permanently fixed tag made of stainless steel or other corrosion- resistant material, to indicate:

a) the manufacturer's name or trade mark

b) the style, type, model or other manufacturer's designation for the device

c) the size of the outlet for which the device is approved

d) the approved location for installation, including maximum or minimum length of pipe, if any, between the device and the atmosphere

e) the direction of flow through the device

f) the test laboratory and report number, and

g) compliance with the requirements of this Appendix.

3 Sizing, location and installation of devices

3.1 Sizing of devices

3.1.1 To determine the size of devices to avoid inadmissible pressure or vacuum in cargo tanks during loading or discharging, calculations of pressure losses are to be carried out.

The following parameters are to be taken into account:

a) loading/discharge rates

b) gas evolution

c) pressure loss through devices, taking into account the resistance coefficient

d) pressure loss in the vent piping system

e) pressure at which the vent opens if a high velocity valve is used

f) density of the saturated vapour/air mixture

g) possible fouling of a flame arrester; 70% of its rated performance is to be used in the pressure drop calculation of the installation.

3.2 Location and installation of devices

3.2.1 General

a) Devices are to be located at the vent outlets to atmosphere unless tested and approved for in-line installation.

b) Devices for in-line installation may not be fitted at the outlets to atmosphere unless they have also been tested and approved for that position.

3.2.2 Detonation flame arresters

Where detonation flame arresters are installed as in-line devices venting to atmosphere, they are be located at a sufficient distance from the open end of the pipeline so as to preclude the possibility of a stationary flame resting on the arrester.

3.2.3 Access to the devices

Means are to be provided to enable personnel to reach devices situated more than 2 m above deck to facilitate maintenance, repair and inspection.

4 Type test procedures

4.1 Principles

4.1.1 Tests are to be conducted by a laboratory acceptable to the Society.

4.1.2 Each size of each model is to be submitted for type testing. However, for flame arresters, testing may be limited to the smallest and the largest sizes and one additional size in between to be chosen by the Society. Devices are to have the same dimensions and most unfavourable clearances expected in the production model. If a test device is modified during the test program, the testing is to be restarted.

4.1.3 Tests described in this Article using gasoline vapours (a non-leaded petroleum distillate consisting essentially of aliphatic hydrocarbon compounds with a boiling range approximating 65°C – 75°C), technical hexane vapours or technical propane, as appropriate, are suitable for all devices protecting tanks containing a flammable atmosphere of the cargoes referred to in Sec 1, 1.1.1. This does not preclude the use of gasoline vapours or technical hexane vapours for all tests referred to in this Article.

4.1.4 After the relevant tests, the device is not to show mechanical damage that affects its original performance.

4.1.5 Before the tests the following equipment, as appropriate, is to be properly calibrated:

a) gas concentration meters

b) thermometers

c) flow meters

d) pressure meters, and

e) time recording devices.

4.1.6 The following characteristics are to be recorded, as appropriate, throughout the tests:

a) concentration of fuel in the gas mixture

b) temperature of the test gas mixture at inflow of the device, and

c) flow rates of the test gas mixtures when applicable.

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

4.2 Test procedure for flame arresters located at openings to the atmosphere

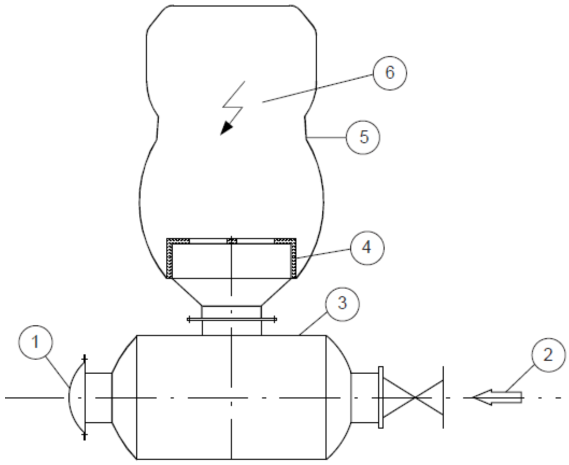
4.2.1 Test rig

The test rig is to consist of an apparatus producing an explosive mixture, a small tank with a diaphragm, a flanged prototype of the flame arrester, a plastic bag and a firing source in three positions (see Fig 4.1). Other test rigs may be used, provided the tests referred to in this Article are carried out to the satisfaction of the Society.

Note 1: The dimensions of the plastic bag are dependent on those of the flame arrester, but for flame arresters normally used on tankers the plastic bag may have a circumference of 2 m, a length of 2.5 m and a wall thickness of 0.05 mm.

Note 2: In order to avoid remnants of the plastic bag from falling back on to the device being tested after ignition of the fuel/air mixture, it may be useful to mount a coarse wire frame across the device within the plastic bag. The frame is to be so constructed as not to interfere with the test result.

Figure 4.1 : Test rig for flashback test



(1): Plastic bursting diaphragm

(2): Explosive mixture inlet

(3): Tank

(4): Flame arresting device

(5): Plastic bag

(6): Ignition source

4.2.2 Flashback test

A flashback test is to be carried out as follows:

a) The tank, flame arrester assembly and the plastic bag (see 4.2.1) enveloping the prototype flame arrester are to be filled so that this volume contains the most easily ignitable propane/air mixture (see IEC Publication 79/1).

The concentration of the mixture is to be verified by appropriate testing of the gas composition in the plastic bag. Where devices referred to in 2.3.1, 2.3.1, Note 3 are tested, the plastic bag is to be fitted at the outlet to atmosphere. Three ignition sources are to be installed along the axis of the bag, one close to the flame arrester, another as far away as possible therefrom, and the third at the mid-point between these two. These three sources are to be fired in succession, twice in each of the three positions. The temperature of the test gas is to be within the range of 15°C to 40°C.

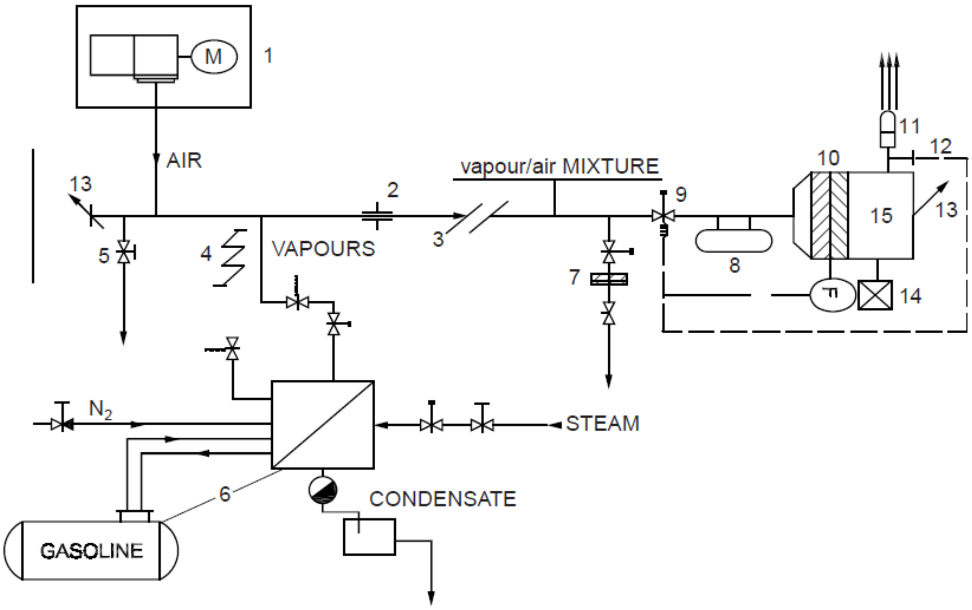
b) If a flashback occurs, the tank diaphragm will burst and this will be audible and visible to the operator by the emission of a flame. Flame, heat and pressure sensors may be used as an alternative to a bursting diaphragm.

4.2.3 Endurance burning test

An endurance burning test is to be carried out, in addition to the flashback test, for flame arresters at outlets where flows of explosive vapour are foreseeable:

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

Figure 4.2 : Schematic plan of the test plant for high velocity valves (endurance burning test only)



(1): Fan with variable speed (2): Volume rate indicator

(3): Pipe (diameter=500 mm, length=30 m) (4): Heated vapour pipe

(5): Air bypass (6): Evaporator and gasoline storage tank

(7): Vapour/air mixture bypass (8): Extinguishing agents

(9): Automatic control and quick action stop valve

(10): Explosion arresting crimped ribbon with temperature sensors for the safety of the test rig

(11): High velocity valve to be tested (12): Flame detector

(13): Bursting diaphragm (14): Concentration indicator

(15): Tank

b) Endurance burning is to be achieved by using the most easily ignitable gasoline vapour/air mixture or the most easily ignitable technical hexane vapour/air mixture with the aid of a continuously operated pilot flame or a continuously operated spark igniter at the outlet. The test gas is be introduced upstream of the tank shown in Fig 4.1. Maintaining the concentration of the mixture as specified above, by varying the flow rate, the flame arrester is to be heated until the highest obtainable temperature on the cargo tank side of the arrester is reached. Temperatures are to be measured, for example, at the protected side of the flame quenching matrix of the arrester (or at the seat of the valve in the case of testing high velocity vents according to 4.3). The highest obtainable temperature may be considered to have been reached when the rate of rise of temperature does not exceed 0,5°C per minute over a ten-minute period. This temperature is to be maintained for a period of ten minutes, after which the flow is to be stopped and the conditions observed. The temperature of the test gas is to be within the range of 15°C to 40°C.

If no temperature rise occurs at all, the arrester is to be inspected for a more adequate position of the temperature sensor, taking account of the visually registered position of the stabilised flame during the first test sequence. Positions which require the drilling of small holes into fixed parts of the arrester are to be taken into account. If all this is not successful, the temperature sensor is to be affixed at the unprotected side of the arrester in a position near to the stabilised flame.

If difficulties arise in establishing stationary temperature conditions (at elevated temperatures), the following criteria is to apply: using the flow rate which produced the maximum temperature during the foregoing test sequence, endurance burning is to be continued for a period of two hours from the time the above-mentioned flow rate has been established. After that period the flow is to be stopped and the conditions observed. Flashback is not to occur during this test.

4.2.4 Pressure/vacuum valve integrated to a flame arresting device

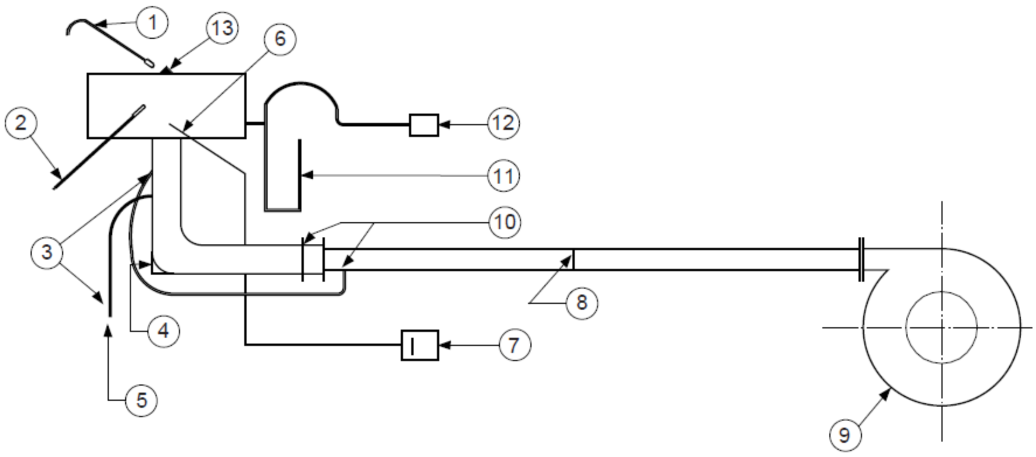
When a pressure/vacuum valve is integrated to a flame arresting device, the flashback test is to be performed with the pressure/ vacuum valve blocked open. If there are no additional flame quenching elements integrated in a pressure valve, this valve is to be considered and tested as a high velocity vent valve according to 4.3.

4.3 Test procedures for high velocity vents

4.3.1 Test rig

The test rig is to be capable of producing the required volume flow rate. In Fig 4.2 and Fig 4.3 drawings of suitable test rigs are shown. Other test rigs may be used provided the tests are performed to the satisfaction of the Society.

Figure 4.3 : Test rig for high velocity vents



(1): Primary igniter	(2): Secondary igniter
(3): Cocks	(4): Explosion door
(5): Gas supply	(6): Flashback detector
(7): Chart recorder	(8): Flow meter
(9): Fan	(10): Spade blank and bypass line for low rates
(11): Pressure gauge	(12): Gas analyser
(13): High velocity vent to be tested	

4.3.2 Flow condition test

A flow condition test is to be carried out with high velocity vents using compressed air or gas at agreed flow rates. The following are to be recorded:

a) the flow rate; where air or a gas other than vapours of cargoes with which the vent is to be used is employed in the test, the flow rates achieved are to be corrected to reflect the vapour density of such cargoes

b) the pressure before the vent opens; the pressure in the test tank on which the device is located is not to rise at a rate greater than 0.01 $N/mm^2/min$

c) the pressure at which the vent opens

d) the pressure at which the vent closes

e) the efflux velocity at the outlet which is not to be less than 30 m/s at any time when the valve is open.

4.3.3 Fire safety tests

The following fire safety tests are to be conducted while adhering to 2.3.6 using a mixture of gasoline vapour and air or technical hexane vapour and air, which produces the most easily ignitable mixture at the point of ignition. This mixture is to be ignited with the aid of a permanent pilot flame or a spark igniter at the outlet.

a) Flashback tests in which propane may be used instead of gasoline or hexane are to be carried out with the vent in the upright position and then inclined at 10° from the vertical. For some vent designs further tests with the vent inclined in more than one direction may be necessary.

In each of these tests the flow is to be reduced until the vent closes and the flame is extinguished, and each is to be carried out at least 50 times. The vacuum side of combined valves is to be tested in accordance with 4.2.2 with the vacuum valve maintained in the open position for the duration of this test, in order to verify the efficiency of the device which is to be fitted.

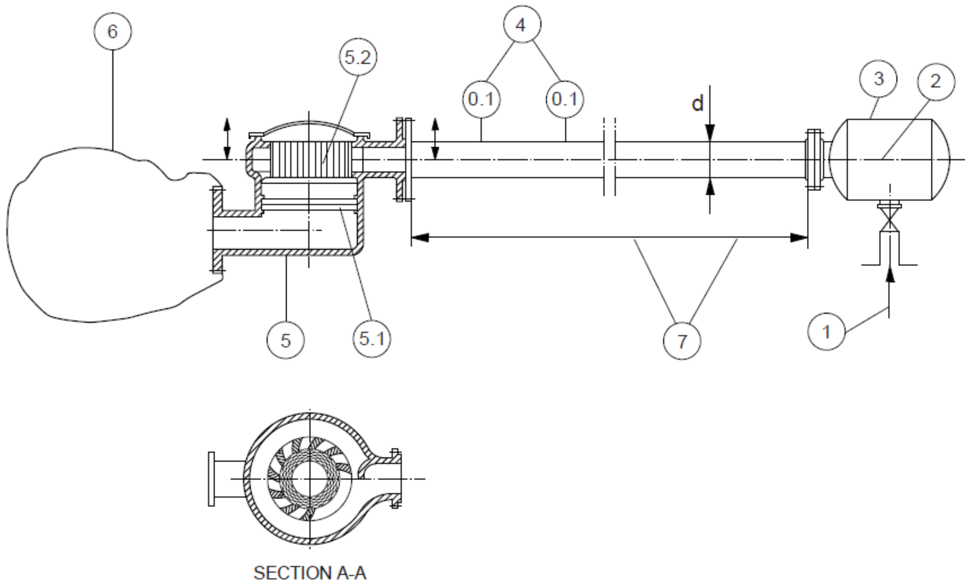
b) An endurance burning test, as described in 4.2.3, is to be carried out. Following this test, the main flame is to be extinguished and then, with the pilot flame burning or the spark igniter discharging, small quantities of the most easily ignitable mixture are to be allowed to escape for a period of ten minutes maintaining a pressure below the valve of 90% of the valve opening setting, during which time flashback is not to occur. For the purpose of this test the soft seals or seats are to be removed.

4.4 Test rig and test procedures for detonation flame arresters located in-line

4.4.1 A flame arrester is to be installed at one end of a pipe of suitable length and of the same diameter as the flange of the flame arrester. On the opposed flange a pipe of a length corresponding to 10 pipe diameters is to be affixed and closed by a plastic bag or diaphragm. The pipe is to be filled with the most easily ignitable mixture of propane and air, which is then to be ignited. The velocity of the flame near the flame arrester is to be measured and is to have the same value as that for stable detonations.

Note 1: The dimensions of the plastic bag are to be at least 4 m circumference, 4 m length and a material wall thickness of 0.05 mm.

Figure 4.4 : Test rig for arresters located in-line



(1): Explosive mixture inlet

(2): Ignition source; ignition within non-streaming mixture

(3): Tank

(4): Measuring system for flame speed of a stable detonation

(5): Flame arrester located in-line; (5.1): Flame arrester element; (5.2): Shock wave absorber

(6): Platic bag

(7): l/d = 100

4.4.2 Three detonation tests are to be conducted, no flashback is to occur through the device and no part of the flame arrester is to be damaged or show permanent deformation.

4.4.3 Other test rigs may be used provided the tests are carried out to the satisfaction of the Society. A drawing of the test rig is shown in Fig 4.4.

4.5 Operational test procedure

4.5.1 Corrosion test

A corrosion test is to be carried out. In this test a complete device, including a section of the pipe to which it is fitted, is to be exposed to a 5% sodium chloride solution spray at a temperature of 25°C for a period of 240 hours, and allowed to dry for 48 hours. An equivalent test may be conducted to the satisfaction of the Society. Following this test, all movable parts are to operate properly and there are to be no corrosion deposits which cannot be washed off.

4.5.2 Hydraulic pressure test

A hydraulic pressure test is to be carried out in the casing or housing of a sample device, in accordance with 2.2.15.

4.6 Laboratory report

4.6.1 The laboratory report is to include:

a) detailed drawings of the device

b) types of tests conducted; where in-line devices are tested, this information is to include the maximum pressures and velocities observed in the test

c) specific advice on approved attachments

d) types of cargo for which the device is approved

e) drawings of the test rig

f) in the case of high velocity vents, the pressures at which the device opens and closes and the efflux velocity, and

g) all the information marked on the device in 2.5.

Appendix 2 Design of Crude Oil Washing Systems

1 General

1.1 Application

1.1.1 This Appendix reproduces the text of IMO Resolution A.446. It applies to ships having the notation oil tanker in the conditions stated in Sec 4, 4.6.1.

1.2 Definitions

1.2.1 Arrival ballast

For the purpose of this Appendix, بarrival ballastپmeans clean ballast as defined in Sec 1,1.3.4.

1.2.2 Departure ballast

For the purpose of this Appendix, بdeparture ballastپmeans ballast other than arrival ballast.

1.3 Operations and Equipment Manual

1.3.1 The Operations and Equipment Manual of the crude oil washing system is to be submitted to the Society for information. It is to contain at least the following information:

a) line drawing of the crude oil washing system showing the respective position of pumps, lines and washing machines which relate to the crude oil washing system

b) a description of the system and a listing of procedures for checking that equipment is working properly during crude oil washing operations. This is to include a listing of the system and equipment parameters to be monitored, such as line pressure, oxygen level, machine revolutions, duration of cycles, etc. The established values for these parameters are to be included. The results of the tests carried out in accordance with 3.3 and the values of all parameters monitored during such tests are also to be included.

c) other information referred to in 2.1.8, 2.2.2, 2.3.2, 2.3.5, 2.4.3 and 3.3.1.

2 Design and installation

2.1 Piping

2.1.1 The crude oil washing pipes and all valves incorporated in the supply piping system are to be of steel or other equivalent material, of adequate strength having regard to the pressure to which they may be subjected, and properly jointed and supported.

Note 1: Grey cast iron may be permitted in the supply system for crude oil washing systems when complying with nationally approved standards.

2.1.2 The crude oil washing system is to consist of permanent pipework and is to be independent of the fire mains and of any system other than for tank washing except that sections of the shipۑ cargo system may be incorporated into the crude oil washing system provided that they meet the requirements applicable to crude oil pipework.

Notwithstanding the above requirements, in combination carriers the following arrangements may be allowed:

a) the removal of the equipment, if necessary, when carrying cargoes other than crude oil, provided that, when reinstated, the system is as originally fitted and tested for oil-tightness

b) the use of flexible hose pipes to connect the crude oil washing system to tank washing machines if it is necessary to locate these machines in a cargo tank hatch cover. Such flexible hose pipes are to be provided with flanged connections, manufactured and tested in accordance with standards acceptable to the Society, and consistent with the duties the hoses are required to perform. The length of these hoses is not to be greater than necessary to connect the tank washing machines to an adjacent point just outside the hatch coaming. The hoses are to be removed to a suitably prepared and protected stowage location when not in use.

2.1.3 Provisions are to be made to prevent overpressure in the tank washing supply piping. Any relief device fitted to prevent overpressure is to discharge into the suction side of the supply pump. Alternative methods to the satisfaction of the Society may be accepted provided an equivalent degree of safety and environmental protection is provided.

Note 1: Where the system is served only by centrifugal pumps so designed that the pressure derived cannot exceed that for which the piping is designed, a temperature sensing device located in the pump casing is required to stop the pump in the case of overheating.

2.1.4 Where hydrant valves are fitted for water washing purposes on tank washing lines, all such valves are to be of adequate strength and provisions are to be made for such connections to be blanked off by blank flanges when washing lines may contain crude oil. Alternatively, hydrant valves are to be isolated from the crude oil washing system by spade blanks.

2.1.5 All connections for pressure gauges or other instrumentation are to be provided with isolating valves adjacent to the lines unless the fitting is of the sealed type.

2.1.6 No part of the crude oil washing system is to enter machinery spaces. Where the tank washing system is fitted with a steam heater for use when water washing, the heater is to be located outside machinery spaces and effectively isolated during crude oil washing by double shut-off valves or by clearly identifiable blanks.

2.1.7 Where combined crude oil-water washing supply piping is provided, the piping is to be so designed that it can be drained so far as practicable of crude oil, before water washing is commenced, into designated spaces. These spaces may be the slop tank or other cargo spaces.

2.1.8 The piping system is to be of such diameter that the greatest number of tank cleaning machines required, as specified in the Operations and Equipment Manual, can be operated simultaneously at the designed pressure and throughput. The arrangement of the piping is to be such that the required number of tank cleaning machines for each cargo compartment as specified in the Operations and Equipment Manual can be operated simultaneously.

2.1.9 The crude oil washing supply piping is to be anchored (firmly attached) to the ship's structure at appropriate locations, and means are to be provided to permit freedom of movement elsewhere to accommodate thermal expansion and flexing of the ship. The anchoring is to be such that any hydraulic shock can be absorbed without undue movement of the supply piping. The anchors are normally to be situated at the ends furthest from the entry of the crude oil supply to the supply piping. If tank washing machines are used to anchor the ends of branch pipes then special arrangements are necessary to anchor these sections when the machines are removed for any reason.

2.2 Tank washing machines

2.2.1 Tank washing machines for crude oil washing are to be permanently mounted and of a design acceptable to the Society.

2.2.2 The performance characteristic of a tank washing machine is governed by nozzle diameter, working pressure and the movement pattern and timing. Each tank cleaning machine fitted is to have a characteristic such that the sections of the cargo tank covered by that machine will be effectively cleaned within the time specified in the Operations and Equipment Manual.

2.2.3 Tank washing machines are to be mounted in each cargo tank and the method of support is to be to the satisfaction of the Society. Where a machine is positioned well below the deck level to cater for protuberances in the tank, consideration may need to be given to additional support for the machine and its supply piping.

2.2.4 Each machine is to be capable of being isolated by means of stop valves in the supply line. If a deck mounted tank washing machine is removed for any reason, provision is to be made to blank off the oil supply line to the machine for the period the machine is removed. Similarly, provision is to be made to close the tank opening with a plate or equivalent means.

Note 1: Where more than one submerged machine is connected to the same supply line, a single isolating stop valve in the supply line may be acceptable provided the rotation of the submerged machine can be verified in accordance with 2.2.10

2.2.5 The number and location of tank washing machines are to be to the satisfaction of the Society.

2.2.6 The location of the machines is dependent upon the characteristics detailed in 2.2.2 and upon the configuration of the internal structure of the tank.

2.2.7 The number and location of the machines in each cargo tank are to be such that all horizontal and vertical areas are washed by direct impingement or effectively by deflection or splashing of the impinging jet. In assessing an acceptable degree of jet deflection and splashing, particular attention is to be paid to the washing of upward facing horizontal areas and the following parameters are to be used:

a) For horizontal areas of a tank bottom and the upper surfaces of a tank's stringers and other large primary structural members, the total area shielded from direct impingement by deck or bottom transverses, main girders, stringers or similar large primary structural members is not to exceed 10 per cent of the horizontal area of the tank bottom, the upper surface of stringers, and other large primary structural members.

b) For vertical areas of the sides of a tank, the total area of the tank's sides shielded from direct impingement by deck or bottom transverses, main girders, stringers or similar large primary structural members is not to exceed 15 per cent of the total area of the tank's sides.

In some installations, it may be necessary to consider the fitting of more than one type of tank washing machine in order to effect adequate coverage.

Note 1: With regard to the application of this requirement, a slop tank is considered as a cargo tank.

2.2.8 At the design stage the following minimum procedures are to be used to determine the area of the tank surface covered by direct impingement:

a) Using suitable structural plans, lines are set out from the tips of each machine to those parts of the tank within the range of the jets.

b) Where the configuration of the tanks is considered by the Society to be complicated, a pinpoint of light simulating the tip of the tank washing machine in a scale model of the tank is to be used.

2.2.9 The design of the deck mounted tank washing machines is to be such that means are provided external to cargo tanks which, when crude oil washing is in progress, would indicate the rotation and arc of the movement of the machine. Where the deck mounted machine is of the nonprogrammable, dual nozzle type, alternative methods to the satisfaction of the Society may be accepted provided an equivalent degree of verification is attained.

2.2.10 Where submerged machines are required, they are to be non-programmable and, in order to comply with the requirements of 2.2.7, it is to be possible to verify their rotation by one of the following methods:

a) by indicators external to the tanks

b) by checking the characteristic sound pattern of the machine, in which case the operation of the machine is to be verified towards the end of each wash cycle.

Where two or more submerged machines are installed on the same supply line, valves are to be provided and arranged so that the operation of each machine can be verified independently of other machines on the same supply line.

c) by gas freeing the tank and checking the operation of the machine with water during ballast voyages.

2.3 Pumps

2.3.1 Pumps supplying crude oil to tank cleaning machines are to be either the cargo pumps or pumps specifically provided for the purpose.

2.3.2 The capacity of the pumps is to be sufficient to provide the necessary throughput at the required pressure for the maximum number of tank cleaning machines required to be operated simultaneously as specified in the Operations and Equipment Manual. In addition to the above requirement, if an eductor system is fitted for tank stripping, the pumps are to be capable of supplying the eductor driving fluid to meet the provisions of 2.4.2.

2.3.3 The capacity of the pumps is to be such that the requirements of 2.3.2 can be met with any one pump inoperative. The pumping and piping arrangements are to be such that the crude oil washing system can be effectively operated with any one pump out of use.

2.3.4 The carriage of more than one grade of cargo is not to prevent crude oil washing of tanks.

2.3.5 To permit crude oil washing to be effectively carried out where the back pressure presented by the shore terminal is below the pressure required for crude oil washing, provision is to be made such that an adequate pressure to the washing machines can be maintained in accordance with 2.3.2. This requirement is to be met with any one cargo pump out of action. The minimum supply pressure required for crude oil washing is to be specified in the Operations and Equipment Manual. Should this minimum supply pressure not be obtainable, crude oil washing operations are not to be carried out.

2.4 Stripping system

2.4.1 The design of the system for stripping crude oil from the bottom of every cargo tank is to be to the satisfaction of the Society.

2.4.2 The design and capacity of the tank stripping system are to be such that the bottom of the tank being cleaned is kept free of accumulations of oil and sediment towards completion of the tank washing process.

2.4.3 The stripping system is to be at least 1,25 times the total throughput of all the tank cleaning machines to be operated simultaneously when washing the bottom of the cargo tanks as described in the shipِي Operations and Equipment Manual.

2.4.4 Means such as level gauges, hand dipping and stripping system performance gauges as referred to in 2.4.8 are to be provided for checking that the bottom of every cargo tank is dry after crude oil washing. Suitable arrangements for hand dipping are to be provided at the aftermost portion of a cargo tank and in three other suitable locations unless other approved means are fitted for efficiently ascertaining that the bottom of every cargo tank is dry. For the purpose of this paragraph, the cargo tank bottom is to be considered ـِ dryپ if there is no more than a small quantity of oil near the stripping suction with no accumulation of oil elsewhere in the tank.

2.4.5 Means are to be provided to drain all cargo pumps and lines at the completion of cargo discharge, where necessary, by connection to a stripping device. The line and pump draining is to be capable of being discharged both to a cargo tank and ashore. For discharge ashore, a special small diameter line is to be provided for this purpose and connected outboard of the shipِي manifold valve. The crosssectional area of this line is not to exceed 10 per cent of that of a main cargo discharge line.

Note 1: In crude oil tankers having individual cargo pumps in each tank, each pump having an individual piping system, dispensation from the required special small diameter line may be granted in cases where the combined amount of oil left in the tank after stripping and the volume of oil in the piping system from the manifold to the tank is less than 0,00085 times the volume of the cargo tank.

The above consideration is also to apply if a deepwell cargo pump system is provided with an evacuating system for retained oil.

2.4.6 The means for stripping oil from cargo tanks are to be a positive displacement pump, self-priming centrifugal pump or eductor or other methods to the satisfaction of the Society. Where a stripping line is connected to a number of tanks, means are to be provided for isolating each tank not being stripped at that particular time.

2.4.7 The carriage of more than one grade of cargo is not to prevent crude oil washing of tanks.

2.4.8 Equipment is to be provided for monitoring the efficiency of the stripping system. All such equipment is to have remote read out facilities in the cargo control room or in some other safe and convenient place easily accessible to the officer in charge of cargo and crude oil washing operations.

Where a stripping pump is provided, the monitoring equipment is to include either a flow indicator, or a stroke counter or revolution counter as appropriate, and pressure gauges at the inlet and discharge connections of the pump or equivalent. Where eductors are provided, the monitoring equipment is to include pressure gauges at the driving fluid intake and at the discharge and a pressure/vacuum gauge at the suction intake.

2.4.9 The internal structure of the tank is to be such that drainage of oil to the tank suctions of the stripping system is adequate to meet the requirements of 2.4.2 and 2.4.4.

2.5 Ballast lines

2.5.1 Where a separate ballast water system for ballasting cargo tanks is not provided, the arrangement is to be such that the cargo pump, manifolds and pipes used for ballasting can be safely and effectively drained of oil before ballasting.

3 Inspection and testing

3.1 Initial survey

3.1.1 The initial survey required in Sec 4, 6.3.2 is to include a complete inspection of the crude oil washing equipment and arrangements and, except for the cases specified in 3.3.3, an examination of the tanks after they have been crude oil washed and the additional checks specified in 3.3.1 and 3.3.2 to ensure that the washing system efficiency is in accordance with this Appendix.

3.2 Piping

3.2.1 The piping system is to be tested to one and a half times the working pressure after it has been installed on the ship.

3.3 Tank washing machines

3.3.1 To confirm the cleanliness of the tank and to verify the design in respect of the number and location of the tank washing machines, a visual inspection is to be made by entry to the tanks after a crude oil wash but prior to any water rinse which may be specified in the Operations and Equipment Manual. The bottom of the tank to be inspected may, however, be flushed with water and stripped in order to remove any wedge of liquid crude oil remaining on the tank bottom before gas freeing for entry. This inspection is to ensure that the tank is essentially free of oil clingage and deposits. If the flushing procedure is adopted, a similar but unflushed tank is to be used for the test specified in 3.3.2 below.

3.3.2 To verify the effectiveness of the stripping and drainage arrangements, a measurement is to be made of the amount of oil floating on top of the departure ballast. The ratio of the volume of oil on top of the departure ballast water to the volume of tanks that contain this water is not to exceed 0,00085. This test is to be carried out after crude oil washing and stripping in a tank similar in all relevant respects to the tank examined in accordance with 3.3.1 above, which has not been subjected to a water rinse or to the intervening water flushing permissible in 3.3.1 above.

3.3.3 When the Society is satisfied that ships are similar in all relevant respects, the provisions of 3.3.1 and 3.3.2 need only be applied to one such ship. Furthermore, where a ship has a series of tanks that are similar in all relevant respects then, for that series of tanks, the requirements of 3.3.1 need only be applied to one tank of that series.

3.4 Stripping system

3.4.1 Care is to be taken that both longitudinal and transverse drainage are satisfactory. Drainage is to be verified during the inspection required by 3.3.

Appendix 3 Lists of Oils

1 Application

1.1 Scope of the lists of oils

1.1.1 The lists set out in this Appendix include the oils the carriage in bulk of which is covered by the service notations oil tanker or oil tanker, flash point > 60°C or oil tanker, asphalt carrier, under the provisions of Sec 1, 1.1.1.

2 Lists of products

2.1 List of oils

2.1.1 The list given in Tab 1 is reproduced from Appendix 1 of the MARPOL 73/78 Convention, except that naphtha solvent is, in the opinion of the Society, to be considered as a chemical to which Part IV, Chapter 5 applies. This list is not necessarily comprehensive.

Table 1 : List of oils

Asphalt solutions پ Blending stocks پ Roofers flux پ Straight run residue
Oils پ Clarified پ Crude oil پ Mixtures containing crude oil پ Diesel oil پ Fuel oil nخ4 پ Fuel oil nخ5 پ Fuel oil nخ6 پ Residual fuel oil پ Road oil پ Transformer oil پ Aromatic oil (excluding vegetable oil) پ Lubricating oils and blending stocks پ Mineral oil پ Spindle oil پ Turbine oil
Distillates پ Straight run پ Flashed feed stocks
Gas oil پ Cracked
Gasoline blending stock پ Alkylates - fuel پ Reformates پ Polymer تfuel
Gasolines پ Casinghead (natural) پ Automotive پ Aviation پ Straight run پ Fuel oil n° 1 (kerosene) پ Fuel oil nخ1-D پ Fuel oil nخ2 پ Fuel oil nخ2-D
Jet fuels پ JP-1 (kerosene) پ JP-3 پ JP-4 پ JP-5 (kerosene, heavy) پ Turbo fuel پ Kerosene پ Mineral spirit
Naphtha پ Petroleum پ Heartcut distillate oil

Appendix 4 List of Chemicals for which Chapter 5 and IBC Code do not Apply

1 Application

1.1 Scope of the list

1.1.1 The list set out in this Appendix includes all chemical products to which Part IV, Chapter 5 and IBC Code do not apply. Such products are allowed to be carried by ships having the service notation FLS tanker or, where their flash point is above 60 °C, also by ships having the service notation FLS tanker flash point > 60 °C.

Where indicated in the list, some products are also allowed to be carried by ships having the service notation tanker.

1.2 Safety and pollution hazards

1.2.1

a) The following are chemicals which have been reviewed for their safety and pollution hazards and determined not to present hazards to such an extent as to warrant application of the IBC Code and Part IV, Chapter 5. This may be used as a guide in considering bulk carriage of chemicals whose hazards have not yet been evaluated.

b) Although the chemicals listed in this Chapter fall outside the scope of the IBC Code and Part IV, Chapter 5, the attention is drawn to the fact that some safety precautions are needed for their safe transportation. Relevant requirements are summarized in Tab 1.1.

c) Some chemicals are identified as falling into pollution category Z and, therefore, subject to certain operational requirements of Annex II of MARPOL 73/78.

d) Liquid mixtures which are provisionally assessed under Regulation 6(4) of Annex II of MARPOL 73/78 as falling into pollution category Z, and which do not present safety hazards, may be carried under the entry for "noxious liquid, not otherwise specified" in this Chapter.

Similarly, those mixtures provisionally assessed as falling outside pollution category X, Y or Z, and which do not present safety hazards, may be carried under the entry for "non-noxious liquid not otherwise specified" in this Appendix.

e) The substances identified as falling into pollution category OS are not subject to any requirements of Annex II of MARPOL 73/78 in particular in respect of:

- the discharge of bilge or ballast water or other residues or mixtures containing only such substances
- the discharge into the sea of clean ballast or segregated ballast.

2 List of chemicals for which Part V, Chapter 5 and IBC code do not apply

2.1

2.1.1 The list of chemicals for which Part V, Chapter 5 and IBC code do not apply is given in Tab 1.1. The relevant symbols and notations used in Tab 1.1 are given in Tab 2.1.

Table 1.1 List of easy chemicals

Product name	Pollution category	Tank vents	Elec. eqpt temp. class	Elec. eqpt apparatus group	Flash-point (°C)	Gau-ging	Vapour detec-tion	Fire protec-tion	High level alarm	Chem. family	Density (t/m³)	Melting point (°C)	Service notation
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
Acetone	Z	Cont	T1	IIA	-18	R	F	A	Y	18	0,79	-	FLS
Alcoholic beverages, not otherwise specified.	Z	Cont	-	-	20 to 60 **(1)**	R	F	A	Y	-	1,00	-	FLS
Apple juice	OS	Open	-	-	NF	O	-	-	N	-	1,00	-	T
n-Butyl alcohol	Z	Cont	T2	IIA	29	R	F	A	Y	20	0,81	-	FLS
sec-Butyl alcohol	Z	Cont	T2	IIA	24	R	F	A	Y	20	0,81	-	FLS
Calcium nitrate solutions 50% or less)	Z	Open	-	-	NF	O	-	-	N	-	1,50	-	T
Clay slurry	OS	Open	-	-	NF	O	-	-	N	-	1,50	-	T
Coal slurry	OS	Open	-	-	NF	O	-	A, B	N	-	1,50	-	T
Diethylene glycol	Z	Open	T3	IIB	>60	O	-	A	N	40	1,12	-	FLS>60
Ethyl alcohol	Z	Cont	T2	IIA	13	R	F	A	Y	20	0,79	-	FLS
Ethylene carbonate	Z	Open	T2	-	>60	O	-	A	N	-	1,32	36	FLS>60
Glucose solution	OS	Open	-	-	NF	O	-	-	N	-	1,50	-	T
Glycerine	Z	Open	T2	IIA	>60	O	-	A	N	20	1,26	18	FLS>60
Hexamethylenetetramine solutions	Z	Open	-	-	NF	O	-	-	N	7	1,50	-	T
Hexylene glycol	Z	Open	T2	IIA	>60	O	-	B, C	N	20	0,92	-	FLS>60
Hydrogenated starch hydrolysate	OS	Open	-	-	NF	O	-	-	-	-	1,025	-	T
Isopropyl alcohol	Z	Cont			22	R	F	A	Y	20	0,78	-	FLS
Kaolin slurry	OS	Open			NF	O	-	-	N	43	1,50	-	T
Lecithin	OS	Open			NF	O	-	-	N	-	1,75	-	T
Magnesium hydroxide slurry	Z	Open	-	-	NF	O	-	-	N	-	1,23	-	T
Maltitol solution	OS	Open	-	-	NF	O	-	-	N	-	1,025	-	T
Methyl propyl ketone	Z	Cont	-	-	<60	R	F	A	Y	18	0,82	-	FLS
Molasses	OS	Open	-	-	>60	O	-	A	N	20	1,45	-	FLS>60
Noxious liquid (11), not otherwise specified, Cat. Z	Z	Cont	-	-	<60	R	F	A	Y	-	1,00	-	FLS
Non-noxious liquid (12), not otherwise specified, Cat. OS	OS	Cont	-	-	<60	R	F	A	Y	-	1,00	-	FLS

Product name	Pollution category	Tank vents	Elec. eqpt temp. class	Elec. eqpt apparatus group	Flash-point (°C)	Gau-ging	Vapour detec-tion	Fire protec-tion	High level alarm	Chem. family	Density (t/m^3)	Melting point (°C)	Service notation
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
Polyaluminium chloride solution	Z	Open	-	-	NF	O	-	-	N	-	1,25	-	T
Polyglycerin, sodium salt solution (con-taining less than 3% sodium hydroxide)	Z	Open	-	-	>60	O	-	-	N	-	1,27	-	FLS>60
Potassium formate solution	Z	Open	-	-	NF	O	-	-	N	-	1,025	-	FLS>60
Propylene glycol	Z	Open	T2	IIA	>60	O	-	A	N	20	1,03	-	FLS>60
Propylene carbonate	Z	Open	-	-	NF	O	-	-	N	-	1,025	-	FLS>60
Sodium acetate solutions	Z	Open	-	-	NF	O	-	-	N	-	1,45	-	T
Sodium sulphate solutions	Z	Open	-	-	NF	O	-	-	N	-	1,45	-	T
Sorbitol solution	OS	Open	-	-	>60	O	-	A	N	20	1,50	-	FLS>60
Sulphonated polyacrylate solution	Z	Open	-	-	NF	O	-	-	N	-	1,025	-	FLS>60
Tetraethys silicate monoma/oligoma (20% in ethanol	Z	Open	-	-	NF	O	-	-	N	-	1,025	-	FLS>60
Triethylene glycol	Z	Open	T2	IIA	>60	O	-	A	N	40	1,12	-	FLS>60
Vegetable protein solution (hydrolysed)	OS	Open	-	-	NF	O	-	-	N	-	1,20	-	T
Water	OS	Open	-	-	NF	O	-	-	N	-	1,00	-	T
(1) Composition dependent													

Table 2.1 : Symbols and notations used in the list of easy chemicals

Items	Col.	Comments
Product name	a	Gives the alphabetical name of the products.
Pollution category	b	The letter Z refers to the pollution category Z as defined in Annex II of MARPOL 73/78. The symbol OS means that the product was evaluated and found to fall outside the pollution categories X, Y and Z defined in Annex II of MARPOL 73/78.
Tank vents	c	
Electrical equipment temperature class	d	The symbols T1 to T6 refer to the electrical equipment temperature classes defined in IEC Publication 79-0.
Electrical equipment apparatus group	e	The symbols IIA and IIB refer to the electrical equipment apparatus groups defined in IEC Publication 79-0.
Flash point	f	
Gauging	g	
Vapour detection	h	
Fire protection	i	The letters A, B, C and D refer to the following fire-extinguishing media determined to be effective for certain products: A : Alcohol-resistant foam (or multi-purpose foam) B : Regular foam, encompasses all foams that are not of an alcohol-resistant type, including fluoro-protein and aqueous-film-forming foam (AFFF) C : Water spray D : Dry chemical (powder).
High level alarm	j	
Chemical family	k	
Density	l	
Melting point	m	
Service notation	n	The symbols FLS, FLS>60 and T are defined as follows: FLS : Means that the product is allowed to be carried by a ship having the service notation FLS tanker FLS>60 : Means that the product is allowed to be carried by a ship having the service notation FLS tanker, flash point > 60°C T : Means that the product is allowed to be carried by a ship having the service notation tanker.

Appendix 5 Damage Assumptions and Outflow of Oil

Symbols

L_{LL} : Load line length, in m.

1 General

1.1 Purpose

1.1.1 The purpose of the present Appendix is to provide a method for the calculation of the hypothetical oil outflow referred to in Sec 2, 3.4.1.

1.2 Application

1.2.1 The requirements of the present Appendix apply only to ships having one of the following notations:

- oil tanker
- oil tanker, flash point > 60°C
- oil tanker, asphalt carrier.

2 Damage assumptions and calculation of hypothetical oil outflows

2.1 Damage assumptions

2.1.1 General

For the purpose of calculating hypothetical oil outflow from oil tankers, damages having the extent defined in 2.1.2 are assumed.

2.1.2 Damage extent

The assumed extents of damage are specified in Tab 2.1.

Three dimensions of the extent of damage of a parallelepiped on the side and bottom of the ship are assumed. In the case of bottom damages, two conditions are set forth to be applied individually to the stated portions of the oil tanker.

2.2 Hypothetical outflow of oil

2.2.1 General

The hypothetic outflow of oil in case of side damage and bottom damage is to be calculated by the formulae given in 2.2.2 with respect to compartments breached by damage to all conceivable locations along the length of the ship to the extent as defined in 2.1.

2.2.2 Calculation of oil outflow

The oil outflow is to be calculated as follows:

a) for side damages:

$O_C=\Sigma W_i+\Sigma K_iC_i$

Note 1: If a void space or segregated ballast tank of a length li less than lc as defined in Sec 3, 1.3.2 is located between wing oil tanks, O_c may be calculated on the basis of volume W_i

being the actual volume of one such tank (where they are of equal capacity) adjacent to such space, multiplied by S_i as defined below and taking for all other wing tanks involved in

such a collision the value of the actual full volume.

$S_i=1-l_i/l_c$

where l_i = length in metres of the void space or segregated ballast tank under consideration

b) for bottom damages:

$O_S=1/3(\Sigma Z_i W_i+\Sigma Z_i C_i)$

Note 2: In the case where bottom damage simultaneously involves four centre tanks, the value of O_s may be calculated using the formula:

$O_S=1/4(\Sigma Z_i W_i+\Sigma Z_i C_i)$

where:

W_i : Volume of a wing tank in cubic metres assumed to be breached by the damage as specified in 2.1; W_i for a segregated ballast tank may be taken equal to zero

Table 2.1 : Extent of damage

Type of damage		Longitudinal extent	Transverse extent	Vertical extent
Side damage		$l_C = 1/3\ (L_{LL})^{2/3}$ or 14.5 m whichever is the less	t_C = B/5 or 11.5 m whichever is the less (1)	v_C = from the base line upwards without limit
Bottom damage	For 0.3 L_{LL} from the forward perpendicular of the ship	$l_S = L_{LL}/10$	t_S = B/6 or 10 m whichever is the less, but not less than 5 m	v_S = B/15 or 6m, whichever is the less
	Any other part of the ship	$l_S = L_{LL}/10$ or 5m whichever is the less	t_S = 5 m	v_S = B/15 or 6m, whichever is the less

(1) t_c is to be measured inboard the ship side at right angles to the centreline at the level corresponding to the assigned summer freeboard.

C_i : Volume of a centre tank in cubic metres assumed to be breached by the damage as

specified in [2.1]; C_i for a segregated ballast tank may be taken equal to zero

K_i : Coefficient defined as:

$= 1 - b_i / t_C$ for $b_i < t_C$

$= 0$ for $b_i \geq t_C$

Z_i : Coefficient defined as:

$= 1 - h_i / v_S$ for $h_i < v_S$

$= 0$ for $h_i \geq v_S$

b_i : Width, in m, of wing tank under consideration measured inboard from the ship side at right angles to the centreline at the level corresponding to the assigned summer freeboard.

Note 3: In a case where the width bi is not constant along the length of a particular wing tank, the smallest b_i value in the tank is to be used for the purposes of assessing the hypothetical outflows of oil O_C and O_S.

h_i : Minimum depth, in m, of the double bottom under consideration; where no double bottom

is fitted h_i is to be taken equal to zero

t_C : Transverse extent of side damage as defined in Tab 2.1

v_S : Vertical extent of bottom damage as defined in Tab 2.1.

2.2.3 Assumptions

a) For the purpose of calculating OS, credit is only to be given in respect of double bottom tanks which are either empty or carrying clean water when cargo is carried in the tanks above.

b) Where the double bottom does not extend for the full length and width of the tank involved, the double bottom is considered non-existent and the volume of the tanks above the area of the bottom damage is to be included in the formula of Os in 2.2.2 even if the tank is not considered breached because of the installation of such a partial double bottom.

c) Suction wells may be neglected in the determination of the value hi provided such wells are not excessive in area and extend below the tank for a minimum distance and in no case more than half the height of the double bottom. If the depth of such a well exceeds half the height of the double bottom hi is to be taken equal to the double bottom height minus the well height.

Piping serving such wells if installed within the double bottom is to be fitted with valves or other closing arrangements located at the point of connection to the tank served to prevent oil outflow in the event of damage to the piping.

2.2.4 Reduction of oil outflow

The Society may credit as reducing oil outflow in the event of bottom damage, an installed cargo transfer system having an emergency high suction in each cargo oil tank, capable of transferring from a breached tank or tanks to segregated ballast tanks or to available cargo tankage if it can be ensured that such tanks will have sufficient ullage. Credit for such a system would be governed by ability to transfer in two hours of operation oil equal to one half of the largest of the breached tanks involved and by availability of equivalent receiving capacity in ballast or cargo tanks. The credit is to be confined to permitting calculation of O_s according to the formula in 2.2.2, Note 2.

The pipes for such suctions are to be installed at least at a height not less than the vertical extent of the bottom damage v_S.

v_S is the vertical extent of bottom damage as defined in 2.1.2.

2.2.5 Alternative methods for calculating oil outflow As an alternative to the formulae indicated in 2.2.2, the probabilistic methodology for calculating oil outflow as described in IMO Resolution MEPC.66(37) may be applied.

Chapter 5 Chemical Tankers

Section 1 General

1 Scope

1.1 Application

1.1.1 Chemical tankers

The Chemical tanker service notation, in accordance with Pt I, Ch 1, may be granted to ships which are intended for the carriage of products listed in Sec 17. These ships are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) including the first set of amendments to the IBC Code Res. MEPC.32(27) and MEPC.55(33). In these Rules, reference to this Code and its amendments is made by the wording “IBC Code”.

1.1.2 IBC Code requirements and the Society’s rules

a) For ships with the service notation Chemical tanker, the IBC Code requirements are to be considered as rule requirements, with the exception indicated in 1.1.3.

b) The requirements of this Chapter supplement those of the IBC Code, which is incorporated in its entirety in the Annex to this Chapter. These requirements include additional mandatory class requirements, as well as the Society’s interpretations of the IBC Code, which are also to be considered mandatory for class.

c) In general, this Chapter applies to cargo containment and handling systems and to the interfaces between these systems and the other parts of the ship, which are to comply with the applicable Sections of the hull and machinery Rules.

1.1.3 IBC Code requirements not within the scope of classification

The following requirements of the IBC Code are not within the scope of classification:

- Chapter 1, Section 1.4 - Equivalents
- Chapter 1, Section 1.5 - Surveys and certification
- Chapter 2, as far as survival requirements after flooding are concerned, when the additional class notation SDS is not granted
- Chapter 16 - Operating requirements

These requirements are applied by the Society when acting on behalf of the flag Administration, within the scope of delegation (see 1.1.8).

1.1.4 Carriage of products not listed in the Code

The requirements of the IBC Code and the additional requirements of this Chapter are also applicable to new products, which may be considered to come within the scope of these Rules, but are not at present listed in either of the tables in Chapter 17 or Chapter 18 of the IBC Code.

1.1.5 Particularly hazardous products

For the carriage in bulk of products which are not listed in either of the tables in Sec 17 or Sec 18, presenting more severe hazards than those covered by the IBC Code, the Society reserves the right to establish requirements and/or conditions additional to those contained in these Rules.

1.1.6 Correspondence of the IBC Code with this Chapter

All the requirements of this Chapter are cross referenced to the applicable Chapters, Sections or paragraphs of the IBC Code, as appropriate. In addition, a marker has been introduced in the IBC Code, included in the Annex, corresponding to every Chapter, Section or paragraph which is to be integrated by one or more additional requirements contained in this Chapter.

1.1.7 Equivalence

As far as the requirements for class are concerned, the following wording in the IBC Code is to be given the meanings indicated in Tab 1.1.

Table 1.1 :

IBC Code wording	Meaning for Classification only
Administration	Society
IGC-Code or Gas Code	Part IV, Chapter 6 of the Rules
Recognised Standard	Rules
should be	is to be or are to be (as appropriate)

1.1.8 Certificate of Fitness

a) The responsibility for interpretation of the IBC Code requirements for the purpose of issuing an International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk lies with the Administration of the state whose flag the ship is entitled to fly.

b) Whenever the Society is authorised by an Administration to issue on its behalf the "Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk", or where the Society is authorised to carry out investigations and surveys on behalf of an Administration on the basis of which the "Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk" will be issued by the Administration, or where the Society is requested to certify compliance with the IBC Code, the full compliance with the requirements of the IBC Code, including the operative requirements mentioned in 1.1.3, is to be granted by the Society.

2 Additional requirements

2.1 Emergency towing arrangement

2.1.1 Emergency towing arrangements are to be fitted on chemical tankers of 20.000 dwt and above in accordance with Pt III, Ch 5, 4.

2.2 Steering gear

2.2.1 Additional requirements for steering gear of chemical tankers of 10000 dwt and above are given in Ch 4, Sec 4, 7.

3 Documentation to be submitted

3.1 Tab 3.1 lists the plans, information, analysis, etc. which are to be submitted in addition to the information required in the other Parts of the Rules for the parts of the ship not affected by the cargo, as applicable.

Table 3.1 :

No	A/I	Document
1	I	List of products to be carried, including maximum vapour pressure, maximum liquid cargo temperature, cargo mass density and other important design conditions
2	I	General arrangement plan, showing location of cargo tanks and fuel oil, ballast and other tanks
3	A	Gas-dangerous zones plan
4	A	Location of void spaces and accesses to dangerous zones
5	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
6	A	Details of hull structure in way of cargo tanks, including support arrangement for tanks, saddles, anti-floating and anti-lifting devices, deck sealing arrangements, independent cargo tanks, etc.
7	A	Hull stress analysis
8	A	Hull ship-motion analysis, where a direct analysis is preferred to the methods indicated in Section 4
9	A	Intact and damage stability calculations
10	A	Scantlings, material and arrangement of the cargo containment system
11	A	Details of steel cladding or lining
12	A	Plans and calculations of safety relief valves
13	A	Details of cargo handling, including arrangements and details of piping and fittings and details of heating system, if any
14	A	Details of cargo pumps
15	A	Details of process pressure vessels and relative valving arrangement
16	A	Bilge and ballast system in cargo area
17	A	Gas freeing system in cargo tanks including inert gas system
18	A	Ventilation system in cargo area
19	A	Details of electrical equipment installed in cargo area, including the list of certified safe equipment and apparatus and electrical bonding of cargo tanks and piping
20	A	Schematic electrical wiring diagram
21	A	Gas detection system
22	A	Cargo tank instrumentation
23	A	Details of fire-extinguishing appliances and systems in cargo area
24	I	Loading and unloading operation description, including cargo tank filling limits, where applicable
25	I	Procedure and arrangement manual

Note 1: A = to be submitted for approval in four copies

I = to be submitted for information in duplicate

Section 2 Ship Survival Capability and Location of Cargo Tanks

1 Freeboard And Intact Stability

1.1 Intact stability

1.1.1 General

IBC CODE REFERENCE: Ch 2, 2.2.2

The stability of the ship for the loading conditions in Pt III, Ch 4, App 2 is to be in ompliance with the requirements in Pt III, Ch 4, Sec 2.

1.1.2 Free surface effect of liquids

IBC CODE REFERENCE: Ch 2, 2.2.3

The free surface effect is to be calculated in accordance with Pt III, Ch 4, Sec 2, [4].

1.1.3 Information to be supplied

IBC CODE REFERENCE: Ch 2, 2.2.5

The Master of the ship is to be supplied with a Loading Manual as specified in Pt III and a Trim and Stability booklet as specified in Pt III, Ch 4, App 2.

2 Conditions of loading

2.1 Additional loading conditions for ships where additional class notation SDS is requested

2.1.1

IBC CODE REFERENCE: Ch 2, 2.9.2.3

Loading conditions other than those in the Loading Manual and the Trim and Stability booklet are to be previously submitted to the Society. Alternatively, such cases may be examined by the Master or a delegated officer when a loading instrument approved in accordance with the requirements in Pt III, Ch 2, App 2 is installed on board.

3 Location of cargo tanks

3.1 Minimum distance of cargo tanks from shell

3.1.1 Exceptions

IBC CODE REFERENCE: Ch 2, 2.6.1

Any cargo tank, irrespective of its location, may be used for collecting contaminated cargo pump room bilge water or tank washings, as an exception to the requirements in IBC Code 2.6.1.1.

3.2 Suction wells

3.2.1

IBC CODE REFERENCE: Ch 2, 2.6.2

In general, the area of suction wells is not to be greater than that required to accommodate cargo pumps, suction pipes, valves, heating coils etc., and to ensure efficient flow and the necessary access for cleaning and maintenance.

4 Flooding assumptions for ships where additional class notation SDS is requested

4.1 Tunnels, ducts and pipes in the damaged zone

4.1.1 Strength of internal structures

IBC CODE REFERENCE: Ch 2, 2.7.7

Tunnels, ducts, pipes, doors, bulkheads and decks which might form watertight boundaries of intact spaces in the case of assumed conventional damage are to have minimum strength adequate to withstand the pressure height corresponding to the deepest equilibrium waterline in damaged conditions.

4.1.2 Progressive flooding

IBC CODE REFERENCE: Ch 2, 2.7.7

Progressive flooding is to be considered in accordance with Pt III, Ch IV, Sec 3, 3.3.

5 Standard of damage for ships where additional class notation SDS is requested

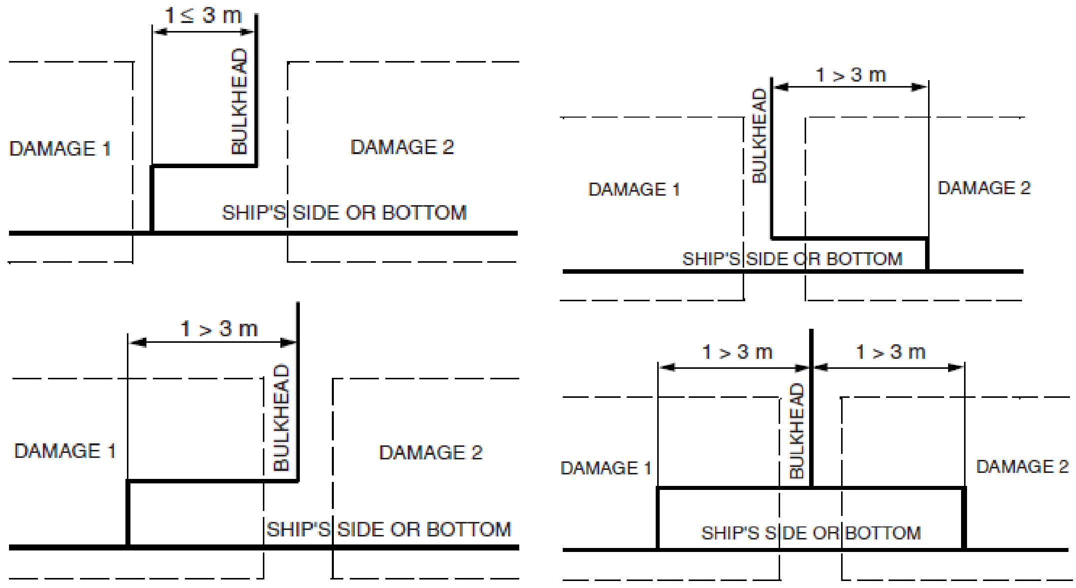
5.1 Damage to stepped machinery space forward bulkhead

5.1.1

IBC CODE REFERENCE: Ch 2, 2.8

The concept of a stepped machinery space forward bulkhead is already implicit in the requirements in IBC Code 3.2.1 and Regulation II-2/56 of SOLAS 74(83). For damage stability considerations, when the recess for a pump room or for a cargo pump room extends into the adjacent machinery space or cargo tank by more than 3 metres, damage is to be treated as defined in Fig 5.1.

Figure 5.1 : Damage to stepped machinery space forward bulkhead



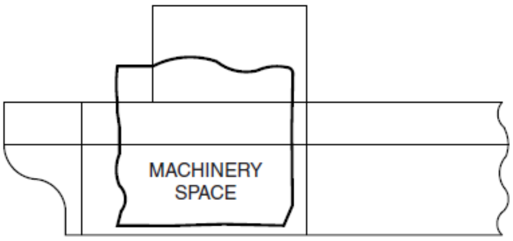
5.2 Longitudinal extension of damage to superstructure

5.2.1

IBC CODE REFERENCE: Ch 2, 2.8

The longitudinal extent of damage to the superstructure in the case of side damage to a machinery space aft, with the standards of damage as per IBC Code 2.8.1, is generally to be the same as the longitudinal extent of the side damage to the machinery space (see Fig 5.2).

Figure 5.2 : Longitudinal extent of damage to superstructure



6 Survival requirements for ships where additional class notation SDS is requested

6.1 General

6.1.1

IBC CODE REFERENCE: Ch 2, 2.9

Ships are to be capable of surviving the assumed damage specified in IBC Code 2.5.1 and 2.5.2 to the standard provided in IBC Code 2.8.1 and for the loading conditions in Pt III, Ch V, App 2 in a condition of stable equilibrium and such as to satisfy the criteria in IBC Code 2.9.

6.2 Intermediate stages of flooding

6.2.1

IBC CODE REFERENCE: Ch 2, 2.9.2.3

The criteria applied to the residual stability during intermediate stages of flooding are to be those relevant to the final stage of flooding as specified in IBC Code 2.9.3. However, small deviation from these criteria may be accepted by the Society on a case by case basis.

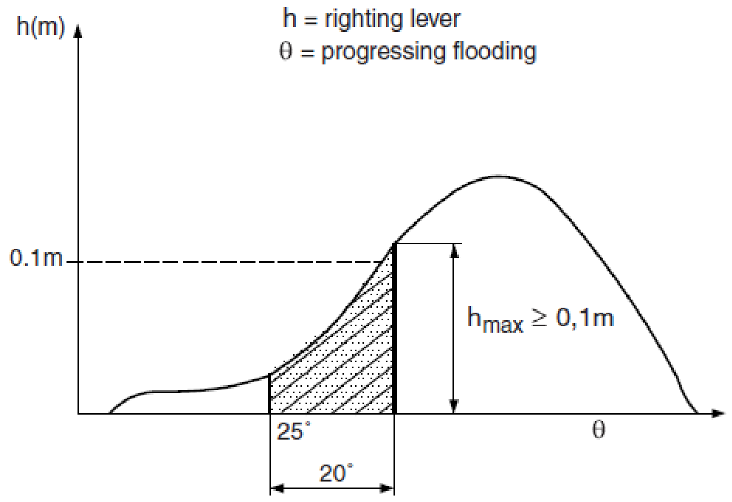
6.3 Definition of range of positive stability

6.3.1

IBC CODE REFERENCE: Ch 2, 2.9

The 20° range may be measured from any angle commencing between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs) (see Fig 6.1).

Figure 6.1 : Range of positive stability



6.4 Type 3 ships less than 125 m in length

6.4.1

IBC CODE REFERENCE: Ch 2, 2.8.1.6

The flooding of the machinery space, if located aft on a type 3 ship less than 125 m in length, is to comply as far as practicable with the criteria in IBC Code 2.9. Relaxation of parts of these requirements may be accepted on a case-by-case basis.

Section 3 Ship Arrangement

1 Cargo segregation

1.1 Segregation of cargoes mutually reacting

1.1.1 Common edges

IBC CODE REFERENCE: Ch 3, 3.1.2

The common edge in a cruciform joint, either vertically or horizontally, may be considered a "double barrier" for the purpose of segregation:

- between mutually reactive products (see Fig 1.1)
- between water reactive products and water (see Fig 1.1).

1.1.2 Chain lockers

IBC CODE REFERENCE: Ch 3, 3.1.2

The chain locker is to be arranged outside the cargo area.

1.2 Cargo piping arrangement

1.2.1 Bow or stern loading arrangement

IBC CODE REFERENCE: Ch 3, 3.1.3

The requirement in IBC Code 3.1.3 is considered to be satisfiedif the requirements in IBC Code 3.7, relevant to bow or stern loading and unloading arrangements, are complied with.

2 Accommodation, service and machinery spaces and control stations

2.1 Air intakes and other openings to accommodation spaces

2.1.1

IBC CODE REFERENCE: Ch 3, 3.2.2

The requirements relevant to air intakes in IBC Code 3.2.2 are also intended to be applicable to air outlets. This interpretation also applies to the requirements in IBC Code 3.2.3, 3.7.4, 8.2.3, 15.12.1.3 and 19.3.8.

2.2 Windows, sidescuttles and doors to accommodation spaces

2.2.1 General requirements

IBC CODE REFERENCE: Ch 3, 3.2.3

a) Access facing the cargo area or other prohibited zones is to be restricted to stores for cargo-related and safety equipment, cargo control stations and emergency shower spaces.

b) Entrances and openings to service spaces located forward of the cargo area may not face such area. However, for small ships alternative arrangements may be specially considered by the Society.

c) The bolt spacing for bolted plates mentioned in the paragraph in the reference is to be such as to guarantee a suitable gas-tightness.

2.2.2 Ships fitted with deckhouses originating from main deck

IBC CODE REFERENCE: Ch 3, 3.2.3

On all chemical tankers, regardless of the type of products to be carried, where a deckhouse is substituted for a superstructure and liquid products could flow along the sides of the house, the house front is to be continued to the sides of the ship in the form of a sill, or a permanent spillage barrier is to be arranged as described in Regulation II-2/56.6 of SOLAS 74(83).

3 Cargo pump rooms

3.1 General requirement

3.1.1 Means of escape

IBC CODE REFERENCE: Ch 3, 3.3.1

In general, a cargo pump room is to be provided with one set of access/escape ladders. Where it is envisaged that personnel are normally employed in a pump room or the pump room is unusually large, an additional means of escape may be required.

3.1.2 Segregation

IBC CODE REFERENCE: Ch 3, 3.3.1

Cargo pump rooms and pump rooms may not give direct access to other ship spaces and are to be separated from adjacent spaces by means of gas-tight bulkheads and/or decks.

3.2 Machinery driven by shafting passing through pump room bulkheads

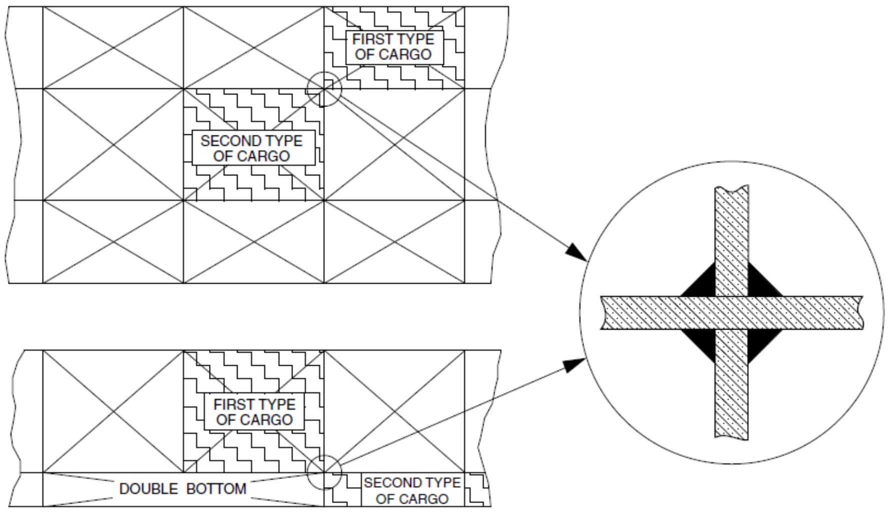
3.2.1

IBC CODE REFERENCE: Ch 3, 3.3.7

a) Bulkhead or deck penetrations of cargo pump rooms, or of pump rooms intended for runs of shafts driving pumps and/or fans, are to be provided with gas-tight sealing devices to the satisfaction of the Society.

b) Lubrication or other means of ensuring permanence of gas-tightness of the above-mentioned sealing devices is to be arranged in such a way that it can be checked from outside the cargo pump room.

Figure 1 : Segregation of mutually hazardously reactive cargoes



4 Access to spaces in the cargo area

4.1 General

4.1.1 Access to fuel oil tanks

IBC CODE REFERENCE: Ch 3, 3.4.1

The requirements in IBC Code 3.4.1 apply to fuel oil tanks adjacent to cargo tanks even if such fuel oil tanks are not included in the ڋcargo areaڀas defined in IBC Code 1.3.5.

4.1.2 Accesses and escapes from double bottom tanks and similar spaces

IBC CODE REFERENCE: Ch 3, 3.4.1

To cater for restrictions in the movement of personnel and to limit the time needed for a possible emergency escape, two separate means of access are generally to be fitted in double bottom tanks and similar spaces where obstructions impede movement. The two accesses are to be as widely separated as practicable. Only one access may be approved in special circumstances if, it being understood that the escapes have the required dimensions, the ability to readily traverse the space and to remove an injured person can be proved to the satisfaction of the Society.

4.2 Horizontal openings

4.2.1

IBC CODE REFERENCE: Ch 3, 3.4.2

The shape of the minimum acceptable clear opening of 600 mm by 600 mm is indicated in Fig 4.1.

4.3 Vertical openings

4.3.1

IBC CODE REFERENCE: Ch 3, 3.4.3

For pressure cargo tanks only, access openings may be circular openings having a diameter not less than 600 mm.

The minimum size of vertical oval openings is defined in Fig 4.2.

Figure 4.1 : Shape of minimum acceptable clear opening of 600 mm by 600 mm

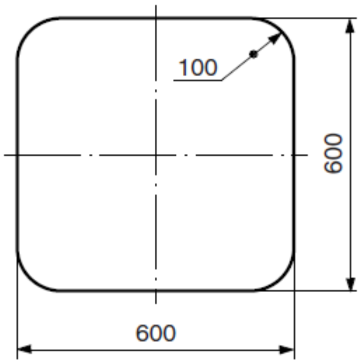
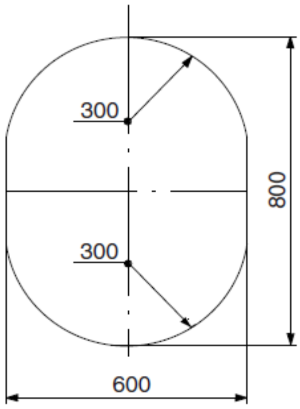


Figure 4.2 : Minimum size of vertical oval openings



5 Bilge and ballast arrangements

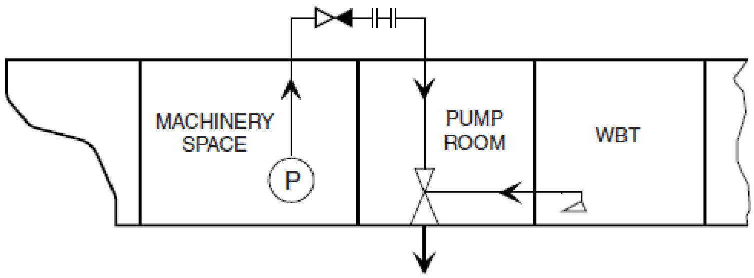
5.1 Ballast segregation

5.1.1 Eductors

IBC CODE REFERENCE: Ch 3, 3.5.1

An eductor situated in the cargo area using water power from pumps in the machinery spaces may be accepted as a means to discharge permanent ballast from tanks and/or double bottoms adjacent to cargo tanks, provided the supply line is above deck level and a non-return valve and removable spool piece are fitted in the supply line outside the machinery space (see Fig 5.1).

Figure 5.1 : Discharge arrangement



5.2 Ballast filling arrangement

5.2.1 Clarification

IBC CODE REFERENCE: Ch 3, 3.5.2

The filling of cargo tanks with ballast may be performed at deck level by means of pumps serving permanent ballast tanks, as specified in IBC Code 3.5.2, provided that a removable spool piece or flexible hose plus a shut-off valve are fitted on the inlet to the cargo tank. The shut-off valve is in addition to the required non-return valve. Consideration is to be given to the arrangement of the in-tank piping and the possible creation of static electricity (see Fig 5.1).

5.3 Bilge

5.3.1 Arrangement

IBC CODE REFERENCE: Ch 3, 3.5.3

The relaxation relevant to the bilge system for spaces which are separated from cargo tanks by a double bulkhead is to be understood as limited to spaces not enclosing piping which may contain cargo.

5.3.2 Use of cargo pumps as bilge pumps

IBC CODE REFERENCE: Ch 3, 3.5.3

a) Cargo pumps may also be used as bilge pumps provided they are connected to the bilge piping through a shut-off valve and a non-return valve arranged in series.

b) In the case of carriage of corrosive liquids, one of the cargo pumps may be used for bilge service provided it is connected to the bilge piping through two shut-off valves plus a non-return valve arranged in series.

c) In cargo pump rooms of ships carrying toxic or corrosive products, suitable means for conveying spills from cargo pumps and valves to collecting trays are to be fitted.

Trays may also consist of part of the pump room bottom, suitably bounded and protected against the corrosive action of products. Spills may be disposed of by means of suitable pumps or eductors. In the case of carriage of mutually incompatible products, the abovementioned means for collecting and disposing of spills are to be different and separated from each other.

6 Bow or stern loading and unloading arrangements

6.1 Coamings

6.1.1

IBC CODE REFERENCE: Ch 3, 3.7.7

In general, the height of the coaming is to be not less than 150 mm. In any case, it is to be not less than 50 mm above the upper edge of the sheerstrake.

Section 4 Cargo Containment

Symbols

k : Material factor for steel,

1 Structure design principles

1.1 Materials

1.1.1 Steels for hull structure

IBC CODE REFERENCE: CHAPTER 4

In addition to the requirements of Pt III, Ch 1, Sec 2, materials of cargo tanks are to be considered by the Society on a case-by-case basis for all the products intended to be carried.

1.1.2 Rolled plates

IBC CODE REFERENCE: CHAPTER 4

Rolled plates of non-alloyed steel or stainless steel may be used for the construction of tanks. Mechanical characteristics, approval procedure and testing of these plates are to comply with the applicable requirements of Pt II.

1.1.3 Youngيs modulus for stainless steels

IBC CODE REFERENCE: CHAPTER 4

For stainless steels, Youngيs modulus is to be taken equal to 193000 N/mm^2.

1.1.4 Rubber and synthetic material liner

IBC CODE REFERENCE: CHAPTER 4

The suitability of rubber or synthetic material lining is to be considered by the Society on a case-by-case basis.

1.2 Hull structure

1.2.1 Framing arrangement

IBC CODE REFERENCE: CHAPTER 4

In general, within the cargo tank region of chemical tankers of more than 90 m in length, the bottom, the inner bottom and the deck are to be longitudinally framed.

Different framing arrangements are considered by the Society on a case-by-case basis, provided that they are supported by direct calculations.

1.3 Bulkhead structure

1.3.1 Corrugated bulkhead connections

IBC CODE REFERENCE: CHAPTER 4

For ships with $L < 120$ m, vertically corrugated transverse or longitudinal bulkheads may be connected to the double bottom and deck plating (see Fig 1.1).

Figure 1.1 : Corrugated bulkhead connections without stool

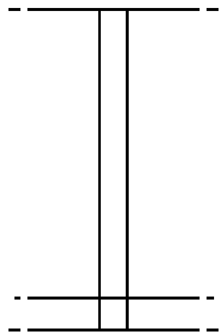
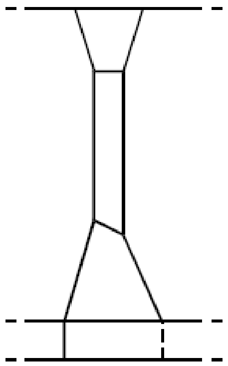


Figure 1.2 : Corrugated bulkhead connections with lower and upper stools



For ships with L□120 m, a lower and an upper stool are generally to be fitted (see Fig 1.2). Different arrangements may be considered by the Society on a case-by-case basis, provided that they are supported by direct calculations carried out according to Pt III, Ch 2. These calculations are to investigate, in particular, the zones of connection of the bulkhead with bottom and deck plating and are to be submitted to the Society for review.

2 Hull girder loads

2.1 Still water loads

2.1.1 Loading conditions

IBC CODE REFERENCE: CHAPTER 4

In addition to the requirements in Pt III, Ch 2, Sec 1, still water loads are to be calculated for the following loading conditions:

- homogeneous loading conditions (excluding tanks intended exclusively for segregated ballast tanks) at maximum draught
- partial loading conditions (see 2.1.2)
- high density cargo, heated cargo and segregated cargo loading conditions
- any specified non-homogeneous loading condition
- light and heavy ballast conditions

ﭼ mid-voyage conditions related to tank cleaning or other operations where these differ significantly from the ballast conditions.

2.1.2 Partial filling

Loading conditions with partial filling of the tanks by cargoes with a mass density above the cargo mass density used for the design may be allowed.

3 Scantlings of integral tanks

3.1 Plating

3.1.1 Minimum net thicknesses

IBC CODE REFERENCE: CHAPTER 4

The net thickness of the strength deck and bulkhead plating is to be not less than the values given in Tab 3.1.

Table 3.1 : Minimum net thickness of the strength deck and bulkhead plating

Plating	Minimum net thickness, in mm
Strength deck	$(5.5 + 0.02\ L)\ k^{1/2}$ for $L < 200$ $(8 + 0.0085\ L)\ k^{1/2}$ for L □200
Tank bulkhead	$L^{1/3}\ k^{1/6} + 4.5\ s$
Watertight bulkhead	$0.85\ L^{1/3}\ k^{1/6} + 4.5\ s$
Wash bulkhead	$0.8 + 0.013\ L\ k^{1/2} + 4.5\ s$

Note 1:

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

3.1.2 Calculation of equivalent thickness for clad plates made of non-alloyed steel ت stainless steel

IBC CODE REFERENCE: CHAPTER 4

The clad plate thickness is to be not less than that obtained from the following formula:

$t_p=t+t_s(1-E_I/206000)$

where:

t : Thickness, in mm, of the clad plate, to be obtained from the applicable formulae in Pt III,

Ch 2, as if it were made of homogeneous material with the following properties:

ﭼ elastic modulus, in N/mm^2, to be taken equal to:

E = 206000

ﭼ material factor, to be obtained from the following formula:

$k_o=k\ E_I/206000$

k : Material factor of the rolled stainless steel plate

E_I : Elastic modulus, in N/mm^2, of the rolled stainless steel plate

t_S : Thickness, in mm, of the stainless steel cladding, to be taken not less than 2.0 mm.

Stainless steel cladding thicknesses other than those above are to be considered by the Society on a case-by-case basis.

3.2 Ordinary stiffeners

3.2.1 Minimum net thicknesses

IBC CODE REFERENCE: CHAPTER 4

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formula:

$t_{MIN} = 0.75\ L^{1/3}\ k^{1/6} + 4.5\ s$

where s is the spacing, in m, of ordinary stiffeners.

3.3 Primary supporting members

3.3.1 Minimum net thicknesses

IBC CODE REFERENCE: CHAPTER 4

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

$t_{MIN} = 1.45\ L^{1/3}\ k^{1/6}$

3.3.2 Loading conditions

IBC CODE REFERENCE: CHAPTER 4

The still water and wave loads are to be calculated for the most severe of the loading conditions specified in 2.1.1, with a view to maximising the stresses in the longitudinal structure and primary supporting members in load cases

3.3.3 Cargo tank structure with hopper tank analysed through a three dimensional beam model

IBC CODE REFERENCE: CHAPTER 4

Where the cargo tank structure with hopper tank is analysed through a three dimensional beam model, to be carried out in accordance with the requirements of three dimensional model, the net shear sectional area of floors within 0.1 l from the floor ends (see Fig 3.1 for the definition of *l*) is to be not less than the value obtained, in cm^2, from the following

formula:

$A_{sh} = 20\ \gamma_R\ \gamma_m Q/R_y$

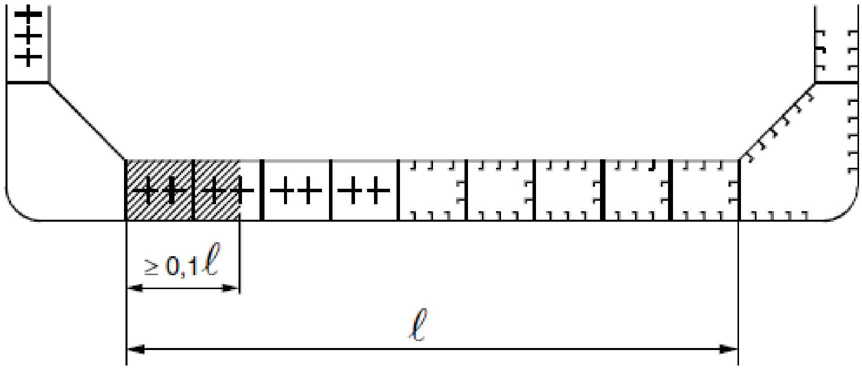
where:

Q : Maximum shear force, in kN, obtained from the direct calculations

γ_R : Resistance partial safety factor: $\gamma_R = 1.2$

γ_m : Material partial safety factor: $\gamma_m = 1.02$

Figure 3.1 : End area of floors



4 Scantlings of independent tank structures

4.1 Plating

4.1.1 Strength checks

IBC CODE REFERENCE: CHAPTER 4

In general, the net thickness of plating of independent tanks is to be not less than those obtained from the applicable formulae in Pt III, Ch2 and the hull girder stresses may be taken equal to zero.

Where, due to the tank arrangement, the above approximation is deemed unacceptable by the Society, the stresses in the tank due to the hull girder loads are to be taken into account. These stresses are, in general, to be calculated by means of direct calculations based on a finite element model of the hull and the tank with its supporting and keying system.

4.1.2 Calculation of equivalent thickness of clad plates made of non-alloyed steel تstainless steel

IBC CODE REFERENCE: CHAPTER 4

The requirements in 3.1.2 apply.

4.2 Ordinary stiffeners

4.2.1 Strength check

IBC CODE REFERENCE: CHAPTER 4

In general, the net scantlings of ordinary stiffeners of independent tanks are to be not less than those obtained from the applicable formulae in Pt III, Ch 2 and the hull girder stresses may be taken equal to zero.

Where, due to the tank arrangement, the above approximation is deemed unacceptable by the Society, the stresses in the tank due to the hull girder loads are to be taken into account. These stresses are generally to be calculated as specified in 4.1.1.

4.3 Primary supporting members

4.3.1 Loading conditions

IBC CODE REFERENCE: CHAPTER 4

The still water and wave loads are to be calculated for the most severe of the loading conditions specified in 2.1.1, with a view to maximising the stresses in the longitudinal structure, primary supporting members and supporting structure of the tanks.

4.3.2 Strength checks

IBC CODE REFERENCE: CHAPTER 4

The net scantlings of primary supporting members of both the hull and independent tanks are to be obtained by means of direct calculations based on criteria to be agreed by the Society on a case-by-case basis.

5 Supports of independent tanks

5.1 Structural arrangement

5.1.1 General

IBC CODE REFERENCE: CHAPTER 4

The reaction forces in way of tank supports are to be transmitted as directly as possible to the hull primary supporting members, minimising stress concentrations.

Where the reaction forces are not in the plane of primary members, web plates and brackets are to be provided in order to transmit these loads by means of shear stresses.

5.1.2 Openings

IBC CODE REFERENCE: CHAPTER 4

In tank supports and hull structures in way, openings are to be reduced as much as possible and local strengthening is to be provided as necessary.

5.2 Calculation of reaction forces in way of tank supports

5.2.1

IBC CODE REFERENCE: CHAPTER 4

The reaction forces in way of tank supports are to be obtained from the structural analysis of the tank, considering the loads specified in Part III, Ch2.

If the tank supports are not able to react in tension, the final distribution of the reaction forces at the supports is not to show any tensile forces.

5.3 Scantlings of independent tank supports and hull structures in way

5.3.1 Scantlings

IBC CODE REFERENCE: CHAPTER 4

The net scantlings of plating, ordinary stiffeners and primary supporting members of tank supports and hull structures in way are to be not less than those obtained by applying the criteria in Part III, Chapter 2, where the hull girder loads and and the lateral pressure are to be calculated according to rules.

The values of reaction forces in way of tank supports to be considered for the scantlings of these structural elements are defined in 5.2.

6 Other structures

6.1 Machinery space

6.1.1 Extension of the hull structures within the machinery space

IBC CODE REFERENCE: CHAPTER 4

Longitudinal bulkheads carried through cofferdams are to continue within the machinery space and be used preferably as longitudinal bulkheads for liquid cargo tanks. This extension is to be compatible with the shape of the structures of the double bottom, of the deck and of platforms in the machinery space.

7 Protection of hull metallic structures

7.1 Aluminium coatings

7.1.1

IBC CODE REFERENCE: CHAPTER 4

The use of aluminium coatings is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

7.2 Passivation treatment

7.2.1

IBC CODE REFERENCE: CHAPTER 4

For a stainless steel structure, a passivation treatment is to be made carefully on the whole area of the tanks for a new ship, and on the whole repaired area in the case of repairs.

This applies in particular to the passivation treatment of the welds.

8 Construction and testing

8.1 Welding and weld connections

8.1.1 Welding of bulkheads of cargo tanks of type 1 chemical carriers

IBC CODE REFERENCE: CHAPTER 4

The boundaries of bulkheads of cargo tanks of type 1 chemical carriers are to be connected, for their whole length, to the hull structures by means of full penetration welding.

8.1.2 Welding of bulkheads of cargo tanks of type 2 chemical carriers

IBC CODE REFERENCE: CHAPTER 4

The lower part (over 10% in height, as a minimum) of the boundaries of bulkheads of cargo tanks, i.e. the connection with the bottom (or double bottom, if any) and the connection with the lower part of the sloping plates, of type 2 chemical carriers are to be connected, for their whole length, to the hull structures by means of full penetration welding.

The other part of the tank boundaries may be connected by means of fillet welding.

8.1.3 Welding of stiffeners made of non-alloyed steel to stainless steel plates

IBC CODE REFERENCE: CHAPTER 4

In general, stiffeners made of non-alloyed steel may not be directly welded to thin stainless steel plates.

However, where the welding of stiffeners and hull components made of normal strength steel to stainless steel plates is deemed acceptable by the Society, such welding is to be performed using austenitic-ferritic electrodes with highgrade nickel and chromium, such as the electrode type with 24% Cr, 14% Ni and 3% Mo.

8.1.4 Welding on clad plates

IBC CODE REFERENCE: CHAPTER 4

Welds carried out on clad plates are to be considered by the Society on a case-by-case basis.

In particular, when fillet welding is carried out directly on the rolled plate, the ultrasonic inspection of the plating bond is to be performed on a strip bond 100 mm wide, centred on the plate perpendicular to the plating. This ultrasonic inspection is to be carried out in accordance with rules requirements.

8.2 Structural details

8.2.1

IBC CODE REFERENCE: CHAPTER 4

The specific requirements in Pt III, for ships with the service notation chemical tanker are to be complied with.

8.3 Testing

8.3.1 Tank testing

IBC CODE REFERENCE: CHAPTER 4

In addition to the requirements in Pt III, Ch 12, Sec 3, [2],

the tank testing is to comply with Tab 8.1.

Table 8.1: Additional requirements for chemical carrier tank testing

Structure to be tested	Testing requirements	Structural test pressure
Integral or independent tanks	Structural testing of cargo tank boundaries from at least one side, as defined in Pt III, Ch 7	The greater of the following: - 2.4 m head of water above the highest point of the tank - setting pressure of the safety relief valves, where relevant

Section 5 Cargo Transfer

1 Piping scantlings

1.1 General

1.1.1 Other requirements

IBC CODE REFERENCE: Ch 5, 5.1

Cargo pipes and accessories are to satisfy requirements of Pt IV, Ch 1, Sec 11.

1.2 Pipe classes

1.2.1

IBC CODE REFERENCE: Ch 5, 5.1

According to Pt IV, Ch 1, Sec 11, 1.5.2, cargo pipes and associated accessories are considered as:

a) class I when the design pressure is above 1.5 MPa, or the pipe is intended for toxic substances

b) class II when the design pressure is equal to or less than 1.5 MPa

c) class III when they are open ended or placed inside cargo tanks.

1.3 Pipe wall thickness calculation

1.3.1 Piping subjected to green seas

IBC CODE REFERENCE: Ch 5, 5.1.1

For piping subjected to green seas, the design pressure P, in MPa, in the formula in 5.1.1 of the IBC Code is to be replaced by an equivalent pressure Pبgiven by the following formula:

$$P' = 0.5(P + \sqrt{P^2 + 0.006R'KD_C / D})$$

where:

D_C : External diameter of the pipe taking into account the insulation (in mm), whose thickness is to be taken at least equal to:

40 mm if D □50 mm

80 mm if D □150 mm

Intermediate values are to be determined by interpolation

Rب: Drag corresponding to the effect of green seas, in daN/mm^2, such as given in Tab 1.1 as a function of the location of the pipes and of their height H (in m) above the deepest loadline;

intermediate values are to be determined by interpolation

1.3.2 Corrosion allowance

IBC CODE REFERENCE: Ch 5, 5.1.1

The coefficient C (added corrosion thickness) for the formula in 5.1.1 of the IBC Code is normally to be equal to at least 3 mm. The Society may accept a lesser value for pipes made of austenitic or austenitic-ferritic stainless steel, pipes with internal lining or, if applicable, pipes with acceptable external protective lining or painting.

2 Piping fabrication and joining details

2.1 Pipes not required to be joined by welding

2.1.1

IBC CODE REFERENCE: Ch 5, 5.2.2

Cargo piping is to be welded except for necessary flanged connections to valves, expansion joints (as permitted in 5.2.2.1 of the IBC Code), spool pieces and similar fittings or where required for coating, lining, fabrication, inspection or maintenance.

2.2 Expansion joints

2.2.1

IBC CODE REFERENCE: Ch 5, 5.2.4

The use of bellows is not permitted for corrosive and polymerizing products, except if provision is made to prevent stagnation of liquids.

2.3 Non-destructive testing of welding

2.3.1

IBC CODE REFERENCE: Ch 5, 5.5.2

a) Butt welded pipes and accessories are to be X-rayed at random and entirely checked by means of a dye-penetrant test or an equivalent method.

b) X-rays are to cover at least 10% of the connections and may be extended, at the request of the Surveyor depending on the results of the inspection.

c) Relaxation of the above requirements may be considered by the Society on a case-by-case basis for pipes welded at workshops. However, this only applies to ships exclusively intended to carry cargoes with minor fire risk.

Table 1.1 :

External diameter of pipe(1)	Aft of the quarter of the shipی length			Forward of the quarter of the shipی length		
	H□8	H=13	H□8	H□8	H=13	H□8
□25	1500	250	150	2200	350	150
50	1400	250	150	2000	350	150
75	1100	250	150	1600	350	150
100	700	250	150	700	350	150
□150	500	250	150	700	350	150

(1) DC if the pipe is insulated, D otherwise.

3 Piping arrangements

3.1 Arrangement of cargo piping

3.1.1 Arrangement of cargo piping under deck

IBC CODE REFERENCE: Ch 5, 5.5.2

The intent of the provisions in 5.5.2 of the IBC Code is to preclude the hazard of cargo leaking past a shut-off valve gland into the space where the valve is located.

3.1.2 Arrangement of cargo piping on deck

IBC CODE REFERENCE: Ch 5, 5.5.2

Cargo piping on cargo tanks is to be extended down to the bottom of each tank.

3.1.3 Arrangement of cargo piping inside cargo tanks

IBC CODE REFERENCE: Ch 5, 5.5.2

The ends of cargo tank filling pipes are to be located as near as possible to the tank bottom in order to reduce the risk of generating static electricity.

3.1.4 Pipe connections

IBC CODE REFERENCE: Ch 5, 5.3.2

Flanges are to be provided on connections to prevent the projection of liquids in case of leakage if pipes are intended to carry cargoes involving serious risks of skin toxicity.

3.1.5 Aluminised pipes

IBC CODE REFERENCE: Ch 5, 5.5

Aluminised pipes may be permitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

3.2 Removable piping systems

3.2.1

IBC CODE REFERENCE: Ch 5, 5.5

Pumps, piping and associated fittings are to constitute a permanently fitted system; in general, removable parts are not allowed, except for specific cases for which it can be

proved, to the satisfaction of the Society, that no effective alternative solutions are available. In such circumstances, the safety measures deemed necessary will be considered by the Society on a case-by-case basis.

4 Cargo transfer control systems

4.1 General

4.1.1

IBC CODE REFERENCE: Ch 5, 5.6.1

a) One blank flange is to be provided in addition to the stop valve required in 5.6.1.2 of the IBC Code at each cargo hose connection.

b) The requirements of 5.6.1 of the IBC Code are not intended to be additional to those for piping below deck in 5.5.2 and 5.5.3 of the IBC Code.

4.2 Control, monitoring and alarm devices and cargo control room

4.2.1

IBC CODE REFERENCE: Ch 5, 5.6

a) The cargo pump control is to be fitted in a position which is readily accessible, even in the event that the cargo piping or hoses break. This position is to be clearly indicated.

b) Where a cargo control room is fitted, the following controls, monitoring and alarms are to be connected to this room:

- cargo pump control
- control of loading/unloading valves
- level gauges
- temperature indicators
- high level alarms
- very high level alarms
- high/low temperature alarms
- high/low pressure alarms
- fixed gas detecting system alarms.

c) In general, high/low temperature alarms are also to be transduced to the navigating bridge.

d) The cargo control room is to be located above the weather deck and may be considered as a dangerous space or a safe space, depending on its location and on the possible presence of a product or of its vapours. If it is considered a dangerous space, it is to be provided with a ventilation system capable of supplying at least 20 air changes per hour, it is not to be located in the accommodation area and only safe type electrical equipment is allowed.

e) A cargo control room without cargo pump and valve control is defined as a "cargo control station".

5 Ship’s cargo hoses

5.1 Compatibility

5.1.1

IBC CODE REFERENCE: Ch 5, 5.7.1

The requirement of 5.7.1 of the IBC Code applies to cargo hoses carried on board the vessel and "compatibility with the cargo" means that:

a) the cargo hose does not lose its mechanical strength or deteriorate unduly when in contact with the cargo, and

b) the cargo hose material does not affect the cargo in a hazardous way.

Consideration is to be given to internal and external surfaces with respect to the above where hoses may be used as an integral part of, or connected to, emergency cargo pumps and submerged in the cargo tank.

6 Bonding

6.1 Static electricity

6.1.1 Acceptable resistance

IBC CODE REFERENCE: Ch 10, 10.3

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than $10^6 \Omega$.

6.1.2 Bonding straps

IBC CODE REFERENCE: Ch 10, 10.3

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

a) clearly visible so that any shortcoming can be clearly detected

b) designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint

c) easy to install and replace.

7 Certification, inspection and testing

7.1 Application

7.1.1 The provisions of this Article are related to cargo piping and other equipment fitted in the cargo area. They supplement those given in Pt IV, Ch 1, Sec 11, 20 for piping systems.

7.2 Workshop tests

7.2.1 Tests for materials

Where required in Tab 7.1, materials used for pipes, valves and fittings are to be subjected to the tests specified in Pt IV, Ch 1, Sec 11, 20.3.2.

7.2.2 Inspection of welded joints

Where required in Tab 7.1, welded joints are to be subjected to the examinations specified in 2.3.1 and Pt IV, Ch 1, Sec 11, 3.6 for class II pipes.

7.2.3 Hydrostatic testing

IBC CODE REFERENCE: Ch 5, 5.4.2

a) Where required in Tab 7.1, cargo pipes, valves, fittings and pump casings are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt IV, Ch 1, Sec 11, 20.4.

b) Expansion joints and cargo hoses are to be submitted to hydrostatic tests in accordance with the relevant provisions of Pt IV, Ch 1, Sec 11, 20.4.

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

7.2.4 Tightness tests

Tightness of the gas-tight penetration glands is to be checked.

Note 1: These tests may be carried out in the workshops or on board.

7.2.5 Summarising table

Inspections and tests required for cargo piping and other equipment fitted in the cargo area are summarised in Tab 7.1.

7.3 Shipboard tests

7.3.1 Pressure test

IBC CODE REFERENCE: Ch 5, 5.4.3

After installation on board, the cargo piping system is to be checked for leakage under operational conditions.

Table 7.1 : Inspection and testing at works

No	Item	Tests for materials		Inspections and tests for the products			References to the Rules
		Y/N (1)	Type of material certificate (2)	during manufacturing (1)	after completion (1) (3)	Type of product certificate (2)	
1	seamless or stainless steel cargo pipes	Y	C where ND > 25mm W where ND □25mm	Y (4)	Y	C	7.2.1 7.2.1 7.2.2 7.2.3
2	pipes of class II, cargo valves and fittings	Y	C where ND > 100mm W where ND □100mm	Y (4)	Y	C	7.2.1 7.2.1 7.2.2 7.2.3
3	expansion joints and cargo hoses	Y (5)	W	N	Y	C	7.2.1 7.2.3
4	cargo pumps	Y	C	Y (6)	Y	C	See note (6) 7.2.3
5	gas-tight penetration glands	N		N	Y	C	7.2.3 7.2.4
6	cargo tank P/V valves	Y	C	Y	Y	C	7.2.1 7.2.2 7.2.3 Sec8, 2.1.1
7	flame arresters	N		N	Y	C	See note(3)

(1) Y = required, N = not required.

(2) C = class certificate, W = works certificate.

(3) includes the checking of the rule characteristics according to the approved drawings.

(4) only in the case of welded construction.

(5) if metallic.

(6) inspection during manufacturing is to be carried out according to a program approved by the Society.

Section 6 Materials for Construction

1 General

1.1 Material and coating characteristics

1.1.1

IBC CODE REFERENCE: Ch 6

a) Materials and coating systems of structures and equipment which may come into contact with liquid cargo or vapour are to be selected in accordance with the list of cargoes intended to be carried.

b) The resistance of materials and coatings and their compatibility with intended cargoes are the responsibility of the Builder or Owner. All supporting documents are, however, to be given to the Society to permit the drafting of the list of cargoes annexed to the classification certificate.

Copy of the charts of coating and/or material resistance issued by the manufacturers is to be kept on board.

These documents are to indicate the possible restrictions relative to their use.

c) As a general requirement, the provisions under Pt II, Materials and Welding apply. Materials for tanks are, in any case, to have properties which are not lower than those of hull steels used according to Pt II Materials and Welding.

d) The above-mentioned materials are, in themselves, to be resistant to the action of the products to be carried.

However, materials which are not, in themselves, resistant to such action may be used, provided they are protected by resistant materials after the positive outcome of prior checks and tests performed to the satisfaction of the Society. In this case, the Society may also require surveys to be carried out at shorter intervals than those between normal surveys.

e) In the construction of cargo tanks intended to carry cargo and sea water ballast alternately, the utmost care is to be given to the selection of structural material (in general austenitic stainless steel) with particular attention to its resistance to different types of isolated corrosion:

- pitting
- stress corrosion
- interstice corrosion.

In addition, these structures are to be constructed with the same type of material to avoid galvanic corrosion, which would arise if dissimilar materials were present.

In addition to the structures, the above is also intended to apply to the materials of systems, devices and apparatuses fitted in the tanks.

f) Sea water ballast tank structures may be partly of stainless steel and partly of hull steel, provided suitable measures are taken against hull steel corrosion. The use of appropriate protective coatings is subject to the positive outcome of the previous checks and tests, to the satisfaction of the Society, which may also require surveys to be performed at shorter intervals than for normal surveys.

In estimating the suitability of the protective system, the Society may also require that the cathodic area is drastically reduced (for example, by also suitably protecting stainless steel structures) for the purpose of avoiding extremely isolated corrosion in hull steel structures which could possibly turn out, for various reasons, not to be protected by coating.

g) The use of aluminium coatings is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo gas may accumulate.

2 Special requirements for materials

2.1 Miscellaneous requirements

2.1.1 Non-metallic materials

IBC CODE REFERENCE: Ch. 6

Non-metallic materials used in cargo tanks and connected equipment are to be suitable for the liquids and vapours to which they are exposed.

2.1.2 Primers

IBC CODE REFERENCE: Ch. 6

Primers containing zinc may not be used for stainless steel.

Where such type of primer is used for other items which are welded to stainless steel, provisions are to be made to avoid the contamination of the stainless steel by zinc.

Section 7 Cargo Temperature Control

1 General

1.1 Heated cargoes

1.1.1 Approval

The capacity of a ship to maintain specific cargoes under heated conditions is the responsibility of the Builder or the Owner.

However, all relevant supporting documents are to be given to the Society in order to establish the list of cargoes possibly attached to the classification certificate as per Pt I, Ch2.

1.1.2 Application

Except for ships intended for restricted voyages, any cargo with a melting point equal to 20°C, or above, is to be capable of being maintained under heated conditions.

Attention is drawn to the fact that, for safety reasons, certain cargoes are not to be heated above a specific temperature.

1.1.3 Temperature indication

When a ship is fitted with a heating system capable of maintaining the liquid temperature above 45°C, the ship's structure and materials are to be checked for this temperature and the maximum permissible temperature is to be stated on the classification certificate or on its annex.

1.2 Cargo heating and cooling systems

1.2.1 Cargo temperature control systems

IBC CODE REFERENCE: Ch 7, 7.1.1

Wherever a particular temperature (higher or lower than the ambient temperature) is required to be maintained for the preservation of the cargo, one of the following systems is to be adopted:

a) thermal insulated tanks capable of maintaining the temperature of the cargo within acceptable limits for the time of the voyage.

b) a heating or cooling plant or refrigerating plant.

c) a combination of a) and b) above.

1.2.2 Additional requirements for heating and cooling plants

IBC CODE REFERENCE: Ch 7, 7.1.1

a) Manifolds for the delivery and backflow of heating media are to be fitted on the weather deck; connections to cargo tanks for inlet and outlet are to be in way of the cargo tank top.

b) Where the heat exchanger room is located in the accommodation area and considered as gas-safe, it is to be treated as a machinery space (not a category A machinery space) and provided with independent mechanical extraction ventilation as well as with scuppers discharging directly into the machinery space.

1.2.3 Reference temperature

IBC CODE REFERENCE: Ch 7, 7.1.1

Wherever the cargo temperature is maintained by a heating or refrigerating plant, unless otherwise indicated in the contract specification, the system is to be designed taking into account the reference temperatures indicated in Tab 1.1.

Table 1.1 :

Reference temperature (°C)		
	Heating system	Cooling system
Sea	0	32
Air	5	45

1.2.4 Redundancy

IBC CODE REFERENCE: Ch 7, 7.1.1

Wherever the heating or cooling system is essential for the preservation of the cargo, the following components are to be duplicated:

a) coils and ducts in cargo tanks

b) heating or cooling sources

c) circulating pumps for cargo and heating cooling media; if suitable for the use, cargo pumps may be employed for the circulation of the heating or cooling media

d) refrigeration plant.

1.2.5 Maximum surface temperature

Depending on the class temperature of the cargoes being carried, the maximum surface temperature of the heating system, within enclosed spaces inside the cargo area should not exceed the values of Tab 1.2.

Table 1.2 :

Class temperature	Maximum surface temperatureof the heating system
T1	450°C
T2	300°C
T3	200°C
T4	135°C
T5	100°C
T6	85°C

1.3 Valves and other fittings

1.3.1 Means for purging

IBC CODE REFERENCE: Ch 7, 7.1.3

Cargo heating or cooling systems are to be fitted with the necessary connections to purge, by inert gas or compressed air, the heating or cooling circuit of each cargo tank and to perform the pressure testing of the system.

1.4 Cargo temperature measuring system

1.4.1 Alarm

IBC CODE REFERENCE: Ch 7, 7.1.5

a) An alarm system is required for those products which are carried in a heated condition (see 15.13.6 of the IBC Code) and for which, in column "o" of the tables in Chapter 17 of the IBC Code, reference is made to the requirements of 15.13 of the IBC Code.

b) An alarm system is required for those products for which a carrying temperature not greater than certain limits is required by Chapter 15 of the IBC Code, such as elementary phosphorus and molten sulphur.

c) An alarm connection to the navigating bridge and to the cargo control station, if fitted, is to be provided.

1.5 Requirements for special products

1.5.1 Products which may damage the cargo heating or cooling system

IBC CODE REFERENCE: Ch 7, 7.1.6

a) The provisions of 7.1.6 of the IBC Code also apply to products which may damage the cargo heating or cooling system.

b) If the sampling equipment mentioned in 7.1.6.3 of the IBC Code consists of an observation tank for drains, this tank is generally to comply with the following requirements:

- it is to be located in the cargo area and provided with an air pipe with the end fitted with a flame screen, as per the Rules, and arranged at not less than 3 m from openings of accommodation spaces and from sources of ignition
- it is to be fitted with a connection for discharge into the slop tanks with associated shut-off valves and sight glass and equipped with a sampling cock for backflowing medium analysis.

Section 8 Cargo Tank Venting and Gas-Freeing Arrangements

1 Cargo tank venting

1.1 Venting system drainage

1.1.1 Large amounts of drainage

IBC CODE REFERENCE: Ch. 8, 8.2.2

When large amounts of drainage from vent lines of the cargo tanks are envisaged, a hose connection to the drain line of the slop tank is to be provided.

2 Types of tank venting system

2.1 Controlled tank venting system

2.1.1 Tests of pressure / vacuum valves

IBC CODE REFERENCE: Ch. 8, 8.3.2

The tightness and the setting pressure of the cargo tanks pressure/vacuum or pressure- and vacuum-relief valves are to be checked. Inspections and tests for these valves are given in Sec 5, Tab 7.1.

2.1.2 Flame arresters

IBC CODE REFERENCE: Ch. 8, 8.3.5

Inspections and tests for flame arresters are given in Sec 5, Tab 7.1.

2.2 Position of vent outlets

2.2.1 Outlets from tanks intended for flammable and toxic products

IBC CODE REFERENCE: Ch. 8, 8.3.3

Vent outlets of cargo tanks intended for the carriage of flammable or toxic products are to be arranged at a distance of not less than 3 m from exhaust ducts and as far as possible from inlet ducts to pump rooms and cargo pump rooms.

3 Cargo tank gas-freeing

3.1 Fans

3.1.1

IBC CODE REFERENCE: Ch 8, 8.5

The impellers and housing of either fixed or portable fans fitted in dangerous spaces are to be of non-sparking materials according to 12.1.8 of the IBC Code.

Section 9 Environmental Control

1 General

1.1 Control by padding

1.1.1 Padding medium

IBC CODE REFERENCE: Ch 9, 9.1.3

The padding medium is to be compatible from the point of view of safety with the products to be carried, it is not to react with them and with air and it is to have chemical and physical properties deemed suitable by the Society. The system is to comply with the requirements for inert gas systems, as applicable.

1.2 Control by drying

1.2.1 Simultaneous carriage of incompatible products

IBC CODE REFERENCE: Ch 9, 9.1.4

In the case of simultaneous carriage of mutually incompatible products, dry gas supply piping systems to each cargo space are to be separate from each other.

1.3 Control by inerting

1.3.1 Application

IBC CODE REFERENCE: Ch 9, 9.1

a) Chemical tankers carrying crude oil or petroleum products having a flashpoint not exceeding 60°C (closed cup test), as determined by an approved flashpoint apparatus, and a Reid vapour pressure which is below the atmospheric pressure, or other liquid products having a similar fire hazard, are to be equipped with an inert gas system complying with the requirements of Article 2.

b) Chemical tankers carrying flammable cargoes other than crude oil or petroleum products such as cargoes listed in Sec 17 and Sec 18 are not required to be fitted with an inert gas system, provided that:

- the capacity of tanks used for their carriage does not exceed 3000 m3 and
- the individual nozzle capacity of tank washing machines does not exceed 17.5 m^3/h and
- the total combined throughput from the number of machines in use in a cargo tank at any one time does not exceed 110 m^3/h.

1.3.2 Simultaneous carriage of incompatible products

IBC CODE REFERENCE: Ch 9, 9.1

The inert gas is to comply with the requirements of 9.1.3 of the IBC Code, adapted, to the satisfaction of the Society, to the individual characteristics of the products to be carried.

In the case of simultaneous carriage of mutually incompatible products, inert gas supply piping systems to each cargo space are to be separate from each other.

1.3.3 Ships with no fixed inert gas system

IBC CODE REFERENCE: Ch 9, 9.1

Where no fixed installation for inert gas and/or dry gas production is provided for on board, the minimum quantity to be kept on board is established by the Master, based on the duration of the voyage, the anticipated daily temperature variations, gas leakage through cargo tank seals and experience of previous similar cases.

1.3.4 Additional requirements

IBC CODE REFERENCE: Ch 9, 9.1

a) In addition to the provisions in 9.1.3 of the IBC Code, the inert gas system is to comply with the requirements of Article 2 which includes the provisions of IMO Resolution A 567(14).

b) These requirements apply where an inert gas system based on Nitrogen or oil fired inert gas generators is fitted on board chemical tankers. Any proposal to use other sources of inert gas will be specially considered.

1.4 Control by ventilation

1.4.1

IBC CODE REFERENCE: Ch 9, 9.1

When a cargo space ventilation system other than the venting system mentioned under 8.2 of the IBC Code is required following these provisions, such system is to be specially examined by the Society.

2 Engineering specifications of inert gas systems

2.1 General

2.1.1

a) Throughout this Article 2 the term ﺑ cargo tankﭘincludes also ﺑ slop tankﭘ

b) Inert gas generator systems shall be designed, constructed and tested to the satisfaction of the Society.

They shall be designed and operated so as to render and maintain the atmosphere of cargo tanks non-flammable at all times except when such tanks are required to be maintained empty and gas-free. Inert gas systems supplied by one or more oil fired inert gas generators may be accepted. The Society may accept systems using inert gas from other sources provided that an equivalent standard of safety is achieved.

Note 1: "Inert gas generator system" means the machinery dedicated to the production and supply of inert gas and includes the air blowers, combustion chambers, fuel oil pumps and

burners, gas coolers/scrubbers and automatic combustion control and supervisory equipment, e.g. flame failure devices.

c) The systems shall be capable of:

1) inerting empty cargo tanks by reducing the oxygen content of the atmosphere in each tank to a level at which combustion cannot be supported

2) maintaining the atmosphere, in all parts of each cargo tank designated to carry flammable products requiring protection by an inert gas system, with an oxygen content not exceeding 8% by volume and at a positive pressure at all times in port and at sea except when it is necessary for such a tank to be gasfree

3) eliminating the need for air to enter a tank during normal operations except when it is necessary for such a tank to be gas-free

4) purging empty cargo tanks of flammable vapour, so that subsequent gas-freeing operations will at no time create a flammable atmosphere within the tank.

d) The inert gas piping systems shall not pass through accommodation, service and control station spaces.

2.2 Component requirements

2.2.1

a) Supply of inert gas and inert gas generators

1) The systems shall be capable of delivering inert gas to the cargo tanks at a rate of at least 125% of the maximum rate of discharge capacity of the ship expressed as a volume. The Society may accept inert gas systems having a lower delivery capacity provided that the maximum rate of discharge of cargoes from cargo tanks being protected by the system is restricted to 80% of the inert gas capacity.

2) The systems shall be capable of delivering inert gas with an oxygen content of not more than 5% by volume in the inert gas supply main to the cargo tanks at any required rate of flow.

3) Two fuel oil pumps shall be fitted to each inert gas generator. The Society may permit only one fuel oil pump on condition that sufficient spares for the fuel oil pump and its prime mover are carried on board to enable any failure of the fuel oil pump and its prime mover to be rectified by the shipض crew.

4) Suitable fuel in sufficient quantity shall be provided for the inert gas generators.

5) The inert gas generators shall be located outside the cargo tank area. Spaces containing inert gas generators shall have no direct access to accommodation, service or control station spaces, but may be located in machinery spaces. If they are not located in machinery spaces they shall be located in a compartment reserved solely for their use. Such a compartment shall be separated by a gas-tight steel bulkhead and/or deck from accommodation, service and control station spaces. Adequate positivepressure- type mechanical ventilation shall be provided for such a compartment. Access to such compartments located aft shall be only from an open deck outside the cargo tank area. Access shall be located on the end bulkhead not facing the cargo area and/or on the outboard side of the superstructure or deckhouse at a distance of at least 25% of the length of the ship but not less than 5 m from the end of the superstructure or deckhouse facing the cargo area. In the case of such a compartment being

located in the forecastle, access shall be through the deckhead forward of the cargo area.

b) Cooling means and filters

1) Means shall be provided which will effectively cool the volume of gas specified in items a) 1) and a) 2) above and remove solids and sulphur combustion products. The cooling water arrangements shall be such that an adequate supply of water will always be available without interfering with any essential services of the ship. Provisions shall also be made for an alternative supply of cooling water.

2) Filters or equivalent devices shall be fitted to minimize the amount of water carried over to the inert gas main.

c) Blowers

1) Two air blowers shall be fitted to each inert gas generator, which together shall be capable of delivering to the cargo tanks, required to be protected by the system, at least the volume of gas required in item a) 1) above. The Society may permit only one blower if it is capable of delivering to the protected cargo tanks the total volume of gas required in item a) 1) above, provided that sufficient spares for the air blower and its prime mover are carried on board to enable any failure of the air blower and its prime mover to be rectified.

2) The inert gas systems shall be so designed that the maximum pressure which they can exert on any cargo tank will not exceed the test pressure of any cargo tank.

3) Where more than one inert gas generator is provided, suitable shut-off arrangements shall be provided on the discharge outlet of each generator plant.

4) Arrangements shall be made to vent the inert gas to the atmosphere in case the inert gas produced is offspecification, e.g. during starting-up or in case of equipment failure.

5) Where inert gas generators are served by positive displacement blowers, a pressure relief device shall be provided to prevent excess pressure being developed on the discharge side of the blower.

d) Water seal

1) The water seal referred to in item a) 2) of 2.3.1 shall be capable of being supplied by two separate pumps, each of which shall be capable of maintaining an adequate supply at all times.

2) The arrangement of the water seal and its associated fittings shall be such that it will prevent backflow of flammable vapours and will ensure the proper functioning of the water seal under operating conditions.

3) Provisions shall be made to ensure that any water seal is protected against freezing, in such a way that the integrity of water seal is not impaired by overheating.

4) A water loop or other approved arrangement shall also be fitted to all associated water supply and drain piping and to all venting or pressure sensing piping leading to gas-safe spaces. Means shall be provided to prevent such loops from being emptied by vacuum.

5) Any water seal or equivalent device and all loop arrangements shall be capable of preventing the return of flammable vapours to an inert gas generator at a pressure equal to the test pressure of the cargo tanks.

6) In respect of the low water level in the water seal as per the seventh bullet of item c) 1) of 2.4.1, the Society shall be satisfied as to the maintenance of an adequate reserve of water at all times and the integrity of the arrangements to permit the automatic formation of the water seal when the gas flow ceases.

The audible and visual alarm on the low level of water in the water seal shall operate when the inert gas is not being supplied.

2.3 Installation requirements

2.3.1

a) Safety measures in the system

1) Gas regulation valves

- A gas regulating valve shall be fitted in the inert gas supply main. This valve shall be automatically controlled to close as required in item a) 3) below. It shall also be capable of automatically regulating the flow of inert gas to the cargo tanks unless other means are provided to automatically control the inert gas flow rate.
- The valve referred to in the preceding item shall be located at the forward bulkhead of the forwardmost gas- safe space through which the inert gas supply main passes.

Note 1: Gas-safe space is a space in which the entry of hydrocarbon gases would produce hazards with regard to flammability or toxicity.

2) Non-return devices of flue gas

- At least two non-return devices, one of which shall be a water seal, shall be fitted in the inert gas supply main in order to prevent the return of flammable vapour to the inert gas generator and to any gas-safe space under all normal conditions of trim, list and motion of the ship. They shall be located between the automatic valve required by item a) 1) above and the first connection to any cargo tank or cargo pipeline. The Society may permit an alternative arrangement or device providing a measure of safety equivalent to that of a water seal.
- The devices referred to in the preceding item shall be located in the cargo area on deck.
- The second device shall be a non-return valve or equivalent capable of preventing the return of vapours or liquids or both and fitted between the water seal (or the equivalent device) required in the first bullet of this item a) 2) and the first connection from the inert gas main to a cargo tank.

It shall be provided with positive means of closure.

As an alternative to positive means of closure, an additional valve having such means of closure may be provided between the nonreturn valve and the first connection to the cargo tanks to isolate the water seal (or equivalent device).

- As an additional safeguard against the possible leakage of flammable liquids or vapours back from the deck main, means shall be provided to permit this section of the line between the valve having positive means of closure referred to in the previous item and the valves referred to in item a) 1) above to be vented in a safe manner when the first of these valves is closed.
- As an alternative to the above water seal in the inert gas line on deck, an arrangement consisting of two shut-off valves in series with a venting valve in between may be accepted (double block and bleed). The following conditions apply:
  - The operation of the valve is to be automatically executed. Signals for opening/closing are to be taken from the process directly, e.g. inert gas flow or differential pressure.
  - Alarm for faulty operation of the valves is to be provided, e.g. the operation status of "blower stop" and "supply valve(s) open" is an alarm condition.

3) Automatic shutdown

- Automatic shutdown of the gas regulating valve and of the fuel oil supply to the inert gas generator shall be arranged on predetermined limits being reached in respect of the first and third bullets of item c) 1) of 2.4.1.
- Automatic shutdown of the gas regulating valve shall be arranged in respect of the fourth bullet of item c) 1) of 2.4.1.

b) Inert gas lines

1) The inert gas main may be divided into two or more branches between the non-return devices required in item a) 2) above and the cargo tanks.

2) Inert gas supply mains shall be fitted with branch piping leading to each cargo tank designated for the carriage of flammable products required to be inerted by the provisions of 1.3. Each cargo tank containing or loading products not required to be inerted shall be separated from the inert gas main by:

- removing spool-pieces, valves or other pipe sections, and blanking the pipe ends, or
- arrangement of two spectacle flanges in series with provisions for detecting leakage into the pipe between the two spectacle flanges.

3) Means shall be provided to protect cargo tanks against the effect of overpressure or vacuum caused by thermal variations when the cargo tanks are isolated from the inert gas mains.

4) Piping systems shall be so designed as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

5) Suitable arrangements shall be provided to enable the inert gas main to be connected to an external supply of inert gas.

2.4 Operational and control requirements

2.4.1

a) Indication devices

Means shall be provided for continuously indicating the temperature and pressure of the inert gas at the discharge side of the system, whenever it is operating.

b) Indicating and recording devices

1) Instrumentation shall be fitted for continuously indicating and permanently recording, when the inert gas is being supplied:

- the pressure of the inert gas supply mains between the non-return devices required by item

a) 2) of 2.3.1, and

- the oxygen content of the inert gas in the inert gas supply mains.

2) The devices referred to in item b) 1) above shall be placed in the cargo control room where provided.

Where no cargo control room is provided, they shall be placed in a position easily accessible to the officer in charge of cargo operations.

3) In addition, meters shall be fitted:

- in the navigating bridge to indicate at all times the pressure referred to in the first bullet of item b) 1) above, and
- in the machinery control room or in the machinery space to indicate the oxygen content referred to in the second bullet of item b) 1) above.

4) Portable instruments for measuring oxygen and flammable vapour concentration shall be provided. In addition, suitable arrangement shall be made on each cargo tank such that the condition of the tank atmosphere can be determined using these portable instruments.

5) Suitable means shall be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments, referred to in the preceding items b) 1) to b) 4).

c) Audible and visual alarms

1) Audible and visual alarms shall be provided to indicate:

- low water pressure or low water flow rate to the cooling and scrubbing arrangement referred to in item b) 1) of 2.2.1
- low fuel supply
- high gas temperature as referred to in item a)
- failure of the power supply to the inert gas generators
- oxygen content in excess of 8 per cent by volume as referred to in the second bullet of item b) 1) above

- failure of the power supply to the indicating devices as referred to in item b) 1) above and to the automatic control systems for the gas regulating valve referred to in item a) 1) of 2.3.1 and the inert gas generator
- low water level in the water seal as referred to in the first bullet of item a) 2) of 2.3.1
- gas pressure less than 100 mm water gauge as referred to in the first bullet of item b) 1) above, and
- high gas pressure as referred to in the first bullet of item b) 1) above.

2) The alarms required in the fifth, sixth and eighth bullets of item c) 1) above shall be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew. All other alarms required by 2.4.1 shall be audible to responsible members of the crew either as individual alarms or as a group alarm.

3) An audible alarm system independent of that required in the eighth bullet of item c) 1) above or automatic shutdown of cargo pumps shall be provided to operate on predetermined limits of low pressure in the inert gas mains being reached.

d) Instruction manual

Detailed instruction manuals shall be provided on board, covering the operations, safety and maintenance requirements and occupational health hazards relevant to the inert gas system and its application to the cargo tank system. The manuals shall include guidance on procedures to be followed in the event of a fault or failure of the inert gas system.

2.5 Additional requirements

2.5.1 General

In addition to the requirements detailed in Resolution A567(14), given above, the following requirements are to be complied with:

a) Plans in diagrammatic form are to be submitted for appraisal and are to include the following:

- details and arrangement of inert gas generating plant including all control monitoring devices
- arrangement of piping system for distribution of the inert gas.

b) In all cases, automatic combustion control, capable of producing suitable inert gas under all service conditions, is to be fitted.

c) When two blowers are provided, the total required capacity of the inert gas system is preferably to be divided equally between the two and in no case is one blower to have a capacity less than 1/3 of the total required.

d) Materials used in inert gas systems are to be suitable for their intended purpose in accordance with the Rules. In particular those parts of scrubbers, blowers, non-return devices, scrubber effluent and other drain pipes which may be subjected to corrosive action of the gases and/or liquids are to be either constructed of corrosion-resistant material or lined with rubber, glass fibre epoxy resin or other equivalent coating material.

e) A compartment in which any oil fired inert gas generator is situated is to be treated as a machinery space of category A in respect of fire protection.

f) All of the equipment is to be installed on board and tried under working conditions to the satisfaction of the Surveyor.

2.5.2 Nitrogen generator systems

a) The requirements of this item are specific only to the gas generator system and apply where inert gas is produced by separating air into its component gases by passing compressed air through a bundle of hollow fibres, semipermeable membranes or adsorber materials.

b) Where such systems are provided in place of the boiler flue gas or oil fired inert gas generators, the previous requirements for inert gas systems applicable to piping arrangements, alarms and instrumentation downstream of the generator are to be complied with, as far as applicable.

c) A nitrogen generator consists of a feed air treatment system and any number of membrane or adsorber modules in parallel necessary to meet the required capacity which is to be at least 125% of the maximum discharge capacity of the ship expressed as a volume.

d) The air compressor and the nitrogen generator may be installed in the engine room or in a separate compartment. A separate compartment is to be treated as one of the "Other machinery spaces" with respect to fire protection.

e) Where a separate compartment is provided, it is to be positioned outside the cargo area and is to be fitted with an independent mechanical extraction ventilation system providing 6 air changes per hour. A low oxygen alarm is to be fitted as well. The compartment is to have no direct access to accommodation spaces, service spaces and control stations.

f) The nitrogen generator is to be capable of delivering high purity nitrogen with O2 content not exceeding 5% by volume. The system is to be fitted with automatic means to discharge off-specification gas to the atmosphere during start-up and abnormal operation.

g) The system is to be provided with two air compressors. The total required capacity of the system is preferably to be divided equally between the two compressors, and in no case is one compressor to have a capacity less than 1/3 of the total capacity required. Only one air compressor may be accepted provided that sufficient spares for the air compressor and its prime mover are carried on board to enable their failure to be rectified by the ship's crew.

h) A feed air treatment system is to be fitted to remove free water, particles and traces of oil from the compressed air, and to preserve the specification temperature.

i) Where fitted, a nitrogen receiver/buffer tank may be installed in a dedicated compartment or in the separate compartment containing the air compressor and the generator or may be located in the cargo area. Where the nitrogen receiver/buffer tank is installed in an enclosed space, the access is to be arranged only from the open deck and the access door is to open outwards.

Permanent ventilation and alarm are to be fitted as required by e) above.

j) The oxygen-enriched air from the nitrogen generator and the nitrogen-product enriched gas from the protective devices of the nitrogen receiver are to be discharged to a safe location on the open deck.

k) In order to permit maintenance, means of isolation are to be fitted between the generator and the receiver.

l) At least two non-return devices are to be fitted in the inert gas supply main, one of which is to be of the double block and bleed arrangement. The second nonreturn device is to be equipped with positive means of closure.

Note 1: A block and bleed arrangement consisting of two shut-off valves in series with a venting valve in between may be accepted provided:

- the operation of the valve is automatically executed. Signal(s) for opening/closing is (are) to be taken from the process directly, e.g. inert gas flow or differential pressure
- alarm for faulty operation of the valves is provided, e.g. the operation status of "Blower stop" and "supply valve(s) open" is an alarm condition.

m) Instrumentation is to be provided for continuously indicating the temperature and pressure of air:

1) at the discharge side of the compressor,

2) at the entrance side of the nitrogen generator.

n) Instrumentation is to be fitted for continuously indicating and permanently recording the oxygen content of the inert gas downstream of the nitrogen generator when inert gas is being supplied.

o) The instrumentation referred to in the preceding item is to be placed in the cargo control room and in the machinery control room (or in the machinery space).

p) Audible and visual alarms are to be provided to indicate:

1) low feed-air pressure from compressor as referred to in m)1) above

2) high air temperature as referred to in m)1) above

3) high condensate level at automatic drain of water separator as referred to in item h) above

4) failure of electrical heater, if fitted

5) oxygen content in excess of that required in item f) above

6) failure of power supply to the instrumentation as referred to in item n) above.

q) Automatic shutdown of the system is to be arranged upon alarm conditions as required by items p) 1) to 5) above.

r) The alarms required by items p) 1) to 6) above are to be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew.

2.5.3 Nitrogen/inert gas systems fitted for purposes other than compliance with 1.3.1

Nitrogen/inert gas systems fitted on chemical tankers for which an inert gas system is not required in pursuance of 1.3.1 are to comply with the following :

a) the requirements of items d) to r) of 2.5.2 apply except item g)

b) where the connections to the carto tanks, to the hold spaces or to the cargo piping are not permanent, the non-return devices required by item l) of 2.5.2 may be replaced by two non-return valves.

Section 10 Electrical Installations

1 General

1.1 Application

1.1.1 The requirements in this Section apply, in addition to those contained in Part IV, Chapter 2, to chemical tankers.

1.1.2 The design is to be in accordance with IEC publication 60092-502.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt IV, Ch 2, the following documents are to be submitted for approval:

a) plan of hazardous areas

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

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 Acceptable systems of supply

The following systems of generation and distribution of electrical energy are acceptable:

a) direct current:

- two-wire insulated

b) alternating current:

- single-phase, two-wire insulated
- three-phase, three-wire insulated.

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.2 Earthed system with hull return

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective systems

b) limited and locally earthed systems, such as starting and ignition systems of internal combustion engines, provided that any possible resulting current does not flow directly through any hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions.

1.3.3 Earthed systems without hull return Earthed systems without hull return are not permitted, with the following exceptions:

a) earthed intrinsically safe circuits and the following other systems to the satisfaction of the Society

b) power supplies, control circuits and instrumentation circuits in non-hazardous areas where technical or safety reasons preclude the use of a system with no connection to earth, provided the current in the hull is limited to not more than 5 A in both normal and fault conditions,

or

c) limited and locally earthed systems, such as power distribution systems in galleys and laundries to be fed through isolating transformers with the secondary windings earthed, provided that any possible resulting hull current does not flow directly through any hazardous

area, or

d) alternating current power networks of 1,000 V root mean square (line to line) and over, provided that any possible resulting current does not flow directly through any hazardous area; to this end, if the distribution system is extended to areas remote from the machinery space, isolating transformers or other adequate means are to be provided.

1.4 Earth detection

1.4.1 Monitoring of circuits in hazardous areas

The devices intended to continuously monitor the insulation level of all distribution systems are also to monitor all circuits, other than intrinsically safe circuits, connected to apparatus in hazardous areas or passing through such areas.

An audible and visual alarm is to be given, at a manned position, in the event of an abnormally low level of insulation.

1.5 Mechanical ventilation of hazardous spaces

1.5.1 Electric motors driving fans of the ventilating systems of hazardous spaces are to be located outside the ventilation ducting.

1.5.2 At the discretion of the Society, motors driving ventilating fans may be located within the ducting provided that they are of a certified safe type and are arranged with an additional enclosure (having a degree of protection of at least IP 44) which prevents the impingement of the ducted air stream upon the motor casing.

1.5.3 The materials used for the fans and their housing are to be in compliance with Ch 4, Sec 1, 1.3.10.

1.5.4 Cargo pump-rooms and other enclosed spaces which contain cargo-handling equipment and similar spaces in which work is performed on the cargo should be fitted with mechanical ventilation systems, capable of being controlled from outside such spaces.

1.5.5 Provisions are to be made to ventilate the spaces defined in Ch 4, Sec 5, 1.5.4 prior to entering the compartment and operating the equipment.

1.6 Electrical installation precautions

1.6.1 Precautions against corrosion

Where products are liable to damage the materials normally used in electrical apparatuses, special attention is to be paid to the selection of materials for conductors, insulation and metal parts to be installed in gas-dangerous spaces. Copper, aluminium and insulation materials are to be protected as far as possible in order to prevent contact with products and/or their corrosive vapours (e.g. by means of encasing). This provision applies to those products for which the symbol Z is listed in column "m" of the tables in Chapter 17 of the IBC Code.

1.6.2 Precautions against inlet of gases or vapours

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

2 Hazardous locations and types of equipment

2.1 Electrical equipment permitted in hazardous areas for ships carrying dangerous chemicals in bulk having a flashpoint not exceeding 60°C and ships carrying dangerous chemicals in bulk having a flash point exceeding 60°C heated to a temperature within 15°C of their flash point or above their flashpoint

2.1.1 In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zone 0, 1 and 2 according to Pt IV, Ch 2. The different spaces are to be classified according to Tab 2.1.

The types of electrical equipment admitted, depending on the zone where they are installed, are specified in Pt IV, Ch2.

2.1.2 A space separated by a gastight boundaries from a hazardous area may be classified as zone 0, 1, 2 or considered as non hazardous, taking into account the sources of release inside that space and its conditions of ventilation.

2.1.3 Access door and other openings are not to be provided between an area intended to be considered as nonhazardous and a hazardous area or between a space intended to be considered as zone 2 and a zone 1, except where required for operational reasons.

2.1.4 In enclosed or semi-enclosed spaces having a direct opening into any hazardous space or area, electrical installations are to comply with the requirements for the space or area to which the opening leads.

2.1.5 Where a space has an opening into an adjacent, more hazardous space or area, it may be made into a less hazardous space or non-hazardous space, taking into account the type of separation and the ventilation system.

2.1.6 A differential pressure monitoring device or a flow monitoring device, or both, are to be provided for monitoring the satisfactory functioning of pressurisation of spaces having an opening into a more hazardous zone.

In the event of loss of the protection by the over-pressure or loss of ventilation in spaces classified as zone 1 or zone 2, protective measures are to be taken.

2.2 Electrical equipment permitted in hazardous areas for ships carrying dangerous chemicals in bulk having a flashpoint exceeding 60°C unheated or heated to a temperature below and not within 15°C of their flashpoint

2.2.1 For systems of supply and earth detection, the requirements under Ch 4, Sec 5, 1.3 and 1.4 apply.

2.2.2 Cargo tanks, slop tanks, any pipe work of pressurerelief or other venting systems for cargo and slop tanks, pipes and equipment containing the cargo are to be classified as zone 2.

2.3 Electrical equipment permitted in tankers carrying cargoes (for example acids) reacting with other products/materials to evolve flammable gases

2.3.1 The different spaces are to be classified according to Tab 2.1.

Table 2.1 : Space descriptions and hazardous area zones for ships carrying dangerous chemicals in bulk having a flash point not exceeding 60°C and ships carrying dangerous chemicals in bulk having a flash point exceeding 60°C heated to a temperature within 15°C of their flash point or above their flash point

No	Description of spaces	Hazardous area
1	The interior of cargo tanks, slop tanks, any pipework of pressure-relief or other venting systems for cargo and slop tanks, pipes and equipment containing the cargo or developing flammable gases and vapours	Zone 0
2	Void space adjacent to, above or below integral cargo tanks	Zone 1
3	Hold spaces	Zone 1
4	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks	Zone 1
5	Cargo pump rooms	Zone 1
6	Enclosed or semi-enclosed spaces, immediately above cargo tanks (for example, between decks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the Society	Zone 1
7	Spaces, other than cofferdam, adjacent to and below the top of a cargo tank (for example, trunks, passageways and hold)	Zone 1
8	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump-room ventilation outlets, and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation	Zone 1
9	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet	Zone 1
10	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5 m of cargo pump room entrances, cargo pump room ventilation inlet, openings into cofferdams, or other zone 1 spaces	Zone 1
11	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2,4 m above the deck	Zone 1
12	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where structures are restricting the natural ventilation and to the full breadth of the ship plus 3 m fore and aft of the forward- most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck	Zone 1
13	Compartments for cargo hoses	Zone 1
14	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located	Zone 1
15	Areas of 1,5 m surrounding a space of zone 1	Zone 2
16	Spaces 4 m beyond the cylinder and 4 m beyond the sphere defined in item 9	Zone 2
17	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service area and 3 m beyond these up to a height of 2,4 m above the deck	Zone 2
18	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3 m fore and aft of the forward- most and aft-most cargo tank bulkhead, up to a height of 2,4 m above the deck surrounding open or semi-enclosed spaces of zone 1	Zone 2
19	Spaces forward of the open deck areas to which reference is made in 12 and 18, below the level of the main deck, and having an opening on to the main deck or at a level less than 0,5 m above the main deck, unless: - the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilating system inlets and exhausts, are situated at least 5 m from the foremost cargo tank and at least 10 m measured horizontally from any cargo tank outlet or gas or vapour outlet; and - the spaces are mechanically ventilated	Zone 2

Table 2.2 : Space descriptions and hazardous area zones in tankers carrying cargoes (for example acids) reacting with other products/materials to evolve flammable gases.

No	Description of spaces	Hazardous area
1	The interior of cargo tanks, slop tanks, any pipework of pressure-relief or other venting systems for cargo and slop tanks, pipes and equipment containing the cargo or developing flammable gases and vapours.	Zone 1
2	Cargo pump rooms.	Zone 1
3	Compartments for cargo hoses.	Zone 1
4	Areas of 1,5 m surrounding the openings of zone 1 spaces specified above.	Zone 2
5	Void space adjacent to, above or below integral cargo tanks.	Zone 2
6	Hold spaces.	Zone 2
7	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks.	Zone 2
8	Enclosed or semi-enclosed spaces, immediately above cargo tanks (for example, between decks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the society.	Zone 2
9	Spaces, other than cofferdam, adjacent to and below the top of a cargo tank (for example, trunks, passageways and hold).	Zone 2
10	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located.	Zone 2
11	Areas on open deck, or semi-enclosed spaces on open deck, within 1,5 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump-room ventilation outlets, and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation.	Zone 2
12	Areas on open deck within spillage coamings surrounding cargo manifold valves and 1,5 m beyond these, up to a height of 1,5 m above the deck.	Zone 2
13	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 3 m radius centred upon the centre of the outlet, and within a hemisphere of 3 m radius below the outlet.	Zone 2

Section 11 Fire Protection and Fire Extinction

1 Cargo pump rooms

1.1 Fixed fire-extinguishing systems

1.1.1 Halogenated hydrocarbon system

IBC CODE REFERENCE: Ch 11, 11.2.1.2

With reference to 11.2.1.2 of the IBC Code, it is to be noted that new installations of halogenated hydrocarbon systems have been prohibited on all (new and existing) ships since 1 October 1994.

2 Cargo area

2.1 Temperature of steam and heating media within the cargo area

2.1.1

IBC CODE REFERENCE: Ch 11, 11.3

The maximum temperature of the steam and heating media in the cargo area is to be adjusted to comply with maximum surface temperature in Sec 7, 1.2.5.

2.2 Monitors and foam applicators

2.2.1 Capacity for ships of less than 4000 tonnes deadweight

IBC CODE REFERENCE: Ch 11, 11.3.7

For ships of less than 4000 tonnes deadweight, the minimum required capacity for a monitor is to be not less than 1000 litres/min and the application rate that each monitor is to be capable of supplying is to be at least 10 litres/min per each square metre of the surface to be protected.

2.3 Simultaneous use of foam and water systems

2.3.1 Required number of jets of water

IBC CODE REFERENCE: Ch 11, 11.3.12

The simultaneous use of the minimum required number of jets of water is to be possible, in general, on deck over the full length of the ship, in the accommodation and service spaces, in control spaces and in machinery spaces.

2.4 Portable fire-extinguishing equipment

2.4.1 Capacity of portable fire-extinguishing equipment

IBC CODE REFERENCE: Ch 11, 11.3.14

The capacity of each item of portable fire-extinguishing equipment is to comply with the relevant provisions of the 1974 SOLAS Convention, as amended.

2.5 Ships carrying flammable products

2.5.1 Internal combustion engines

IBC CODE REFERENCE: Ch 11, 11.3.15

Internal combustion engines are not to be installed in cargo pump rooms, in pump rooms and in other spaces adjacent to or located above cargo tanks. However, reciprocating steam engines with a working temperature lower than the temperature stated in 2.1 may be installed in the abovementioned rooms and spaces.

Section 12 Mechanical Ventilation in the Cargo Area

1 Spaces normally entered during cargo handling operations

1.1 Miscellaneous requirements

1.1.1 Ventilation system stopping

IBC CODE REFERENCE: Ch 12, 12.1

All required ventilation systems are to be capable of being stopped from a position located outside the served spaces and above the weather deck.

1.1.2 Warning notices

IBC CODE REFERENCE: Ch 12, 12.1

In the proximity of entrances to all spaces served by the required mechanical ventilation systems, a clearly visible warning is to be posted requiring such spaces to be adequately ventilated prior to entering and relevant ventilation systems to be kept in operation all the time persons are present in the spaces themselves.

1.1.3 Prevention of dangerous operation of electric motors

IBC CODE REFERENCE: Ch 12, 12.1

A suitable automatic device is to be fitted to prevent operation of electric motors driving cargo pumps and operation of other electrical equipment not of a certified safe type prior to ventilating the spaces where such motors or equipment are located, in order to render them gas-safe (to this end it is pointed out that IEC provisions require at least 10 changes of air based on the volume of the served space).

1.1.4 Prevention of dangerous operation of cargo pumps

IBC CODE REFERENCE: Ch 12, 12.1

An automatic device is to be fitted capable of stopping motors driving cargo pumps and de-energising any other electrical equipment not of a certified safe type in the case of stoppage of ventilation in spaces where such motors and equipment are fitted. This provisions does not apply to motors and other electrical equipment fitted in the engine room.

1.1.5 Alternative to extraction type ventilation systems

IBC CODE REFERENCE: Ch 12, 12.1

As an alternative to ventilation systems of the extraction type, required in 1.1.4, a ventilation system of the positive pressure type may be accepted:

- in the case of cargo pump rooms adjacent to cargo tanks or to other gas-dangerous spaces, or
- where, in adjacent gas-safe spaces, inclusive of spaces containing motors of cargo pumps, an adequate overpressure is kept in relation to the cargo pump rooms themselves.

1.1.6 Location of upper end of inlet ducts

IBC CODE REFERENCE: Ch 12, 12.1

With reference to the requirements of 1.1.5, the upper ends of inlet ducts are generally to be located at a distance not less than 3 m from ventilation ducts and air intakes serving the safe spaces mentioned therein.

1.1.7 Minimum distance between inlet and extraction ducts

IBC CODE REFERENCE: Ch 12, 12.1

With reference to 1.1.6, the upper ends of (inlet and extraction) ventilation ducts serving the same space are to be located at a distance from each other, measured horizontally, of not less than 3 m and, in general, at an adequate height above the weather deck, but in any case not less than 2,4 m. Greater heights are required in 15.17 of the IBC Code.

1.1.8 Upper ends of ventilation ducts in ships carrying materials producing flammable vapours

IBC CODE REFERENCE: Ch 12, 12.1

For flammable products, or for products which may react with the shipِs materials producing flammable vapours (such as strong acids), the upper ends of ventilation ducts are to be located at a distance of not less than 3 m from any source of ignition, as per the provisions of Sec 8, 2.2.

1.1.9 Dampers

IBC CODE REFERENCE: Ch 12, 12.1

Ventilation ducts are to be provided with metallic dampers, fitted with the indication "open" and "closed". The dampers are to be located above the weather deck, in a readily accessible position.

1.1.10 Location of electric motors of fans

IBC CODE REFERENCE: Ch 12, 12.1

Electric motors driving fans are to be placed outside the served spaces and outside the ventilation ducts, in a suitable position with respect to the presence of flammable vapours.

1.1.11 Penetration of motor shafts through bulkheads

IBC CODE REFERENCE: Ch 12, 12.1

Runs of shafts of electric motors driving fans through bulkheads or decks of gas-dangerous spaces or through ventilation ducts are to be provided with gas-tight seals, with oil glands or equivalent means, deemed suitable by the Society.

They have to be fitted with temperature sensing devices for bulkhead shaft glands bearings and pump casings. Alarms are to be initiated in the cargo control room or the pump control station.

Means are to be provided to compensate for any misalignment.

Shaft bulkhead lubricating means is to be located outside the cargo pump room. If the shaft bulkhead penetration system includes a bellow, this bellow is to be hydraulically tested at a pressure of at least 3,5 bars before being fitted on board.

1.2 Additional requirements for non-sparking fans

1.2.1 Non-sparking fans

IBC CODE REFERENCE: Ch 12, 12.1

a) A fan is considered as non-sparking if in both normal and abnormal conditions it is unlikely to produce sparks.

b) The air gap between the impeller and the casing is to be not less than 0,1 of the shaft diameter in way of the impeller bearing and not less than 2 mm. It need not be more than 13 mm.

1.2.2 Materials for non-sparking fans

IBC CODE REFERENCE: Ch 12, 12.1

a) The impeller and the housing in way of the impeller are to be made of alloys which are recognised as being spark proof by appropriate tests.

b) Electrostatic charges in both the rotating body and the casing are to be prevented by the use of antistatic materials.

Furthermore, the installation on board of the ventilation units is to be such as to ensure their safe bonding to the hull.

c) Tests may not be required for fans having the following combinations:

- impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity
- impellers and housings of non-ferrous materials
- impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous materials is fitted in way of the impeller
- any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm design tip clearance.

d) The following impellers and housings are considered as sparking and are not permitted:

- impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance
- housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
- any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

1.2.3 Type test for non-sparking fans

IBC CODE REFERENCE: Ch 12, 12.1

Type tests on the finished product are to be carried out in accordance with the requirements of the Society.

2 Pump rooms and other enclosed spaces normally entered

2.1 Clarification of general requirement

2.1.1

IBC CODE REFERENCE: Ch 12, 12.2

a) The provisions of 12.2 of the IBC Code apply to all pump rooms, whether or not the control for pumps and valves which are installed in such rooms is fitted externally.

b) The distance of the upper ends of extraction and inlet ducts from air intakes and other openings of spaces mentioned in 12.1.5 of the IBC Code is not to be less than 3 m measured horizontally. These systems are to be capable of being controlled from outside the spaces

they serve and, in the proximity of the entrances to such spaces, the warning notice mentioned in 1.1.2 is to be posted.

3 Spaces not normally entered

3.1 Portable fans

3.1.1

IBC CODE REFERENCE: Ch 12, 12.3

The type of portable fans and their connections to spaces to be ventilated are to be deemed suitable by the Society. Portable fans driven by electric or internal combustion motors are not acceptable.

Section 13 Instrumentation

1 Gauging

1.1 Types of gauging devices

1.1.1 Arrangement

IBC CODE REFERENCE: Ch 13, 13.1.1

a) In almost all cases a cargo code which requires a high level alarm and overflow control also requires a closed gauging device. A cargo tank containing such a product therefore requires three sensors:

1) one level gauging

2) one high level alarm

3) one overflow control.

b) The sensing elements for 1), 2) and 3) are to be separated, although sensors for 2) and 3) (reed switches, float chambers, electronic devices, etc.) may be contained in the same tube.

c) Electronic, pneumatic and hydraulic circuits required for sensors 1), 2) and 3) are to be independent of each other such that a fault on any one will not render either of the others inoperative.

d) Where processing units are used to give digital or visual indication, such as in a bridge space, the independence of circuitry is to be maintained at least beyond this point.

e) The power is to be supplied from distribution boards.

f) Where a control room or a bridge space containing a modular unit is envisaged, separate level indication and visual alarms are to be provided for each of the functions 1), 2) and 3). An audible alarm is also to be provided but since this is not directional it need not be separate.

g) An audible alarm is also to be arranged in the cargo area.

h) Where there is no control room, an audible and visual alarm is to be arranged at the cargo control station.

i) Testing of sensors is to be arranged from outside the tanks, although entry into product clean tanks is not precluded.

j) Simulation testing of electronic circuits or circuits which are self-monitored is acceptable.

1.1.2 Example of restricted gauging device

IBC CODE REFERENCE: Ch 13, 13.1.1

A restricted gauging device may consist of a sounding pipe with an inside diameter not greater than 200 mm, fitted with a gas-tight plug. The pipe is to have holes in order to make its internal pressure equal to that of the tank. Therefore the holes are to be located inside the cargo tank in the proximity of the top.

2 Vapour detection

2.1 Vapour detection instruments

2.1.1 Spaces to be monitored

IBC CODE REFERENCE: Ch 13, 13.2.1

Vapour detection instruments, either fixed or portable, are to be of a type recognised suitable by the Society for the products to be carried. The spaces to be monitored are:

- cargo pump rooms
- spaces containing motors driving cargo pumps, except for the machinery space
- enclosed spaces containing cargo piping, equipment connected with cargo handling, cofferdams, enclosed spaces and double bottoms adjacent to cargo tanks
- pipe tunnels
- other spaces, in the opinion of the Society, depending on the ship type.

Where a fixed system is installed, it is to serve the spaces among those listed above which are normally entered by the crew.

Section 14 Protection of Personnel

1 Protective equipment

1.1 Location of protective equipment

1.1.1

IBC CODE REFERENCE: Ch 14, 14.1.2

a) Lockers for work clothes or protective equipment which are not new or have not undergone a thorough cleaning process are not to open directly into accommodation spaces.

b) When a locker for clothes which have not undergone a thorough cleaning process is arranged in the accommodation area, it is to be bounded by "A-0" bulkheads and decks and provided with independent exhaust mechanical ventilation. The access to accommodation spaces, if allowed, is to be arranged through two substantially gastight self-closing steel doors without any hold-back device.

2 Safety equipment

2.1 Additional equipment for ships carrying toxic products

2.1.1

IBC CODE REFERENCE: Ch 14, 14.2.4

With regard to 14.2.4 of the IBC Code, the equivalent quantity of spare bottled air in lieu of the low pressure air line is to be at least 4800 litres.

2.2 Medical first aid equipment

2.2.1

IBC CODE REFERENCE: Ch 14, 14.2.9

First aid equipment, whose preservation in good condition is the Masterڍs responsibility, is to be kept in a special, clearly indicated locker.

Section 15 Special Requirements

1 Ammonium nitrate solution (93% or less)

1.1 Ammonia injection

1.1.1 Injection procedure

IBC CODE REFERENCE: Ch 15, 15.2.6

Gaseous ammonia may be injected into the cargo while the latter is circulated by the cargo pump.

1.2 Cargo pumps

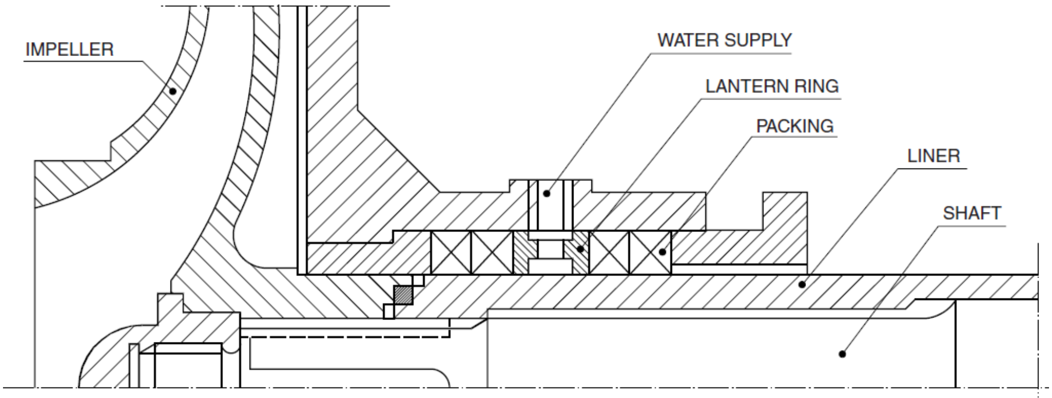
1.2.1 Seal

IBC CODE REFERENCE: Ch 15, 15.2.7

The seal for the centrifugal pump is to be a stuffing box provided with a lantern ring. Fresh water under pressure is to be injected into the stuffing box at the location of the lantern

ring (see Fig 1.1).

Figure 1.1 : Seal



2 Hydrogen peroxide solutions

2.1 Hydrogen peroxide solutions over 60% but not over 70%

2.1.1 Water spray system

IBC CODE REFERENCE: Ch 15, 15.5.10

It is specified that, for the purpose of evaluating the estimated size of the cargo spill in the case of failure, cargo piping/hose failure is to be assumed to be total.

3 Propylene oxide and mixtures of ethylene oxide/propylene oxide with an ethylene oxide content of not more than 30% by weight

3.1 Tank cleaning

3.1.1

IBC CODE REFERENCE: Ch 15, 15.8.3

Until an amendment in this respect is prepared at IMO, it is specified that the initial wording of the text of 15.8.3 of the IBC Code "Before carrying these products, ..." is to be intended as follows: "Before initial loading of these products and before each loading of these products subsequent to loading of other products".

3.2 Joints in cargo lines

3.2.1

IBC CODE REFERENCE: Ch 15, 15.8.12

Screwed connections are only allowed for accessory and instrumental lines with an external diameter of 25 mm or less.

3.3 Oxygen content in tank vapour spaces

3.3.1 Analysing equipment

IBC CODE REFERENCE: Ch 15, 15.8.28

Analysing equipment to determine oxygen and propylene oxide contents is to be of a type recognised as suitable by the Society. When portable analysers are used, there are to be at least two. When a fixed system is installed, a portable analyser is also to be provided.

3.4 Valves at cargo hose connections

3.4.1 Shut-off valve closing time

IBC CODE REFERENCE: Ch 15, 15.8.30

The closing time of shut-off valves provided at each cargo hose connection is to take account of the loading/unloading rate and is to be such as to avoid dangerous overpressure in cargo piping and hoses mentioned in the paragraphs

4 Sulphur (molten)

4.1 Fire-fighting system

4.1.1 Cargo tank protection

IBC CODE REFERENCE: Ch 15, 15.10

Cargo tanks are to be protected by a fixed CO2 extinguishing system in accordance with Pt IV, Ch 4, Sec 13, 4, or a steam extinguishing system. In the latter case, tank drying arrangements are to be provided to prevent corrosion after use of steam.

4.1.2 CO2 nozzles

IBC CODE REFERENCE: Ch 15, 15.10

Under normal service conditions, CO2 tank feed nozzles are to be blanked off by means of a breaking disk to prevent pipes from being chocked by sulphur. Nozzles are to be located at the upper part of the tank, above liquid level.

5 Acids

5.1 Electrical arrangements

5.1.1

IBC CODE REFERENCE: Ch 15, 15.11.5

In enclosed spaces adjacent to cargo tanks, electrical materials and equipment complying with the provisions of 10.1.2.1 of the IBC Code are allowed.

5.2 Leak detection system

5.2.1 Leak detectors

IBC CODE REFERENCE: Ch 15, 15.11.7

There are to be at least two leak detection apparatuses designed and calibrated to detect leakage of cargo into spaces adjacent to cargo tanks. The apparatuses may consist of a pH-meter, a gas detector suitable for the detection of hydrogen/air mixtures, of a type deemed suitable by the Society, or of other suitable systems. These apparatuses may be fixed or portable; if a fixed system is installed, a portable apparatus is also to be provided.

6 Toxic products

6.1 Return line to shore installation

6.1.1 Valving on connection to shore installation

IBC CODE REFERENCE: Ch 15, 15.12.2

The above-mentioned systems are to be fitted with a shutoff valve and a blank flange in way of the vapour return line to the shore installation.

7 Cargoes protected by additives

7.1 Prevention of blockage by polymerisation

7.1.1 Arrangements

IBC CODE REFERENCE: Ch 15, 13.6

In addition to being designed so as to avoid internal obstructions due to polymer formation, the above-mentioned systems are to be fitted with pressure/vacuum valves and devices to prevent the passage of flame which are accessible for inspection and maintenance.

8 Cargoes with a vapour pressure greater than 0,1013 MPa (1,013 bar) absolute at 37,8°C

8.1 General

8.1.1 System for maintaining cargo temperature below boiling point

IBC CODE REFERENCE: Ch 15, 15.14.1

a) Any system installed for the purpose of keeping the cargo temperature below its boiling point is to be constructed to the satisfaction of the Society.

b) Whenever cargo tanks are designed specifically for the carriage of products dealt with in 15.7 of the IBC Code, they are to be capable of withstanding the vapour pressure of such products corresponding to 45°C.

8.2 Return of expelled gases

8.2.1 Valving of shore connection

IBC CODE REFERENCE: Ch 15, 15.14.4

The above-mentioned systems are to be fitted with a shutoff valve and a blank flange in way of the vapour return line to the shore installation.

9 Special cargo pump room requirements

9.1 Clarification

9.1.1

IBC CODE REFERENCE: Ch 15, 15.18

As far as concerns the possibility of allowing the arrangement of cargo pump rooms below deck in specific cases, it is specified that, in practice, no circumstance can be foreseen where such an arrangement may be permitted.

10 Overflow control

10.1 Independence of systems

10.1.1 Gauging devices

IBC CODE REFERENCE: Ch 15, 15.19

In almost all cases where, for the carriage of a product, a cargo high level alarm or cargo overflow control is required, a closed gauging device is also required.

10.1.2 Separation of device sensing elements

IBC CODE REFERENCE: Ch 15, 15.19

A cargo tank intended to carry such a product therefore requires:

a) level gauging

b) high level alarm

c) overflow control.

The sensing elements for the devices under a), b) and c) are to be separated, although sensors for b) and c) (microswitches, float chambers, electronic devices, etc.) may be contained in the same metal tube sections.

10.1.3 Electronic and hydraulic circuits for sensors

IBC CODE REFERENCE: Ch 15, 15.19

Electronic, pneumatic and hydraulic circuits required for sensors for a), b) and c) are to be independent of each other such that a fault on any one of them will not render either of the others inoperative. Where processing units are used to give digital or visual indication such as in a bridge space, the independence of circuitry is to be maintained at least up to such units. The power is to be supplied from distribution boards.

10.1.4 Alarms in cargo control room

IBC CODE REFERENCE: Ch 15, 15.19

Where a cargo control room or a bridge space containing a modular unit is envisaged, separate level indications and visual alarms are to be provided for each of the functions a),

b) and c). An audible alarm is also to be provided; there need not be a separate alarm for each function since separate alarms could not be distinguished. An audible alarm is also to be arranged in the cargo area.

10.1.5 Alarms where cargo control room is not provided

IBC CODE REFERENCE: Ch 15, 15.19

a) Where no cargo control room is provided, an audible and visual alarm is to be arranged at the cargo control station, which generally coincides with the navigating bridge.

b) The audible and visual high level and cargo overflow alarms are to be located so as to be easily heard and noticed by the personnel in charge of loading/unloading operations. Attention is drawn to the fact that such alarms are generally grouped together into two independent signals; therefore it is not possible to single out directly the cargo tank from which the alarm signal is coming. In such cases, the Master is to arrange for a person to be present at the cargo control station, in order to be able to warn the personnel in charge of loading operations on deck.

10.1.6 Testing of sensors

IBC CODE REFERENCE: Ch 15, 15.19

Testing of sensors is to be arranged from outside the tanks, although entry into product clean tanks is not prohibited.

Simulation testing of electronic circuits or circuits which are self-monitoring is acceptable.

Section 16 Operational Requirements

1 General

1.1

1.1.1 This Section is void, as the provisions of Chapter 16 of the IBC Code are operating requirements which are not mandatory for the class.

Section 17 Summary of Minimum Requirements

1 General

1.1

1.1.1 The list of products and the minimum requirements referred to elsewhere in this Section is the one of Chapter 17 of the IBC code.

Section 18 List of Chemicals to which this Chapter does not Apply

1 General

1.1

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 18 of the IBC Code.

Section 19 Index of Products Carried in Bulk

1 General

1.1

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 19 of the IBC Code.

Section 20 Transport of Liquid Chemical Wastes

1 General

1.1

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 20 of the IBC Code.

Section 21 Criteria for Assigning Carriage Requirements for Products Subject to the IBC Code

1 General

1.1

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 21 of the IBC Code.

Chapter 6 Liquefied Gas Carriers

Section 1 General

1 Scope

1.1 Applicability

1.1.1 IGC Code requirements and the Societyۍ Rules

a) Ships which are intended for the carriage of liquefied gases are to comply with the requirements of the latest version of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, as amended. In these Rules reference to this Code and its amendments is made by the wording ۑIGC Codeپ

Accordingly, for ships for which the service notation liquefied gas carrier, is requested, the IGC Code requirements are to be considered as rule requirements, unless otherwise specified and with the exception indicated in 1.1.2.

b) The requirements of this Chapter supplement generally those of the IGC Code, including the first set of amendments to the IGC-Code Res. MSC.30(61), which is incorporated in its entirety in the Annex to this Chapter.

These requirements include additional mandatory class requirements, as well as the Societyۍ interpretations of the IGC Code, which are also to be considered mandatory for class.

c) These Rules and the IGC Code refer to ships carrying those products which are listed in the table in Chapter 19 of the IGC Code and in Sec 19 of this chapter.

d) These Rules and the IGC Code include requirements for the carriage of cargo in containment systems incorporating integral, membrane or independent tank types as detailed in Chapter 4 of the IGC Code and in Sec4 of this chapter.

e) In general, this Chapter applies to cargo containment and handling systems and to the interfaces between these systems and the remainder of the ship, which is to comply with the applicable Sections of the hull and machinery Rules.

1.1.2 IGC Code requirements not within the scope of classification

The following requirements of the IGC Code are not within the scope of classification:

- Chapter 1, Section1.4 - Equivalents
- Chapter 1, Section 1.5 - Surveys and certification
- Chapter 18 - Operating requirements.

These requirements are applied by the Society when acting on behalf of the flag Administration, within the scope of delegation (see 1.1.7).

1.1.3 Carriage of products not listed in the Code

The requirements of the IGC Code and the additional requirements of this Chapter are also applicable to new products, which may be considered to come within the scope of these Rules, but are not at present listed in the table in Chapter 19 of the IGC Code.

1.1.4 Particularly hazardous products

For the carriage in bulk of products which are not listed in the table in Chapter 19 of the IGC Code, presenting more severe hazards than those covered by the IGC Code, the Society reserves the right to establish requirements and/or conditions additional to those contained in these Rules.

1.1.5 Correspondence of the IGC Code with Chapter 6 of the Rules

All the requirements of this Chapter are cross referenced to the applicable Chapters, Sections or paragraphs of the IGC Code, as appropriate. In addition a marker has been introduced in the IGC Code, included in the Annex, corresponding to every Chapter, Section or paragraph which is to be integrated by one or more additional requirements contained in this Chapter.

1.1.6 Equivalencies

As far as the requirements for class are concerned, the following wording in the IGC Code is to be given the meanings indicated in Tab 1.1.

Table 1.1 : Equivalencies

IGC Code word	Meaning for Classification only
Administration	Society
IBC Code or Chemical Code	Part IV, Chapter 8 of the Rules
Recognised Standard	Rules
should be	is to be or are to be (as applicable)

1.1.7 Certificate of fitness

a) The responsibility for interpretation of the IGC Coderequirements for the purpose of issuing an International Certificate of Fitness for the Carriage of Liquefied Gases

in Bulk lies with the Administration of the state whose flag the ship is entitled to fly.

b) Whenever the Society is authorised by an Administration to issue on its behalf the ڔCertificate of Fitness for the Carriage of Liquefied Gases in Bulk", or where the Society is authorised to carry out investigations and surveys on behalf of an Administration on the basis of which the "Certificate of Fitness for the Carriage of Liquefied Gases in Bulk" will be issued by the Administration, or where the Society is requested to certify compliance with the IGC Code, the full compliance with the requirements of the IGC Code, including the operative requirements mentioned in 1.1.2, is to be granted by the Society.

Table 1.2 : Documents to be submitted

No	A/I	Documents
1	I	List of products to be carried, including maximum vapour pressure, maximum liquid temperature and other important design conditions
2	I	General arrangement plan, showing location of cargo tanks and fuel oil, ballast and other tanks
3	A	Gas-dangerous zones plan
4	A	Location of void spaces and accesses to dangerous zones
5	A	Air locks between safe and dangerous zones
6	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
7	A	Details of hull structure in way of cargo tanks, including support arrangement for tanks,saddles, anti-floating and anti-lifting devices, deck sealing arrangements, etc.
8	A	Calculation of the hull temperature in all the design cargo conditions
9	A	Distribution of quality and steel grades in relation to the contemplated actual temperature obtained by the calculation in item 8
10	A	Hull stress analysis
11	A	Hull ship motion analysis, where a direct analysis is preferred to the methods indicated in Sec 4
12	A	Intact and damage stability calculations
13	A	Scantlings, material and arrangement of the cargo containment system, including the secondary barrier, if any.
14	A	Stress analysis of the cargo tanks, including fatigue analysis and crack propagation analysis for type ﺑBﭖtanks. This analysis may be integrated with that indicated in item 10
15	I	Calculation of the thermal insulation suitability, including boil-off rate and refrigeration plant capability, if any, cooling down and temperature gradients during loading and unloading operations
16	A	Details of insulation
17	A	Details of ladders, fittings and towers in tanks and relative stress analysis, if any
18	A	Details of tank domes and deck sealings
19	A	Plans and calculations of safety relief valves
20	A	Details of cargo handling and vapour system, including arrangements and details of piping and fitting
21	A	Details of cargo pumps and cargo compressors
22	A	Details of process pressure vessels and relative valving arrangement
23	A	Bilge and ballast system in cargo area
24	A	Gas freeing system in cargo tanks including inert gas system
25	A	Interbarrier space drainage, inerting and pressurisation systems
26	A	Ventilation system in cargo area
27	A	Hull structure heating system, if any
28	A	Refrigeration and reliquefaction plant system diagram, if any
29	A	Details of electrical equipment installed in cargo area, including the list of certified safe equipment and apparatus and electrical bonding of cargo tanks and piping

No	A/I	Documents
30	A	Schematic electrical wiring diagram in cargo area
31	A	Gas detection system
32	A	Cargo tank instrumentation, including cargo and hull temperature monitoring system
33	A	Emergency shutdown system
34	A	Jettison system, if any
35	A	Details of fire-extinguishing appliances and systems in cargo area
36	A	Loading and unloading operation description, including cargo tank filling limits
37	A	Cargo tank testing and inspection procedures
38	A	Programme of gas trials
39	I	When applicable, P & A manual
40		For machinery using gas as fuel
	I	a) General arrangement plan of the machinery plant
	I	b) Description of the entire plant
	A	c) Gas piping plans for the machinery plant
	A	d) Complete list of the safety, gas detection and warning equipment
	A	e) Drawings of the boilers
	I	f) Detailed drawings of the gas inlet and fuel inlet equipment
	I	g) Gas characteristics
	A	h) General arrangement plan of the gas treatment plant, including gas compressors, prime movers and gas preheaters
	A	i) Drawings of the gas storage tanks
	A	j) Drawings of the gas compressors and preheaters

Note 1: A = to be submitted for approval in four copies

I = to be submitted for information in duplicate

2 Additional requirements

2.1 Emergency towing arrangement

2.1.1 Emergency towing arrangements are to be fitted on liquefied gas tankers of 20.000 dwt and above in accordance with Pt III, Ch 5,4.

2.2 Steering gear

2.2.1 Additional requirements for steering gear of liquefied gas carriers of 10.000 dwt and above are given in Ch 4, Sec 4, 7.

3 Documentation to be submitted

3.1

3.1.1 Tab 1.2 lists the plans, information, analysis, etc. which are to be submitted in addition to the information required in the other Parts of the Rules for the parts of the ship not affected by the cargo, as applicable.

4 Cargo equipment trials

4.1 Scope

4.1.1 Trials in working conditions

All the equipment to which this Chapter is applicable is to be tested in actual working conditions.

4.1.2 Trials to be carried out when the ship is loaded

Those trials which may only be carried out when the ship is loaded are to be held at the first loading of the ship.

For LNG carriers, the extent of the examinations that are to be conducted before and after the first loaded voyage is given in 4.2.4.

4.2 Extent of the tests

4.2.1 Cargo equipment testing procedure

The cargo equipment testing procedure is to be submitted to the Society for review.

4.2.2 Ships with mechanical refrigeration units

Ships fitted with a mechanical refrigeration unit are to be subjected to an initial testing procedure in order to check the suitability of the plant in respect of the applicable requirements. The recording of the data of the reliquefaction system, such as working duration and ambient conditions, may be carried out during the first loaded voyage.

4.2.3 Use of cargo as fuel

The arrangements for using cargo as fuel are to be subjected to a special testing procedure.

4.2.4 First loaded voyage of ships carrying liquefied natural gases (LNG) in bulk

a) The following examinations are to be conducted at the first full loading of the ship:

1) Priority to be given to latter stages of loading (approximately last 6 hours).

2) Review cargo logs and alarm reports.

3) Witness satisfactory operation of the following:

- gas detection system
- cargo control and monitoring systems such as level gauging equipment, temperature sensors, pressure gauges, cargo pumps and compressors, proper control of cargo heat exchangers, if operating, etc.
- nitrogen generating plant or inert gas generator, if operating

- nitrogen pressure control system for insulation, interbarrier, and annular spaces, as applicable
- cofferdam heating system, if in operation
- reliquefaction plant, if fitted
- equipment fitted for the burning of cargo vapors such as boilers, engines, gas combustion units, etc., if operating.

4) Examination of on-deck cargo piping systems including expansion and supporting arrangements.

5) Witness topping off process for cargo tanks including high level alarms activated during normal loading.

6) Advise Master to carry out cold spot examination of the hull and external insulation during transit voyage to unloading port.

b) The following examinations are to be conducted at the first unloading of the ship:

1) Priority to be giving to the commencement of unloading (approximatively first 4-6 hours).

2) Witness emergency shutdown system testing prior to commencement of unlaoding.

3) Review cargo logs and alarm reports.

4) Witness satisfactory operation of the following:

- gas detection system
- cargo control and monitoring systems such as level gauging equipment, temperature sensors, pressure gauges, cargo pumps and compressors, proper control of cargo heat exchangers, if operating, etc.
- nitrogen generating plant or inert gas generator, if operating
- nitrogen pressure control system for insulation, interbarrier, and annular spaces, as applicable
- on membrane vessels, verify that the readings of the cofferdam and inner hull temperature sensors are not below the allowable temperature for the selected grade of steel. Review previous readings
- cofferdam heating system, if in operation
- reliquefaction plant and review of records from previous voyage
- equipment fitted for the burning of cargo vapors such as boilers, engines, gas combustion units, etc., if operating.

5) Examination of on-deck cargo piping systemsincluding expansion and supporting arrangements.

6) Obtain written statement from the Master that the cold spot examination was carried out during the transit voyage and found satisfactory. Where possible, the Surveyor should examine selected spaces.

5 Additional service feature RV

5.1 Application

5.1.1 The additional service feature RV is assigned,to liquefied gas carriers fitted with an installation for revaporisation of the LNG before delivery and complying with the requirements of the present Article.

5.2 Documentation to be submitted

5.2.1 Plans and documents to be submitted for approval

The following plans and documents are to be submitted to the Society for approval:

- piping and instrumentation diagram
- hazardous areas
- details of pumps and gas process vessels
- ventilation systems
- fire protection systems
- gas detection systems.

5.2.2 Plans and documents to be submitted for information

The following plans and documents are to be submitted to the Society for information:

- operation description including emergency shutdown system
- Hazard Identification (HAZID) / Hazard Operability Study (HAZOP)
- sloshing study of:

  - containment system

  - pump mast

  - pump tower supports, at all filling levels during operation.

5.3 General

5.3.1 The revaporisation plant is subject to special examination by the Society, based on the studies mentioned in 5.2.2.

5.3.2 This plant is to comply with the applicable requirements of this Chapter and the applicable requirements of IGC Code.

6 Additional service feature STL-SPM

6.1 General

6.1.1 Application

a) The additional service feature STL-SPM is assigned, to liquefied gas carriers used as regaseification terminal, fitted foreward with equipment for not permament mooring, or for connection to single buoy, and complying with the requirements of the present Article.

b) The buoy and the mooring system may be not included within classification. In case the buoy and the mooring are covered by class, the Rules for the Classification of Offshore Loading and Offloading Buoys are applicable to the buoy and the POSA additional class notation may be assigned to the mooring system.

6.1.2 Scope

The following items are covered by the additional service feature STL-SPM:

- ship structure, in way of the mooring or the single buoy
- hatch cover
- cylinders
- swivel
- piping and risers
- stoppers
- winch
- interface between equipments and ship structure
- ventilation
- handling equipment (HPU and control system)
- drainage of compartment
- fire and gas detection system
- fire extinction system
- emergency escape.

6.1.3 Applicable rules

a) The items listed in 6.1.2 are to comply with the applicable requirements of IGC code.

b) Components of the equipments used for mooring at single point are to comply with the applicable requirements of Emergency Towing Arrangement and SPM (Single Point Mooring).

c) The swivel is to be classed according to the appropriate Rules for the Classification of Offshore Loading and Offloading Buoys.

d) The lifting appliances are to meet the applicable requirements of the Rules for the Classification and Certification of Lifting Appliances of Ships and Offshore Units.

e) The risers are to be specially considered.

6.2 Documentation to be submitted

6.2.1 Plans and documents to be submitted for approval

In addition to the documents listed in Pt III, Ch 1, the following plans and documents are to be submitted to the Society for approval:

- ship structure drawings, in way of the mooring or the single buoy

- local reinforcements of ship structure below equipments
- ventilation plan
- emergency escape
- drawings of equipments
- fire and gas detection, wiring and arrangement diagram
- cable list
- STL, auxilliary and bridge system
- lighting installation, wiring and arrangement diagram
- electrical starter circuit diagram
- architecture diagram of control and safety system
- control and wiring diagram of:

  - hydraulic system for buoy locking devices
  - winches
- fire extinction
- drainage system.

6.2.2 Plans and documents to be submitted for information

The following documents are to be submitted to the Society for information:

- DLOC (design load operating conditions)
- structural calculation
- fatigue calculation
- model test results
- explosion calculation
- CCTV diagram
- operation procedure of system.

6.3 Structural design

6.3.1 Design loads

a) Model tests in mooring conditions are generally to be carried out to determine the loads.

b) For the ship structure, calculations based on test results or mooring and hydrodynamic calculations are to be submitted and subject to special examination by the Society.

6.3.2 Scantlings

The deck structure supporting accessories is to be reinforced on basis of loads given by the designer.

6.4 Mechanical installation

6.4.1 When hydraulic installation is used, it is to be in compliance with the applicable requirements of Pt IV, Ch 1, Sec 11 of the Rules.

6.4.2 The hydraulic cylinders are considered as pressure vessels; the scantlings of the shells and the ends are to be in compliance with the applicable requirements of Pt IV, Ch 1, Sec 5 of the Rules.

6.4.3 Securing devices are to be simple to operate and easily accessible.

6.4.4 Securing devices are to be equipped with mechanical locking arrangement (self locking or separate arrangement), or to be of the gravity type. Where hydraulic securing devices are applied, they have to remain locked in the event of loss of the hydraulic fluid.

6.4.5 The opening and closing systems as well as securing and locking devices are to be interlocked in such a way that they can only operate in the proper sequence.

6.4.6 The hydraulic system for securing and locking devices is to be isolated from other hydraulic circuits, when in closed position.

6.5 Electrical and automation installation

6.5.1 Unless otherwise specified, the requirements in Part IV, Chapters 2 and 3 are applicable to the system fitted in STL.

6.5.2 The STL room is to be considered as hazardous area.

Electrical equipments are to be avoided in this area. When electrical equipments are fitted, they are to be of a safe type IIA T3 and considered as Zone 1.

6.5.3 The STL system is to be considered as a primary essential service.

6.5.4 The electrical equipments located in flooded space are to be IP 68 for the appropriate depth.

6.5.5 The electrical equipments located in non flooded space are to be IP 67.

6.5.6 Local control of systems is always to be available.

Section 2 Ship Survival Capabilities and Location of Cargo Tanks

1 Freeboard and intact stability

1.1 Intact stability

1.1.1 General

IGC CODE REFERENCE: Ch 2, 2.2.2

The stability of the ship for the loading conditions in Pt III, Ch 4, App 2, 1.2.8 is to be in compliance with the requirements in Pt III, Ch 4, Sec 2.

1.1.2 Free surface effect of liquids

IGC CODE REFERENCE: Ch 2, 2.2.3

The free surface effect is to be calculated in accordance with Pt III, Ch 4, Sec 2, 4.

1.1.3 Information to be supplied

IGC CODE REFERENCE: Ch 2, 2.2.5

The Master of the ship is to be supplied with a Loading Manual as specified in Pt III, Ch 2, App 2 and a Trim and Stability booklet as specified in Pt III, Ch 4, App 2.

2 Conditions of loading

2.1 Additional loading conditions

2.1.1

IGC CODE REFERENCE: Ch 2, 2.4

Loading conditions other than those in the Loading Manual and the Trim and Stability booklet are to be previously submitted to the Society. Alternatively, such cases may be examined by the Master or a delegated officer when a loading instrument approved in accordance with the requirements in Pt III, ch 2, App 2 is installed on board.

3 Location of cargo tanks

3.1 Deck cargo tanks

3.1.1

IGC CODE REFERENCE: Ch 2, 2.6.1

Deck cargo tanks are to be located not less than 760 mm inboard from the side shell.

4 Flooding assumptions

4.1 Pipes, ducts and trunks in damaged zones

4.1.1 Strength of internal structures

IGC CODE REFERENCE: Ch 2, 2.7.7

Tunnels, ducts, pipes, doors, bulkheads and decks which might form watertight boundaries of intact spaces in the case of assumed conventional damage are to have minimum strength adequate to withstand the pressure height corresponding to the deepest equilibrium waterline in damaged conditions.

5 Standard of damage

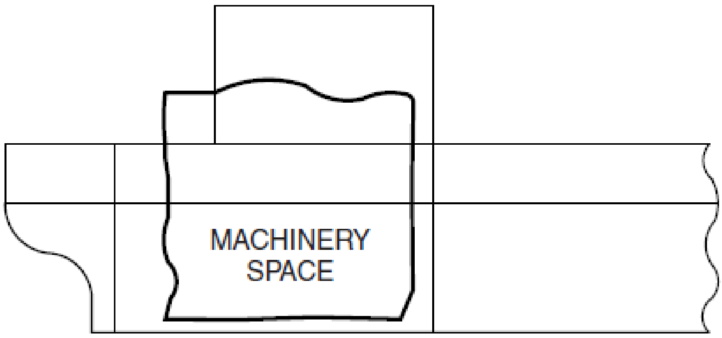
5.1 Longitudinal extent of damage to superstructure

5.1.1

IGC CODE REFERENCE: Ch 2, 2.8

The longitudinal extent of damage to the superstructure (see also IGC Code 2.7.8) in the case of side damage to a machinery space aft, as per IGC Code 2.8.1, is to be the same as the longitudinal extent of the side damage to the machinery space (see Fig 5.1).

Figure 5.1 : Longitudinal extension of superstructure damage



6 Survival requirements

6.1 General

6.1.1

IGC CODE REFERENCE: Ch 2, 2.9

Ships are to be capable of surviving the assumed damage specified in IGC Code 2.5.1 and 2.5.2 to the standard provided in IGC Code 2.8.1 and for the loading conditions in Pt III, Ch 4, App 2, 1.2.8 in a condition of stable equilibrium and such as to satisfy the criteria in IGC Code 2.9.

6.2 Intermediate stages of flooding

6.2.1

IGC CODE REFERENCE: Ch 2, 2.9.1.3

The criteria applied to the residual stability during intermediate stages of flooding are to be those relevant to the final stage of flooding as specified in IGC Code 2.9.2. However, small deviations from these criteria may be accepted by the Society on a case-by-case basis.

6.3 Definition of range of positive stability

6.3.1

IGC CODE REFERENCE: Ch 2, 2.9.2

The 20° range may be measured from any angle commencing between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs) (see Fig 6.1).

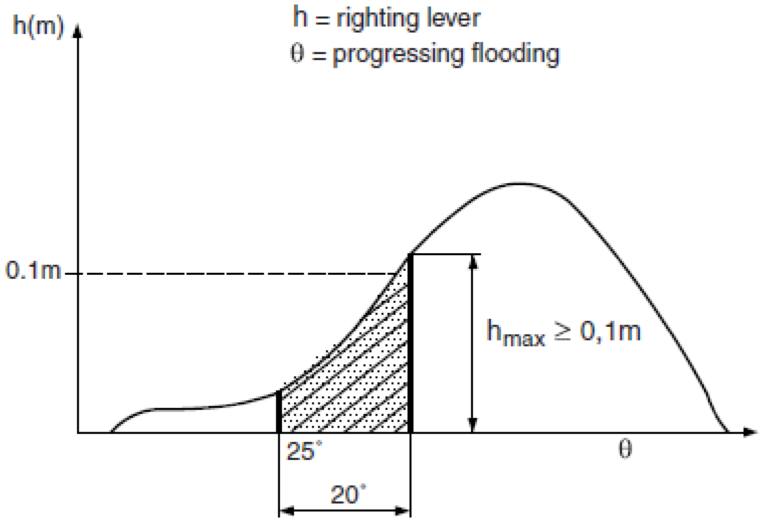
6.4 Type 3G ships less than 125 m in length

6.4.1

IGC CODE REFERENCE: Ch 2, 2.8.1.6

The flooding of the machinery space, if located aft on a type 3G ship less than 125 m in length, is to comply as far as practicable with the criteria in IGC Code 2.9. Relaxation of parts of these requirements may be accepted on a case-bycase basis.

Figure 6.1 : Range of positive stability



Section 3 Ship Arrangement

1 Segregation of the cargo area

1.1 Segregation of hold spaces

1.1.1 Bow thruster location

IGC CODE REFERENCE: Ch 3, 3.1.1

Bow thrusters are allowed to be fitted forward of the hold spaces.

1.2 Cargo containment systems not requiring secondary barriers

1.2.1 Separation between cargo spaces

IGC CODE REFERENCE: Ch 3, 3.1.2

Hold spaces may be separated from each other by single bulkheads. Where cofferdams are used instead of single bulkheads, they may be used as ballast tanks subject to special approval by the Society.

1.3 Cargo containment systems requiring secondary barriers

1.3.1 Separation between cargo spaces

IGC CODE REFERENCE: Ch 3, 3.1.3

The requirement in 1.2.1 is applicable.

2 Accommodation, service and machinery spaces and control stations

2.1 General

2.1.1 Accommodation

IGC CODE REFERENCE: Ch 3, 3.2.1

Some acceptable and unacceptable arrangements of accommodation spaces, with respect to cargo tanks, are shown in Fig 2.1.

2.1.2 Precautions against hazardous vapours

IGC CODE REFERENCE: Ch 3, 3.2.2

Compliance with the relevant requirements of the IGC Code, in particular with 3.2.4, 3.8, 8.2.10 and 12.1.6, as applicable, also ensures compliance with the requirements in IGC Code 3.2.2, relevant to precautions against hazardous vapours.

2.1.3 Spaces located forward of the cargo area

IGC CODE REFERENCE: Ch 3, 3.2.4

Entrances and openings to service spaces located forward of the cargo area may not face such area.

2.1.4 Air outlets

IGC CODE REFERENCE: Ch 3, 3.2.4

The requirements in IGC Code 3.2.4, relevant to air intakes, are also intended to be applicable to air outlets. This interpretation also applies to the requirements in IGC Code 3.2.2, 3.8.4 and 8.2.10.

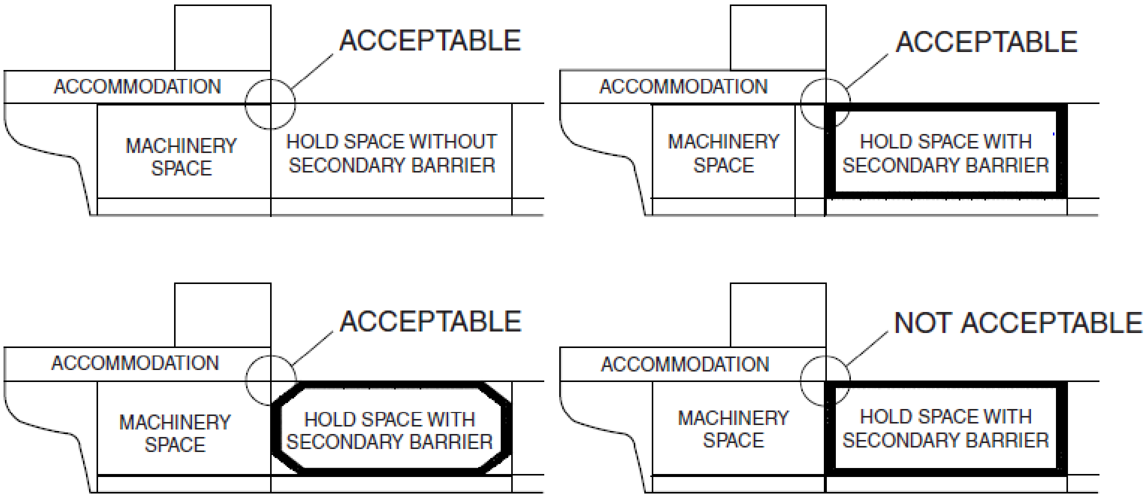
2.1.5 Doors facing cargo area

IGC CODE REFERENCE: Ch 3, 3.2.4

Doors facing the cargo area or located in prohibited zones in the sides are to be restricted to stores for cargo-related and safety equipment, cargo control stations as well as decontamination showers and eye wash.

Where such doors are permitted, the space may not give access to other spaces covered in IGC Code 3.2.4 and the common boundaries with these spaces are to be insulated with A60 class bulkheads.

Figure 2.1 : Acceptability of common corners between hold spaces and other spaces



2.1.6 Exemptions, ventilation openings and type of closures

IGC CODE REFERENCE: Ch 3, 3.2.6

The requirement for fitting air intakes and openings with closing devices operable from inside the space in ships intended to carry toxic products is to apply to spaces which are used for the ship's radio and main navigating equipment, cabins, mess rooms, toilets, hospitals, galleys, etc., but does not apply to spaces not normally manned such as deck stores, forecastle stores, engine room casings, steering gear compartments and workshops. The requirement does not apply to cargo control rooms located within the cargo area.

When internal closing is required, this is to include both ventilation intakes and outlets.

The closing devices are to give a reasonable degree of gastightness.

Ordinary steel fire-flaps without gaskets/seals are normally not considered satisfactory.

2.1.7 Openings for removal of machinery

IGC CODE REFERENCE: Ch 3, 3.2.6

Bolted plates of A60 class for removal of machinery may be accepted on bulkheads facing cargo areas, provided signboards are fitted to warn that these plates may only be opened when the ship is in gas-free condition.

3 Cargo pump rooms and cargo compressor rooms

3.1 Location of cargo pump rooms and cargo compressor rooms

3.1.1 Single failure concept

IGC CODE REFERENCE: Ch 3, 3.3

When cargo pump rooms and compressor rooms are permitted to be fitted at the after end of the aftermost hold space, the bulkhead which separates the cargo pump rooms or compressor rooms from accommodation and service spaces, control stations and machinery spaces of category A is to be so located as to avoid the entry of gas to these spaces through a single failure of a deck or bulkhead. The same condition is also to be satisfied when cargo pump rooms and compressor rooms fitted within the cargo area have a bulkhead in common with accommodation and service spaces, control stations and machinery spaces of category A.

3.1.2 Electrical equipment in cargo pump rooms and cargo compressor rooms

IGC CODE REFERENCE: Ch 3, 3.3

Cargo pump rooms and/or cargo compressor rooms of ships carrying flammable gases may not contain electrical equipment, except as provided for in Chapter 10 of the IGC Code, or other ignition sources such as internal combustion engines or steam engines with operating temperature which could cause ignition or explosion of mixtures of such gases, if any, with air.

4 Access to spaces in the cargo area

4.1 Cargo tank clearances

4.1.1 General

IGC CODE REFERENCE: Ch 3, 3.5

Designated passageways below and above cargo tanks are to have at least the cross-sections as specified in IGC Code 3.5.3.1.

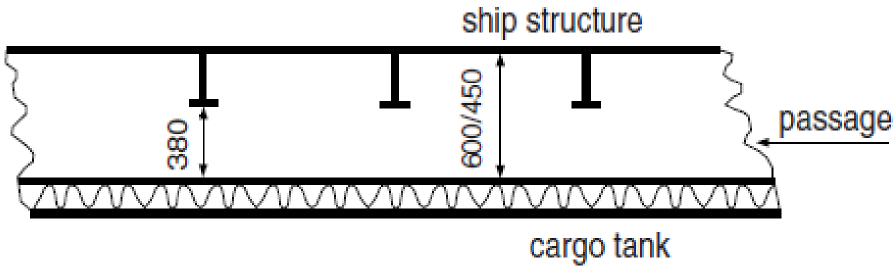
4.1.2 Passage through cargo tanks

IGC CODE REFERENCE: Ch 3, 3.5

For the purpose of the requirements in IGC Code 3.5.1 and 3.5.2, the following applies:

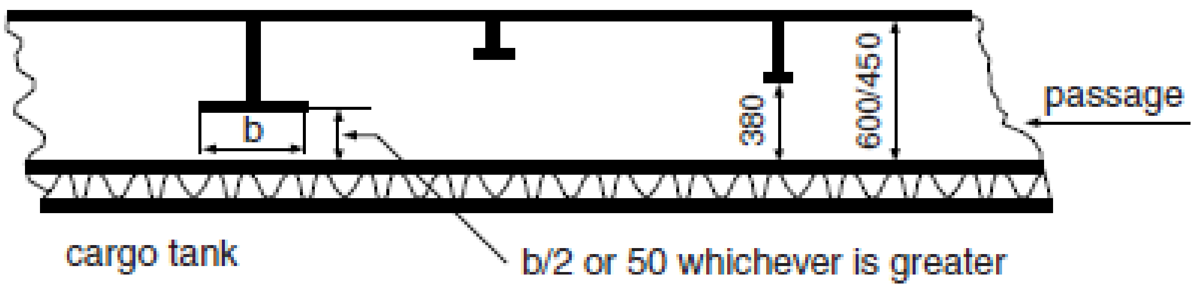
a) Where the Surveyor needs to pass between the flat or curved surface to be inspected and structural elements such as deck beams, stiffeners, frames, girders etc., the distance between that surface and the free edge of the structural elements is to be at least 380 mm. The distance between the surface to be inspected and the surface to which the above structural elements are fitted, e.g. deck, bulkhead or shell, is to be at least 450 mm in the case of a curved tank surface (e.g. type C-tank) or 600 mm in case of a flat tank surface (e.g. type A-tank) (see Fig 4.1).

Figure 4.1 : Minimum passage over cargo tanks



b) Where the Surveyor does not need to pass between the surface to be inspected and any part of the structure, for visibility reasons the distance between the free edge of that structural element and the surface to be inspected is to be at least 50 mm or half the breadth of the structure's face plate, whichever is the greater (see Fig 4.2).

Figure 4.2 : Minimum distance of structures from cargo tank to allow visual inspection



c) If for inspection of a curved surface the Surveyor needs to pass between that surface and another flat or curved surface, to which no structural elements are fitted, the distance between both surfaces is to be at least 380 mm (see Fig 4.3). Where the Surveyor does not need to pass between a curved surface and another surface, a smaller distance than 380 mm may be accepted taking into account the shape of the curved surface.

Figure 4.3 : Minimum passage between curved surfaces

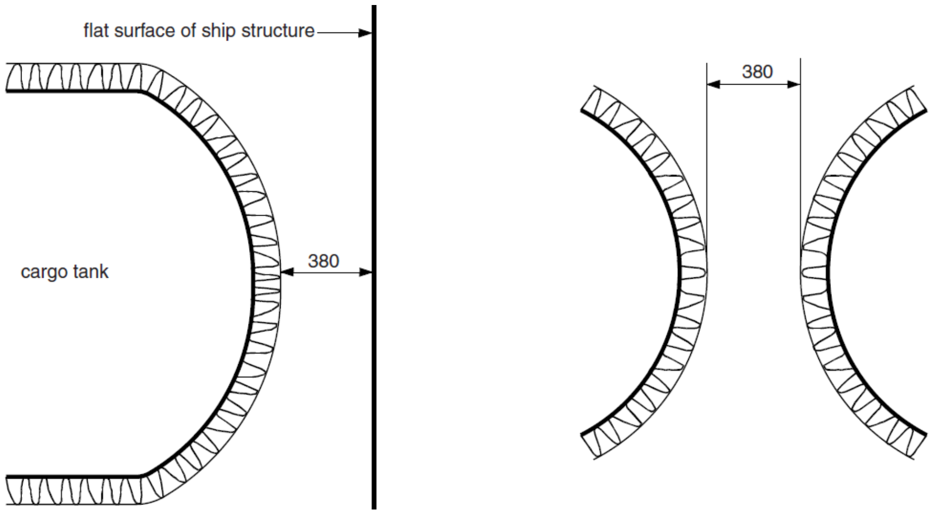
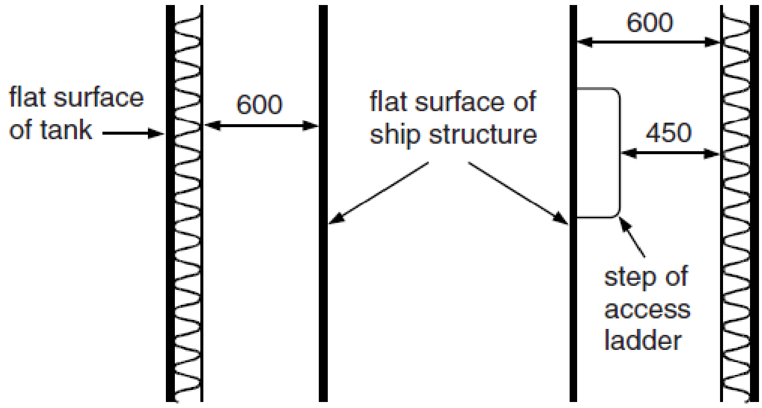


Figure 4.4 : Minimum passage between flat surfaces



d) If for inspection of an approximately flat surface the Surveyor needs to pass between two approximately flat and approximately parallel surfaces, to which no structural elements are fitted, the distance between those surfaces is to be at least 600 mm (see Fig 4.4).

e) The minimum distances between a cargo tank sump and adjacent double bottom structure in way of a suction well may not be less than that defined in Fig 4.5. If there is no suction well, the distance between the cargo tank sump and the inner bottom may not be less than 50 mm.

f) The distance between a cargo tank dome and deck structures may not be less than 150 mm (see Fig 4.6).

g) Where necessary for inspection, fixed or portable staging is to be installed. This staging may not impair the distances specified in IGC Code 3.5.3.

h) Where fixed or portable ventilation ducting is to be fitted in compliance with IGC Code 12.2, such ducting may not impair the distances specified in IGC Code 3.5.3.

Figure 4.5 : Minimum distance of cargo tank sump and inner bottom

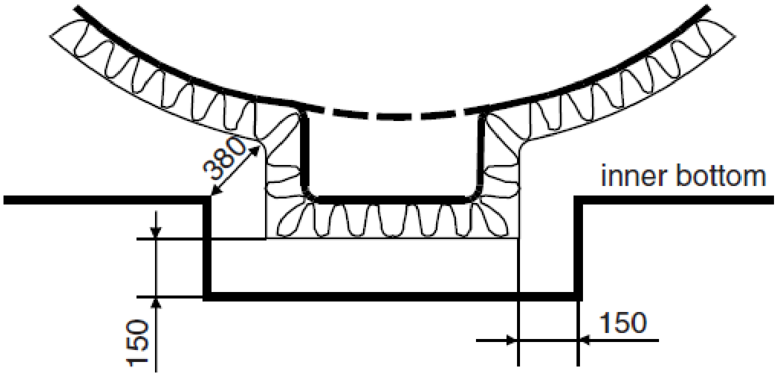
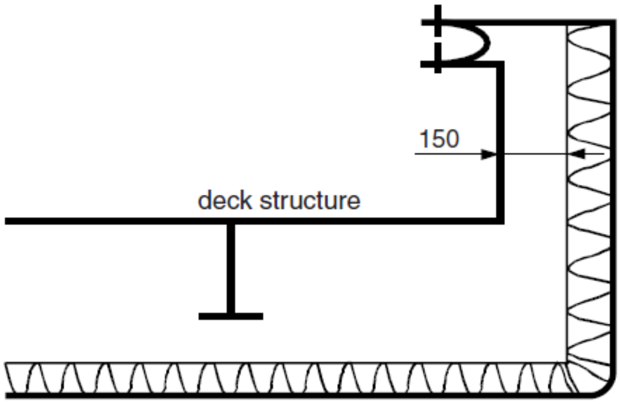


Figure 4.6 : Minimum distance between cargo dome and deck structures



4.1.3 Passage through hatches and manholes

IGC CODE REFERENCE: Ch 3, 3.5

For the purpose of the requirements in IGC Code 3.5.3, the following applies:

a) The term ﺑminimum clear opening of not less than 600 x 600 mmﭘmeans that such openings may have corner radii up to a maximum of 100 mm (see Fig 4.7).

b) The term ﺑminimum clear opening of not less than 600 x 800 mmﭘalso includes an opening of the size specified in Fig 4.8.

Figure 4.7 : Minimum horizontal hatch size

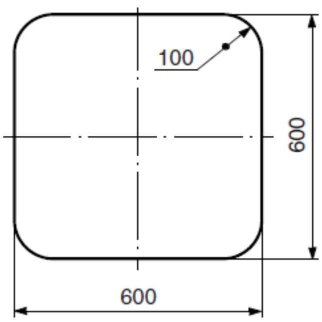
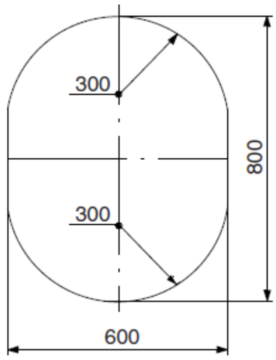


Figure 4.8 : Minimum size of manholes



c) Circular access openings in type C cargo tanks are to have diameters of not less than 600 mm.

4.2 Cofferdams and pipe tunnels

4.2.1 Cofferdams

IGC CODE REFERENCE: Ch 3, 3.5

Where fitted, cofferdams are to have sufficient size for easy access to all their parts. The width of the cofferdams may not be less than 600 mm.

4.2.2 Pipe tunnels

IGC CODE REFERENCE: Ch 3, 3.5

Pipe tunnels are to have enough space to permit inspection of pipes. The pipes in pipe tunnels are to be installed as high as possible from the shipِs bottom.

4.2.3 Access to pipe tunnels

IGC CODE REFERENCE: Ch 3, 3.5

Access to pipe tunnels through manholes in the engine space is not permitted.

5 Air-locks

5.1 Arrangement

5.1.1

IGC CODE REFERENCE: Ch 3, 3.6.1

Air-locks are to be such as to provide easy passage and are to cover a deck area of not less than 1,5 m^2. Air-locks are to be kept unobstructed and may not be employed for other uses, such as storage.

5.2 Alarm

5.2.1 Alarm signalling lamp

IGC CODE REFERENCE: Ch 3, 3.6.3

The alarm systems are to be of the intrinsically safe type.

However, signalling lamps may be of a safe type authorized for the dangerous spaces in which they are installed.

5.3 Electrical equipment

5.3.1 Acceptable alternatives to differential pressure

IGC CODE REFERENCE: Ch 3, 3.6.4

The following means are considered acceptable alternatives to differential pressure sensing devices in spaces having a ventilation rate not less than 30 air changes per hour:

- monitoring of current or power in the electrical supply to the ventilation motors; or
- air flow sensors in the ventilation ducts.

In spaces where the ventilation rate is less than 30 air changes per hour and where one of the above alternatives is fitted, in addition to the alarms required in IGC Code 3.6.3, arrangements are to be made to de-energise electrical equipment which is not of the certified safe type if more than one air-lock door is moved from the closed position.

5.3.2 Compressors for boil-off system

IGC CODE REFERENCE: Ch 3, 3.6.4

Lack of overpressure or air flow is not to imply the stopping of motors driving compressors used for the boil-off system mentioned in IGC Code, Ch 16; therefore, such engines are to be of the certified safe type and the relevant control appliance is to be fitted in a non-gas-dangerous space.

The requirement above is not applicable if, during manoeuvring and operations in port, only fuel oil is used or when the automatic transfer from gas to fuel oil, as per IGC Code 16.5.4, operates also when such electric motors are stopped without causing the shut-off of the boiler.

5.4 Ventilation

5.4.1 Air changes

IGC CODE REFERENCE: Ch 3, 3.6.5

After any loss of the overpressure, the spaces protected by air-locks are to be ventilated for the time necessary to give at least 10 air changes prior to energising the non-safe type electrical installations.

6 Bilge, ballast and fuel oil arrangements

6.1 Drainage arrangement

6.1.1 Drainage of dry spaces in the cargo area

IGC CODE REFERENCE: Ch 3, 3.7

Dry spaces within the cargo area are to be fitted with a bilge or drain arrangement not connected to the machinery space.

Spaces not accessible at all times are to be fitted with sounding arrangements.

Spaces without a permanent ventilation system are to be fitted with a pressure/vacuum relief system or with air pipes.

6.2 Additional requirements relative to the bilge system

6.2.1 Operation of the bilge system in cargo and interbarrier spaces

IGC CODE REFERENCE: Ch 3, 3.7

Bilge arrangements for holds containing cargo tanks and for interbarrier spaces are to be operable from the weather deck.

6.2.2 Diameter of bilge main

The diameter of the bilge main may be smaller than the diameter specified in Pt IV, Ch 1, Sec 11, 6.8.1, provided that this diameter is not less than twice the value given in Pt IV, Ch 1, Sec 11, 6.8.3. This reduction of diameter, however, is not applicable to the determination of the capacity of fire pumps according to Pt IV, Ch 1, Sec 11, 6.7.4.

6.2.3 Means for leakage detection

IGC CODE REFERENCE: Ch 3, 3.7

With reference to the means to ascertain leakages in holds and/or in interbarrier spaces, the following requirements apply:

- the above-mentioned means is to be suitable to ascertain the presence of water:
  - in holds containing type C independent tanks
  - in holds and interbarrier spaces outside the secondary barrier
- the above-mentioned means is to be suitable to ascertain the presence of liquid cargo in the spaces adjacent to cargo tanks which are not type C independent tanks.

Where the aforesaid spaces may be affected by water leakages from the adjacent ship structures, the means is also to be suitable to ascertain the presence of water.

Where the above-mentioned means is constituted by electrical level switches, the relevant circuits are to be of the intrinsically safe type and signals are to be transduced to the wheelhouse and to the cargo control station, if fitted.

7 Bow or stern loading and unloading arrangements

7.1 Locations of stopping devices for cargo pumps and compressors

7.1.1

IGC CODE REFERENCE: Ch 3, 3.8.7

Devices to stop cargo pumps and cargo compressors and to close cargo valves are to be fitted in a position from which it is possible to keep under control the loading/unloading manifolds.

8 Hull outfitting

8.1 Equipment

8.1.1 Emergency towing arrangements

The specific requirements in Pt III, Ch 5, 4 for ships with the service notation liquefied gas carrier and not less than 20000 t deadweight are to be complied with.

Section 4 Cargo Containment

Symbols

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

R_m : Minimum ultimate tensile strength, in N/mm^2, of the material

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

k : Material factor for steel, defined in Pt III, Ch 2, Sec 1, 3

s : Spacing, in m, of ordinary stiffeners

l : Span, in m, of ordinary stiffeners, measured between the supporting members

c_a : Aspect ratio of the plate panel, equal to:

$$C_a = 1.21\sqrt{1+0.33(s/l)^2} - 0.69s/l$$

to be taken not greater than 1.0

c_r : Coefficient of curvature of the panel, equal to:

$$C_r = 1 - 0.5s/r$$

to be taken not less than 0.5

$\square_b$, $\square_s$: Coefficients defined as follow.

Brackets at ends	Brackets lengths	$\square_b$	$\square_s$
0	-	1	1
1	l_b	$(1-l_b/2l)^2$	$(1-l_b/2l)$
2	$l_{b1};l_{b2}$	$(1-l_{b1}l_{b2}/4l^2)^2$	$(1-l_{b1}l_{b2}/4l^2)$

1 Definitions

1.1 Design pressure in harbour conditions

1.1.1

IGC CODE REFERENCE: Ch 4, 4.2.6.4

Where the vapour pressure in harbour conditions is greater than p0 , defined in IGC Ch 4, 4.2.6.4, this value is to be specified in the operating instructions for the ship's Master.

1.2 Design temperature

1.2.1 Use of cargo heater to raise the cargo temperature

IGC CODE REFERENCE: Ch 4, 4.2.7

Where a cargo heater, intended to raise the cargo temperature to a value permissible for cargo tanks, is envisaged, the following requirements are to be complied with:

- the piping and valves involved are to be suitable for the design loading temperature
- a thermometer is to be fitted at the heater outlet. It is to be set at the design temperature of the tanks and, when activated, it is to give a visual and audible alarm. This alarm is to be installed in the cargo control station or, when such a station is not foreseen, in the wheelhouse.
- The following note is to be written on the Certificate of Fitness: بThe minimum permissible temperature in the cargo preheater is..... خCپ

2 Design loads

2.1 Internal pressure for type A, type B and type C independent tanks

2.1.1 General

IGC CODE REFERENCE: Ch 4, 4.3.2

The inertial internal liquid pressure is to be calculated considering the ship in the following mutually exclusive conditions:

- upright ship conditions (see 2.1.2)
- inclined ship conditions (see 2.1.3).

2.1.2 Accelerations in upright ship conditions

In these conditions, the ship encounters waves which produce ship motions in the X-Z plane, i.e. surge, heave and pitch.

The dimensionless acceleration $a_{\square}$ is to be obtained, for an arbitrary direction □, in accordance with Fig 2.1, in which the wave longitudinal and vertical accelerations a_X and a_Z, respectively, are calculated from the formula in IGC Ch 4, 4.12.

2.1.3 Accelerations in inclined ship conditions

In these conditions, the ship encounters waves which produce ship motions in the X-Y and Y-Z planes, i.e. sway, heave, roll and yaw.

The dimensionless acceleration $a_{\square}$ is to be obtained, for an arbitrary direction □ in accordance with Fig 2.2, in which the wave transverse and vertical accelerations a_Y and a_Z, respectively, are calculated from the formula in IGC Ch 4, 4.12

2.1.4 Liquid heights and pressure

IGC CODE REFERENCE: Ch 4, 4.3.2.2

The liquid heights $Z_{\square}$ are to be calculated in accordance with Fig 2.3 at each calculation point of the tank.

At each calculation point, the maximum internal pressure $(P_{gd})_{max}$ is to be obtained for the □ direction which gives the maximum value of P_{gd} , according to IGC Ch 4, 4.3.2.2 (see Fig 2.4).

Figure 2.1 : Dimensionless acceleration in upright ship condition

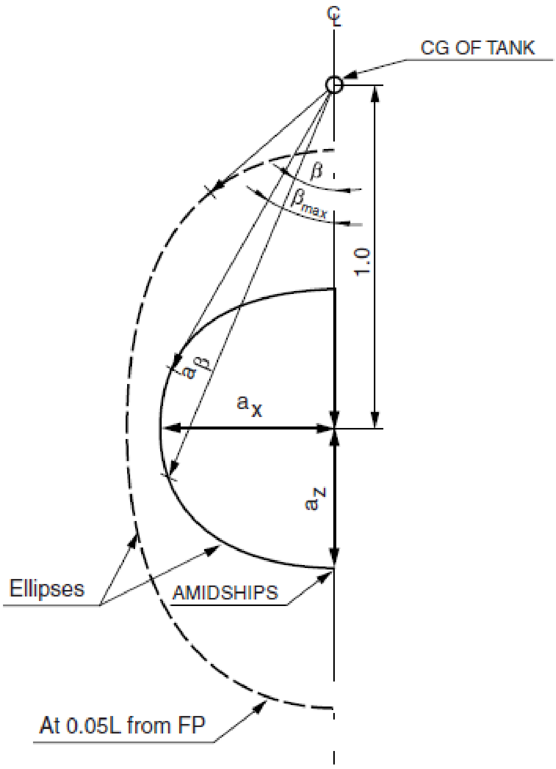


Figure 2.2 : Dimensionless acceleration in inclined ship condition

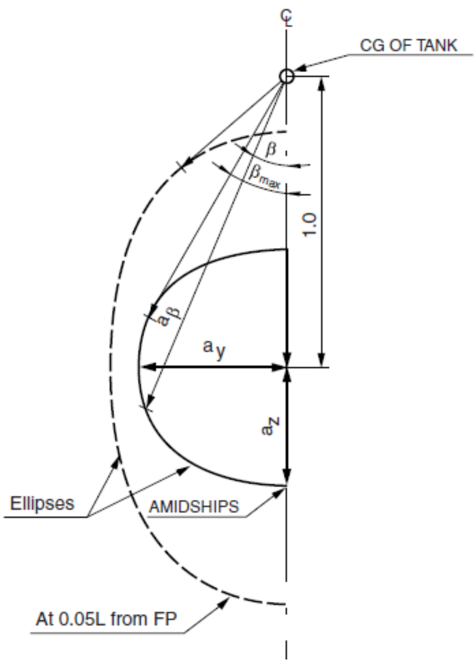


Figure 2.3 : Determination of liquid height Z□for pressure points 1, 2 and 3

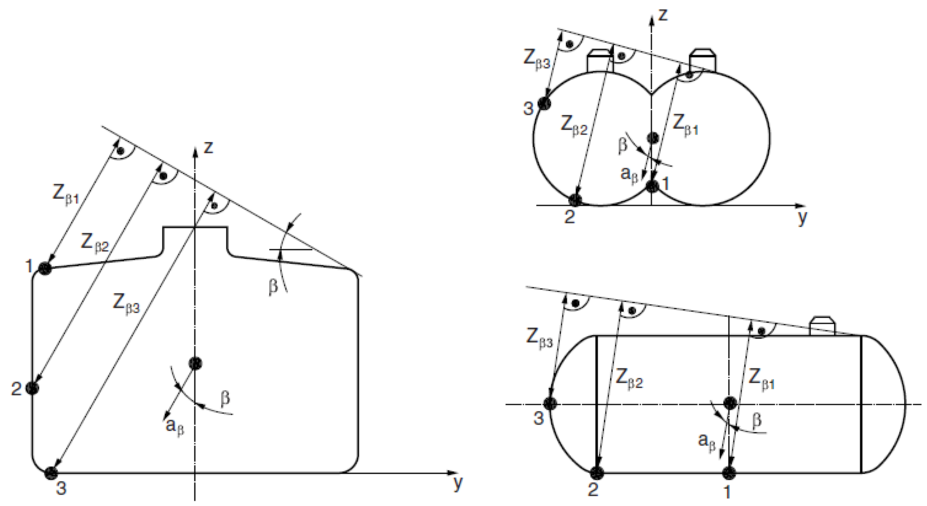
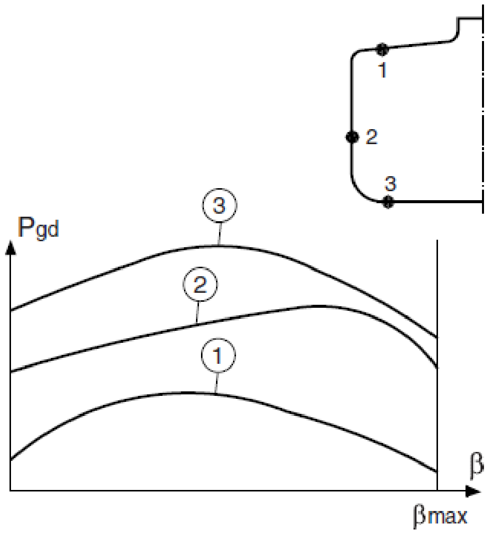


Figure 2.4 : Determination of internal pressure for pressure points 1, 2 and 3



2.1.5 Cargo mass density

IGC CODE REFERENCE : Ch 4, 4.3.2.2

Where the maximum mass density of the liquid carried is not given, the following values, in t/m^3, are to be considered:

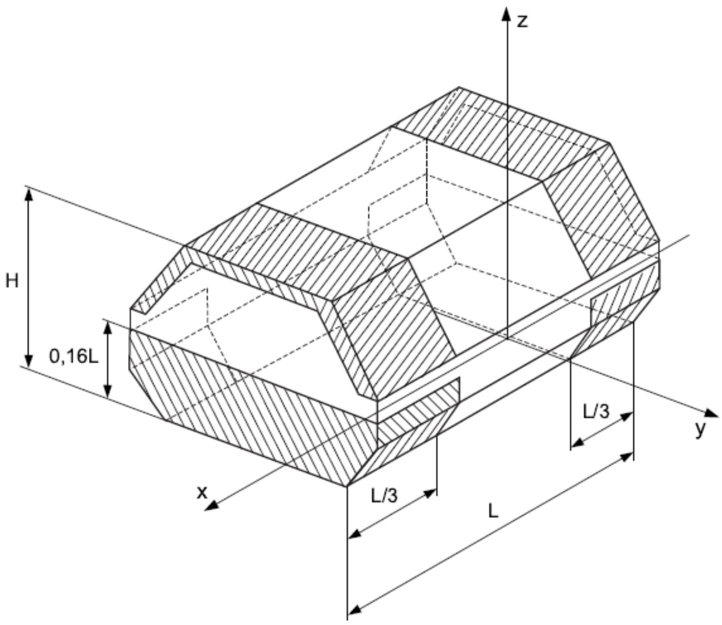
- □ = 0.50 t/m^3 for methane
- □ according to Sec 19, Tab 1.1 for other products.

2.2 Internal pressure for integral tanks and membrane tanks

2.2.1 General

The inertial internal liquid pressure is to be calculated according to Part III.

Figure 2.5 : Areas to be checked for sloshing



2.2.2 Sloshing pressure

Sloshing pressure in membrane tanks of ships having a total capacity over 155000 m^3 is to be specially considered by the Society.

Sloshing pressure to be considered in membrane tanks of ships having a total capacity less than 155000 m^3 is defined in 2.3.

2.3 Sloshing pressure for membrane tanks of ships having a capacity less than 155000 m^3

2.3.1 Standard filling levels

Standard filling levels are:

- full load condition:

the liquid height in the cargo tank is comprised between 70% and 98% of the cargo tank height

- ballast condition:

the liquid height in the cargo tank is comprised between 0% and 10% of the cargo tank length.

2.3.2 Pressures and tank regions

For standard filling levels, the sloshing pressure is to be obtained, in kN/m^2, from the following formula

$p_s = p_{wi} + p_{pv}$

where:

p_{wi} : Quasi static pressure, in kN/m^2, taken equal to:

$p_{wi} = 240\ kN/m^2$

p_{pv} : Setting pressure of safety valves, in kN/m^2.

The areas to be checked accordingly are described in Fig 2.5

where:

H : Height of the tank, in m

L : Length of the tank, in m.

For filling levels other than standard filling levels, the sloshing pressure is to be specially considered by the Society.

3 Hull scantlings

3.1 Application

3.1.1

The requirements in 3.2 to 3.4 apply to the hull structure, with the exception of the independent tank structure.

3.2 Plating

3.2.1 Minimum net thicknesses

The net thickness of the weather strength deck, trunk deck, tank bulkhead and watertight bulkhead plating is to be not less than the values given in Tab 3.1.

3.2.2 Plating subjected to sloshing

For yielding check, the net thickness of the plating is to be checked, considering appropriate value of the partial safety factor for sloshing pressure.

No buckling check is required.

3.3 Ordinary stiffeners

3.3.1 Minimum net thicknesses

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

$t_{MIN} = 0.8 + 0.013\ L\ k^{1/2} + 4.5\ s$ for L < 220 m

$t_{MIN} = 3\ k^{1/2} + 4.5 + s$ for L □220 m

Table 3.1 : Minimum net thickness of the weather strength deck, trunk deck, tank bulkhead and watertight bulkhead plating

Plating	Minimum net thickness, in mm	
Weather strength deck and trunk deck, if any, for the area within 0.4L amidships (1)	Longitudinal framing	$1.6 + 0.032\ L\ k^{1/2} + 4.5\ s$ for L < 220 $6\ k^{1/2} + 5.7 + s$ for L □220
	Transverse framing	$1.6 + 0.04\ L\ k^{1/2} + 4.5\ s$ for L < 220 $6\ k^{1/2} + 7.5 + s$ for L □220
Weather strength deck and trunk deck, if any, at fore and aft parts and between hatchways (1)	$2.1 + 0.013\ L\ k^{1/2} + 4.5\ s$	
Tank bulkhead	$1.7 + 0.013\ L\ k^{1/2} + 4.5\ s$	
Watertight bulkhead	$1.3 + 0.013\ L\ k^{1/2} + 4.5\ s$	

(1) The minimum net thickness is to be obtained by linearly interpolating between that required for the area within 0.4 L amidships and that at the fore and aft part.

Note 1:

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

3.3.2 Ordinary stiffeners subjected to sloshing

For yielding check, the net section modulus and the net shear sectional area of the ordinary stiffeners, including longitudinals, is to be checked using the formulae given in Pt III, ch2, App 4. An appropriate partial safety factor is to be used.

No buckling check is required.

3.4 Primary supporting members

3.4.1 Minimum net thicknesses

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

$t_{MIN} = 4.1 + 0.015\ L\ k^{1/2}$

3.4.2 Primary supporting members subjected to sloshing

No primary supporting members reinforcement is required.

4 Structural analysis of integral tanks

4.1 Scantlings

4.1.1

IGC CODE REFERENCE: Ch 4, 4.4.1

The net scantlings of plating, ordinary stiffeners and primary supporting members of integral tanks are to be not less than those obtained from Part III, Chapter2, where the hull girder loads and the internal pressure are to be calculated according to rules.

5 Structural analysis of membrane tanks

5.1 General

5.1.1 Specific allowable hull girder stresses and/or deflections, indicated by the Designer, are to be taken into account for the determination of the scantlings.

5.2 Scantlings

5.2.1

IGC CODE REFERENCE: Ch 4, 4.4.2

The net scantlings of plating, ordinary stiffeners and primary supporting members of membrane tanks are to be not less than those obtained from Part III, Chapter 2, where the hull girder loads and the internal pressure are to be calculated according to rules.

6 Structural analysis of type A independent tanks

6.1 Plating

6.1.1 Minimum gross thickness

IGC CODE REFERENCE: Ch 4, 4.4.4

The gross thickness of plating of type A independent tanks, in mm, is to be not less than:

$t = 3.5 + 5\ s$

6.1.2 Plating subject to lateral pressure

IGC CODE REFERENCE: Ch 4, 4.4.4

The gross thickness of plating subject to lateral pressure, in mm, is to be not less than:

$t = 16.5 c_a\ c_r s\ (p_{IGC} / R_y)^{1/2}$

where:

p_{IGC} : Internal lateral pressure, in kN/m^2, in the tank, as defined in 2.1].

6.1.3 Plating subject to testing conditions

IGC CODE REFERENCE: Ch 4, 4.4.4

The gross thickness of plating subject to testing pressure, in mm, is to be not less than:

$t = 15.4 c_a\ c_r s\ (p_{ST} / R_y)^{1/2}$

where:

p_{ST} : Testing pressure, in kN/m^2, obtained according to IGC Ch 4, 4.10.10.

6.1.4 Plating subject to sloshing conditions

IGC CODE REFERENCE: Ch 4, 4.4.4

The thickness of plating subject to sloshing pressure, in mm, is to be obtained according to Pt III, Ch 2.

6.2 Ordinary stiffeners

6.2.1 Minimum gross thickness

IGC CODE REFERENCE: Ch 4, 4.4.4

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

$t = 4.5 + 0.02\ L\ k^{1/2}$

where L is to be taken not greater than 275.

6.2.2 Ordinary stiffeners subject to lateral pressure

IGC CODE REFERENCE: Ch 4, 4.4.4

The gross section modulus w, in cm^3, and the gross shear sectional area A_{sh}, in cm^2, of ordinary stiffeners subjected to lateral pressure are to be not less than the values obtained from the following formulae:

$w = \square_b\ p_{IGC}\ s\ l^2 10^3/(12\square_{ALL})$

$A_{sh} = 10\ \square_s\ p_{IGC}\ (1\text{-}s/2l)s\ l/(\square_{ALL})$

where:

p_{IGC} : Internal lateral pressure, in kN/m^2, as defined in 2.1

$\square_{ALL}$: Allowable stress, in N/mm^2, taken equal to the lower of R_m /2.66 or R_{eH}/1.33.

6.2.3 Ordinary stiffeners subject to testing conditions

IGC CODE REFERENCE: Ch 4, 4.4.4

The gross section modulus w, in cm^3, and the gross shear sectional area A_{sh} , in cm^2, of ordinary stiffeners subjected to testing pressure are to be not less than the values obtained from the following formulae:

$w = 1.22\square_b\ p_{ST}\ s\ l^2 10^3/(12R_y)$

$A_{sh} = 12.2\ \square_s\ p_{ST}\ (1\text{-}s/2l)s\ l/(R_y)$

where:

p_{ST} : Testing pressure, in kN/m^2, obtained according to IGC Ch 4, 4.10.10.

6.2.4 Ordinary stiffeners subject to sloshing conditions

IGC CODE REFERENCE: Ch 4, 4.4.4

The scantlings of ordinary stiffeners subjected to sloshing pressure are to be obtained according to Pt III, Ch 2.

6.3 Primary supporting members

6.3.1 Minimum gross thickness

IGC CODE REFERENCE: Ch 4, 4.4.4

The gross thickness of the web of primary supporting members, in mm, is to be not less than:

$t = 5 + 0.02\ L\ k^{1/2}$

where L is to be taken not greater than 275.

6.3.2 Scantlings of primary supporting members

IGC CODE REFERENCE: Ch 4, 4.4.4

The scantlings of primary supporting members are to be not less than those obtained from PtIII, Ch 2, where the hull girder loads and the lateral pressures are to be calculated according to Part III, with the resistance partial safety factor γ_R obtained from Tab 6.1, for general case of yielding check.

When calculating the internal pressure, the presence of the dome may be disregarded.

Table 6.1 : Type A independent tanks primary supporting members - Resistance partial safety factor γ_R

Type of three dimensional model	Resistance partial safety factor γ_R
Beam or coarse mesh finite element model	1.30
Fine mesh finite element model	1.15

7 Structural analysis of type B independent tanks

7.1 Plating and ordinary stiffeners

7.1.1 Strength check of plating and ordinary stiffeners subject to lateral pressure

IGC CODE REFERENCE: Ch 4, 4.4.5

The net scantlings of plating and ordinary stiffeners of type B independent tanks are to be not less than those obtained from the applicable formulae in Part III, Chapter 2, where the internal pressure is to be calculated according to 2.1.

7.1.2 Buckling check

IGC CODE REFERENCE: Ch 4, 4.4.5

The scantlings of plating and ordinary stiffeners of type B independent tanks are to be not less than those obtained from the applicable formulae in Part III, Chapter 2.

7.2 Primary supporting members

7.2.1 Analysis criteria

IGC CODE REFERENCE: Ch 4, 4.4.5

The analysis of the primary supporting members of the tank subjected to lateral pressure based on a three dimensional model is to be carried out according to the following requirements:

- the structural modelling is to comply with the rule requirements
- the stress calculation is to comply with the requirements
- the model extension is to comply with 7.2.2
- the wave hull girder loads and the wave pressures to be applied on the model are to comply with 7.2.3
- the inertial loads to be applied on the model are to comply with 7.2.4.

7.2.2 Model extension

IGC CODE REFERENCE: Ch 4, 4.4.5

The longitudinal extension of the structural model is to comply with requirements. In any case, the structural model is to include the hull and the tank with its supporting and keying system.

7.2.3 Wave hull girder loads and wave pressures

IGC CODE REFERENCE: Ch 4, 4.4.5

Wave hull girder loads and wave pressures are to be obtained from a complete analysis of the ship motion and accelerations in irregular waves, to be submitted to the Society for approval, unless these data are available from similar ships.

These loads are to be obtained as the most probable the ship may experience during its operating life, for a probability level of 10^{-8}.

7.2.4 Inertial loads

IGC CODE REFERENCE: Ch 4, 4.4.5

The inertial loads are to be obtained from the formulae in IGC Ch 4, 4.3.2.

7.2.5 Yielding check of primary supporting members of type B independent tanks

primarily constructed of bodies of revolution IGC CODE REFERENCE: Ch 4, 4.4.5

The equivalent stresses of primary supporting members are to comply with the following formula:

$\sigma_E \le \sigma_{ALL}$

where:

σ_E : Equivalent stress, in N/mm^2, to be obtained from the formula in IGC Ch 4, 4.5.1.8 for each of the following stress categories, defined in IGC Ch 4, 4.13:

- primary general membrane stress
- primary local membrane stress
- primary bending stress
- secondary stress

σ_{ALL} : Allowable stress, defined in IGC Ch 4, 4.5.1.4 for each of the stress categories above.

7.2.6 Yielding check of primary supporting members of type B independent tanks primarily constructed of plane surfaces

IGC CODE REFERENCE: Ch 4, 4.4.5

The equivalent stresses of primary supporting members are to comply with the following formula:

$\sigma_E \le \sigma_{ALL}$

where:

σ_E : von Mises Equivalent stress, in N/mm^2 as a result of direct calculations to be carried out in accordance with 7.2.1

σ_{ALL} : Allowable stress, in N/mm^2, to be obtained from Tab 7.1.

Table 7.1: Allowable stress for primary supporting members primarily constructed of plane surfaces

Material	Allowable stress, in N/mm^2
C-Mn steel and Ni-steels	The lesser of: - 0.75 R_{eH} - 0.5 R_m
Austenitic steels	The lesser of: - 0.80 R_{eH} - 0.4 R_m
Aluminium alloy	The lesser of: - 0.75 R_{eH} - 0.35 R_m

Note 1:

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

R_m : Ultimate minimum tensile strength, in N/mm^2, of the material

7.2.7 Buckling check of local buckling of plate panels of primary supporting members

IGC CODE REFERENCE: Ch 4, 4.4.5

A local buckling check is to be carried out according to Pt III, Ch 2, App 4 for plate panels which constitute primary supporting members.

In performing this check, the stresses in the plate panels are to be obtained from direct calculations to be carried out in accordance with 7.2.1.

7.3 Fatigue analysis

7.3.1 General

IGC CODE REFERENCE: Ch 4, 4.4.5.6

The fatigue analysis is to be performed for areas where high wave induced stresses or large stress concentrations are expected, for welded joints and parent material. Such areas are to be defined by the Designer and agreed by the Society on a case-by-case basis.

7.3.2 Material properties

IGC CODE REFERENCE: Ch 4, 4.4.5.6

The material properties affecting fatigue of the items checked are to be documented. Where this documentation is not available, the Society may request to obtain these properties from experiments performed in accordance with recognised standards.

7.3.3 Wave loads

In upright ship and in inclined ship conditions the wave loads to be considered for the fatigue analysis of the tank include:

- maximum and minimum wave hull girder loads and wave pressures, to be obtained from a complete analysis of the ship motion and accelerations in irregular waves, to be submitted to the Society for approval, unless these data are available from similar ships. These loads are to be obtained as the most probable the ship may experience during its operating life, for a probability level of 10^{-8}.
- Maximum and minimum inertial pressures, to be obtained from the formulae in IGC Ch 4, 4.3.2 as a function of the arbitrary direction β

7.3.4 Simplified stress distribution for fatigue analysis

IGC CODE REFERENCE: Ch 4, 4.3.4.3

The simplified long-term distribution of wave loads indicated in IGC Code 4.3.4.3 may be represented by means of 8 stress ranges, each characterised by an alternating stress $\pm\sigma_i$ and a number of cycles n_i (see Fig 7.1). The corresponding values of σ_i and n_i are to be obtained from the following formulae:

$\sigma_i = \sigma_0(1.0625 - i/8)$

$n_i = 0.9 \times 10^i$

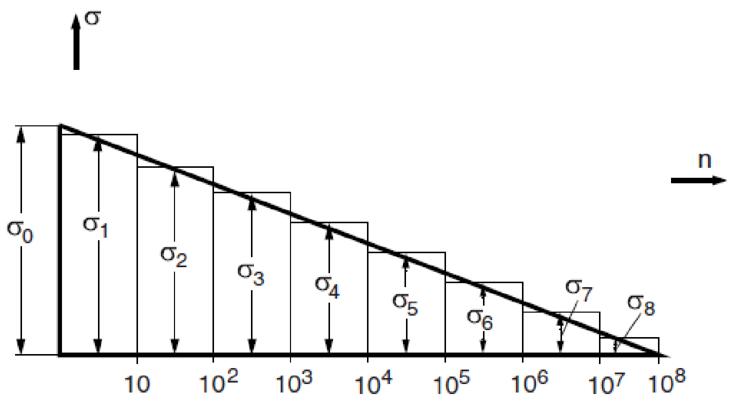
where:

σ_i: Stress (i = 1, 2,..., 8), in N/mm^2 (see Fig 7.1)

σ_0 : Most probable maximum stress over the life of the ship, in N/mm^2, for a probability level of 10^{-8}

n_i : Number of cycles for each stress σ_i considered (i = 1, 2,..., 8).

Figure 7.1 : Simplified stress distribution for fatigue analysis



7.3.5 Conventional cumulative damage

IGC CODE REFERENCE: Ch 4, 4.4.5.6

For each structural detail for which the fatigue analysis is to be carried out, the conventional cumulative damage is to be calculated according to the following procedure:

- The long-term value of hot spot stress range $\Delta\sigma_{S,0}$ is to be obtained from the following formula:

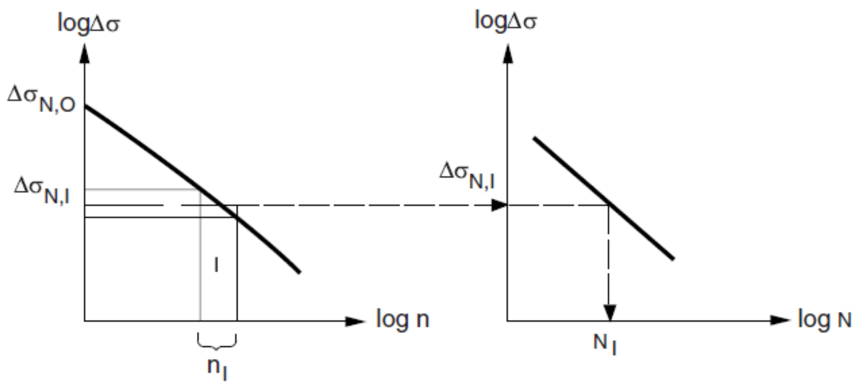
$$\Delta\sigma_{s,0} = \left|\sigma_{s,Max} - \sigma_{s,Min}\right|$$

where:

$\sigma_{s,MAX}$, $\sigma_{s,MIN}$: Maximum and minimum hot spot stress to be obtained from a structural analysis carried out in accordance with Pt III, Ch 2, where the wave loads are those defined in 7.3.3.

- The long-term value of the notch stress range $\Delta\sigma_{N,0}$ is obtained as a function of the hot spot stress range $\Delta\sigma_{S,0}$.
- The long-term distribution of notch stress ranges $\Delta\sigma_{N,I}$ is to be calculated. Each stress range $\Delta\sigma_{N,I}$ of the distribution, corresponding to ni stress cycles, is obtained from the formulae in 7.3.4, where $\Delta\sigma_0$ is taken equal to $\Delta\sigma_{N,0}$.
- For each notch stress range $\Delta\sigma_{N,I}$, the number of stress cycles NI which cause the fatigue failure is to be obtained by means of S-N curves corresponding to the as-rolled condition (see Fig 7.2). The criteria adopted for obtaining the S-N curves are to be documented. Where this documentation is not available, the Society may require the curves to be obtained from experiments performed in accordance with recognised standards.

Figure 7.2 : Fatigue check based on conventional cumulative damage method



Distribution of notch stress ranges   S-N curve corresponding to the as-rolled condition

- The conventional cumulative damage for the i notch stress ranges $\Delta\sigma_{N,I}$ is to be obtained from the formula in IGC Ch 4, 4.4.5.6.

7.3.6 Check criteria

The conventional cumulative damage, to be calculated according to 7.3.5, is to be not greater than CW, defined in IGC Ch 4, 4.4.5.6.

7.4 Crack propagation analysis

7.4.1 General

IGC CODE REFERENCE: Ch 4, 4.4.5

The crack propagation analysis is to be carried out for highly stressed areas. The latter are to be defined by the Designer and agreed by the Society on a case-by-case basis.

Propagation rates in the parent material, weld metal and heat-affected zone are to be considered.

The following checks are to be carried out:

- crack propagation from an initial defect, in order to check that the defect will not grow and cause a brittle fracture before the defect is detected; this check is to be carried out according to 7.4.4
- crack propagation from an initial through thickness defect, in order to check that the defect, resulting in a leakage, will not grow and cause a brittle fracture less than 15 days after its detection; this check is to be carried out according to 7.4.5.

7.4.2 Material properties

IGC CODE REFERENCE: Ch 4, 4.4.5

The material fracture mechanical properties used for the crack propagation analysis, i.e. the properties relating the crack propagation rate to the stress intensity range at the crack tip, are to be documented for the various thicknesses of parent material and weld metal alike. Where this documentation is not available, the Society may request to obtain these properties from experiments performed in accordance with recognised standards.

7.4.3 Simplified stress distribution for crack propagation analysis

IGC CODE REFERENCE: Ch 4, 4.3.4.4

The simplified wave load distribution indicated in IGC Code 4.3.4.4 may be represented over a period of 15 days by means of 5 stress ranges, each characterised by an alternating stress $\pm\sigma_i$ and number of cycles, n_i (see Fig 7.3). The corresponding values of σ_i and n_i are to be obtained from the following formulae:

$\sigma_i=\sigma_0(1.1-i/5.3)$

$n_i=0.913\ 10^i$

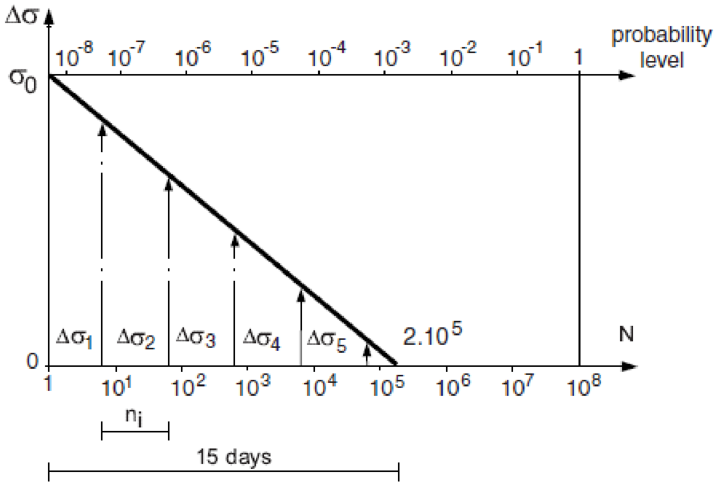
where:

σ_i : Stress (i = 1.06; 2.12; 3.18; 4.24; 5.30), in N/mm^2 (see Fig 7.3)

σ_0 : Defined in 7.3.4

n_i : Number of cycles for each stress σ_i considered (i = 1.06; 2.12; 3.18; 4.24; 5.30).

Figure 7.3 : Simplified stress distribution for crack propagation analysis



7.4.4 Crack propagation analysis from an initial defect

IGC CODE REFERENCE: Ch 4, 4.4.5

It is to be checked that an initial crack will not grow, under wave loading based on the stress distribution in 7.3.4, beyond the allowable crack size.

The initial size and shape of the crack is to be considered by the Society on a case-by-case basis, taking into account the structural detail and the inspection method.

The allowable crack size is to be considered by the Society on a case-by-case basis; in any event, it is to be taken less than that which may lead to a loss of effectiveness of the structural element considered.

7.4.5 Crack propagation analysis from an initial through thickness defect

IGC CODE REFERENCE: Ch 4, 4.4.5

It is to be checked that an initial through thickness crack will not grow, under dynamic loading based on the stress distribution in 7.4.3, beyond the allowable crack size.

The initial size of the through thickness crack is to be taken not less than that through which the minimum flow size that can be detected by the monitoring system (e.g. gas detectors) may pass.

The allowable crack size is to be considered by the Society on a case-by-case basis; in any event, it is to be taken far less than the critical crack length, defined in 7.4.6.

7.4.6 Critical crack length

IGC CODE REFERENCE: Ch 4, 4.4.5

The critical crack length is the crack length from which a brittle fracture may initiate and it is to be considered by the Society on a case-by-case basis. In any event, it is to be evaluated for the most probable maximum stress experienced by the structural element in the ship life, which is equal to the stress in the considered detail obtained from the structural analysis to be performed in accordance with 7.2.1.

8 Structural analysis of type C independent tanks

8.1 Scantlings

8.1.1

IGC CODE REFERENCE: Ch 4, 4.4.6

The type C independent cargo tanks are to comply with the requirements of Pt IV, Ch 1, Sec 5 related to class 1 pressure vessels, the allowable stresses being those required by the IGC Code.

8.2 Stiffening rings in way of tank supports

8.2.1 Structural model

IGC CODE REFERENCE: Ch 4, 4.4.6

The stiffening rings in way of supports of horizontal cylindrical tanks are to be modelled as circumferential beams constituted by web, flange, doubler plate, if any, and plating attached to the stiffening rings.

8.2.2 Width of attached plating

IGC CODE REFERENCE: Ch 4, 4.4.6

On each side of the web, the width of the attached plating to be considered for the yielding and buckling checks of the stiffening rings, as in 8.2.5 and 8.2.6, respectively, is to be obtained, in mm, from the following formulae:

- $b = 0.78\sqrt{rt}$
- $b = 20\ t_b$ for longitudinal bulkheads (in the case of lobe tanks)

where:

r : Mean radius, in mm, of the cylindrical shell

t : Shell thickness, in mm

t_b : Bulkhead thickness, in mm.

A doubler plate, if any, may be considered as belonging to the attached plating.

8.2.3 Boundary conditions

IGC CODE REFERENCE: Ch 4, 4.4.6

The boundary conditions of the stiffening ring are to be modelled as follows:

- circumferential forces applied on each side of the ring, whose resultant is equal to the shear force in the tank and calculated through the bi-dimensional shear flow theory
- reaction forces in way of tank supports, to be obtained according to 9.2.

8.2.4 Lateral pressure

IGC CODE REFERENCE: Ch 4, 4.4.6

The lateral pressure to be considered for the check of the stiffening rings is to be obtained from 2.1.

8.2.5 Yielding check

IGC CODE REFERENCE: Ch 4, 4.4.6

The equivalent stress in stiffening rings in way of supports is to comply with the following formula:

$\sigma_E \le \sigma_{ALL}$

where:

σ_E : Equivalent stress in stiffening rings calculated for the load cases defined in IGC Ch 4, 4.6.2 and IGC 4.6.3, in N/mm^2, and to be obtained from the following formula:

$$\sigma_E = \sqrt{(\sigma_N + \sigma_B) + 3\tau^2}$$

σ_N : Normal stress, in N/mm^2, in the circumferential direction of the stiffening ring

σ_B : Bending stress, in N/mm^2, in the circumferential direction of the stiffening ring

τ: Shear stress, in N/mm^2, in the stiffening ring

σ_{ALL} : Allowable stress, in N/mm^2, to be taken equal to the lesser of the following values:

- 0.57 R_m
- 0.85 R_{eH}

8.2.6 Buckling check

IGC CODE REFERENCE: Ch 4, 4.4.6

The buckling strength of the stiffening rings is to be checked in compliance with the applicable formulae in Pt III, Ch 2, App 4.

9 Supports

9.1 Structural arrangement

9.1.1 General

REFERENCE IGC CODE: Ch 4, 4.6

The reaction forces in way of tank supports are to be transmitted as directly as possible to the hull primary supporting members, minimising stress concentrations.

Where the reaction forces are not in the plane of primary members, web plates and brackets are to be provided in order to transmit these loads by means of shear stresses.

9.1.2 Structure continuity

Special attention is to be paid to continuity of structure between circular tank supports and the primary supporting members of the ship.

9.1.3 Openings

IGC CODE REFERENCE: Ch 4, 4.6

In primary supporting members of tank supports and hull structures in way of tank supports which constitute hull supports, openings are to be avoided and local strengthening may be necessary.

9.1.4 Antiflotation arrangements

IGC CODE REFERENCE: Ch 4, 4.6.7

Adequate clearance between the tanks and the hull structures is to be provided in all operating conditions.

9.2 Calculation of reaction forces in way of tank supports

9.2.1

IGC CODE REFERENCE: Ch 4, 4.6

The reaction forces in way of tank supports are to be obtained from the structural analysis of the tank or stiffening rings in way of tank supports, considering the loads specified in:

- 6.3, for the structural analysis of type A independent tanks
- 7, for the structural analysis of type B independent tanks
- 2.1, for the structural analysis of type C independent tanks.

The final distribution of the reaction forces at the supports is not to show any tensile forces.

9.2.2

IGC CODE REFERENCE Ch 4, 4.6.2

Moreover the tanks with supports are also to be designed for a static angle of heel of 30°.

9.3 Supports of type A and type B independent tanks

9.3.1 General

Fillings lower than 90% are generally not admitted for tanks having no upper antirolling supports.

9.3.2 Supports

The structure of the tank and of the ship is to be reinforced in way of the supports so as to withstand the reactions and the corresponding moments.

It is to be checked that the combined stress, in N/mm^2, in supports is in compliance with the following formula:

$\sigma_C \leq \sigma_{ALL}$

where:

σ_{ALL} : Allowable stress, in N/mm^2, defined in:

- Tab 9.1, for type A independent tanks
- IGC Ch 4, 4.6, for type B independent tanks.

9.3.3 Antirolling supports

Antirolling supports are to be checked under transverse and vertical accelerations, as defined in 9.2.1 for the inclined ship conditions, and applied on the maximum weight of the full tank.

It is to be checked that the combined stress, in N/mm^2, in antirolling supports is in compliance with the following formula:

$\sigma_c \leq \sigma_{ALL}$

where:

σ_{ALL} : Allowable stress, in N/mm^2, defined in:

- Tab 9.1, for type A independent tanks
- IGC Ch 4, 4.6, for type B independent tanks.

9.3.4 Antipitching supports

Antipitching supports are to be checked under longitudinal accelerations and vertical accelerations, as defined in 9.2.1for the upright conditions, and applied on the maximum weight of the full tank.

It is to be checked that the combined stress, in N/mm^2, in antipitching supports is in compliance with the following formula:

$\sigma_c \leq \sigma_{ALL}$

where:

σ_{ALL} : Allowable stress, in N/mm^2, defined in:

- Tab 9.1, for type A independent tanks
- IGC Ch 4, 4.6, for type B independent tanks.

Table 9.1 : Allowable stresses in supports of type A independent tanks

Type of support	Allowable stress σ_{ALL} , in N/mm^2	
	Three dimensional model	Beam model
Support Antirolling support Antipitching support	230/k	The lower of: - R_m / 2.66 - R_{eH} / 1.33

9.3.5 Anticollision supports

Anticollision supports are to be provided to withstand a collision force acting on the tank corresponding to one half the weight of the tank and cargo in the forward direction and one quarter the weight of the tank and cargo in the aft direction.

Antipitching supports may be combined with anticollision supports.

It is to be checked that the combined stress, in N/mm^2, in anticollision supports is in compliance with the following formula:

$\sigma_c \leq 235/k$

9.3.6 Antiflotation supports

Antiflotation supports are to be provided and are to be suitable to withstand an upward force caused by an empty tank in a hold space flooded to the summer load draught of the ship.

It is to be checked that the combined stress, in N/mm^2, in anticollision supports is in compliance with the following formula:

$\sigma_c \leq 235/k$

9.4 Supports of type C independent tanks

9.4.1

IGC CODE REFERENCE: Ch 4, 4.6

The net scantlings of plating, ordinary stiffeners and primary supporting members of tank supports and hull structures in way are to be not less than those obtained by applying the criteria in Part III, Chapter 2.

The hull girder loads and the lateral pressure to be considered in the formulae above are to be obtained from the formulae in Part III, Chapter 2.

9.4.2

IGC CODE REFERENCE: Ch 4, 4.6

In addition to 9.4.1, the anticollision supports and antiflotation supports are to be checked according to 9.3.5 and 9.3.6.

9.5 Materials

9.5.1 Insulating materials for tank supports are to be type approved by the Society.

Note 1: In addition to the justification of mechanical properties, the water absorption of the material should not be more than 6% when determined in accordance with DIN 53 495.

10 Secondary barrier

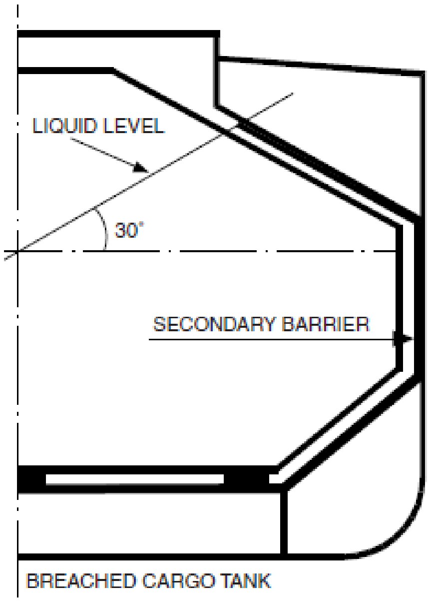
10.1 Secondary barrier extent

10.1.1

IGC CODE REFERENCE: Ch 4, 4.7

The extent of the secondary barrier is to be not less than that necessary to protect the hull structures assuming that the cargo tank is breached at a static angle of heel of 30°, with an equalisation of the liquid cargo in the tank (see Fig 10.1).

Figure 10.1 : Secondary barrier extension



11 Insulation

11.1 Heating of structures

11.1.1 Segregation of heating plant

IGC CODE REFERENCE: Ch 4, 4.8.4

Where a hull heating system complying with IGC Ch 4, 4.8.4 is installed, this system is to be contained solely within the cargo area or the drain returns from the hull heating coils in the wing tanks, cofferdams and double bottom are to be led to a degassing tank. The degassing tank is to be located in the cargo area and the vent outlets are to be located in a safe position and fitted with a flame screen.

11.1.2 First loaded voyage

Attention is drawn to the requirements of Sec 1, 4.2.4 regarding the satisfactory operation of the heating plant, that is to be ascertained during the first full loading and the subsequent first unloading of ships carrying liquefied natural gases (LNG) in bulk.

12 Materials

12.1 Insulation material characteristics

12.1.1

IGC CODE REFERENCE: Ch 4, 4.9.5 AND 4.9.6

The materials for insulation are to be approved by the Society.

The approval of bonding materials, sealing materials, lining constituting a vapour barrier or mechanical protection is to be considered by the Society on a case-by-case basis. In any event, these materials are to be chemically compatible with the insulation material.

A particular attention is to be paid to the continuity of the insulation in way of tank supports.

12.1.2

IGC CODE REFERENCE: Ch 4, 4.9.5 AND 4.9.6

Before applying the insulation, the surfaces of the tank structures or of the hull are to be carefully cleaned.

12.1.3

IGC CODE REFERENCE: Ch 4, 4.9.5 AND 4.9.6

Where applicable, the insulation system is to be suitable to be visually examined at least on one side.

12.1.4

IGC CODE REFERENCE: Ch 4, 4.9.5 AND 4.9.6

When the insulation is sprayed or foamed, the minimum steel temperature at the time of application is to be not less than the temperature given in the specification of the insulation.

13 Construction and testing

13.1 Construction and welding

13.1.1

IGC CODE REFERENCE: Ch 4, 4.10.9

The following provisions apply to independent tanks:

- Tracing, cutting and shaping are to be carried out so as to prevent, at the surface of the pieces, the production of defects detrimental to their use. In particular, marking the plates by punching and starting welding arcs outside the welding zone are to be avoided.
- Before welding, the edges to be welded are to be carefully examined, with possible use of non-destructive examination, in particular when chamfers are carried out.
- In all cases, the working units are to be efficiently protected against bad weather.
- The execution of provisional welds, where any, is to be subjected to the same requirements as the constructional welds. After elimination of the fillets, the area is to be carefully ground and inspected (the inspection is to include, if necessary, a penetrant fluid test).
- All welding consumables are subject to agreement.

Welders are also to be agreed.

13.2 Integral tank testing

13.2.1

IGC CODE REFERENCE: Ch 4, 4.10.6

The testing of integral tanks is to comply with the rules requirements in Pt III, Ch 7.

13.3 Membrane and semi-membrane tanks testing

13.3.1

IGC CODE REFERENCE: Ch 4, 4.10.7

The testing of membrane and semi-membrane tanks is to comply with the requirements.

13.4 Independent tank testing

13.4.1

IGC CODE REFERENCE: Ch 4, 4.10.10

The conditions in which testing is performed are to simulate as far as possible the actual loading on the tank and its supports.

13.4.2

IGC CODE REFERENCE: Ch 4, 4.10.10

When testing takes place after installation of the cargo tank, provision is to be made prior to the launching of the ship in order to avoid excessive stresses in the ship structures.

13.5 Final tests

13.5.1

IGC CODE REFERENCE: Ch 4, 4.10

The tests on the completed system are to be performed in the presence of a Surveyor and are to demonstrate that the cargo containment arrangements are capable of being inerted, cooled, loaded and unloaded in a satisfactory way and that all the safety devices operate correctly.

13.5.2

IGC CODE REFERENCE: Ch 4, 4.10

Tests are to be performed at the minimum service temperature or at a temperature very close to it.

13.5.3

IGC CODE REFERENCE: Ch 4, 4.10

The reliquefaction and inert gas production systems, if any, and the installation, if any, for use of gas as fuel for boilers and internal combustion engines are also to be tested to the satisfaction of the Surveyor.

13.5.4

IGC CODE REFERENCE: Ch 4, 4.10

- All operating data and temperatures read during the first voyage of the loaded ship are to be sent to the Society.

- Attention is drawn to the requirements of Sec 1, 4.2.4 regarding the cold spots examination that is to be carried out on ships carrying liquefied natural gases (LNG) in bulk during the first loaded voyage.

13.5.5

IGC CODE REFERENCE: Ch 4, 4.10

All data and temperatures read during subsequent voyages are to be kept at the disposal of the Society for a suitable period of time.

14 Structural details

14.1 Special structural details

14.1.1 The specific requirements in Pt III for ships with the service notation liquefied gas carrier are to be complied with.

14.2 Knuckles of the inner hull plating

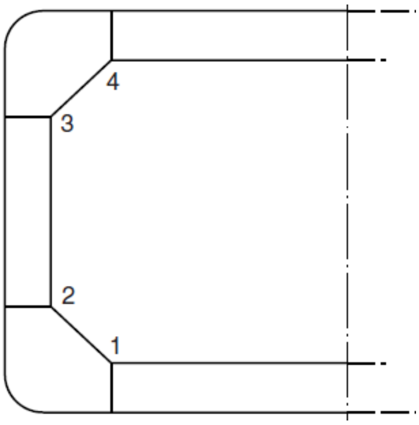
14.2.1

IGC CODE REFERENCE: Ch 4, 4.10

The detail arrangement of knuckles of the inner hull plating i.e. at points 1, 2, 3 and 4 in Fig 14.1, is to be made according to rules requirements.

14.2.2 Where there is no prolonging bracket in way of knuckle joints in positions 1 and/or 2, the connection of transverse webs to the inner hull and longitudinal girder plating is to be made with partial penetration welds over a length not less than 400 mm.

Figure 14.1 : Positions of connections



14.3 Connections of inner bottom with transverse cofferdam bulkheads

14.3.1 General

In addition to general requirements of Pt III, the requirements in 14.3.2 to 14.3.4 apply.

14.3.2 Floors

IGC CODE REFERENCE: Ch 4, 4.10

The thickness and material properties of the supporting floors are to be at least equal to those of the cofferdam bulkhead plating.

14.3.3 Vertical webs within cofferdam bulkhead

IGC CODE REFERENCE: Ch 4, 4.10

Vertical webs fitted within the cofferdam bulkhead are to be aligned with the double bottom girders.

14.3.4 Manholes

IGC CODE REFERENCE: Ch 4, 4.10

Manholes in double bottom floors aligned with the cofferdam bulkhead plating are to be located as low as practicable and at mid-distance between two adjacent longitudinal girders.

14.4 Cut-outs and connections

14.4.1 Cut-outs

IGC CODE REFERENCE: Ch 4, 4.10

Cut-outs for the passage of inner hull and cofferdam bulkhead ordinary stiffeners through the vertical webs are to be closed by collar plates welded to the inner hull plating.

14.4.2 Connection of the cargo containment system to the hull structure

IGC CODE REFERENCE: Ch 4, 4.10

Where deemed necessary, adequate reinforcements are to be fitted in the double hull and transverse cofferdams at connection of the cargo containment system to the hull structure. Details of the connection are to be submitted to the Society for approval.

Section 5 Process Pressure Vessels and Liquid, Vapour and Pressure Piping Systems

1 General

1.1 Process pressure vessels

1.1.1

IGC CODE REFERENCE: Ch 5, 5.1.2

Process pressure vessels handling cargo are to be considered as class 1 pressure vessels, in accordance with Pt IV, Ch 5.

2 Cargo and process piping

2.1 General

2.1.1 Other requirements

Cargo and process pipings have to comply with the applicable requirements of Pt IV, Ch 1, Sec 11 for class I pressure piping, unless otherwise specified in IGC Code or in the present Article.

2.1.2 Provisions for protection of piping against thermal stress

IGC CODE REFERENCE: Ch 5, 5.2.1.2

Expansion joints are to be protected from extensions and compressions greater than the limits fixed for them and the connected piping is to be suitably supported and anchored.

Bellow expansion joints are to be protected from mechanical damage.

2.1.3 Segregation of high temperature piping

IGC CODE REFERENCE: Ch 5, 5.2.1.3

High temperature pipes are to be thermally isolated from the adjacent structures. In particular, the temperature of pipelines is not to exceed 220°C in gas-dangerous zones.

2.1.4 Pressure relief valve setting

IGC CODE REFERENCE: Ch 5, 5.2.1.6

Pressure relief valves are to be set to discharge at a pressure not greater than the design pressure such that the overpressure during discharge does not exceed 110% of the design pressure.

2.1.5 Protection against leakage

IGC CODE REFERENCE: Ch 5, 5.2.1

Where the piping system is intended for liquids having a boiling point lower than □30خC, permanent means to avoid possibility of contact between leaks and hull structures are to be provided in all those locations where leakage might be expected, such as shore connections, pump seals, flanges subject to frequent dismantling, etc.

2.1.6 Means to detect the presence of liquid cargo

IGC CODE REFERENCE: Ch 5, 5.2.1

The means to detect the presence of liquid cargo may be constituted by electrical level switches whose circuit is intrinsically safe. The alarm signals given by the level switches are to be transmitted to the wheelhouse and to the cargo control station, if provided.

2.1.7 Connections of relief valve discharges to cargo tanks

IGC CODE REFERENCE: Ch 5, 5.2.1

The connections, if any, to the cargo tanks of relief valve discharges fitted on the liquid phase cargo piping are not to be fitted with shut-off valves, but are to be provided with non-return valves in the proximity of the tanks.

2.1.8 Centrifugal pumps

IGC CODE REFERENCE: Ch 5, 5.2.1

Overpressure relief valves on cargo pumps may be omitted in the case of centrifugal pumps having a maximum delivery head, the delivery valve being completely closed, not greater than that permitted for the piping.

2.1.9 Type approval

IGC CODE REFERENCE: Ch 5, 5.3.1

The piping components mentioned in the present Article are subject to a type approval by the Society.

2.1.10 Examination before and after the first loaded voyage

IGC CODE REFERENCE: Ch 5, 5.5.4

Attention is drawn to the requirements of Sec 1, 4.2.4 regarding the examination of the on-deck cargo pipping system, that are to be conducted on ships carrying liquefied natural gases (LNG) in bulk during the first full loading and the subsequent first unloading of the ship.

2.2 Scantlings based on internal pressure

2.2.1 Piping subject to green seas

IGC CODE REFERENCE: Ch 5, 5.2.2

In particular for piping subject to green seas, the design pressure P in the formula in paragraph 5.2.3 of the IGC Code is to be replaced by an equivalent pressure Pبgiven by the following formula:

$$P' = 0.5(P + \sqrt{P^2 + 6R'KD_C / D})$$

where:

K : Allowable stress, in MPa.

K is to be the lower of (R/2.7) and (R_e/1.8), where:

R : Specified minimum tensile strength at room temperature, in MPa

R_e : Specified lower minimum yield stress or 0.2% yield stress at room temperature, in MPa

D : External diameter of the pipe, in mm

D_C : External diameter of the pipe taking into account the insulation (in mm), whose thickness is to be taken at least equal to:

40 mm if D □50 mm

80 mm if D □150 mm

Intermediate values are to be determined by interpolation.

Rب: Drag corresponding to the effect of green seas, in MPa, such as given in Tab 2.1 as a function of the location of the pipes and of their height H (in m) above the deepest loadline; intermediate values are to be determined by interpolation.

Table 2.1 : Drag Rب corresponding to the effect of green seas (in MPa)

External diameter of pipe (1)	Aft of the quarter of the shipي length			Forward of the quarter of the shipي length		
	H□8	H=13	H□8	H□8	H=13	H□8
□25	0.015	0.0025	0.0015	0.022	0.0035	0.0015
50	0.014	0.0025	0.0015	0.020	0.0035	0.0015
75	0.011	0.0025	0.0015	0.016	0.0035	0.0015
100	0.007	0.0025	0.0015	0.007	0.0035	0.0015
□150	0.005	0.0025	0.0015	0.007	0.0035	0.0015

(1) D_C if the pipe is insulated, D otherwise.

2.3 Design pressure

2.3.1 Design pressure definition

IGC CODE REFERENCE: Ch 5, 5.2.3.1

For each piping section, the maximum pressure value among those applicable in paragraph 5.2.2.1 of the IGC Code is to be considered.

2.4 Permissible stress

2.4.1 Flanges not complying with standards

IGC CODE REFERENCE: Ch 5, 5.2.4.5

For flanges not complying with a standard, the dimensions

and type of gaskets are to be to the satisfaction of the Society.

2.5 Stress analysis

2.5.1 Calculations in accordance with recognized standards

IGC CODE REFERENCE: Ch 5, 5.2.5

When such an analysis is required, it is to be carried out in accordance with the requirements listed below. Subject to this condition, calculations in accordance with recognized standards are admitted by the Society.

2.5.2 Calculation cases

IGC CODE REFERENCE: Ch 5, 5.2.5

The calculations are to be made for every possible case of operation, but only those leading to the most unfavourable results are required to be submitted.

2.5.3 Loads to be taken for calculation

IGC CODE REFERENCE: Ch 5, 5.2.5

The calculations are to be carried out taking into account the following loads:

a) piping not subject to green seas:

- pressure
- weight of the piping and of the internal fluid
- contraction

b) piping subject to green seas that is liable to be in operation at sea and in port:

- pressure
- weight of the piping and of the internal fluid
- green seas
- contraction
- ship motion accelerations

c) piping subject to green seas that is in operation only in port; the more severe of the following two combinations of loads:

- pressure
- weight of the pipe and of the internal fluid
- contraction

and

- weight of the piping
- green seas
- expansion, assuming that the thermal stresses are fully relaxed.

2.5.4 Green sea directions

IGC CODE REFERENCE: Ch 5, 5.2.5

When green seas are considered, their effects are to be studied, unless otherwise justified, in the following three directions:

- axis of the ship
- vertical

- horizontal, perpendicular to the axis of the ship. The load on the pipes is the load R defined in 2.2.1.

2.5.5 Stress intensity

IGC CODE REFERENCE: Ch 5, 5.2.5

The stress intensity is to be determined as specified in the formulae in Pt IV, Ch 1, Sec 11, 2.3.2 for pipes intended for high temperatures:

a) for primary stresses resulting from:

- pressure
- weight
- green seas

b) for primary stresses and secondary stresses resulting from contraction.

2.5.6 Stress intensity limits

IGC CODE REFERENCE: Ch 5, 5.2.5

a) For the first case, the stress intensity is to be limited to the lower of:

0.8 R_e and 0.4 R_m

b) For the second case, the stress intensity is to be limited to the lower of:

1.6 R_e and 0.8 R_m.

2.5.7 Piping with expansion devices

IGC CODE REFERENCE: Ch 5, 5.2.5

For piping fitted with expansion devices, their characteristics are to be submitted to the Society. Where these characteristics are such that the forces and moments at the ends of the devices are negligible for the contraction they must absorb, the calculation of the loads due to contraction in the corresponding piping is not required. It is, however, to be checked that the stress intensity corresponding to the primary stresses does not exceed the limits given in 2.5.6.

2.5.8 Flexibility coefficient

IGC CODE REFERENCE: Ch 5, 5.2.5

The flexibility coefficient of elbows is to be determined from the formulae given in Pt IV, Ch 1, Sec 11, 2.3.2 for pipes intended for high temperatures.

2.5.9 Local stresses

IGC CODE REFERENCE: Ch 5, 5.2.5

Particular attention is to be paid to the calculation of local stresses in the assemblies subjected to axial forces and bending moments. The Society reserves the right to request additional justifications or local strengthening where considered necessary.

2.6 Aluminised pipes

2.6.1

IGC CODE REFERENCE: Ch 5, 5.2.6

Aluminised pipes may be fitted in ballast tanks, in inerted cargo tanks and, provided the pipes are protected from accidental impact, in hazardous areas on open deck.

3 Cargo system valving requirements

3.1 Cargo tank connections for gauging

3.1.1 Exemption

IGC CODE REFERENCE: Ch 5, 5.6.2

The requirements in paragraph 5.6.2 of the IGC Code relevant to cargo tank connections for pressure gauges and measuring devices do not apply to tanks with an MARVS not exceeding 0.07 MPa.

3.2 Emergency shutdown

3.2.1 Clarification on location of fusible elements

IGC CODE REFERENCE: Ch 5, 5.6.4

The cargo stations in way of which the fusible elements mentioned in paragraph 5.6.4 of the IGC Code are to be fitted are to be intended as the loading and unloading manifolds.

4 Cargo transfer methods

4.1 Discharge into common header

4.1.1

IGC CODE REFERENCE: Ch 5, 5.8

When two or more pumps located in different cargo tanks are operating at the same time discharging into a common header, the stopping of the pumps is to activate an alarm at the centralised cargo control location.

5 Bonding

5.1 Static electricity

5.1.1 Acceptable resistance

IGC CODE REFERENCE: Ch 5, 5.2.1

To avoid the hazard of an incentive discharge due to the build-up of static electricity resulting from the flow of the liquid/ gases/vapours, the resistance between any point on the surface of the cargo and slop tanks, piping systems and equipment, and the hull of the ship is not to be greater than 10^{6} □.

5.1.2 Bonding straps

IGC CODE REFERENCE: Ch 5, 5.2.1

Bonding straps are required for cargo and slop tanks, piping systems and equipment which are not permanently connected to the hull of the ship, for example:

a) independent cargo tanks

b) cargo tank piping systems which are electrically separated from the hull of the ship

c) pipe connections arranged for the removal of the spool pieces.

Where bonding straps are required, they are to be:

a) clearly visible so that any shortcoming can be clearly detected

b) designed and sited so that they are protected against mechanical damage and are not affected by high resistivity contamination, e.g. corrosive products or paint

c) easy to install and replace.

Section 6 Materials for Construction

1 Material requirements

1.1 Tubes, forgings and castings for cargo and process piping

1.1.1

IGC CODE REFERENCE: Ch 6, Table 6.4

a) In general, impact tests are not required for forgings, rolled products and seamless pipes in stainless austenitic steel of grades 304, 304L, 316, 316L, 321 and 347.

b) Impact tests are required for:

- castings in steel grades 304, 304L, 321 and 347 when the service temperature is below −60°C
- castings in steel grades 316 and 316L (which contain molybdenum) at any temperature. A reduction of the tests may be granted for design temperatures above −60°C after examination of each case by the Society.

1.2 Aluminium coatings

1.2.1

IGC CODE REFERENCE : Ch 6, 6.2

The use of aluminium coatings is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo gas may accumulate.

2 Welding and non-destructive testing

2.1 Welding consumables

2.1.1

IGC CODE REFERENCE : Ch 6, 6.3.2

The content of paragraph 6.3.2 of the IGC Code is also to cover process pressure vessels and secondary barriers.

2.2 Test requirements

2.2.1 Bend tests

IGC CODE REFERENCE : Ch 6, 6.3.4.2

As an alternative to the bend test indicated in paragraph 6.3.2 of the IGC Code, a test over a mandrel having a diameter equal to 3 times the thickness with a bend angle up to 120° may be required.

Section 7 Cargo Pressure/Temperature Control

1 Additional requirements for refrigerating plants

1.1

1.1.1

IGC CODE REFERENCE: Ch 7, 7.2

In general, in addition to the requirements of 7.2 of the IGC Code, refrigerating plants are to comply with the provisions of Pt IV, Ch 1, Sec 13 as applicable.

1.1.2 Examination before and after the first loaded voyage

Attention is drawn to the requirements of Sec 1, 4.2.4 regarding the satisfactory operation of the reliquefaction plant, if installed, and of any other equipment fitted for the burning of cargo vapors, that is to be ascertained during the first full loading and the subsequent first unloading of ships carrying liquefied natural gasses (LNG) in bulk.

2 Reliquefaction plant of motor-driven LNG carriers

2.1 Mechanical refrigeration fitted as the primary system for cargo pressure control

2.1.1 General

IGC CODE REFERENCE: Ch 7, 7.2

Paragraph 7.2 of the IGC Code relative to refrigerating systems is based on the assumption that maintenance of the cargo pressure described in 7.1 of the IGC Code is complied with by using means defined in 7.1.1.2 of the Code.

That is to say, a mechanical refrigeration system is fitted as the primary means of maintaining the cargo tank pressure below MARVS.

2.1.2 Standby refrigerating units

IGC CODE REFERENCE: Ch 7, 7.2

Paragraph 7.2 of the IGC Code is to apply to refrigeration systems fitted on LNG carriers, i.e. the standby capacity required is to be as detailed in 7.2.1 of the IGC Code. A standby LNG/refrigerant heat exchanger need not be provided and the fitted LNG/refrigerant heat exchanger is not required to have 25% excess capacity over that for normal requirements. Other heat exchangers utilising water cooling are to have a standby or to have at least 25% excess capacity.

2.1.3 Alternative means for cargo pressure/temperature control

IGC CODE REFERENCE: Ch 7, 7.2

Paragraph 7.2.1 of the IGC Code states that unless an alternative means of controlling the cargo pressure/temperature is provided to the satisfaction of the Administration, a standby unit (or units) affording spare capacity at least equal to the largest required single unit is (are) to be fitted.

For the purpose of complying with the above, a suitable alternative means of pressure/temperature control would be:

a) auxiliary boiler(s) capable of burning the boil-off vapours and disposing of the generated steam or an alternative waste heat system acceptable to the Society.

Consideration will be given to systems burning only part of the boil-off vapour if it can be shown that MARVS will not be reached within a period of 21 days.

b) controlled venting of cargo vapours as specified in paragraph 7.1.1.5 of the IGC Code if permitted by the Administration concerned.

2.2 Mechanical refrigeration fitted as a secondary system for cargo pressure control

2.2.1

IGC CODE REFERENCE: Ch 7, 7.2

Where a refrigeration plant is fitted as a means of disposing of excess energy as detailed in the second sentence of 7.1.1.2, no standby unit will be required for the refrigeration plant.

2.3 Examination before and after the first loaded voyage

2.3.1 Attention is drawn to the requirements of Sec 1, 4.2.4 regarding the satisfactory operation of the inert gas generating plant and of the associated control system that is to be ascertained during the first full loading and the subsequent first unloading of ships carrying liquefied natural gasses (LNG) in bulk.

Section 8 Cargo Tank Venting System

1 Pressure relief systems

1.1 Interbarrier spaces

1.1.1 Protection of interbarrier spaces

IGC CODE REFERENCE : Ch 8, 8.2.2

a) The formula for determining the relieving capacity given in paragraph 8.3.2 of the IGC Code is developed for interbarrier spaces surrounding independent type A cargo tanks, where the thermal insulation is fitted to the cargo tanks.

b) The relieving capacity of pressure relief devices of interbarrier spaces surrounding independent type B cargo tanks may be determined on the basis of the method given in paragraph 8.2 of the IGC Code; however, the leakage rate is to be determined in accordance with 4.7.6.1 of the IGC Code.

c) The relieving capacity of pressure relief devices for interbarrier spaces of membrane and semi-membrane tanks is to be evaluated on the basis of specific membrane/ semi-membrane tank design.

d) The relieving capacity of pressure relief devices for interbarrier spaces adjacent to integral type cargo tanks may, if applicable, be determined as for type A independent cargo tanks.

e) Interbarrier space pressure relief devices in the scope of this interpretation are emergency devices for protecting the hull structure from being unduly overstressed in the event of a pressure rise in the interbarrier space due to primary barrier failure. Therefore such devices need not comply with the requirements of paragraphs 8.2.9 and 8.2.10 of the IGC Code.

1.1.2 Size of pressure relief devices

IGC CODE REFERENCE : Ch 8, 8.2.2

The combined relieving capacity, in m^3/s, of the pressure relief devices for interbarrier spaces surrounding type A independent cargo tanks where the insulation is fitted to the cargo tanks may be determined by the following formula:

$$Q_{sa} = 3.4\, A_C \frac{\rho}{\rho_v} \sqrt{h}$$

where:

Q_{sa} : Minimum required discharge rate of air in standard conditions of 273 K and 1.013 bar

A_C : Design crack opening area, in m2, equal to:

$$A_C = \frac{\pi}{4} \delta l$$

where:

□Maximum crack opening width, in m, equal to:

□= 0.2 t

t being the thickness of tank bottom plating, in m

l : Design crack length, in m, equal tothe diagonal of the largest plate panel of the tank bottom (see Fig 1.1)

h : Maximum liquid height above tank bottom plus 10 □MARVS, in m

□: Density of product liquid phase, in kN/m^3, at the set pressure of the interbarrier space relief device

□$_v$: Density of product vapour phase, in kN/m^3, at the set pressure of the interbarrier space relief device and a temperature of 273 K.

1.2 Vents

1.2.1

IGC CODE REFERENCE : Ch 8, 8.2.9

The height of vent exits as indicated in paragraph 8.2.9 of the IGC Code is also to be measured above storage tanks and cargo liquid lines, where applicable.

1.3 Segregation of vents

1.3.1 Additional requirements on vent location

IGC CODE REFERENCE : Ch 8, 8.2.10

a) The distances of the vent exits are to be measured horizontally.

b) In the case of carriage of flammable and/or toxic products, the vent exits are to be arranged at a distance of at least 5 m from exhaust ducts and at least 10 m from intake ducts serving cargo pump rooms and/or cargo compressor rooms.

c) The distances are also intended to refer to outlets of ventilation ducts of safe spaces.

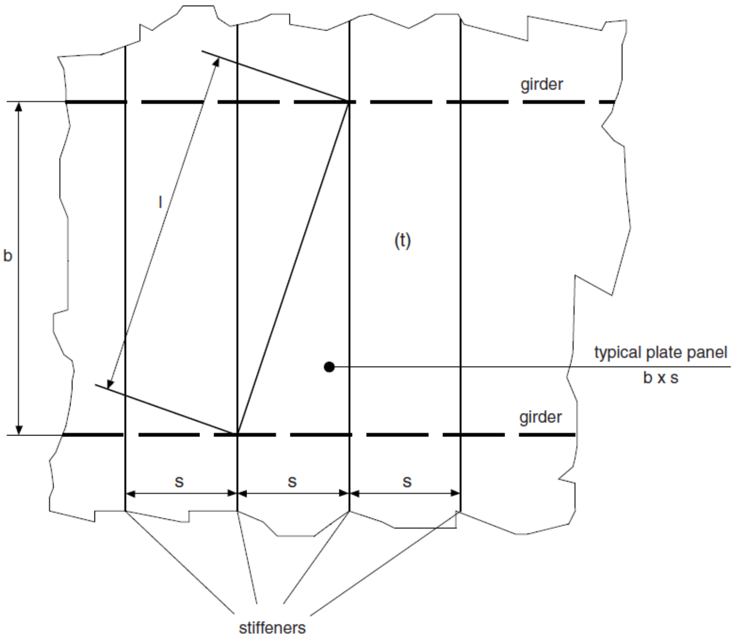
1.4 Back pressure

1.4.1 Pressure drop in vent lines

IGC CODE REFERENCE : Ch 8, 8.2.16

The pressure drop in the vent line from the tank to the pressure relief valve inlet is not to exceed 3% of the valve set pressure. For unbalanced pressure relief valves the back pressure in the discharge line is not to exceed 10% of the gauge pressure at the relief valve inlet with the vent lines under fire exposure.

Figure 1.1 : Determination of l



2 Additional pressure relieving system for liquid level control

2.1 General

2.1.1 Additional pressure relieving system

IGC CODE REFERENCE : Ch 8, 8.2.2

The override arrangement indicated in paragraph 8.3.1.2 of the IGC Code is to be capable of being manually operated.

As an alternative, means for manual venting are to be provided.

2.1.2 Tank filling limits

IGC CODE REFERENCE : Ch 8, 8.2.2

The words 'to prevent the tank from becoming liquid full' in paragraph 8.3.1.1 of the IGC Code have the following meaning:

At no time during the loading, transport or unloading of the cargo including fire conditions will the tank be more than 98% liquid full, except as permitted by 15.1.3 of the IGC Code. These requirements, together with those of 8.2.17 of the IGC Code, are intended to ensure that the pressure relief valves remain in the vapour phase.

Section 9 Environmental Control

1 Inerting

1.1 General

1.1.1 Dew point

IGC CODE REFERENCE: Ch 9, 9.3 and Ch 9, 9.4.1

As far as the IGC Code requirements relevant to the dew point are concerned, the following additional provisions apply:

a) where cargo tank insulation is not protected from water vapour penetration by means of an effective vapour barrier, accepted by the Society, the maximum value of the dew point is to be less than the design temperature

b) where cargo tank insulation is protected by an effective vapour barrier, accepted by the Society, the maximum value of the dew point is to be less than the minimum temperature which may be found on any surface within the spaces filled with dry inert gas or dry air

c) the temperature of the hull structures adjacent to cargo tanks is not to become lower than the minimum permissible working temperature, specified in Sec 6, for the steel grade employed for such hull structures

d) The capacity of dry air or inert gas equipment to produce dry air is to be verified in workshop

e) Means are to be provided on board to measure the dryness of the hold space atmosphere. The equipment may be portable provided permanent connections and/or sampling pipes are fitted.

1.1.2 Precautions against fire

IGC CODE REFERENCE: Ch 9, 9.4.1

Precautions are to be taken to minimise the risk that static electricity generated by the inert gas system may become a source of ignition.

2 Inert gas production on board

2.1 Exemptions

2.1.1

IGC CODE REFERENCE: Ch 9, 9.5

a) Inert gas generating systems are to be considered as essential services and are to comply with the applicable Sections of the Rules, as far as applicable.

b) Where, in addition to inert gas produced on board, it is possible to introduce dry air into the above-mentioned spaces, where this is acceptable depending on the type of cargo tank adopted, or to introduce inert gas from a supply existing on board, it is not necessary that standby or spare components for the inert gas system are kept on board.

2.2 Engineering specifications

2.2.1 The requirements of Ch 5, Sec 9, 2 are to be complied with, as far as applicable.

Section 10 Electrical Installations

1 General

1.1 Application

1.1.1 The requirements in this Section apply, in addition to those contained in Part IV, Chapter 2, to gas carriers.

1.1.2 The design is to be in accordance with IEC publication 60092-502.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt IV, Ch 2, the following are to be submitted for approval:

a) plan of hazardous areas

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

c) diagrams of tank level indicator systems, high level alarm systems and overflow control systems where requested.

1.3 System of supply

1.3.1 Acceptable systems of supply

IGC CODE REFERENCE: Ch 10, 10.1.1

The following systems of generation and distribution of electrical energy are acceptable:

a) direct current:

- two-wire insulated

b) alternating current:

- single-phase, two-wire insulated
- three-phase, three-wire insulated.

In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

1.3.2 Earthed system with hull return

IGC CODE REFERENCE: Ch 10, 10.1.1

Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective systems

b) limited and locally earthed systems, such as starting and ignition systems of internal combustion engines, provided that any possible resulting current does not flow directly through any hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions.

1.3.3 Earthed systems without hull return

IGC CODE REFERENCE: Ch 10, 10.1.1

Earthed systems without hull return are not permitted, with the following exceptions:

a) earthed intrinsically safe circuits and the following other systems to the satisfaction of the Society

b) power supplies, control circuits and instrumentation circuits in non-hazardous areas where technical or safety reasons preclude the use of a system with no connection to earth, provided the current in the hull is limited to not more than 5 A in both normal and fault conditions,

or

c) limited and locally earthed systems, such as power distribution systems in galleys and laundries to be fed through isolating transformers with the secondary windings earthed, provided that any possible resulting hull current does not flow directly through any hazardous

area, or

d) alternating current power networks of 1,000 V root mean square (line to line) and over, provided that any possible resulting current does not flow directly through any hazardous area; to this end, if the distribution system is extended to areas remote from the machinery space, isolating transformers or other adequate means are to be provided.

1.4 Earth detection

1.4.1 Monitoring of circuits in hazardous areas

IGC CODE REFERENCE: Ch 10, 10.1.1

The devices intended to continuously monitor the insulation level of all distribution systems are also to monitor all circuits, other than intrinsically safe circuits, connected to apparatus in hazardous areas or passing through such areas.

An audible and visual alarm is to be given, at a manned position, in the event of an abnormally low level of insulation.

1.5 Mechanical ventilation of hazardous spaces

1.5.1 Electric motors driving fans of the ventilating systems of hazardous spaces are to be located outside the ventilation ducting.

1.5.2 At the discretion of the Society, motors driving ventilating fans may be located within the ducting provided that they are of a certified safe type and are arranged with an additional enclosure (having a degree of protection of at least IP 44) which prevents the impingement of the ducted air stream upon the motor casing.

1.5.3 The materials used for the fans and their housing are to be in compliance with Ch 4, Sec 1, [1.2.10].

1.5.4 Cargo compressor rooms and other enclosed spaces which contain cargo-handling equipment and similar spaces in which work is performed on the cargo should be fitted with mechanical ventilation systems, capable of being controlled from outside such spaces.

1.5.5 Provisions are to be made to ventilate the spaces defined in 1.5.4 prior to entering the compartment and operating the equipment.

1.6 Electrical installation precautions

1.6.1 Precautions against inlet of gases or vapours

IGC CODE REFERENCE: Ch 10, 10.1.2

Suitable arrangements are to be provided, to the satisfaction of the Society, so as to prevent the possibility of gases or vapours passing from a gas-dangerous space to another space through runs of cables or their conduits.

2 Hazardous locations and types of equipment

2.1 Electrical equipment permitted in gasdangerous spaces and zones

2.1.1 In order to facilitate the selection of appropriate electrical apparatus and the design of suitable electrical installations, hazardous areas are divided into zone 0, 1 and 2 according to Pt IV, Ch 2. The different spaces are to be classified according to Tab 2.1.

The types of electrical equipment admitted, depending on the zone where they are installed, are specified in Pt IV, Ch 2.

2.1.2 A space separated by a gastight boundaries from a hazardous area may be classified as zone 0, 1, 2 or considered as non hazardous, taking into account the sources of release inside that space and its conditions of ventilation.

2.1.3 Access door and other openings are not to be provided between an area intended to be considered as nonhazardous and a hazardous area or between a space intended to be considered as zone 2 and a zone 1, except where required for operational reasons.

2.1.4 In enclosed or semi-enclosed spaces having a direct opening into any hazardous space or area, electrical installations are to comply with the requirements for the space or area to which the opening leads.

2.1.5 Where a space has an opening into an adjacent, more hazardous space or area, it may be made into a less hazardous space or non-hazardous space, taking into account the type of separation and the ventilation system.

2.1.6 A differential pressure monitoring device or a flow monitoring device, or both, are to be provided for monitoring the satisfactory functioning of pressurisation of spaces having an opening into a more hazardous zone.

In the event of loss of the protection by the over-pressure or loss of ventilation in spaces classified as zone 1 or zone 2, protective measures are to be taken.

2.2 Submerged cargo pumps

2.2.1 Exceptions

Submerged cargo pumps are not permitted in connection with the following cargoes:

- diethyl ether
- vinyl ethyl ether
- ethylene oxide
- propylene oxide
- mixtures of ethylene oxide and propylene oxide.

2.2.2 Submerged electric motors

a) Where submerged electric motors are employed, means are to be provided, e.g. by the arrangements specified in paragraph 17.6 of the IGC Code, to avoid the formation of explosive mixtures during loading, cargo transfer and unloading.

b) Arrangements are to be made to automatically shut down the motors in the event of low liquid level. This may be accomplished by sensing low pump discharge pressure, low motor current, or low liquid level. This shutdown is to be alarmed at the cargo control station.

Cargo pump motors are to be capable of being isolated from their electrical supply during gas-freeing operations.

3 Product classification

3.1 Temperature class and explosion group

3.1.1 Tab 3.1 specifies temperature class and explosion group data for the products indicated in Chapter 19 of the IGC Code. The data shown in brackets have been derived from similar products.

Table 2.1 : Space descriptions and hazardous area zones

No	Description of spaces	Hazardous area
1	The interior of cargo tanks, any pipework of pressure-relief or other venting systems for cargo, pipes and equipment containing the cargo or developing flammable gases and vapours.	Zone 0
2	Interbarrier spaces, hold spaces where cargo is carried in a cargo containment system requiring a secondary barrier.	Zone 0
3	Void space adjacent to, above or below integral cargo tanks.	Zone 1
4	Hold spaces where cargo is carried in a cargo containment system not requiring a secondary barrier.	Zone 1
5	Cofferdams and permanent (for example, segregated) ballast tanks adjacent to cargo tanks.	Zone 1
6	Cargo pump rooms and cargo compressor rooms.	Zone 1
7	Enclosed or semi-enclosed spaces, immediately above cargo tanks (for example, between decks) or having bulkheads above and in line with cargo tank bulkheads, unless protected by a diagonal plate acceptable to the society.	Zone 1
8	Spaces, other than cofferdam, adjacent to and below the top of a cargo tank (for example, trunks, passageways and hold).	Zone 1
9	Areas on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo manifold valve, cargo valve, cargo pipe flange, cargo pump-room ventilation outlets, cargo compressor room ventilation outlets and cargo tank openings for pressure release provided to permit the flow of small volumes of gas or vapour mixtures caused by thermal variation.	Zone 1
10	Areas on open deck, or semi-enclosed spaces on open deck above and in the vicinity of any cargo gas outlet intended for the passage of large volumes of gas or vapour mixture during cargo loading and ballasting or during discharging, within a vertical cylinder of unlimited height and 6 m radius centred upon the centre of the outlet, and within a hemisphere of 6 m radius below the outlet.	Zone 1
11	Areas on open deck, or semi-enclosed spaces on open deck, within 1.5 m of cargo pump room entrances, cargo pump room ventilation inlet, openings into cofferdams, cargo compressor room entrances, cargo compressor room ventilation inlets or other zone 1 spaces.	Zone 1
12	Areas on open deck within spillage coamings surrounding cargo manifold valves and 3 m beyond these, up to a height of 2.4 m above the deck.	Zone 1
13	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where structures are restricting the natural ventilation and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2.4 m above the deck	Zone 1
14	Compartments for cargo hoses.	Zone 1
15	Enclosed or semi-enclosed spaces in which pipes containing cargoes are located.	Zone 1
16	A space separated from a hold space, where cargo is carried in a cargo tank requiring a secondary barrier, by a single gastight boundary.	Zone 1
17	Enclosed or semi-enclosed spaces in which pipes containing cargo products for boil-off gas fuel burning systems are located, unless special precautions approved by the society are provided to prevent product gas escaping into such spaces.	Zone 1
18	Areas of 1.5 m surrounding a space of zone 1.	Zone 2
19	Spaces 4 m beyond the cylinder and 4 m beyond the sphere defined in item 10.	Zone 2
20	The spaces forming an air lock as defined in IEC publication 60092-502 4.1.5.2.c.	Zone 2
21	Areas on open deck extending to the coamings fitted to keep any spills on deck and away from the accommodation and service area and 3 m beyond these up to a height of 2.4 m above the deck.	Zone 2
22	Areas on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) where unrestricted natural ventilation is guaranteed and to the full breadth of the ship plus 3 m fore and aft of the forward-most and aft-most cargo tank bulkhead, up to a height of 2.4 m above the deck surrounding open or semi-enclosed spaces of zone 1.	Zone 2
23	Spaces forward of the open deck areas to which reference is made in 13 and 22, below the level of the main deck, and having an opening on to the main deck or at a level less than 0.5 m above the main deck, unless: ﭘ the entrances to such spaces do not face the cargo tank area and, together with all other openings to the spaces, including ventilating system inlets and exhausts, are situated at least 5 m from the foremost cargo tank and at least 10 m measured horizontally from any cargo tank outlet or gas or vapour outlet, and ﻳ the spaces are mechanically ventilated. Zone 2	Zone 2
24	An area within 2.4 m of the outer surface of a cargo tank where such surface is exposed to the weather.	Zone 2

Table 3.1 : Temperature class and explosion group of certain products

Product name	Temperature class	Explosion group	Product name	Temperature class	Explosion group
Acetaldehyde	T4	II A	Isopropylamine	T2	II A
Ammonia anhydrous	T1	II A	Methane	T1	II A
Butadiene	T2	II B	Methyl cetylene propadiene mixture	T4	II A
Butane	T2	II A	Methyl bromide	T3	II A
Butane/propane mixture	T2	II A	Methyl chloride	T1	II A
Butylenes	T3	II A	Monoethylamine	T2	II A
Carbon dioxide	NF	NF	Nitrogen	NF	NF
Chlorine	NF	NF	Pentane (all isomers)	(T2)	(II A)
Diethyl ether	T4	II B	Pentene (all isomers)	(T3)	(II B)
Dimethylamine	T2	II A	Propane	T1	II A
Dimethyl ether	T3	II B	Propylene	T2	II B
Ethane	T1	II A	Propylene oxide	T2	II B
Ethyl chloride	T2	II A	Refrigerant gases	NF	NF
Ethylene	T2	II B	Sulphur dioxide	(T3)	(II B)
Ethylene oxide	T2	II B	Vinyl chloride	T2	II A
Ethylene oxide propylene oxide mixture (max. 30% w/w ethylene oxide)	T2	II B	Vinyl ethylether	T3	II B
Isoprene	T3	II B	Vinylidene chloride	T2	II A

Section 11 Fire Protection and Fire Extinction

1 Fire safety requirements

1.1 Temperature of steam and heating media within the cargo area

1.1.1

REFERENCE IGC CODE: Ch 11, 11.1.2

The maximum temperature of the steam and heating media in the cargo area is to be adjusted to take into account the temperature class of the cargo.

2 Water spray system

2.1 Water-spray system coverage

2.1.1

REFERENCE IGC CODE: Ch 11, 11.3.1

The water spray system mentioned in paragraph 11.3.1 of the IGC Code is also to cover boundaries of spaces containing internal combustion engines and/or fuel treatment units, of store-rooms for flammable liquids having a flashpoint equal to or less than 60°C and of paint lockers.

2.2 Water-spray system capacity

2.2.1

REFERENCE IGC CODE: Ch 11, 11.3.2

.In general the vertical distance between the water spray nozzle rows protecting vertical surfaces should not exceed 3.7 m.

2.3 Protection of poop front

2.3.1

REFERENCE IGC CODE: Ch 11, 11.3

A stop valve is to be fitted on the water-spray main as close as possible to the poop front so that the accommodation spaces are always protected in the case of a spray-main failure.

3 Dry chemical powder fireextinguishing system

3.1 System capacity

3.1.1

REFERENCE IGC CODE: Ch 11, 11.4.2

Any exposed point of the cargo area, including cargo piping, is to be capable of being reached by powder delivered from at least two hoses or from a fixed monitor and one hose, which are not to be supplied by the same powder unit.

3.2 System arrangement

3.2.1 Additional miscellaneous requirements on powder units

REFERENCE IGC CODE: Ch 11, 11.4.3

a) Two powder units, even if mutually connected through a common main, may be considered independent on condition that non-return valves or other arrangements suitable to prevent powder from passing from one unit to the other are fitted.

b) The powder units which constitute the system are to contain, in general, the same powder quantity and, when they are not grouped together in a single position, they are to be uniformly located over the area to be protected.

c) Where powder units are grouped together in a single position or, in the case of ships having a cargo capacity less than 1000 m3, a single powder unit is installed, the said units are to be located aft of the cargo area.

4 Cargo compressor and pump rooms

4.1 Carbon dioxide system

4.1.1 Alarms

REFERENCE IGC CODE: Ch 11, 11.5.1

Audible alarms fitted to warn of the release of fire extinguishing medium into pump rooms, are to be of the pneumatic type or electric type.

a) In cases where the periodic testing of pneumatically operated alarms is required, CO_2 operated alarms should not be used owing to the possibility of the generation of static electricity in the CO_2 cloud. Air operated alarms may be used provided the air supply is clean and dry.

b) When electrically operated alarms are used, the arrangements are to be such that the electric actuating mechanism is located outside the pump room except where the alarms are certified intrinsically safe.

4.2 Portable fire extinguishers

4.2.1

REFERENCE IGC CODE: Ch 11, 11.5

In pump rooms and cargo compressor rooms, at least two portable extinguishers of a recognised type are to be fitted.

Section 12 Mechanical Ventilation in the Cargo Area

1 Spaces required to be entered during normal cargo handling

operations

1.1 Location of discharges from dangerous spaces

1.1.1 Ventilation duct arrangement

IGC CODE REFERENCE: Ch 12, 12.1.6

a) Ventilation ducts are to be arranged at a suitable height from the weather deck. This height is not to be less than 2.4 m for intake ducts.

b) Ventilation ducts are to be fitted with metallic fire dampers provided with "open" and "closed" signs. These dampers are to be arranged in the open, in a readily accessible position.

c) Gas-dangerous spaces for the purpose of 1.1.1.a) are those mentioned in paragraph 12.1.5 of the IGC Code. For other spaces which are gas-dangerous only due to their position, some relaxation may be granted.

1.2 Recirculation prevention

1.2.1

IGC CODE REFERENCE: Ch 12, 12.1.7

a) Exhaust ducts from gas-dangerous spaces are to be arranged at a distance in the horizontal direction of at least 10 m from ventilation outlets of gas-safe spaces.

Shorter distances may be accepted for ventilation outlets from safe spaces protected by air-locks.

b) Intakes of gas-dangerous spaces are to be arranged at a distance in the horizontal direction of at least 3 m from ventilation intakes and outlets and openings of accommodation spaces, control stations and other gas-safe spaces.

c) Exhaust and intake ducts for the same gas-dangerous space, or for the same space rendered safe by an airlock, are to be arranged at a distance from each other in the horizontal direction of not less than 3 m.

1.3 Additional requirements for non-sparking fans

1.3.1 Non-sparking fans

IGC CODE REFERENCE: Ch 12, 12.1.9

a) A fan is considered as non-sparking if in both normal or abnormal conditions it is unlikely to produce sparks.

b) The air gap between the impeller and the casing is to be not less than 0.1 of the shaft diameter in way of the impeller bearing and not less than 2 mm. It need not be more than 13 mm.

c) Protection screens of not more than 13 mm2 mesh are to be fitted in the inlet and outlet of ventilation ducts to prevent the entrance of objects into the fan housing.

1.3.2 Materials for non-sparking fans

IGC CODE REFERENCE: Ch 12, 12.1.9

a) The impeller and the housing in way of the impeller are to be made of alloys which are recognised as being spark proof by appropriate tests.

b) Electrostatic charges both in the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation on board of the ventilation units is to be such as to ensure their safe bonding to the hull.

c) Tests may not be required for fans having the following combinations:

- impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity
- impellers and housings of non-ferrous materials
- impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous materials is fitted in way of the impeller
- any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm design tip clearance.

d) The following impellers and housings are considered as sparking and are not permitted:

- impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance
- housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance
- any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

1.3.3 Type test for non-sparking fans

IGC CODE REFERENCE: Ch 12, 12.1.9

Type tests on the finished product are to be carried out in accordance with the requirements of the Society or an equivalent national or international standard.

1.3.4 Motor shafting

IGC CODE REFERENCE: 12, 12.1.9

The shafting penetration of motors driving fans through bulkheads and decks of dangerous spaces or through ventilation ducts is to be fitted with a gas-tight sealing device, of the oilseal type or equivalent, deemed suitable by the Society.

2 Spaces not normally entered

2.1 General requirements

2.1.1 Minimum number of air changes

IGC CODE REFERENCE: 12, 12.2

Both fixed and portable systems are to guarantee the efficient ventilation of such spaces in relation to the relative density, in respect of the air, and to the toxicity of the gases transported. Such ventilation system is to be capable of effecting not less than 8 air changes per hour. The type of portable fans and their connection to the spaces served are to be approved by the Society. In no case are portable electrical fans acceptable.

Section 13 Instrumentation (Gauging, Gas Detection)

1 General

1.1 Cargo tank instrumentation

1.1.1 The instrumentation is to be of a type approved by the Society.

1.1.2 Attention is drawn to the requirements of Sec 1, 4.2.4 regarding the satisfactory operation of the cargo control and monitoring system and of the level alarm system, that is to be ascertained during the first full loading and the subsequent first unloading of ships carrying liquefied natural gasses (LNG) in bulk.

1.2 Detection of leak through secondary barrier

1.2.1

IGC CODE REFERENCE: Ch 13, 13.1.2

Upon special approval, appropriate temperature indicating devices may be accepted by the Society instead of gas detecting devices when the cargo temperature is not lower than -55°C.

1.3 Indicator location

1.3.1 Monitoring list

IGC CODE REFERENCE: Ch 13, 13.1.3

The following information and alarms are to be concentrated in the positions specified in this requirement.

a) The following is to be transduced to the "cargo control room" and the "control position" as defined in 3.4.1 of the IGC Code:

1) the indication signalling the presence of water and/or liquid cargo in holds or interbarrier spaces
2) the cargo heater low temperature alarm required in 4.2.7 of the IGC Code
3) the alarm signalling the presence of liquid cargo in the vent main as per 5.2.1.7 of the IGC Code
4) the indication of the hull temperature and the hull structure low temperature alarm required in 13.5.2 of the IGC Code
5) the alarm signalling the automatic shutdown of electrically driven submerged pumps required in 10.2.2 of the IGC Code
6) the indication of the cargo level and the cargo tank high level alarm required in 13.3.1 of the IGC Code
7) the indication of the vapour space pressure and the vapour space pressure gauges of each cargo tank and associated high and low pressure alarms required in 13.4.1 of the IGC Code
8) the gas detection equipment alarm required in 13.6.4 of the IGC Code

9) the cargo compressor high temperature alarm required in 17.4.2.2 of the IGC Code

10) the alarm for automatic shutdown of the cargo compressor for high pressure or high temperature, as required in 17.18.4.4 of the IGC Code.

When the cargo system is not remote controlled and therefore the aforesaid "control positions" are not required, the above-mentioned controls, information and alarms are to be located in a suitable, easily accessible location.

If this position is an enclosed space, it is to comply with the requirements of 3.3.3 of the IGC Code. This position should preferably be located in the wheelhouse.

b) Independently of the above, the following is to be transduced to the wheelhouse:

1) the alarm signalling the presence of water and/or liquid cargo in holds or interbarrier spaces

2) the cargo heater low temperature alarm required in 4.2.7 of the IGC Code

3) the alarm signalling the presence of liquid cargo in the vent main as per 5.2.1.7 of the IGC Code

4) the indication of the pressure value in the vapour space of each cargo tank mentioned in 13.4.1 of the IGC Code; such indication is to give the setting pressure value of the relief valve and the minimum allowable pressure value in the cargo tank concerned

5) the high pressure and low pressure alarms, when required, for cargo tanks as per 13.4.1 of the IGC Code

6) the hull structure low temperature alarm required in 13.5.2 of the IGC Code

7) the gas detection equipment alarm required in 13.6.4 of the IGC Code

8) the cargo compressor high temperature alarm required in 17.4.2.2 of the IGC Code

9) the alarm for automatic shutdown of the cargo compressor for high pressure or high temperature, as required in 17.18.4.4 of the IGC Code.

c) Where the cargo control room is located within the accommodation spaces and is readily accessible, the alarms in 13.3.2 of the IGC Code may be grouped in a single audible and visual alarm except for the indication and alarms in [1.3.1] item b) 4), item b) 5) and item b) 7), which are to be independent from each other.

d) The high level and high or low pressure audible and visual alarms for cargo tanks as per 13.3.1 and 13.3.2 of the IGC Code and the alarm signalling the presence of liquid in the vent main are to be located in such a position as to be clearly heard and identifiable by the personnel in charge of loading operation control.

2 Level indicators for cargo tanks

2.1 General

2.1.1

IGC CODE REFERENCE: Ch 13, 13.2.1

a) In order to assess whether or not one level gauge is acceptable, the wording "any necessary maintenance" is to be interpreted to mean that any part of the level gauge can be overhauled while the cargo tank is in service.

b) Where level gauges containing cargo are arranged outside the tank they serve, means are to be provided to shut them off automatically in the event of failure.

3 Overflow control

3.1 Overflow alarm and shutdown

3.1.1 Shut-off valve for overflow control

IGC CODE REFERENCE: Ch 13, 13.3.1

The sensor for automatic closing of the loading valve for overflow control may be combined with the liquid level indicators required by paragraph 13.2.1 of the IGC Code.

3.1.2 Shut-off valve closing time

IGC CODE REFERENCE: Ch 13, 13.3.1

The closing time of the valve referred to in 13.3.1 of the IGC Code (i.e. time from shutdown signal initiation to complete valve closure), in seconds, is to be not greater than:

3600 U/LR

where:

U : Ullage volume at operating signal level, in m^3

LR : Maximum loading rate agreed between ship and shore facility, in m3/h.

The loading rate is to be adjusted to limit surge pressure on valve closure to an acceptable level taking into account the loading hose or arm, and the ship and shore piping systems, where relevant.

4 Pressure gauges

4.1 Pressure gauges in cargo tanks

4.1.1

IGC CODE REFERENCE: Ch 13, 13.4.1

The low pressure alarm indicated in paragraph 13.4.1 of the IGC Code is also to be located in the cargo control room.

5 Temperature indicating devices

5.1 General

5.1.1 Temperature recording

IGC CODE REFERENCE: Ch 13, 13.5.1

The temperatures are to be continuously recorded at regular intervals. Audible and visual alarms are to be automatically activated when the hull steel temperature approaches the lowest temperature for which the steel has been approved.

6 Gas detection requirements

6.1 Position of sampling heads

6.1.1

IGC CODE REFERENCE: Ch 13, 13.6.2

Sampling heads in cargo holds are not to be located in positions where bilge water may collect.

6.2 Gas sampling lines

6.2.1

IGC CODE REFERENCE: Ch 13, 13.6.5

Gas sampling lines are to be located outside accommodation spaces, unless they are fitted within gas-tight pipes.

6.3 Protected spaces

6.3.1

IGC CODE REFERENCE: Ch 13, 13.6.7

In addition to the list in paragraph 13.6.7 of the IGC Code, the gas detection system is also to serve spaces adjacent to pump rooms and compressor rooms.

6.4 Portable gas detectors

6.4.1

IGC CODE REFERENCE: Ch 13, 13.6.13

For ships intended to carry toxic and flammable gases, two sets for toxic gases and two sets for flammable gases are to be provided.

Section 14 Protection of Personnel

1 Personnel protection requirements for individual products

1.1 Showers and eye wash

1.1.1

IGC CODE REFERENCE: Ch 14, 14.4.3

The showers and eye wash are to be fitted with a heating system, or other suitable installation, in order to avoid any ice formation in their piping.

Section 15 Filling Limits for Cargo Tanks

1 General

1.1

1.1.1 This Section is void, as there are no additional or alternative requirements to those indicated in Chapter 15 of the IGC Code.

Section 16 Use of Cargo as Fuel

1 Gas fuel supply

1.1 Piping

1.1.1 Piping runs

IGC CODE REFERENCE: Ch 16, 16.3.1

a) The main gas line between the gas make-up station and the machinery space is to be as short as possible.

b) The gas piping is to be installed as high in the space as possible and at the greatest possible distance from the ship's hull.

1.1.2 Segregation of piping

IGC CODE REFERENCE: Ch 16, 16.3.1

Gas piping is to be independent of other systems and may only be used for the conveyance of gas. It is to be ensured by its arrangement that it is protected against external damage.

1.1.3 Earthing

IGC CODE REFERENCE: Ch 16, 16.3.1

Gas piping is to be suitably earthed.

1.1.4 Testing

IGC CODE REFERENCE: Ch 16, 16.3.1

Piping, valves and fittings are to be hydrostatically tested, after assembly on board, to 1.5 times the working pressure but to not less than 7 bar. Subsequently, they are to be pneumatically tested to ascertain that all the joints are perfectly tight.

1.2 Valves

1.2.1 Manual operation

IGC CODE REFERENCE: Ch 16, 16.3.6

The three valves indicated in paragraph 16.3.6 of the IGC Code are to be capable of being manually operated.

1.2.2 Automatic operation

IGC CODE REFERENCE: Ch 16, 16.3.6

It is to be possible to operate the valves indicated in paragraph 16.3.6 of the IGC Code locally and from each control platform. They are to close automatically under the following service conditions:

a) whenever the gas pressure varies by more than 10 % or, in the case of supercharged engines, if the differential pressure between gas and charging air is no longer constant

b) in the event of one of the following fault situations:

1) Gas supply to boiler burners

- insufficient air supply for complete combustion of the gas
- extinguishing of the pilot burner for an operating burner, unless the gas supply line to every individual burner is equipped with a quick-closing valve that automatically cuts off the gas
- low pressure of the gas

2) Gas supply to internal combustion engines

- failure of supply to pilot fuel injection pump
- drop of engine speed below the lowest service speed
- indication by the gas detector in the crankcase vent line that the gas concentration is approaching the lower explosion limit.

2 Gas make-up plant and related storage tanks

2.1 General

2.1.1 Location of equipment for making up gas

IGC CODE REFERENCE: Ch 16, 16.4.1

Means for purging of flammable gases before opening are to be provided in the equipment for making up gas.

2.1.2 Equipment located on weather deck

IGC CODE REFERENCE: Ch 16, 16.4.1

Where the equipment (heaters, compressors, filters) for making up the gas for its use as fuel and the storage tanks are located on the weather deck, they are to be suitably protected from atmospheric agents and the sea.

2.2 Compressors

2.2.1 Miscellaneous requirements

IGC CODE REFERENCE: Ch 16, 16.4.2

a) The compressors are to be capable of being remotely stopped from an always and easily accessible, non-dangerous position in the open, and also from the engine room.

b) In addition, the compressors are to be capable of automatically stopping when the suction pressure reaches a certain value depending on the setting pressure of the vacuum relief valves of the cargo tanks.

c) The automatic shutdown device of the compressors is to have a manual resetting.

d) Piston-type compressors are to be fitted with relief valves discharging to a position in the open, such as not to give rise to hazards.

e) Volumetric compressors are to be fitted with pressure/ vacuum relief valves discharging into the suction line of the compressor.

f) The size of the pressure relief valves is to be determined in such a way that, with the delivery valve kept closed, the maximum pressure does not exceed the maximum working pressure by more than 10%.

g) The compressors are to be automatically stopped by the emergency shutdown system of the cargo valves.

h) The compressors are to be fitted with shut-off valves and flame screens on both the suction and delivery sides.

2.3 Heaters

2.3.1 Additional miscellaneous requirements

IGC CODE REFERENCE: Ch 16, 16.4.3

a) Operation of the heaters is to be automatically regulated depending on the gas temperature at the heater outlet.

b) Before it is returned to the machinery space, the heating medium (steam or hot water) is to go through a degassing tank located in the cargo area.

c) Provisions are to be made to detect and signal the presence of gas in the tank. The vent outlet is to be in a safe position and fitted with a flame screen.

3 Special requirements for main boilers

3.1 Boiler arrangement

3.1.1 Forced air circulation

IGC CODE REFERENCE: Ch 16, 16.5.1

Boilers are to be located as high as possible in boiler spaces and are to be of the membrane wall type or equivalent, so as to create a space with forced air circulation between the membrane wall and the boiler casing.

3.2 Combustion chamber

3.2.1 Gas detectors in the combustion chamber

IGC CODE REFERENCE: Ch 16, 16.5.3

The Society may, at its discretion, require gas detectors to be fitted in those combustion chamber areas where gas could accumulate, as well as the provision of suitable air nozzles.

3.3 Burner system

3.3.1 Safety devices

IGC CODE REFERENCE: Ch 16, 16.5.4

A mechanical device is to be installed to prevent the gas valve from opening until the air and the fuel oil controls are in the ignition position. A flame screen, which may be incorporated in the burner, is to be fitted on the pipe of each gas burner.

3.3.2 Shut-off

IGC CODE REFERENCE: Ch 16, 16.5.4

The gas supply is to be automatically stopped by the shutoff devices specified in paragraph 16.3.6 of the IGC Code.

4 Special requirements for gas fired internal combustion engines and gas fired turbines

4.1 Gas fuel supply to engine

4.1.1 Flame arresters

IGC CODE REFERENCE: Ch 16, 16.6

Flame arresters are to be provided at the inlet to the gas supply manifold for the engine.

4.1.2 Manual shut-off

IGC CODE REFERENCE: Ch 16, 16.6

Arrangements are to be made so that the gas supply to the engine can be shut off manually from the starting platform or any other control position.

4.1.3 Prevention of fatigue failure

IGC CODE REFERENCE: Ch 16, 16.6

The arrangement and installation of the gas piping are to provide the necessary flexibility for the gas supply piping to accommodate the oscillating movements of the engines without risk of fatigue failure.

4.1.4 Protection of gas line connections

IGC CODE REFERENCE: Ch 16, 16.6

The connecting of gas line and protection pipes or ducts as per 4.2.1 to the gas fuel injection valves is to provide complete coverage by the protection pipe or ducts.

4.2 Gas fuel supply piping systems

4.2.1 Fuel piping in machinery spaces

IGC CODE REFERENCE: Ch 16, 16.6

Gas fuel piping may pass through or extend into machinery spaces or gas-safe spaces other than accommodationspaces, service spaces and control stations provided that they fulfil one of the following conditions:

a) The system complies with paragraph 16.3.1.1 of the IGC Code, and in addition, with 1) to 3) below:

1) The pressure in the space between concentric pipes is monitored continuously. Alarm is to be issued and the automatic valves specified in 16.3.6 of the IGC Code (hereafter referred to as "interlocked gas valves") and the master gas fuel valves specified in 16.3.7 of the IGC Code (hereafter referred to as "master gas valves") are to be closed before the pressure drops to below the inner pipe pressure (however, an interlocked gas valve connected to the vent outlet is to be opened).

2) The construction and strength of the outer pipes are to comply with the requirements of 5.2 of the IGC Code.

3) It is to be so arranged that the inside of the gas fuel supply piping system between the master gas valve and the engine is automatically purged with inert gas when the master gas valve is closed; or

b) The system complies with paragraph 16.3.1.2 of the IGC Code, and, in addition, with 1) to 4) below:

1) The materials, construction and strength of protection pipes or ducts and mechanical ventilation systems are to be sufficiently durable against bursting and rapid expansion of high pressure gas in the event of gas pipe burst.

2) The capacity of mechanical ventilating systems is to be determined considering the flow rate of gas fuel and construction and arrangement of protective pipes or ducts, as deemed appropriate by the Society.

3) The air intakes of mechanical ventilating systems are to be provided with non-return devices effective for gas fuel leaks. However, if a gas detector is fitted at the air intakes, this requirement may be dispensed with.

4) The number of flange joints of protective pipes or ducts is to be minimised; or

c) Alternative arrangements to those given in a) and b) will be specially considered by the Society based upon an equivalent level of safety.

4.2.2 High pressure pipes

IGC CODE REFERENCE: Ch 16, 16.6

High pressure gas piping systems are to be checked for sufficient constructive strength by carrying out stress analysis taking into account the stresses due to the weight of the piping system including acceleration load, when significant, internal pressure and loads induced by hog and sag of the ship.

4.2.3 Valves and expansion joints

IGC CODE REFERENCE: Ch 16, 16.6

All valves and expansion joints used in high pressure gas fuel supply lines are to be of an approved type.

4.2.4 Pipe joints

IGC CODE REFERENCE: Ch 16, 16.6

Joints on the entire length of the gas fuel supply lines are to be butt-welded joints with full penetration and to be fully radiographed, except where specially approved by the Society.

4.2.5 Non-welded pipe joints

IGC CODE REFERENCE: Ch 16, 16.6

Pipe joints other than welded joints at the locations specifically approved by the Society are to comply with the appropriate standards recognised by the Society, or with joints whose structural strength has been verified through test analysis as deemed appropriate by the Society.

4.2.6 Post-weld heat treatment

IGC CODE REFERENCE: Ch 16, 16.6

For all butt-welded joints of high pressure gas fuel supply lines, post-weld heat treatment is to be performed depending on the kind of material.

4.3 Shut-off of gas fuel supply

4.3.1 Fuel supply shut-off

IGC CODE REFERENCE: Ch 16, 16.6

In addition to the causes specified in 16.3.6 of the IGC Code, supply of gas fuel to engines is to be shut-off by the interlocked gas valves in the event of the following abnormalities including engine stops due to any cause.

4.3.2 Master gas valve shut-off

IGC CODE REFERENCE: Ch 16, 16.6

In addition to the causes specified in 16.3.7 of the IGC Code, the master gas valve is to be closed in the event of any of the following:

a) the oil mist detector or bearing temperature detector detects abnormality

b) any kind of gas fuel leakage is detected

4.3.3 Automatic operation

IGC CODE REFERENCE: Ch 16, 16.6

The master gas valve is to close automatically upon activation of the interlocked gas valves.

4.4 Emergency stop of dual fuel engines

4.4.1

IGC CODE REFERENCE: Ch 16, 16.6

Dual fuel engines are to be stopped before the gas concentration detected by the gas detectors specified in 16.2.2 of the IGC Code reaches 60% of the lower flammable limit.

4.5 Gas fuel make-up plant and related storage tanks

4.5.1 Equipment construction

IGC CODE REFERENCE: Ch 16, 16.6

The construction, control and safety system of high pressure gas compressors, pressure vessels and heat exchangers constituting a gas fuel make-up plant are to be arranged to the satisfaction of the Society.

4.5.2 Fatigue

IGC CODE REFERENCE: Ch 16, 16.6

The possibility of fatigue failure of the high pressure gas piping due to vibration is to be considered.

4.5.3 Gas pressure pulsation

IGC CODE REFERENCE: Ch 16, 16.6

The possibility of pulsation of gas fuel supply pressure caused by the high pressure gas compressor is to be considered.

4.6 Requirements on dual fuel engines

4.6.1

IGC CODE REFERENCE: Ch 16, 16.6

Specific requirements on internal combustion engines supplied by gas are given in Pt IV,Ch1.

Section 17 Special Requirements

1 Materials for construction

1.1 Materials exposed to cargo

1.1.1

IGC CODE REFERENCE: Ch 17, 17.2

Materials "exposed to cargo" are those constituting systems, cargo appliances or arrangements which are in contact with (liquid or vapour) cargo in normal operating conditions.

2 Inhibition

2.1 Polymerisation prevention ـتAlternative requirement

2.1.1

IGC CODE REFERENCE: Ch 17, 17.8.1

a) As an alternative to the addition of inhibited liquid, it may be accepted that, at the end of each refrigeration period, the liquid is completely removed from the refrigeration system by means of vapour from compressors or by means of inert gas. In such case, the following wording is to be entered on the Certificate of Fitness:

"At the end of each refrigeration period, the liquid is to be completely removed from the refrigeration system by means of vapour from compressors or by means of inert gas."

b) On the cargo compressor delivery side, a temperature switch is to be fitted, set at a suitable temperature, depending on the characteristics of the product carried (e.g. 60°C for butadiene), giving a visual and audible alarm on the navigation bridge and in the cargo control station, if any, which causes the compressor to stop when such temperature is exceeded.

3 Chlorine

3.1 Cargo containment system

3.1.1 Relief valves

IGC CODE REFERENCE: Ch 17, 17.14.1.4

Chlorine discharge from pressure relief valves is to be led to an absorption device deemed suitable by the Society.

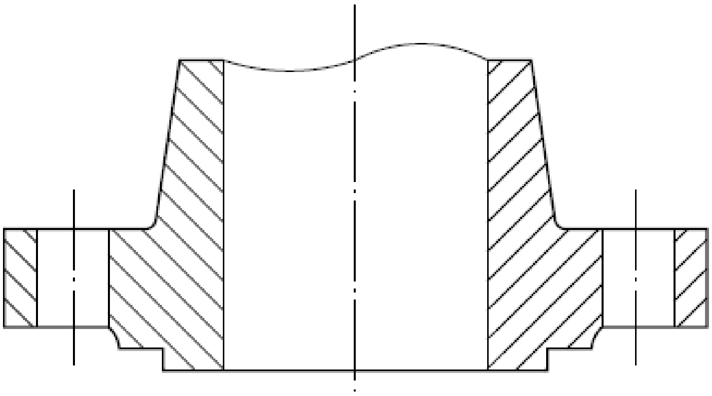
3.2 Cargo piping system

3.2.1 Piping design and fabrication

IGC CODE REFERENCE: Ch 17, 17.14.2.2

A welding neck type flange deemed suitable is shown in Fig 3.1 as an example.

Figure 3.1 : Suitable neck type flange



3.3 Instrumentation - Safety devices

3.3.1 Gas detection system

IGC CODE REFERENCE: Ch 17, 17.14.4.3

The gas detection system is to be permanently installed.

3.4 Protection of personnel

3.4.1 Additional equipment

IGC CODE REFERENCE: Ch 17, 17.14.5

In addition to the source of uncontaminated air, two complete and independent air breathing apparatuses, not employing oxygen supplies, each having a capacity of at least 1200 litres of non-compressed air and two sets of protective equipment, complete with gas-tight boots, gloves and eye protection, are to be provided. The above-mentioned equipment and clothing are to be kept in the space indicated in paragraph 17.14.5.1 of the IGC Code and are additional to those required in other parts of this Chapter.

3.5 Filling limits for cargo tanks

3.5.1

IGC CODE REFERENCE: Ch 17, 17.14.6.1

When determining the filling limits of the cargo tanks for the transport of chlorine, the effect of the refrigeration plant is not to be considered.

4 Carbon dioxide

4.1 Interpretation and application of the IGC Code for ships carrying liquefied carbon dioxide in bulk

4.1.1 Interpretation and application of the IGC Code for ships carrying liquefied carbon dioxide in bulk are given in Tab 4.1.

Table 4.1 : Interpretation and application of the IGC Code for ships carrying carbon dioxide in bulk

Paragraph	Interpretation
3.1.2	A single A-0 bulkhead is sufficient.
5.2.1.4	Electrical bonding of piping and tanks is not required.
5.6.4	Fusible elements in the emergency shutdown system are not required.
10	Certified safe electrical equipment is not required.
11	This entire chapter is not applicable.
12.1.9	Safe placing and safe construction of electrical fan motors is not required.
12.1.11	Protection screens in vent ducts are not required.
13.6	Only paragraphs 13.6.13 and 13.6.14 are applicable.

Section 18 Operating Requirements

1 General

1.1

1.1.1 This Section is void, as the provisions of Chapter 18 of the IGC Code are operating requirements which are not mandatory for the class, with exception of 18.8.2 which is referred to in Sec 13, 3.1.2.

Section 19 Summary of Minimum Requirements

1 Additional information on products

1.1

1.1.1

IGC CODE REFERENCE: Ch 19

Tab 1.1 lists some additional information for those products which are listed in the table in Chapter 19 of the IGC Code.

The list shown in Tab 1.1 gives properties for pure products.

The specific gravity to be taken into account for the design of a ship might be altered considering the actual properties of the commercial product.

Information on temperature classes and explosion groups for electrical equipment in connection with the products to be carried is indicated in Sec 10, Tab 2.1.

Table 2.1 :

Product name	Boiling temperature (°C)	Specific gravity at boiling point (kg/m^3)	Ratio vapour/air density
Acethaldehyde	20.8	780	1.52
Ammonia, anhhydrous	□33.4	680	0.60
Butiadene	□4.5	650	1.87
Butane	□0.5 /11.7	600	2.02
Butylenes	□6.3/-7	625	1.94
Carbon dioxide	□79.0	1180	1.50
Chlorine	□34	1560	2.49
Diethyl ether	34.6	640	2.55
Dimethylamine	6.9	670	1.55
Dimethyl ether	□24.4	720	1.62
Ethane	□88.6	549	1.04
Ethyl chloride	12.4	920	2.22
Ethylene	□104	570	0.97
Ethylene oxide	□10.7	870	1.52
Isoprene	34.5	680	2.35
Isopropylamine	32.5	700	2.03
Methane (LNG)	□61.5	420	0.55
Methyl acetylene/propadiene mixture	□32/-14	□	□
Methyl bromide	4.5	1730	3.27
Methyl chloride	□23.7	1000	1.78
Monoethylamine	16.6	690	1.56
Nitrogen	□196	808	0.97
Pentanes (all isomers)	36.1	610	2.60
Pentene (all isomers)	30.1/37	610	2.60
Propane	□42.3	580	1.56
Propylene	□47.7	610	1.50
Propylene oxides	34.5	860	2.00
Refrigerant gases Dichlorodifluoromethane (R12) Dichloromonofluoroethane(R21) Dichlorotetrafluoroethane(R114) Monochlorodifluoromethane(R22) Monochlorotetrafluoroethane(R124) Monochlorotrifluoromethane(R13)	 □30 8.9 3.8 □42 □ □81.4	 1486 1480 1510 1420 □ 1520	 4.26 3.90 1.31 2.98 4.70 3.60
Sulphur dioxide	□10	1460	2.30
Vinyl chloride	□13.9	970	2.15
Vinyl ethyl ether	35.5	754	2.50
Vinylidene chloride	31.7	1250	3.45

Chapter 7 Tankers

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Tanker as defined in Pt I.

1.1.2 Ships dealt with in this Chapter and which are covered by the SOLAS Convention are to comply with the requirements stipulated in Pt I, II, III and IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to tankers.

1.1.3 Ships dealt with in this Chapter and which are not covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I and IV, as applicable, and with the requirements of this Chapter, which are specific to tankers.

1.1.4 The liquid cargoes which are allowed to be carried by such ships are specified in Ch 4, App 4.

Section 2 Hull and Stability

1 General Arrangement Design

1.1 Compartment arrangement

1.1.1 General

Tankers may be built with independent or integral cargo tanks.

1.1.2 Integral tanks

Cofferdams are to be fitted between cargo tanks and compartments intended for liquids likely to alter edible liquids carried.

Tanks are to be separated from any compartment containing heat sources by cofferdams or duly heat-insulated bulkheads.

1.1.3 Arrangement of tanks

In general, each tank is to be fitted with:

- a graduated metal gauge rod or any other equivalent sounding device
- an inspection door of adequate size fitted with a watertight metal cover secured by wing bolts or any other device offering equivalent safety
- an expansion system intended to avoid any excessive pressure and any risk of overflow due to a rise in temperature or occasional fermentation; the expansion capacity is to be about 0.5% of the tank cubic capacity
- a drain well that may be suppressed where precautions are taken to improve the running of liquids towards the suction pipes.

2 Stability

2.1 Intact stability

2.1.1 General

The stability of the ship for the loading conditions in Pt III, Ch 4, App 2, 1.2.3 is to be in compliance with the requirements in Pt III, Ch 4, Sec 2.

In general, a representative sample of loading conditions intended to be used for the ship is also to be submitted. The additional loading conditions are also to be in compliance with the requirements of Pt III, Ch 4, Sec 2.

3 Structure design principles

3.1 Materials

3.1.1 Steels for hull structure

For ships having a poop, the steel type used for the strength deck plating in way of the poop front is to be extended forward to cover any pump room openings.

4 Design loads

4.1 Hull girder loads

4.1.1 Still water loads

In addition to the requirements in Pt III, Ch 2, still water loads are to be calculated for the following loading conditions:

- homogeneous loading conditions (excluding tanks intended exclusively for segregated ballast tanks) at maximum draft
- partial loading conditions
- any specified non-homogeneous loading condition
- light and heavy ballast conditions
- mid-voyage conditions relating to tank cleaning or other operations where, at the Society's discretion, these differ significantly from the ballast conditions.

5 Hull scantlings

5.1 Plating

5.1.1 Minimum net thicknesses

The net thickness of the strength deck and bulkhead plating is to be not less than the values given in Tab 5.1.

Table 5.1 : Minimum net thickness of the strength deck and bulkhead plating

Plating	Minimum net thickness (mm)	
Strength deck	$(5.5 + 0.02\ L)\ k^{1/2}$	for $L < 200$
	$(8 + 0.0085\ L)\ k^{1/2}$	for $L \geq 200$
Tank bulkhead	$L^{1/3}\ k^{1/6} + 4.5\ s$	for $L < 275$
	$1.5\ k^{1/2} + 8.2 + s$	for $L \geq 275$
Watertight bulkhead	$0.85\ L^{1/3}\ k^{1/6} + 4.5\ s$	for $L < 275$
	$1.5\ k^{1/2} + 7.5 + s$	for $L \geq 275$
Wash bulkhead	$0.8 + 0.013\ L\ k^{1/2} + 4.5\ s$	for $L < 275$
	$3\ k^{1/2} + 4.5 + s$	for $L \geq 275$

Note 1:

k : Material factor for steel, as defined in Pt III, Ch 2, Sec1.

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

5.2 Ordinary stiffeners

5.2.1 Minimum net thicknesses

The net thickness of the web of ordinary stiffeners is to be not less than the value obtained, in mm, from the following formulae:

$t_{MIN} = 0.75\ L^{1/3}\ k^{1/6} + 4.5\ s$ for $L < 275$

$t_{MIN} = 1.5\ k^{1/2} + 7.0 + s$ for $L \geq 275$

where s is the spacing, in m, of ordinary stiffeners.

5.3 Primary supporting members

5.3.1 Minimum net thicknesses

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

$t_{MIN} = 1.45\ L^{1/3}\ k^{1/6}$

5.4 Scantlings of independent tank structure

5.4.1 Structure in way of the connection between the tank and the hull structure

The tanks are to be locally strengthened in way of their connection to the hull structure and of their securing points, if any.

The structure of the ship is to be strengthened so as to avoid excessive deformations, due to the weight of the full tanks and inertia forces caused by motions of the ship, specified in Part III.

5.5 Strength check with respect to stresses due to the temperature gradient

5.5.1 Direct calculations of stresses induced in the hull structures by the temperature gradient are to be performed for ships intended to carry cargoes at temperatures exceeding 90°C. In these calculations, the water temperature is to be assumed equal to 0°C.

The calculations are to be submitted to the Society for review.

6 Other structures

6.1 Machinery space

6.1.1 Extension of the hull structures within the machinery space

Longitudinal bulkheads carried through cofferdams are to continue within the machinery space and be used preferably as longitudinal bulkheads for liquid cargo tanks. In any case, such extension is to be compatible with the shape of the structures of the double bottom, deck and platforms of the machinery space.

Section 3 Machinery and Cargo Systems

1 General

1.1 Documents to be submitted

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

2 Piping systems

2.1 General

2.1.1 Materials

a) Materials used for piping systems are to comply with the provisions of Pt IV, Ch 1, Sec 11, 2.1.

b) Attention is drawn to any national standards or regulations which might restrict the use of materials in contact with edible substances.

2.1.2 Independence of piping systems

a) The cargo piping system is to be entirely separated from other piping systems serving the ship.

b) In the case of carriage of edible substances, arrangements are to be made to avoid any inadvertent contamination of the cargo. In particular, the filling and discharge connections serving the cargo tanks are to be located remote from those serving the machinery piping systems.

2.1.3 Passage of pipes through tanks

Cargo tanks containing edible substances are not to be passed through by pipes conveying other liquids.

2.2 Cargo piping and pumping

2.2.1 Cargo pumps

At least two cargo pumps are to be provided for transferring the cargo.

2.2.2 Level gauging systems

Level gauging systems of tanks containing edible substances are to be so designed as to avoid any contamination of the cargo.

2.3 Air pipes

2.3.1

a) Air pipes of cargo tanks are to be fitted with automatic closing appliances. Refer to Pt IV, Ch 1, Sec 11, 9.1.

b) Air pipes of tanks containing edible substances are to be led as far as practicable from:

- air pipes of sewage or flammable oil tanks
- machinery ventilation outlets.

2.4 Refrigerating installations

2.4.1

a) Where the cargo needs to be kept refrigerated for conservation purposes, the refrigerating installation is to comply with the applicable requirements.

b) Provisions are to be made to avoid any contamination of the cargo by the refrigeration fluid.

2.5 Cargo tank cleaning systems

2.5.1 Adequate means are to be provided for cleaning the cargo tanks.

2.6 Additional requirements for ships carrying category Z substances

2.6.1 Tankers carrying category Z substances are to comply with the provisions of Ch 4, Sec 4, 9.2.2.

Table 1 : Documents to be submitted

Item No	Description of the document (1)
1	Diagram of the cargo piping system
2	Diagram of the cargo tank venting system
3	Diagram of the cargo tank level gauging system
4	Diagram of the cargo tank cleaning system
5	Diagram of the bilge and ballast systems serving the cargo spaces
6	Diagram of the cargo heating and refrigerating systems

(1) Diagrams are also to include, where applicable:

- the (local and remote) control and monitoring systems and automation systems
- the instructions for the operation and maintenance of the piping system concerned (for information).

Chapter 8 Passenger Ships

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Passenger ship, as defined in Pt I.

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts I, II, III, IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to passenger ships.

Section 2 Ship Arrangement

1 General

1.1 Definitions

1.1.1 Deepest subdivision load line

Deepest subdivision load line is the waterline which corresponds to the summer load line of the ship.

1.1.2 Subdivision length L_S

Subdivision length L_S of the ship is the greatest projected moulded length of that part of the ship at or below deck or decks limiting the vertical extent of flooding with the ship at the deepest subdivision load line.

The length referred to in 2 is the length L_S.

1.1.3 Passenger spaces

Passenger spaces are those spaces which are provided for the accommodation and use of passengers, excluding baggage, store, provision and mail rooms.

In all cases volumes and areas are to be calculated to moulded lines.

2 General arrangement design

2.1 Openings in watertight bulkheads below the bulkhead deck

2.1.1 Openings in machinery spaces

Not more than one door apart from the doors to shaft tunnels may be fitted in each watertight bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion.

Where two or more shafts are fitted the tunnels are to be connected by an inter-communicating passage. Only one door is to be provided between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors are to be of the sliding type and are to be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck is to be situated outside the spaces containing the machinery.

Portable plates on bulkheads are not permitted except in machinery spaces. Such plates are always to be in place before the ship leaves port, and are not to be removed during navigation except in the case of urgent necessity at the discretion of the Master. The necessary precautions are to be taken in replacing them to ensure that the joints are watertight. The Society may permit not more than one power-operated sliding watertight door in each watertight bulkhead larger than 1.20 m to be substituted for these portable plates, provided these doors are intended to remain closed during navigation except in the case of urgent necessity at the discretion of the Master. These doors need not meet the requirements of complete closure by handoperated gear in 90 seconds (see 2.3.3 e).

2.1.2 Openings in cargo spaces

Watertight doors complying with the requirements of 2.3.1 may be fitted in watertight bulkheads dividing cargo between deck spaces. Such doors may be hinged, rolling or sliding doors but are not to be remotely controlled. They are to be fitted at the highest level and as far from the shell plating as practicable, but in no case are the outboard vertical edges to be situated at a distance from the shell plating which is less than one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line.

The doors accessible during the voyage are to be fitted with a device which prevents unauthorised opening. When it is proposed to fit such doors, the number and arrangements are to receive the special consideration of the Society.

2.1.3 Openings in passenger ships carrying goods vehicles and accompanying personnel

This requirement applies to passenger ships designed or adapted for the carriage of goods vehicles and accompanying personnel where the total number of persons on board, other than passengers exceeds 12.

If in such a ship the total number of passengers which include personnel accompanying vehicles does not exceed:

$N=12+A/25$

where:

N : the maximum number of passengers for which the ship is certified

A : the total deck area, in m^2, of spaces available for the stowage of goods vehicles, and where the clear height at the stowage position and at the entrance to such spaces is not less than 4 m, the provisions of 2.1.2 in respect of watertight doors apply except that the doors may be fitted at any level in watertight bulkheads dividing cargo spaces.

Additionally, indicators are required on the navigating bridge to show automatically when each door is closed and all door fastenings are secured.

2.1.4 Trunks and tunnels

Where trunkways or tunnels for access from crew accommodation to the stokehold, for piping, or for any other purpose are carried through watertight bulkheads, they are to be watertight and in accordance with the requirements of Pt III, Ch 2, Sec 9. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, is to be through a trunk extending watertight to a height sufficient to permit access above the bulkhead deck. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels are not to extend through the first subdivision bulkhead abaft the collision bulkhead.

Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings are to be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

2.1.5 Additional requirements

In addition to 2.1.1 to 2.1.4, the requirements reported in 2.3.3 are to be complied with.

2.2 Openings in bulkheads above the bulkhead deck

2.2.1 General

Measures such as the fitting of partial bulkheads or webs are to be taken to limit the entry and spread of water above the bulkhead deck. When partial watertight bulkheads and webs are fitted on the bulkhead deck, above or in the immediate vicinity of watertight bulkheads, their connections with the shell and bulkhead deck are to be watertight so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the partial watertight bulkhead does not line up with the bulkhead below, the bulkhead deck between is to be made effectively watertight. Where openings, pipes, scuppers, electric cables etc. are carried through the partial watertight bulkheads or decks within the immersed part of the bulkhead deck, arrangements are to be made to ensure the watertight integrity of the structure above the bulkhead deck. The coamings of all openings in the exposed weather deck are to be of ample height and strength and are to be provided with efficient means for expeditiously closing them weathertight. Freeing ports, open rails and scuppers are to be fitted as necessary for rapidly cleaning the weather deck of water under all weather conditions.

Sidescuttles, gangway, cargo and fuelling ports and other means for closing openings in the shell plating above the bulkhead deck are to be of efficient design and construction and of sufficient strength having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision load line.

Efficient inside deadlights, so arranged that they can be easily and effectively closed and secured watertight, are to be provided for all sidescuttles to spaces below the first deck above the bulkhead deck.

2.2.2 Open end of air pipes

The open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15 degrees, or the maximum angle of heel during intermediate stages of flooding, as determined by direct calculation, whichever is the greater. Where no information regarding the above angle of heel is available, the open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15° or 0.5 m above the waterline when the ship heels to an angle of 15° from the bulkhead deck, whichever is the greater.

Alternatively, air pipes from tanks other than oil tanks may discharge through the side of the superstructure. The provisions of this paragraph are without prejudice to the provisions of the International Convention on Load Lines in force.

2.2.3 Additional requirements

In addition to 2.2.1, 2.2.2, the requirements in 2.3.4 are to be complied with.

2.3 Doors

2.3.1 Requirements for doors

The requirements relevant to the degree of tightness, as well as the operating systems, for doors complying with the prescriptions in 2.3.2 and 2.3.3 are specified in Tab 2.1.

2.3.2 Construction of watertight doors

The design, materials and construction of all watertight doors are to be to the satisfaction of the Society.

Such doors are to be suitably marked to ensure that they may be properly used to provide maximum safety.

The frames of vertical watertight doors are to have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

2.3.3 Doors in watertight bulkheads below the bulkhead deck

a) Watertight doors, except as provided in 2.1.2 paragraph 1 and 2.1.3, are to be capable of being closed simultaneously from the central operating console at the navigation bridge in not more than 60 s with the ship in the upright position.

b) The means of operation whether by power or by hand of any power-operated sliding watertight door are to be capable of closing the door with the ship listed to 15° either way. Consideration is to also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door.

c) Watertight door controls, including hydraulic piping and electrical cables, are to be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimise the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls are to be such that if the ship sustains damage within one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line, the operation of the watertight doors clear of the damaged portion of the ship is not impaired.

d) All power-operated sliding watertight doors are to be provided with means of indication which show at all remote operating positions whether the doors are open or closed. Remote operating positions are only to be located at the navigating bridge and at the location where hand operation above the bulkhead deck is required by e).

e) Each power-operated sliding watertight door:

- is to move vertically or horizontally;
- is to be normally limited to a maximum clear opening width of 1.20 m. The Society may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:

  - special consideration is to be given to the strength of the door and its closing appliances in order to prevent leakages;
  - the door is to be located outside the damage zone B/5.

- is to be fitted with the necessary equipment to open and close the door using electrical power, hydraulic power, or any other form of power that is acceptable to the Society;
- is to be provided with an individual hand-operated mechanism. It is to be possible to open and close the door by hand at the door itself from either side and, in addition, close the door from an accessible position above the bulkhead deck with an all round crank motion or some other movement providing the same degree of safety acceptable to the Society.

Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, may not exceed 90 s with the ship in the upright position;

- is to be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console at the navigation bridge;
- is to be provided with an audible alarm, distinct from any other alarm in the area, which is to sound whenever the door is closed remotely by power and which is to sound for at least 5 s but no more than 10 s before the door begins to move and is to continue sounding until the door is completely closed.

In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving. Additionally, in passenger areas and areas of high ambient noise, the Society may require the audible alarm to be supplemented by an intermittent visual signal at the door;

- is to have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position, is to in no case be less than 20 s or more than 40 s with the ship in the upright position.

f) The electrical power required for power-operated sliding watertight doors is to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck.

The associated control, indication and alarm circuits are to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by a transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power.

The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to control, indication and alarm circuits at least for half an hour.

g) Power-operated sliding watertight doors are to have either:

- a centralised hydraulic system with two independent power sources each consisting of a motor and pump capable of simultaneously closing all doors. In addition, there are to be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closedopen-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure.

The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. The power operating system is to be designed to minimise the possibility of having a single failure in the hydraulic piping adversely affect the operation of more than one door. The hydraulic system is to be provided with a low-level alarm for hydraulic fluid reservoirs serving the power-operated system and a low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators. These alarms are to be audible and visual and are to be situated on the central operating console at the navigating bridge; or

- an independent hydraulic system for each door with each power source consisting of a motor or pump capable of opening and closing the door. In addition, there is to be a hydraulic accumulator of sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. A low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators is to be provided at the central operating console on the navigation bridge. Loss of stored energy indication at each local operating position is to also be provided; or

- an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source is to be capable of being automatically supplied by the transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°.

The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to watertight doors, but not necessarily all of them simultaneously, unless an independent source of stored energy is provided.

For the systems specified above, provision is to be made as follows:

Power systems for power-operated watertight sliding doors are to be separate from any other power system.

A single failure in the electrical or hydraulic power-operated systems excluding the hydraulic actuator is not to prevent the hand operation of any door.

h) Control handles are to be provided at each side of the bulkhead at a minimum height of 1,6 m above the floor and are to be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidentally. The direction of movement of the handles in opening and closing the door is to be in the direction of door movement and is to be clearly indicated.

i) As far as practicable, electrical equipment and components for watertight doors are to be situated above the bulkhead deck and outside hazardous areas and spaces.

j) The enclosures of electrical components necessarily situated below the bulkhead deck are to provide suitable protection against the ingress of water.

k) Electric power, control, indication and alarm circuits are to be protected against faults in such a way that a failure in one door circuit is not to cause a failure in any other door circuit. Short-circuits or other faults in the alarm or indicator circuits of a door are not to result in a loss of power operation of that door. Arrangements are to be such that leakage of water into the electrical equipment located below the bulkhead deck is not to cause the door to open.

l) A single electrical failure in the power operating or control system of a power-operated sliding watertight door is not to result in a closed door opening. Availability of the power supply is to be continuously monitored at a point in the electric circuit as near as practicable to each of the motors required in g). Loss of any such power supply is to activate an audible and visual alarm at the central operating console at the navigation bridge.

m) The central operating console at the navigation bridge is to have a ﺑmaster modeﭖ switch with two modes of control:

ﭘ a ﺑlocal controlﭖmode which is to allow any door to be locally opened and locally closed after use without automatic closure, and

ﭘ a ﺑdoors closedﭖmode which is to automatically close any door that is open. The ﺑdoors closedﭖ mode is to permit doors to be opened locally and is to automatically reclose the doors upon release of the local control mechanism.

The ﺑmaster modeﭖswitch is to normally be in the ﺑlocal controlﭖmode. The ﺑdoors closedﭖmode is to only be used in an emergency or for testing purposes.

Special consideration is to be given to the reliability of the ﺑmaster modeﭖswitch.

n) The central operating console at the navigation bridge is to be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light is to indicate a door is fully open and a green light is to indicate a door is fully closed. When the door is closed remotely the red light is to indicate the intermediate position by flashing. The indicating circuit is to be independent of the control circuit for each door.

o) It is not to be possible to remotely open any door from the central operating console.

p) All watertight doors are to be kept closed during navigation.

Certain watertight doors may be permitted to remain open during navigation only if considered absolutely necessary; that is, being open is determined essential to the safe and effective operation of the ship's machinery or to permit passengers normally unrestricted access throughout the passenger area. Such determination is to be made by the Society only after careful consideration of the impact on ship operations and survivability. A watertight door permitted to remain thus open is to be clearly indicated in the ship's stability information and the damage control documentation and is always to be ready for immediate closure.

Table 1 : Doors

			Sliding Type			Hinged type			Rolling Type (cargo between deck spaces)
			Remote operation indication on the bridge	Indicator on the bridge	Local operation only	Remote operation indication on the bridge	Indicator on the bridge	Local operation only	
Watertight	below the bulkhead deck	open at sea	X						
		normally closed (4)	X						
		remain closed (4)					X (1)		X(1) (3)
Weathertight/ semiwatertight (2)	above the bulkhead deck	open at sea	X			X			
		normally closed (4)		X			X		
		remain closed (4)						X	

(1) The door is to be closed before the voyage commences.

(2) Semi-watertight doors are required when they are located below the waterline at the equilibrium of the intermediate stages of flooding.

(3) If the door is accessible during the voyage, a device which prevents unauthorised opening is to be fitted.

(4) Notice to be affixed on both sides of the door: ٍto be kept closed at seaپ

2.3.4 Doors in bulkheads above the bulkhead deck

a) General

Doors are to be capable of being opened and closed by hand locally from both sides of the doors with the ship listed to 15° to either side. If the ship is allowed to heel up to 20°, during intermediate stages of flooding, then the doors are to be capable of operation by hand with the ship listed to 20° to either side.

Position indicators are to be provided on the bridge as well as locally on both sides of the doors to show that the doors are open or closed and that the dogs are fully and properly engaged.

Where the doors also serve as fire doors they are to be provided with position indicators at the fire control station and audible alarms as required for fire doors, as well as for weathertight doors. Where two doors are fitted they must be capable of independent operation remotely and from both sides of each door.

b) Doors normally closed at sea In addition to a), doors not required for frequent access while at sea are to be kept normally closed and may be of either hinged or sliding type.

Doors kept normally closed are to have local operation from both sides of the doors and are to be labelled on both sides: ـِ to be kept closed at seaپ

c) Doors normally open at sea Where fitted in public spaces for the passage of passengers and crew, the doors may be kept normally open at sea and may be either hinged or sliding type.

In addition to a), doors kept normally open at sea are to have local power operation from both sides of the door and remote closing from the bridge. Operation of these doors is to be similar to that specified in Pt IV, Ch 4, Sec 5 where, using a ـِ master modeپswitch on the bridge, local control can override the remote closing feature after which the door is automatically remotely reclosed upon release of the local control mechanism.

Doors kept normally open at sea are to have audible alarms, distinct from any other alarm in the area, which sound whenever the doors are closed remotely. The alarms are to sound for at least 5 s but not more than 10s before the doors begins to move and continue sounding until the doors are completely closed. In passenger areas and areas of high ambient noise, the audible alarms are to be supplemented by visual signals at both sides of the doors.

2.4 Ballast compartment arrangement

2.4.1 Water ballast is not to be, in general, carried in tanks intended for fuel oil. In ships in which it is not practicable to avoid putting water in fuel oil tanks, oily-water separating equipment to the satisfaction of the Society is to be fitted, or other alternative means, such as discharge to shore facilities, acceptable to the Society is to be provided for disposing of the oily-water ballast (see Pt IV, Ch 1, Sec 11, 7).

2.5 Double bottom arrangement

2.5.1 A double bottom is to be fitted extending from the collision bulkhead to the after peak bulkhead, as far as this is practicable and compatible with the design and proper working of the ship.

2.5.2 Where a double bottom is required to be fitted, the inner bottom is to be continued out to the shipِs sides in such a manner as to protect the bottom to the turn of the bilge. Such protection is to be deemed satisfactory if the inner bottom is not lower at any part than a plane parallel with the keel line and which is located not less than a vertical distance, h, measured from the keel line, as calculated by the formula:

h = B/20

However, in no case is the value of, h, to be less than 760 mm, and need not to be taken as more than 2 m.

2.5.3 Small wells constructed in the double bottom, in connection with the drainage arrangements of holds, are not to extend downward more than necessary. A well extending to the outer bottom, is, however, permitted at the after end of the shaft tunnel of the ship. Other wells may be permitted by the Society if it is satisfied that the arrangements give protection equivalent to that afforded by a double bottom complying with 2.5. In no case, the vertical distance from the bottom of such a well to a plane coinciding with the keel line is to be less than 500 mm.

2.5.4 A double bottom need not be fitted in way of watertight tanks, including dry tanks of moderate size, provided the safety of the ship is not impaired in the event of bottom or side damage as defined in Pt III, Ch 4, Sec 3, 3.4.

2.5.5 Any part of a ship that is not fitted with a double bottom in accordance with 2.5.1 or 2.5.4 is to be capable of withstanding bottom damages, as specified in Pt III, Ch 4, Sec 3, 3.4 in that part of the ship.

2.5.6 In the case of unusual bottom arrangements, it is to be demonstrated that the ship is capable of withstanding bottom damages, as specified in Pt III, Ch 4, Sec 3, 3.4.

2.5.7 In case of large lower holds in passenger ships, the Society may require an increased double bottom height of not more than B/10 or 3 m, whichever is less, measured from the keel line. Alternatively, bottom damages may be calculated for these areas, in accordance with Pt III, Ch 4, Sec 3, 3.4, but assuming an increased vertical extent.

2.6 Machinery compartment arrangement

2.6.1 When longitudinal bulkheads are fitted in the machinery space, adequate self-operating arrangements are to be provided in order to avoid excessive heel after damage.

Where such arrangements are cross-flooding systems, their area is to be calculated in accordance with the requirements in Pt III, Ch 3. In addition, such systems are to comply with the criteria for the maximum time necessary to cross flood according to Sec 3, 1.3.5 c).

Section 3 Hull and Stability

1 Stability

1.1 Definitions

1.1.1 Deepest subdivision draught

The deepest subdivision draught (d_S) is the waterline which corresponds to the summer load line draught of the ship.

1.1.2 Light service draught

Light service draught (d_L) is the service draught corresponding to the lightest anticipated loading and associated tankage, including, however, such ballast as may be necessary for stability and/or immersion.

1.1.3 Partial subdivision draught

The partial subdivision draught (d_P) is the light service draught plus 60% of the difference between the light service draught and the deepest subdivision draught.

1.1.4 Subdivision length L_s

The subdivision length L_s is the greatest projected moulded length of that part of the ship at or below deck or decks limiting the vertical extent of flooding with the ship at the deepest subdivision draught.

1.1.5 Machinery space

Machinery spaces are spaces between the watertight boundaries of a space containing the main and auxiliary propulsion machinery, including boilers, generators and electric motors primarily intended for propulsion. In the case of unusual arrangements, the Society may define the limits of the machinery spaces.

1.1.6 Other definitions

Mid-length is the mid point of the subdivision length of the ship.

Aft terminal is the aft limit of the subdivision length.

Forward terminal is the forward limit of the subdivision length.

Breadth B is the greatest moulded breadth, in m, of the ship at or below the deepest subdivision draught.

Draught d is the vertical distance, in m, from the moulded baseline at mid-length to the waterline in question.

Permeability □of a space is the proportion of the immersed volume of that space which can be occupied by water.

1.2 Intact stability

1.2.1 General

Every passenger ship regardless of size is to be inclined upon its completion and the elements of its stability determined.

The Master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service.

A copy of the stability information is to be furnished to the Society.

Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

1.2.2 Periodical lightweight check

At periodical intervals not exceeding five years, a lightweight survey is to be carried out on all passenger ships to verify any changes in lightship displacement and longitudinal centre of gravity. The ship is to be re-inclined whenever, in comparison with the approved stability information, a deviation from the lightship displacement exceeding 2% or a deviation of the longitudinal centre of gravity exceeding 1% of Ls is found, or anticipated.

1.2.3 Standard requirements

In addition to Pt III, Ch 4, Sec 2, 2 the requirements in 1.2.4 to 1.2.6 are to be complied with for the loading conditions defined in Pt III, Ch 4, App 2, 1.2.1 and Pt III, Ch 4, App 2, 1.2.9.

1.2.4 Crowding of passengers

The angle of heel on account of crowding of passengers to one side as defined below may not exceed 10°:

- a minimum weight of 75 kg is to be assumed for each passenger except that this value may be increased subject to the approval of the Society. In addition, the mass and distribution of the luggage is to be approved by the Society;
- the height of the centre of gravity for passengers is to be assumed equal to:
  - 1 m above deck level for passengers standing upright. Account may be taken, if necessary, of camber and sheer of deck; and
  - 0.3 m above the seat in respect of seated passengers.
- passengers and luggage are to be considered to be in the spaces normally at their disposal;
- passengers without luggage are to be considered as distributed to produce the most unfavourable combination of passenger heeling moment and/or initial metacentric height, which may be obtained in practice. In this connection, a value higher than four persons per square metre is not necessary.

1.2.5 Maximum turning angle

The angle of heel on account of turning may not exceed 10° when calculated using the following formula:

$$M_g = 0.02\frac{V_0^2}{L_s}\Delta(KG - T_1/2)$$

where:

M_R : Heeling moment, in t.m

V_0 : Service speed, in m/s

T_1 : Mean draught, in m

KG : Height of centre of gravity above keel, in m.

1.2.6 Where anti-rolling devices are installed in a ship, the Society is to be satisfied that the above criteria can be maintained when the devices are in operation.

1.3 Damage stability for ships where SDS notation has been required

1.3.1 General

The requirements of this Section are to be applied to passenger ships in conjunction with the exploratory notes as set out by the IMO Resolution MSC 281(85).

1.3.2 Required subdivision index R

These regulations are intended to provide ships with a minimum standard of subdivision. In addition to these requirements, the requirements of 1.3.12 are to be complied with.

$$R = 1 - \frac{5000}{L_s + 2.5N + 15.225}$$

where: $N = N_1 + 2N_2$

N_1 : Number of persons for whom lifeboats are provided

N_2 : Number of persons (including officers and crew) the ship is permitted to carry in excess of N_1.

Where the conditions of service are such that compliance with $N = N_1 + 2N_2$ is impracticable and where the Society considers that a suitably reduced degree of hazard exists, a lesser value of N may be taken but in no case less than $N = N_1 + N_2$. The reduced value of N is also to be subject to the agreement of the flag administration.

1.3.3 Attained subdivision index A

The attained subdivision index A is to be calculated in accordance with Pt III, Ch 4, App 3, 1.4.

The partial indices A_s, A_p and A_L are not to be less than 0.9 R.

1.3.4 Calculation of the factor p_i

The factor p_i is to be calculated in accordance with Pt III, Ch 4, App 3, 1.5.

1.3.5 Calculation of the factor s_i

The factor s_i is to be determined for each case of assumed flooding, involving a compartment or group of compartments, in accordance with the following notations and the provisions in this regulation.

θ_e : The equilibrium heel angle in any stage of flooding, in degrees

$\square_v$: The angle, in any stage of flooding, where the righting lever becomes negative, or the angle at which an opening incapable of being closed weathertight becomes submerged

GZ_{max} : The maximum positive righting lever, in metres, up to the angle $\square_v$

Range : The Range of positive righting levers, in degrees,measured from the angle $\square_e$ The positive range is to be taken up to the angle $\square_v$ Flooding stage is any discrete step during the flooding process, including the stage before equalization (if any) until final equilibrium has been reached.

The factor s_i, for any damage case at any initial loading condition,d_i, shall be obtained from the formula:

s_i = minimum {$s_{intermediate,i}$ or $s_{final,i}$ $s\square_{mom,i}$}

where:

$s_{intermediate,i}$: The probability to survive all intermediate flooding stages until the final equilibrium stage, and is calculated in accordance with item a)

$s_{final,i}$: The probability to survive in the final equilibrium stage of flooding. It is calculated in accordance with item b)

$s_{mom,i}$: The probability to survive heeling moments, and is calculated in accordance with item c)

a) Calculation of sintermediate:

The factor sintermediate,i is to be taken as the least of the s factors obtained from all flooding stages including the stage before equalization, if any, and is to be calculated as follows:

$$s_{intermediate,i} = \left[\frac{GZ_{max}}{0.05} \frac{Range}{7} \right]^{0.25}$$

where GZ_{max} is not to be taken as more than 0.05 m and Range as not more than 7°. $s_{intermediate}$= 0, if the intermediate heel angle exceeds 15□Where cross-flooding fittings are required, the time for equalization is not to

exceed 10 min. The time for equalization is to be calculated in accordance with App 1

b) Calculation of sfinal:

The factor $s_{final,i}$ is to be obtained from the formula:

$$s_{final,i} = K \left[\frac{GZ_{max}}{0.12} \frac{Range}{16} \right]^{0.25}$$

where:

GZ_{max} is not to be taken as more than 0.12 m

Range is not to be taken as more than 16°.

K = 1 if $\square_e \square\square_{min}$

K = 0 if $\square_e \square\square_{max}$

$$K = \sqrt{\frac{\theta_{\max} - \theta_e}{\theta_{\max} - \theta_{\min}}} \text{ otherwise}$$

where:

□$_{min}$ is equal to 7°

□$_{max}$ is equal to 15°.

c) Calculation of s moment:

The factor smom,i is to be calculated at the final equilibrium from the formula:

$$s_{mom,i} = \frac{(GZ_{\max} - 0.04)\text{Displacement}}{M_{heel}}$$

where:

Displacement is the intact displacement at the subdivision draught

M_{heel} is the maximum assumed heeling moment as calculated as follows :

M_{heel} = maximum {$M_{passenger}$ or M_{wind} or $M_{Survivalcraft}$}

where the heeling moments $M_{passenger}$, M_{wind} and $M_{survivalcraft}$ are calculated in 1.3.11.

$s_{mom,i}$ □1

1.3.6 Equalization arrangements

Unsymmetrical flooding is to be kept to a minimum consistent with the efficient arrangements. Where it is necessary to correct large angles of heel, the means adopted shall, where practicable, be self-acting, but in any case where controls to equalization devices are provided they are to be operable from above the bulkhead deck. These fittings together with their controls are to be acceptable to the Society. Suitable information concerning the use of equalization devices are to be supplied to the master of the ship.

Tanks and compartments taking part in such equalization are to be fitted with air pipes or equivalent means of sufficient cross-section to ensure that the flow of water into the equalization compartments is not delayed.

1.3.7 Cases where s_i is to be equal to zero

In all cases, s_i is to be taken as zero in those cases where the final waterline, taking into account sinkage, heel and trim, immerses:

- the lower edge of openings through which progressive flooding may take place and such flooding is not accounted for in the calculation of factor si. Such openings are to include air-pipes, ventilators and openings which are closed by means of weathertight doors or hatch covers, but the openings closed by means of watertight manhole covers and flush scuttles, small watertight hatch covers, remotely operated sliding watertight doors, side scuttles of the non-opening type as well as watertight access doors and hatch covers required to be kept closed at sea need not be considered.
- any part of the bulkhead deck considered a horizontal evacuation route.

The factor s_i is to be taken as zero if, taking into account sinkage, heel and trim, any of the following occur in any intermediate stage or in the final stage of flooding:

- immersion of any vertical escape hatch in the bulkhead deck intended for compliance with the applicable requirements of Pt IV, Ch 4, Sec 8.
- any controls intended for the operation of watertight doors, equalization devices, valves on piping or on ventilation ducts intended to maintain the integrity of watertight bulkheads from above the bulkhead deck become inaccessible or inoperable.
- immersion of any part of piping or ventilation ducts carried through a watertight boundary that is located within any compartment included in damage cases contributing to the attained index A, if not fitted with watertight means of closure at each boundary.

1.3.8 Calculation of the factor ν_i

Where horizontal watertight boundaries are fitted above the waterline under consideration the s-value calculated for the lower compartment or group of compartments is to be obtained by multiplying the value as determined in [1.3.5] by the reduction factor ν_m defined below, which represents the probability that the spaces above the horizontal subdivision will not be flooded.

The factor ν_i is to be calculated in accordance with Pt III, Ch 4, App 4, 1.6.7 and 1.6.8.

1.3.9 Contribution dA to the index A

The contribution dA to the index A is to be calculated in accordance with Pt III, Ch 4, App 4, 1.6.9.

1.3.10 Permeability

For the purpose of the subdivision and damage stability calculations of the regulations, the permeability of each general compartment or part of a compartment is to be according to Tab 1.1.

Other figures for permeability may be used if substantiated by calculations.

Table 1.1 : Values of permeability

Spaces	Permeability
Appropriated to stores	0.60
Occupied by accommodation or voids	0.95
Occupied by machinery	0.85
Intended for liquids	0 or 0.95 (1)

(1) whichever results in the more severe requirements.

1.3.11 Inclining moments

The following inclining moments are to be taken into account:

a) Moment due to the crowding of passengers:

Mpassenger is the maximum assumed heeling moment resulting from movement of passengers, and is to be obtained as follows:

$M_{passenger} = (0.075\ N_p)\ (0.45\ B)\ (t_m)$

where:

N_p : maximum number of passengers permitted to be on board in the service condition corresponding to the deepest subdivision draught under consideration; and

B : beam of the ship.

Alternatively, the heeling moment may be calculated assuming the passengers are distributed with 4 persons per square metre on available deck areas towards one side of the ship on the decks where muster stations are located and in such a way that they produce the most adverse heeling moment. In doing so, a weight of 75 kg per passenger is to be assumed.

b) Moment due to launching of all fully loaded davitlaunched survival craft on one side:

MSurvivalcraft is the maximum assumed heeling moment due to the launching of all fully loaded davit-launched survival craft on one side of the ship. It shall be calculated using the following assumptions:

- all lifeboats and rescue boats fitted on the side to which the ship has heeled after having sustained damage are to be assumed to be swung out fully loaded and ready for lowering.
- for lifeboats which are arranged to be launched fully loaded from the stowed position, the maximum heeling moment during launching is to be taken.
- a fully loaded davit-launched liferaft attached to each davit on the side to which the ship has heeled after having sustained damage is to be assumed to be swung out ready for lowering.
- persons not in the life-saving appliances which are swung out are not to provide either additional heeling or righting moment.
- life-saving appliances on the side of the ship opposite to the side to which the ship has heeled are to be assumed to be in a stowed position.

c) Moment due to wind pressure:

M_{wind} is the maximum assumed wind force acting in a damage situation:

$M_{wind} = (P\ A\ Z) / 9.806\ 10^3$ (tm)

P : Wind pressure

$P = 120\ N/m^2$

A : Projected lateral area above waterline z : Distance from centre of lateral projected area above waterline to T/2; and

T : Shipے draught, d_i

1.3.12 Special requirements concerning stability

A passenger ship intended to carry 400 or more persons is to have watertight subdivision abaft the collision bulkhead so that $s_i = 1$ for the three loading conditions on which is based the calculation of the subdivision index and for a damage involving all the compartments within $0.08L_{LL}$ measured from the forward perpendicular.

A passenger ship intended to carry 36 or more persons is to be capable of withstanding damage along the side shell to an extent specified below. Compliance with this regulation is to be achieved by demonstrating that si, as defined in 1.3.5, is not less than 0.9 for the three loading conditions on which is based the calculation of the subdivision index.

The damage extent to be assumed when demonstrating compliance with the above paragraph, is to be dependent on both N as defined in 1.3.2, and L_s as defined in 1.1 , such that:

- the vertical extent of damage is to extend from the ships moulded baseline to a position up to 12.5 m above the position of the deepest subdivision draught as defined in 1.1, unless a lesser vertical extent of damage were to give a lower value of si in which case this reduced extent is to be used.
- where 400 or more persons are to be carried, a damage length of 0.03Ls but not less than 3 m is to be assumed at any position along the side shell, in conjunction with a penetration inboard of 0.1B but not less than 0.75 m measured inboard from the ship side, at right angle to the centreline at the level of the deepest subdivision draught.
- where less than 400 persons are carried, damage length is to be assumed at any position along the shell side between transverse watertight bulkheads provided that the distance between two adjacent transverse watertight bulkheads is not less than the assumed damage length.

If the distance between adjacent transverse watertight bulkheads is less than the assumed damage length, only one of these bulkheads is to be considered effective for the purpose of demonstrating compliance with the criteria s_i □0.9.

- where 36 persons are carried, a damage length of 0.015Ls but not less than 3 m is to be assumed, in conjunction with a penetration inboard of 0.05B but not less than 0.75 m.
- where more than 36, but fewer than 400 persons are carried the values of damage length and penetration inboard, used in the determination of the assumed extent of damage, are to be obtained by linear interpolation between the values of damage length and penetration which apply for ships carrying 36 persons and 400 persons.

1.3.13 Documents to be supplied

The master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service. A copy of the stability information shall be furnished to the Society.

The information should include:

- curves or tables of minimum operational metacentric height (GM) versus draught which assures compliance with the relevant intact and damage stability requirements, alternatively corresponding curves or tables of the maximum allowable vertical centre of gravity (KG) versus draught, or with the equivalents of either of these curves
- instructions concerning the operation of cross-flooding arrangements
- all other data and aids which might be necessary to maintain the required intact stability and stability after damage.

The stability information is to show the influence of various trims in cases where the operational trim range exceeds ± 0.5% of L_s.

The above information is determined from considerations related to the subdivision index, in the following manner:

Minimum required GM (or maximum permissible vertical position of centre of gravity KG) for the three draughts ds, dp and dl are equal to the GM (or KG values) of corresponding loading cases used for the calculation of survival factor s_i. For intermediate draughts, values to be used are to be obtained by linear interpolation applied to the GM value only between the deepest subdivision draught and the partial subdivision draught and between the partial load line and the light service draught respectively. Intact stability criteria will also be taken into account by retaining for each draft the maximum among minimum required GM values or the minimum of maximum permissible KG values for both criteria. If the subdivision index is calculated for different trims, several required GM curves will be established in the same way.

When curves or tables of minimum operational metacentric height (GM) versus draught are not appropriate, the master is to ensure that the operating condition does not deviate from a studied loading condition, or verify by calculation that the stability criteria are satisfied for this loading condition.

1.3.14 Damage control documentation

Plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding are to be permanently exhibited for the guidance of the officer in charge of the ship. In addition, booklets containing the aforementioned information are to be made available to the officers of the ship.

Watertight doors which may be permitted to remain open during navigation as reported in Sec 2, 2.3.3 p) are to be clearly indicated in the damage control plan with the indication that ب doors are always to be ready for immediate closureپ

Detailed description of the information to be included in the damage control documentation is reported in Pt III, Ch 4, Sec 3, 4.

2 Structure design principles

2.1 Hull structure

2.1.1 Framing

In general, the strength deck and the bottom of passenger ships of more than 100 m in length are to be longitudinally framed.

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

3 Design loads

3.1 Sea pressures

3.1.1 Bow impact pressure

The bow impact pressure is obtained, in kN/m2, from the following formula:

$$p_{\mathrm{FI}} = nC_s C_L C_Z (0.22 + 0.15\tan\alpha)(0.4V\sin\beta + 0.6\sqrt{L})^2$$

where:

C_S : Coefficient depending on the type of structures on which the bow impact pressure is considered to be acting:

C_S = 1.8 for plating and ordinary stiffeners

C_S = 0.5 for primary supporting members

C_L : Coefficient depending on the shipبs length:

C_L = 0.0125 L for L < 80 m

C_L = 1.0 for L □80 m

C_Z : Coefficient depending on the distance between the summer load waterline and the calculation point:

ﭼ for z □2 C + T -11:

$$C_Z = [C - 0.5(z - T)]\left[0.82 - 0.09\left(\frac{z - T}{T}\right)\right]$$

ﭼ for z < 2 C + T -11:

$$C_Z = [4.5 - 0.5(z - T)/T]$$

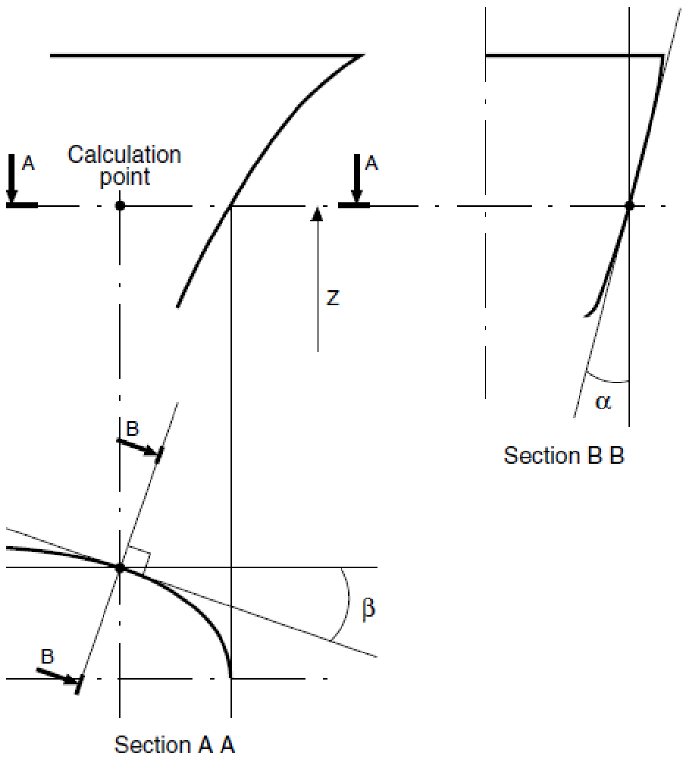
C : Wave parameter, defined in Pt III, Ch 2, Sec 1 z : z co-ordinate, in m, of the calculation point, with respect to the reference co-ordinate system defined in Pt I

□: Flare angle at the calculation point, defined as the angle between a vertical line and the tangent to the side shell plating, measured in a vertical plane normal to the horizontal tangent to the shell plating (see Fig 2.1)

□: Entry angle at the calculation point, defined as the angle between a longitudinal line parallel to the centreline and the tangent to the shell plating in a horizontal plane (see Fig 2.1).

Other values of bow impact pressure may be considered by the Society on a case-by-case basis, provided that they are documented through model tests or full scale measurements.

Figure 2.1 : Definition of angles □and □



4 Hull girder strength

4.1 Basic criteria

4.1.1 Strength deck

In addition to the requirements in Pt III, the contribution of the hull structures up to the strength deck to the longitudinal strength is to be assessed through a finite element analysis of the whole ship in the following cases:

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

5 Hull scantlings

5.1 Plating

5.1.1 Minimum net thicknesses

The net thickness of the inner bottom, side and weather strength deck plating is to be not less than the values given in Tab 5.1.

If a complete deck does exist at a distance from the freeboard deck exceeding 2 times the standard height of superstructures as defined in Pt III, the side shell plating located between this complete deck and the strength deck may be taken not greater than the thickness of deckhouse sides.

Table 5.1 : Minimum net thickness of the inner bottom, side and weather strength deck plating

Plating	Min. net thickness (mm)
Inner bottom outside engine room	$2.0 + 0.02\ L\ k^{1/2} + 4.5\ s$
Side - below freeboard deck - between freeboard deck and strength deck	$2.1 + 0.028\ L\ k^{1/2} + 4.5\ s$
Weather strength deck and trunk deck	$2.2\ k^{1/2} + 2.1 + s$

Note 1:

k : Material factor for steel, defined in Pt III.

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

6 Other structures

6.1 Side doors and stern doors

6.1.1 Side doors may be either below or above the freeboard deck.

Stern doors are to be situated above the freeboard deck.

6.1.2 The requirements applicable to side doors and stern doors are defined in Pt III, Ch 2, Sec 16.

7 Hull outfitting

7.1 Equipment

7.1.1 Mooring lines

The mooring lines are given as a guidance, but are not required as a condition of classification (see also Pt III, Ch 5).

7.1.2 Ships having L □30 m and a navigation notation other than unrestricted navigation

For ships having L □30 m and navigation notation other than unrestricted navigation:

- the equipment in mooring lines of wire or natural fibre may be obtained from Tab 7.1.
- the equipment in stockless anchor and chain cables (or ropes according to Pt III, Ch 5) may be obtained from Tab 7.2.

Table 7.1 : Mooring lines

Equipment number EN A < EN □B		Mooring lines **(1)**		
A	B	N	Length of each line, in m	Breaking load, in kN
19	50	2	40	32
50	70	3	40	34
70	90	3	50	37
90	110	3	55	39
110	130	3	55	44
130	150	3	60	49
150	175	3	60	54

(1) The mooring lines are given as a guidance, but are not required as a condition of classification.

Table 7.2 : Equipment

Equipment number EN A < EN □B		Stockless anchors		Stud link chain cables for anchors			
		N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Q1	Q2	Q3
19	22	1	21	65	7		
22	25	1	27	70	7		
25	30	1	32	70	8		
30	35	1	37	75	8		
35	40	1	43	75	9		
40	45	1	53	80	10		
45	50	1	64	82,5	11		
50	60	1	80	82,5	11	10	
60	70	1	90	82,5	12,5	11	
70	80	1	100	110	12,5	11	10
80	90	1	120	110	14	12,5	11
90	100	1	140	110	14	12,5	11
100	110	1	160	110	16	14	12,5
110	120	1	180	110	16	14	12,5
120	130	1	200	110	16	14	12,5
130	140	1	240	110	17,5	16	14
140	150	1	260	137,5	17,5	16	14
150	175	1	300	137,5	19	17,5	16
175	205	1	360	137,5	20,5	17,5	16
205	240	1	420	137,5	22	19	17,5
240	280	1	480	137,5	24	20,5	19
280	320	1	575	165	26	22	20,5
320	360	1	660	165	28	24	22
360	400	1	700	165	30	26	22
400	450	1	780	165	30	26	24
450	500	1	900	192,5	32	28	26
500	550	1	1020	192,5	34	30	26
550	600	1	1140	192,5	36	32	28
600	660	2	1200	385	38	32	30
660	720	2	1295	385	40	34	30
720	780	2	1440	440	42	36	32
780	840	2	1500	440	42	36	32
840	910	2	1595	440	44	38	34
910	980	2	1740	440	46	40	36
980	1060	2	1920	440	48	42	36

Section 4 Machinery and Systems

1 Bilge system

1.1 General

1.1.1

a) The bilge pumping system required in Pt IV, Ch 1, Sec 11, 6 shall be capable of operation under all practicable conditions after a casualty, whether the ship is upright or listed. For this purpose, wing suctions shall generally be fitted except in narrow compartments at the end of the ship where one suction may be sufficient.

In compartments of unusual form, additional suctions may be required.

b) Arrangements shall be made whereby water in the compartment may find its way to the suction pipes.

c) Where, for particular compartments, the Society is satisfied that the provisions of drainage may be undesirable, it may allow such provision to be dispensed with if damage stability calculations carried out in accordance with Sec 3, 1 show that the survival capability of the ship will not be impaired.

1.2 Bilge pumps

1.2.1 Number and capacity of bilge pumps

a) Any passenger ship shall be provided with at least three power bilge pumps connected to the bilge main, one of which may be driven by the propulsion machinery.

Where the criterion numeral is 30 or more, as stated in Sec 3, 1.3.6, one additional independent power pump shall be provided.

b) Each of the above pumps is to have a capacity not less than that required in Pt IV, Ch 1, Sec 11, 6.7.4.

c) For use of ejectors in lieu of bilge pumps, see Pt IV, Ch1, Sec 11, 6.7.2.

1.2.2 Location of bilge pumps

Where practicable, the power bilge pumps shall be placed in separate watertight compartments and so arranged or situated that these compartments will not be flooded by the same damage. If the main propulsion machinery, auxiliary machinery and boilers are in two or more watertight compartments, the pumps available for bilge service shall be distributed as far as is possible throughout these compartments.

1.2.3 Availability of pumps

On a ship of 91.5 m in length and upwards or having a criterion numeral of 30 or more, as stated in Sec 3, 1.3.6, the arrangements shall be such that at least one power bilge pump will be available for use in all flooding conditions which the ship is required to withstand, as follows:

a) one of the required bilge pumps shall be an emergency pump of a reliable submersible type having a source of power situated above the bulkhead deck, or b) the bilge pumps and their sources of power shall be so distributed throughout the length of the ship that at least one pump in an undamaged compartment will be available.

1.2.4 Draining capability

With the exception of additional pumps which may be provided for peak compartments only, each required bilge pump shall be so arranged as to draw water from any space required to be drained.

1.3 Direct bilge suction

1.3.1

a) In passenger ships subject to subdivision regulations, independent power bilge pumps situated in machinery and/or boiler spaces shall have direct suctions from these spaces, except that not more than two such suctions shall be required in any one space.

b) Where two or more such suctions are provided in one compartment, there shall be at least one on each side of the ship.

c) The Society may require independent power bilge pumps situated in other spaces to have separate direct suctions.

1.4 Control location

1.4.1

a) The spindles of the sea inlet and direct suction valves shall extend well above the engine room platform.

b) Where the circulating pumps are driven by electric motors, their starting equipment shall be located at, or above, the level of the motors.

1.5 Provision against bilge system damage

1.5.1 Damage to the bilge system

Provision shall be made to prevent the compartment served by any bilge suction pipe being flooded in the event of the pipe being severed or otherwise damaged by collision or grounding in any other compartment. For this purpose, where the pipe is at any part situated nearer the side of the ship than one fifth of the breadth of the ship (measured at right angles to the centreline at the level of the deepest subdivision load line), or is in a duct keel, a non-return valve shall be fitted to the pipe in the compartment containing the open end.

1.5.2 Operation in the case of flooding

a) Distribution boxes, cocks and valves in connection with the bilge pumping system shall be so arranged that, in the event of flooding, one of the bilge pumps may be operative on any compartment; in addition, damage to a pump or its pipe connecting to the bilge main outboard of a line drawn at one fifth of the breadth of the ship shall not put the bilge system out of action.

b) If there is only one system of pipes common to all the pumps, the necessary valves for controlling the bilge suctions must be capable of being operated from above the bulkhead deck.

c) Where in addition to the main bilge pumping system an emergency bilge pumping system is provided, it shall be independent of the main system and so arranged that a pump is capable of operating on any compartment under flooding condition; in that case only the valves necessary for the operation of the emergency system need be capable of being operated from above the bulkhead deck.

1.5.3 Valve controls

All cocks and valves referred in 1.5.2 which can be operated from above the bulkhead deck shall have their controls at their place of operation clearly marked and shall be provided with means to indicate whether they are open or closed.

2 Ballast system

2.1

2.1.1 Water ballast should not in general be carried in tanks intended for fuel oil. In ships in which it is not practicable to avoid putting water in fuel oil tanks, oily-water separating equipment to the satisfaction of the Society shall be fitted, or other alternative means, such as discharge to shore facilities shall be provided for disposing of the oily-water ballast.

3 Miscellaneous requirements

3.1 Steering gear

3.1.1 For steering gear arrangements without auxiliary means for steering, see Pt IV, Ch 1, Sec 12.

3.2 Oil-level gauges

3.2.1 For oil-level gauges, see Pt IV, Ch 1, Sec 11, 11.6.7.

3.3 Watertight doors

3.3.1 For watertight doors, see Sec 2.

3.4 Quality failure Analysis

3.4.1 A quality failure analysis is to be submitted in accordance with App 2.

Section 5 Electrical Installations

1 General

1.1 Documentation to be submitted

1.1.1 The documentation dealing with the electrical system for watertight door and fire door systems as requested in Pt IV, Ch 2 and Pt IV, Ch 4 is to be submitted for approval.

1.2 Electrical distribution and protection

1.2.1 In a passenger ship, distribution systems shall be so arranged that fire in any main vertical zone as defined in Part IV, Chapter 4 will not interfere with services essential for safety in any other such zone.

This requirement will be met if main and emergency feeders passing through any such zone are separated both vertically and horizontally as widely as is practicable.

1.2.2 For generators arranged to operate in parallel and for individually operating generators, arrangements are to be made to disconnect automatically the excess load when the generators are overloaded in such a way as to prevent a sustained loss of speed. The operation of such device is to activate a visual and audible alarm.

2 Emergency source of electrical power and emergency installations

2.1 General

2.1.1 A self-contained emergency source of electrical power shall be provided.

2.1.2 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits.

Exceptionally, whilst the vessel is at sea, is understood to mean conditions such as:

a) blackout situation

b) dead ship situation

c) routine use for testing

d) short-term parallel operation with the main source of electrical power for the purpose of load transfer.

Unless instructed otherwise by the Society, the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements of Pt IV, Ch 2 are complied with.

2.1.3 The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously.

2.1.4 The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the services stated in 2.2.3 for the period specified, if they depend upon an electrical source for their operation.

2.1.5 The transitional source of emergency electrical power, where required, is to be of sufficient capacity to supply at least the services stated in 2.2.7 for the periods specified therein, if they depend upon an electrical source for their operation.

2.1.6 An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in Pt IV, Ch 2 are being discharged.

2.1.7 If the services which are to be supplied by the transitional source receive power from an accumulator battery by means of semiconductor converters, means are to be provided for supplying such services also in the event of failure of the converter (e.g. providing a bypass feeder or a duplication of converter).

2.1.8 Where electrical power is necessary to restore propulsion, the capacity of the emergency source shall be sufficient to restore propulsion to the ship in conjunction to other machinery as appropriate, from a dead ship condition within 30 min. after blackout.

For the purpose of this requirement only, the dead ship condition and blackout are both understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation and in restoring the propulsion, no stored energy for starting the propulsion plant, the main source of electrical power and other essential auxiliaries is to be assumed available. It is assumed that means are available to start the emergency generator at all times.

The emergency generator and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes of blackout/dead ship condition as defined above.

Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and/or other essential auxiliaries (emergency generator excluded).

For steam ships, the 30 minute time limit given in SOLAS can be interpreted as the time from blackout/dead ship condition defined above to light-off of the first boiler.

2.1.9 Provision shall be made for the periodical testing of the complete emergency system and shall include the testing of automatic starting arrangements.

2.1.10 For starting arrangements of emergency generating sets, see Pt IV, Ch 2, sec2.

2.1.11 The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the provisions of 2.1.12 or 2.1.13, respectively.

2.1.12 Where the emergency source of electrical power is a generator, it shall be:

a) driven by a suitable prime mover with an independent supply of fuel having a flashpoint (closed cup test) of not less than 43°C

b) started automatically upon failure of the electrical supply to the emergency switchboard from the main source of electrical power and shall be automatically connected to the emergency switchboard; those services referred to in 2.2.7 shall then be transferred automatically to the emergency generating set. The automatic starting system and the characteristic of the prime mover shall be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 s, and c) provided with a transitional source of emergency electrical power according to 2.1.14.

2.1.13 Where the emergency source of electrical power is an accumulator battery, it shall be capable of:

a) carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage

b) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power, and c) immediately supplying at least those services specified in 2.2.7.

2.1.14 The transitional source of emergency electrical power required by 2.1.12 (c) shall consist of an accumulator battery which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the services in 2.2.7 if they depend upon an electrical source for their operation.

2.1.15 Where the emergency and/or transitional source of power is an uninterruptible power system (UPS), it is to comply with the requirements of Pt C, Ch 2.

2.2 Distribution of electrical power

2.2.1 The emergency switch board shall be supplied during normal operation from the main switchboard by an interconnector feeder which shall be adequately protected at the main switchboard against overload and short-circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power.

Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

2.2.2 In order to ensure ready availability of the emergency source of electrical power, arrangements shall be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power shall be available to the emergency circuits.

2.2.3 The emergency source of electrical power shall be capable of supplying simultaneously at least the following services for the periods specified hereafter, if they depend upon an electrical source for their operation:

a) for a period of 36 hours, emergency lighting:

1) at every muster and embarkation station and over the sides

2) in alleyways, stairways and exits giving access to the muster and embarkation stations

3) in all service and accommodation alleyways, stairways and exits, personnel lift cars

4) in the machinery spaces and main generating stations including their control positions
5) in all control stations, machinery control rooms, and at each main and emergency switchboard
6) at all stowage positions for firemen's outfits
7) at the steering gear, and
8) at the fire pump, the sprinkler pump and the emergency bilge pump referred to in (d) below and at the starting position of their motors

b) for a period of 36 hours:

1) the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force, and
2) on ships constructed on or after 1 February 1995 the VHF radio installation required by Regulation IV/7.1.1 and IV/7.1.2 of SOLAS Consolidated Edition 1992, and, if applicable:
   - the MF radio installation required by Regulations IV/9.1.1, IV/9.1.2, IV/10.1.2 and IV/10.1.3
   - the ship earth station required by Regulation IV/10.1.1, and
   - the MF/HF radio installation required by Regulations IV/10.2.1, IV/10.2.2 and IV/11.1

c) for a period of 36 hours:

1) all internal communication equipment required in an emergency (see 2.2.4)
2) the shipborne navigational equipment as required by Regulation V/12; where such provision is unreasonable or impracticable the Head Office may waive this requirement for ships of less than 5,000 tons gross tonnage
3) the fire detection and fire alarm system, the fire door holding and release system, and
4) Intermittent operation of the daylight signaling lamp, the ship's whistle, the manually operated call points and all internal signals (see 2.2.5) that are required in an emergency, unless such services have an independent supply for the period of 36 hours from an accumulator battery suitably located for use in an emergency

d) for a period of 36 hours:

1) one of the fire pumps required by the relevant provisions of Part IV, Chapter 4
2) the automatic sprinkler pump, if any, and
3) the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves

e) for the period of time required in Pt IV, Ch 1, Sec 12, the steering gear if required to be so supplied

f) for a period of half an hour:

1) any watertight doors required by Regulation II-1/15 to be power operated together with their indicators and warning signals

2) the emergency arrangements to bring the lift cars to deck level for the escape of persons. The passenger lift cars may be brought to deck level sequentially in an emergency.

2.2.4 Internal communication equipment required in an emergency generally includes:

a) the means of communication between the navigating bridge and the steering gear compartment

b) the means of communication between the navigating bridge and the position in the machinery space or control room from which the engines are normally controlled.

c) the means of communication which is provided between the officer of the watch and the person responsible for closing any watertight door which is not capable of being closed from a central control station.

d) the public address system or other effective means of communication throughout the accommodation, public and service spaces.

e) the means of communication between the navigating bridge and the main fire control station.

2.2.5 Internal signals required in an emergency generally include:

a) general alarm

b) watertight door indication

c) fire door indication.

2.2.6 In a ship engaged regularly in voyages of short duration, i.e. voyages where the route is no greater than 20 nautical miles offshore or where the vessel has a class notation "Coastal Service", the Society if satisfied that an adequate standard of safety would be attained may accept a lesser period than the 36-hour period specified in 2.2.3 (b) to (e) but not less than 12 hours.

2.2.7 The transitional source of emergency electrical power required is to supply at least the following services if they depend upon an electrical source for their operation:

a) for half an hour:

1) the lighting required by 2.2.3 (b1) and Pt IV, Ch 2, Sec 8 and other relevant parts

2) all services required by 2.2.3 (c1, 3 and 4) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency

b) it is also to supply power to close the watertight doors as required by Regulation II-1/15.7.3.3, but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided. Power to the control, indication and alarm circuits as required by Regulation II-1/15.7.2, for half an hour.

2.3 Low-location lighting

2.3.1 Passenger ships are to be provided with a low-location lighting (LLL) system in accordance with Pt IV, Ch 2.

Where LLL is satisfied by electric illumination, it is to comply with the following requirements.

2.3.2 The LLL system is to be connected to the emergency switchboard and is to be capable of being powered either by the main source of electrical power, or by the emergency source of electrical power for a minimum period of 60 minutes after energising in an emergency.

2.3.3 The power supply arrangements to the LLL are to be arranged so that a single fault or a fire in any one fire zone or deck does not result in loss of the lighting in any other zone or deck. This requirement may be satisfied by the power supply circuit configuration, use of fire-resistant cables complying with IEC Publication 60331: Fire characteristics of electrical cables, and/or the provision of suitably located power supply units having integral batteries adequately rated to supply the connected LLL for a minimum period of 60 minutes.

2.3.4 Single lights and lighting assemblies are to be designed or arranged so that any single fault or failure in a light or lighting assembly, other than a short-circuit, will not result in a break in visible delineation exceeding 1 metre.

2.3.5 Light and lighting assemblies are to be flame-retardant as a minimum, to have an ingress protection of at least IP55 and to meet the type test requirements as specified in Pt IV, Ch 3.

2.3.6 The L_{LL} system is to be capable of being manually activated by a single action from the continuously manned central control station. It may, additionally, be continuously operating or be switched on automatically, e.g. by the presence of smoke within the space(s) being served.

2.3.7 When powered, the systems are to achieve the following minimum luminance:

- for any planar source: 10 cd/m2 from the active parts in a continuous line of 15 mm minimum width
- for any point source: 35 mcd in the typical track directions of approach and viewing which is to be considered:
  - for sources which are required to be viewed from a horizontal position, i.e. deck mounted or horizontally bulkhead mounted fittings, within a 60° cone having its centre located 30° from the horizontal mounting surface of the point source and in line with the track direction, see Fig 2.1 - for sources which are required to be viewed vertically, i.e. the vertical L_{LL} marking up to the door handles, within a 60° cone having its centre located perpendicular to the mounting service of the point source, see Fig 2.2.

Spacing between sources is not to exceed 300 mm.

2.3.8 The lights or lighting assemblies are to be continuous except as interrupted by constructional constraints, such as corridors or cabin doors etc., are to provide a visible delineation along the escape route and, where applicable, are to lead to the exit door handles. Interruption of the L_{LL} system due to constructional constraints is not to exceed 2 metres.

2.3.9 The lighting is to be provided on at least one side of the corridor or stairway. In corridors and stairways in excess of 2 metres width, lighting is to be provided on both sides.

2.3.10 In corridors the lighting is to be installed either on the bulkhead within 300 mm of the deck or, alternatively, on the deck within 150 mm of the bulkhead.

2.3.11 In stairways the lighting is to be installed within 300 mm above the steps such that each step may be readily identified from either above or below that step. The top and bottom steps are to be further identified to show that there are no further steps.

Figure 2.1 :

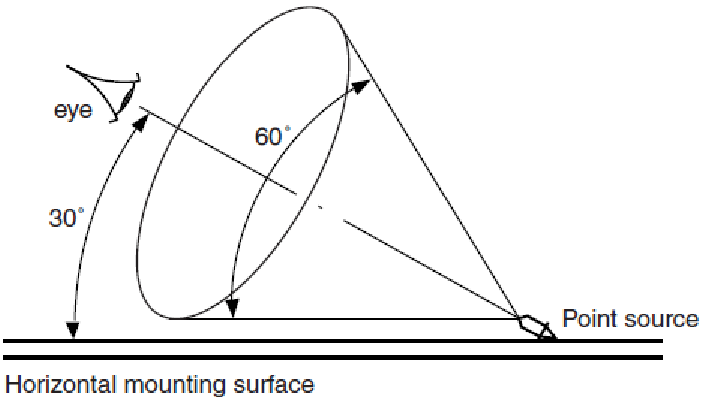
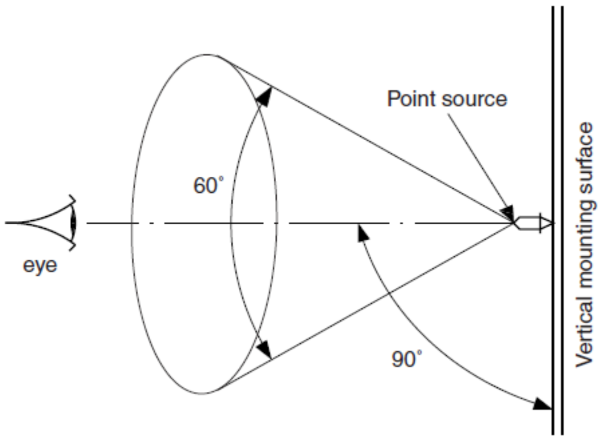


Figure 2.2 :



3 General emergency alarm and public address systems

3.1 General emergency alarm system

3.1.1 An electrically operated bell or klaxon or other equivalent warning system installed in addition to the ship's whistle or siren for sounding the general emergency alarm signal is to comply with the following requirements.

3.1.2 The general emergency alarm system is to be supplemented by either a public address system complying with the requirements in 3.2 or other suitable means of communication.

3.1.3 The entertainment sound system is to be automatically turned off when the general alarm system is activated.

3.1.4 The system is to be continuously powered and is to have an automatic change-over to a standby power supply in case of loss of the normal power supply.

An alarm is to be given in the event of failure of the normal power supply.

3.1.5 The system is to be powered by means of two circuits, one from the ship's main supply and the other from the emergency source of electrical power required by 2.1 and 2.2.

3.1.6 The system is to be capable of operation from the navigation bridge and, except for the ship's whistle, also from other strategic points.

Note 1: Other strategic points are taken to mean those locations, other than the navigation bridge, from where emergency situations are intended to be controlled and the general alarm system can be activated. A fire control station or a cargo control station is normally to be regarded as strategic points.

3.1.7 The alarm is to continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system.

3.1.8 The alarm system is to be audible throughout all the accommodation and normal crew working spaces and on all open decks.

3.1.9 The minimum sound pressure level for the emergency alarm tone in interior and exterior spaces is to be 80 dB (A) and at least 10 dB (A) above ambient noise levels existing during normal equipment operation with the ship underway in moderate weather.

3.1.10 In cabins without a loudspeaker installation, an electronic alarm transducer, e.g. a buzzer or similar, is to be installed.

3.1.11 The sound pressure level at the sleeping position in cabins and in cabin bathrooms is to be at least 75 dB (A) and at least 10 dB (A) above ambient noise levels.

3.1.12 For cables used for the general emergency alarm system, see Pt IV, Ch 2, Sec 9.

3.1.13 Electrical cables and apparatus for the general emergency alarm system and their power supply are to be arranged so that the loss of the system in any one area due to localised fire is minimised.

3.1.14 Where the fire alarm to summon the crew operated from the navigating bridge or fire control station is part of the ship's general alarm system, it is to be capable of being sounded independently of the alarm in the passenger spaces.

3.2 Public address system

3.2.1 The public address system is to be one complete system consisting of a loudspeaker installation which enables simultaneous broadcast of messages from the navigation bridge, and at least one other location on board for use when the navigation bridge has been rendered unavailable due to the emergency, to all spaces where crew members or passengers, or both, are normally present (accommodation and service spaces and control stations and open decks), and to assembly stations (i.e. muster stations).

In spaces such as under deck passageways, busunي locker, hospital and pump room, the public address system is/may not be required.

3.2.2 The public address system is to be arranged to operate on the main source of electrical power, the emergency source of electrical power and transitional sources of electrical power as required by Pt IV, Ch 2.

3.2.3 The controls of the system on the navigation bridge are to be capable of interrupting any broadcast on the system from any other location on board.

3.2.4 Where an individual loudspeaker has a device for local silencing, an override arrangement from the control station(s), including the navigating bridge, is to be in place.

3.2.5 The system is not to require any action by the addressee.

3.2.6 It is to be possible to address crew accommodation and work spaces separately from passenger spaces.

3.2.7 In addition to any function provided for routine use aboard the ship, the system is to have an emergency function control at each control station which:

a) is clearly indicated as the emergency function

b) is protected against unauthorised use

c) automatically overrides any other input system or program, and

d) automatically overrides all volume controls and on/off controls so that the required volume for the emergency mode is achieved in all spaces.

3.2.8 The system is to be installed with regard to acoustically marginal conditions, so that emergency announcements are clearly audible above ambient noise in all spaces where crew members or passengers, or both, are normally present (accommodation and service spaces and control stations and open decks), and at assembly stations (i.e. muster stations).

3.2.9 With the ship underway in normal conditions, the minimum sound pressure level for broadcasting emergency announcements is to be:

a) in interior spaces 75 dB (A) and at least 20 dB (A) above the speech interference level, and

b) in exterior spaces 80 dB (A) and at least 15 dB (A) above the speech interference level.

Evidence of this level is to be shown with test result in open sea or equivalent quay measurement with appropriate correction factor.

3.2.10 The system is to be arranged to prevent feed-back or other interference.

3.2.11 The system is to be arranged to minimise the effect of a single failure so that the emergency messages are still audible (above ambient noise levels) also in the event of failure of any one circuit or component.

3.2.12 Each loudspeaker is to be individually protected against short-circuits.

3.2.13 For cables used for the public address system, see Pt C, Ch 2.

3.2.14 All areas of each fire zone are to be served by at least two dedicated loops of flame-retardant cables which are to be sufficiently separated throughout their length and supplied by two separate and independent amplifiers.

3.2.15 A temperature alarm is to be provided in the public address cabinets in case of forced air cooling.

3.3 Combined general emergency alarm - public address system

3.3.1 Where the public address system is the only means for sounding the general emergency alarm signal and the fire alarm, in addition to the requirements of 3.1 and 3.2, the following are to be satisfied:

- the system automatically overrides any other input system when an emergency alarm is required.
- the system automatically overrides any volume control provided to give the required output for the emergency mode when an emergency alarm is required.
- the system is arranged to minimise the effect of a single failure so that the alarm signal is still audible (above ambient noise levels) also in the event of failure of any one circuit or component, by means of the use of more than one device for generating an electronic sound signal.

3.4 Quality failure analysis

3.4.1 A quality failure analysis is to be submitted in accordance with App 2.

4 Installation

4.1 Section and distribution boards

4.1.1 Cubicles and cupboards in areas which are accessible to any passenger are to be lockable.

5 Type approved components

5.1

5.1.1 Components for Low-Location Lighting systems (LLL) in passenger ship escape routes are to be type approved or in accordance with 5.1.2.

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

Appendix 1 Calculation Method for Cross-Flooding Arrangements

1 Calculation method for crossflooding arrangements

1.1 Definitions

1.1.1 Definitions

Σk : Sum of friction coefficients in the considered cross-flooding arrangement

S : Cross-section area, in m^2, of the cross-flooding pipe or duct. If the cross-section area is not circular, then:

$$S_{\text{equiv}} = \frac{\pi D_{\text{equiv}}^2}{4}$$

where:

$D_{\text{equiv}} = 4A/P$

A : actual cross-section area

p : actual cross-section perimeter

θ_0 : Angle, in degree, before commencement of cross-flooding. This assumes that the crossflooding device is fully flooded but that no water has entered into the equalizing compartment on the opposite side of the damage

θ_f: Heel angle, in degree, at final equilibrium θ_f

θ: Any angle of heel between the commencement of cross-flooding and the final equilibrium at a given time

W_f : Volume, in m^3, of water which is used to bring the ship from commencement of cross-flooding θ_0 to final equilibrium θ_f

W_θ: Volume, in m^3, of water which is used to bring the ship from any angle of heel θ to the final equilibrium θ_f

H_0 : Head of water, in m, before commencement of cross-flooding, with the same assumption as for θ_0

H: Head of water, in m, when any angle of heel θ is achieved

h_f : Final head of water, in m, after cross-flooding ($h_f = 0$, when the level inside the equalizing compartment is equal to the free level of the sea).

1.2 Cross-flooding area

1.2.1 Cross-flooding area calculation

The cross-flooding area S, in m^2, can be calculated from the following formula:

$$S = \frac{2W_f}{T_f F} \frac{\left(1 - \sqrt{h_f / H_0}\right)}{\sqrt{2gH_0}} \frac{1}{\left(1 - h_f / H_0\right)}$$

1.2.2 Calculation of time

T_f : Time required from commencement of cross flooding $\square_0$ to the final equilibrium $\square_f$

T □: Time required to bring the ship from any angle of heel □to the final equilibrium $\square_f$

$$T_\theta = \frac{2W_\theta}{SF}\frac{\left(1-\sqrt{h_f / H_\theta}\right)}{\sqrt{2gH_\theta}}\frac{1}{\left(1-h_f / H_\theta\right)}$$

T : Time required from commencement of cross flooding $\square_0$ until any angle of heel □ is achieved:

$T = T_f$ - T□

1.2.3 Dimensionless factor F

The dimensionless factor of reduction of speed through an equalization device, being a function of bends, valves, etc., in the cross-flooding system is to be calculated as follows:

$$F = \frac{1}{\sqrt{\sum K}}$$

where F is not to be taken as more than 1.

Values for k can be obtained from 1.2.4 or other appropriate sources.

1.2.4 Factor of reduction k

The factor of reduction is to be calculated depending on the following cases:

- Case 1: 90° circular bend
- Case 2: radius bend R/D = 2
- Case 3: mitre bend
- Case 4: 90° double mitre bend
- Case 5: pipe inlet
- Case 6: pipe outlet
- Case 7: non-return valve
- Case 8: pipe friction losses
- Case 9: gate valve
- Case 10: butterfly valve
- Case 11: disc valve.

Case 1: 90° CIRCULAR BEND (see Fig 1.1) The factor k is defined in Tab 1.1.

Figure 1.1 : 90°CIRCULAR BEND

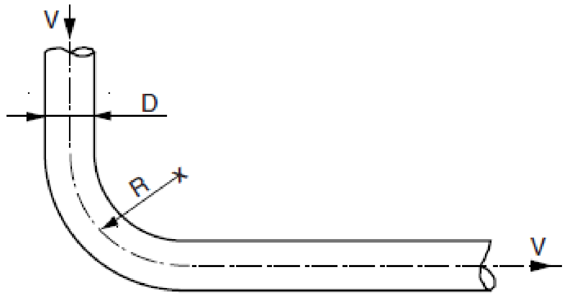


Table 1.1 : Values of factor k

R/D	2	3	4	5	6	7
K	.30	.26	.23	.20	.18	.17

Case 2: RADIUS BEND R/D = 2 (see Fig 1.2) The factor k is defined in Tab 1.2.

Figure 1.2 : RADIUS BEND R/D = 2

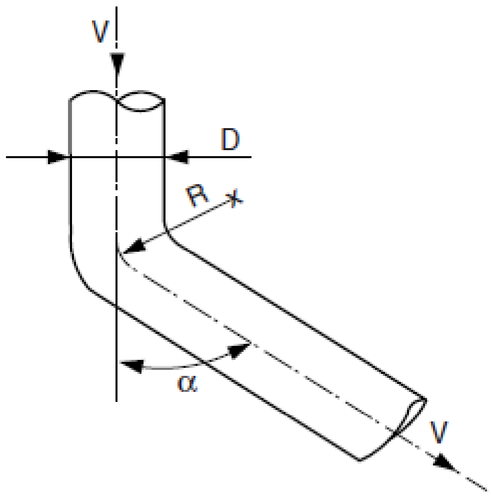


Table 1.2 : Values of factor k

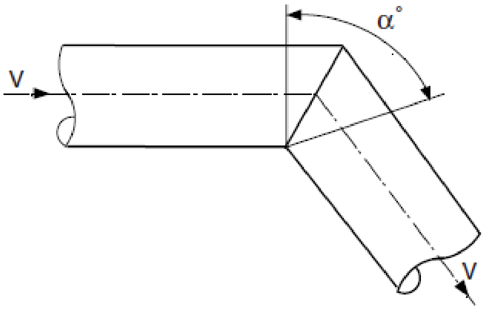
α	15	30	45	60	75	90
K	.06	.12	.18	.24	.27	.30

Case 3: MITRE BEND (see Fig 1.3) The factor k is defined in Tab 1.3.

Table 1.3 : Values of factor k

α	5	15	30	45	60	90
K	.02	.06	.17	.32	.68	1.26

Figure 1.3 : MITRE BEND



Case 4: 90°DOUBLE MITRE BEND (see Fig 1.4) The factor k is defined in Tab 1.4.

Figure 1.4 : 90° DOUBLE MITRE BEND

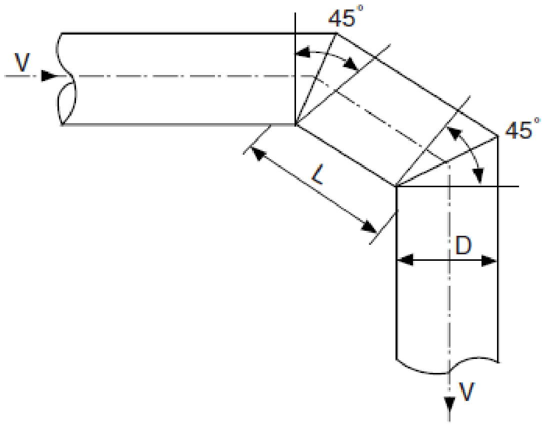


Table 1.4 : Values of factor k

L/D	1	2	3	4	5	6
K	.41	.40	.43	.46	.46	.44

Case 5: PIPE INLET (see Fig 1.5) The factor k is defined in Tab 1.5.

Figure 1.5 : PIPE INLET

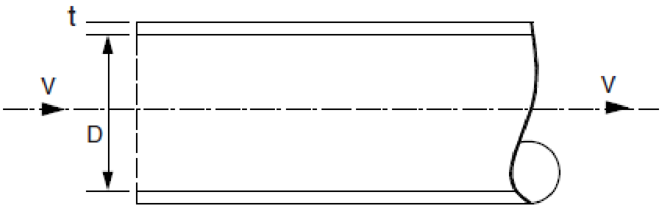
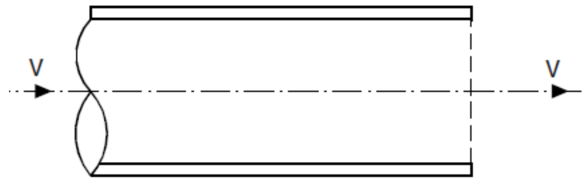


Table 1.5 : Values of factor k

t/D	.01	.02	.03	.04	.05	□05
k	.83	.68	.53	.46	.44	.43

Case 6: PIPE OUTLET (see Fig 1.6) k = 1.0

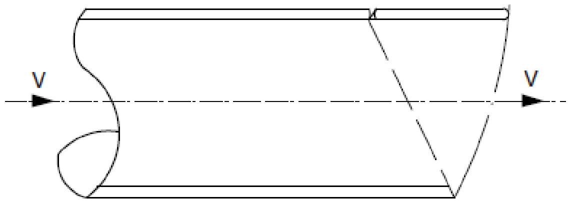
Figure 1.6 : PIPE OUTLET



Case 7: NON-RETURN VALVE (see Fig 1.7) k = 0.5

The value of k actually increases with decrease in Froude number, particularly below speeds of 2m/sec.

Figure 1.7 : NON-RETURN VALVE



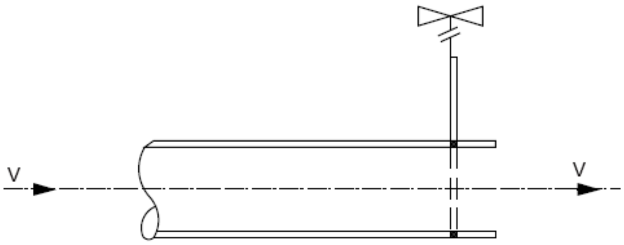
Case 8: PIPE FRICTION LOSSES

The coefficient above is a mean value and does in fact vary as Reynoldڍ number (i.e. varies with V for constant D and v) as well as with relative roughness.

k = 0.02/D per unit length

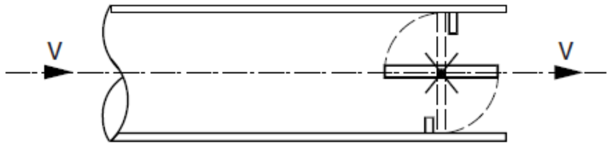
Case 9: GATE VALVE (see Fig 1.8) k = 0.3

Figure 1.8 : GATE VALVE



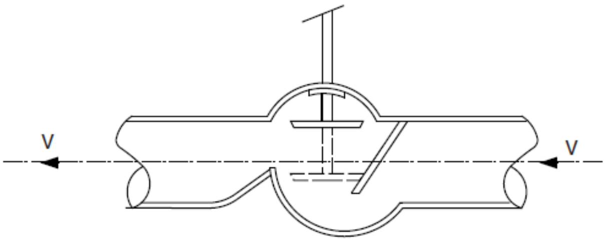
Case 10: BUTTERFLY VALVE (see Fig 1.9) k = 0.8

Figure 1.9 : BUTTERFLY VALVE



Case 11: DISC VALVE (see Fig 1.10) k = 6.0

Figure 1.10 : DISC VALVE



1.2.5 Cross-flooding through successive devices

If the same flow crosses successive flooding devices of cross-section S_1, S_2, S_3,... having corresponding friction coefficients k_1, k_2, k_3,..., then the total k coefficient referred to S_1 is:

$$\sum k = k_1 + k_2 \frac{S_1^2}{S_2^2} + k_3 \frac{S_1^2}{S_3^2} \ldots$$

1.2.6 Different flooding devices not crossed by the same volume

If different flooding devices are not crossed by the same volume, each *k* coefficient is to be multiplied by the square of the ratio of the volume crossing the device and the volume crossing the reference section (which will be used for the time calculation):

$$\sum k = k_1 + k_2 \frac{S_1^2}{S_2^2}\frac{W_2^2}{W_1^2} + k_3 \frac{S_1^2}{S_3^2}\frac{W_3^2}{W_1^2} \ldots$$

1.2.7 Cross flooding through devices in parallel

For cross-flooding through devices in parallel that lead to the same space, equalisation time is to be calculated assuming that:

$SF = S_1F_1 + S_2F_2 + \ldots$

with:

$$F = \frac{1}{\sqrt{\sum K}}$$

for each device of cross section S_i.

1.2.8 Air pipe venting criteria

In arrangements where the total air pipe sectional area is 10% or more of the cross-flooding sectional area, the restrictive effect of any air back pressure may be neglected in the cross-flooding calculations. The air pipe sectional area is to be taken as the minimum or the net sectional area of any automatic closing devices, if that is less.

In arrangements where the total air pipe sectional area is less than 10% of the cross-flooding sectional area, the restrictive effect of air back pressure is to be considered in the cross-flooding calculations. The following method may be used for this purpose:

The k coefficient used in the calculation of cross-flooding time is to take into account the drop of head in the air pipe.

This can be done using an equivalent coefficient ke, which is calculated according to the following formula:

$$k_e = k_w + k_a \frac{\rho_a}{\rho_w}\left(\frac{S_w}{S_a}\right)^2$$

where:

k_w : k coefficient for the cross-flooding arrangement (water)

k_a : k coefficient for the air pipe

ρ_a : Air density

ρ_w : Water density

S_w : Cross-section area of the cross-flooding device (water)

S_a : Cross-section of air pipe

1.2.9 Alternatives

As an alternative to the provisions above, and for arrangements other than those shown in 1.2.4, direct calculation using computational fluid dynamics (CFD), time-domain simulations or model testing may also be used.

1.2.10 Examples

- Cross-flooding through a series of structural ducts with 1 manhole (see Fig 1.11 and Fig 1.12)

  - if $0 < L_i < 1$:

    $k = 0.2748 L_i + 0.0313$

  - if $1 \leq L_i \leq 4$:

    $k = -0.0986 L_i^3 + 0.6873 L_i^2 - 1.0212 L_i + 0.7386$

    if $L_i > 4$:

    $k = 1.34$

- Cross-flooding through a series of structural ducts with 2 manholes (see Fig 1.13)

  - if $0 < L_i < 1$:

    $k = 0.4045 L_i + 0.0627$

  - if $1 \leq L_i \leq 4$

    $k = 0.0424 L_i^3 + 0.3593 L_i^2 - 1.1401 L_i - 0.356$

  - if $Li > 4$:

    $k = 1.17$

Note 1: k is the friction coefficient related to each space between two adjacent girders. k is evaluated with effective cross-section area therefore in calculations use the real cross-section area A and not S_{equiv}. The pressure loss for entrance in the first manhole is already computed in the calculation, and k = 1 has to be added to take into account the outlet losses.

Figure 1.11 : Structural duct with 1 manhole

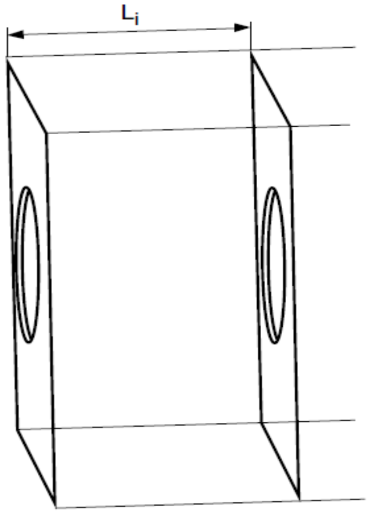


Figure 1.12 : Series of structural ducts with 1 manhole

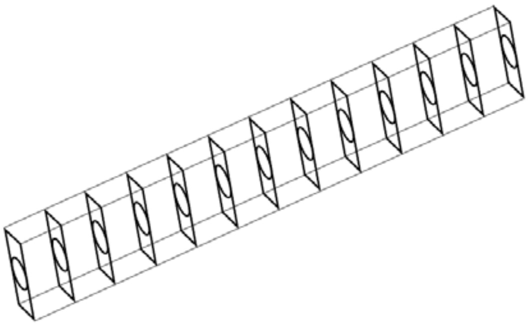
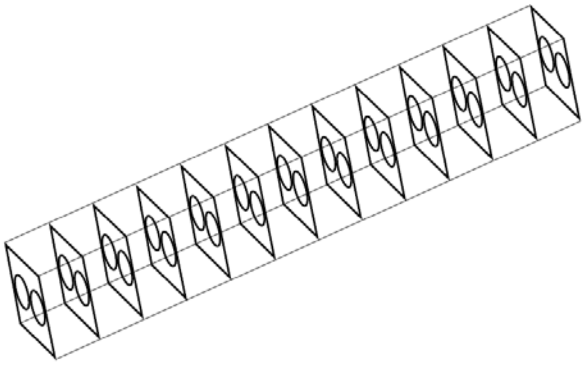


Figure 1.13 : Series of structural ducts with 2 manholes



Appendix 2 Qualitative Failure Analysis for Propulsion and Steering on Passenger Ships

1 General

1.1 Scope

1.1.1 This appendix details qualitative failure analysis for propulsion and steering for new passenger ships including those having a length of 120 m or more or having three or more main vertical zones.

Note 1: This may be considered as the first step for demonstrating compliance with the revised SOLAS Chapter II-2, Regulation 21 ت SOLAS 2006 Amendments, Resolution MSC.216(82), annex 3.

1.2 Objectives

1.2.1 For ships having at least two independent means of propulsion and steering to comply with SOLAS requirements for a safe return to port, items a) and b) below are applicable:

a) Provide knowledge of the effects of failure in all the equipment and systems due to fire in any space, or flooding of any watertight compartment that could affect the availability of the propulsion and steering.

b) Provide solutions to ensure the availability of propulsion and steering upon such failures in item a).

1.2.2 Ships not required to satisfy the safe return to port concept will require the analysis of failure in single equipment and fire in any space to provide knowledge and possible solutions for enhancing availability of propulsion and steering.

2 Method of drafting the quality failure analysis

2.1 Systems to be considered

2.1.1 The qualitative failure analysis is to consider the propulsion and steering equipment and all its associated systems which might impair the availability of propulsion and steering.

2.1.2 The qualitative failure analysis should include:

a) Propulsion and electrical power prime movers, e.g.:

- Diesel engines
- Electric motors.

b) Power transmission systems, e.g.:

- Shafting
- Bearings
- Power converters

- Transformers
- Slip ring systems.

c) Steering gear

- Rudder actuator or equivalent for azimuthing propulsor
- Rudder stock with bearings and seals
- Rudder
- Power unit and control gear
- Local control systems and indicators
- Remote control systems and indicators
- Communication equipment.

d) Propulsors, e.g.:

- Propeller
- Azimuthing thruster
- Water jet.

e) Main power supply systems, e.g.:

- Electrical generators and distribution systems
- Cable runs
- Hydraulic
- Pneumatic.

f) Essential auxiliary systems, e.g.:

- Compressed air
- Oil fuel
- Lubricating oil
- Cooling water
- Ventilation
- Fuel storage and supply systems.

g) Control and monitoring systems, e.g.:

- Electrical auxiliary circuits
- Power supplies
- Protective safety systems
- Power management systems
- Automation and control systems.

h) Support systems, e.g.:

- Lighting
- Ventilation.

To consider the effects of fire or flooding in a single compartment, the analysis is to address the location and layout of equipment and systems.

2.2 Failure criteria

2.2.1 Failures are deviations from normal operating conditions such as loss or malfunction of a component or system such that it cannot perform an intended or required function.

2.2.2 The qualitative failure analysis should be based on single failure criteria, (not two independent failures occurring simultaneously).

2.2.3 Where a single failure cause results in failure of more than one component in a system (common cause failure), all the resulting failures are to be considered together.

2.2.4 Where the occurrence of a failure leads directly to further failures, all those failures are to be considered together.

2.3 Verification of solutions

2.3.1 The shipyard is to submit a report to the Society that identifies how the objectives have been addressed. The report is to include the following information:

- Identify the standards used for analysis of the design
- Identify the objectives of the analysis
- Identify any assumptions made in the analysis
- Identify the equipment, system or sub-system, mode of operation of the equipment
- Identify probable failure modes and acceptable deviations from the intended or required function
- Evaluate the local effects (e.g. fuel injection failure) and the effects on the system as a whole (e.g. loss of propulsion power) of each failure mode as applicable
- Identify trials and testing necessary to prove conclusions.

Note 1: All stakeholders (e.g., owners, shipyard and manufacturers) should as far as possible be involved in the development of the report.

2.3.2 The report is to be submitted prior to approval of detail design plans. The report may be submitted in two parts:

- A preliminary analysis as soon as the initial arrangements of different compartments and propulsion plant are known which can form the basis of discussion. This is to include a structured assessment of all essential systems supporting the propulsion plant after a failure in equipment, fire or flooding in any compartment casualty
- A final report detailing the final design with a detailed assessment of any critical system identified in the preliminary report.

Chapter 9 Ro-Ro Passenger Ships

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Roro passenger ship, as defined in Pt I.

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts I, II, III and IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to ro-ro passenger ships.

Section 2 Ship Arrangement

1 General

1.1 Application

1.1.1 The requirements of Ch 8, Sec 2 and Ch 8, Sec 3 apply to multi-deck ships, with double bottom and, in some cases, with wing tanks up to the lowest deck above the full load waterline, intended for the carriage of:

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

1.2 Definitions

1.2.1 Deepest subdivision load line

Deepest subdivision load line is the waterline which corresponds to the summer load line of the ship.

1.2.2 Length L_S

Subdivision length L_S of the ship is the greatest projected moulded length of that part of the ship at or below deck or decks limiting the vertical extent of flooding with the ship at the deepest subdivision load line.

The length referred to in 2 is the length L_S.

1.2.3 Ro-ro cargo spaces

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

1.2.4 Special category spaces

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 provided that the total overall clear height for vehicles does not exceed 10 m.

2 General arrangement design

2.1 Number and disposition of transverse watertight bulkheads

2.1.1 Where there are less transverse bulkheads than those specified in Pt III, Ch 1or where the distance between them is considered excessive by the Society, ships are to be fitted with a system of partial bulkheads, side transverse frames and deck transverses such as to provide equivalent transverse strength.

2.2 Openings in watertight bulkheads below the bulkhead deck

2.2.1 Openings in machinery spaces

Not more than one door apart from the doors to shaft tunnels may be fitted in each watertight bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion.

Where two or more shafts are fitted the tunnels are to be connected by an inter-communicating passage. Only one door is to be provided between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors are to be of the sliding type and are to be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck is to be situated outside the spaces containing the machinery.

Portable plates on bulkheads are not permitted except in machinery spaces. Such plates are always to be in place before the ship leaves port, and are not to be removed during navigation except in the case of urgent necessity at the discretion of the Master. The necessary precautions are to be taken in replacing them to ensure that the joints are watertight. The Society may permit not more than one power-operated sliding watertight door in each watertight bulkhead larger than 1.20 m to be substituted for these portable plates, provided these doors are intended to remain closed during navigation except in the case of urgent necessity at the discretion of the Master. These doors need not meet the requirements of complete closure by handoperated gear in 90 seconds (see Ch 8, Sec 2, 2.3.3 e).

2.2.2 Openings in cargo spaces

Watertight doors complying with the requirements of 2.4.1 may be fitted in watertight bulkheads dividing cargo between deck spaces. Such doors may be hinged, rolling or sliding doors but are not to be remotely controlled. They are to be fitted at the highest level and as far from the shell plating as practicable, but in no case are the outboard vertical edges to be situated at a distance from the shell plating which is less than one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line.

The doors accessible during the voyage are to be fitted with a device which prevents unauthorised opening. When it is proposed to fit such doors, the number and arrangements are to receive the special consideration of the Society.

2.2.3 Openings in ships carrying goods vehicles and accompanying personnel

This requirement applies to passenger ships designed or adapted for the carriage of goods vehicles and accompanying personnel where the total number of persons on board, other than passengers.

If in such a ship the total number of passengers which include personnel accompanying vehicles does not exceed:

$N = 12 + A / 25$

where:

N : the maximum number of passengers for which the ship is certified

A : the total deck area, in m2, of spaces available for the stowage of goods vehicles,

and where the clear height at the stowage position and at the entrance to such spaces is not less than 4 m, the provisions of 2.2.2 in respect of watertight doors apply except that the doors may be fitted at any level in watertight bulkheads dividing cargo spaces.

Additionally, indicators are required on the navigating bridge to show automatically when each door is closed and all door fastenings are secured.

2.2.4 Trunks and tunnels

Where trunkways or tunnels for access from crew accommodation to the stokehold, for piping, or for any other purpose are carried through watertight bulkheads, they are to be watertight and in accordance with the requirements of Pt III, Ch 2, Sec 9. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, is to be through a trunk extending watertight to a height sufficient to permit access above the bulkhead deck. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels are not to extend through the first subdivision bulkhead abaft the collision bulkhead.

Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings are to be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

Where a ventilation trunk passing through a structure penetrates the bulkhead deck, the trunk is to be capable of withstanding the water pressure that may be present within the trunk, after having taken into account the maximum heel angle allowable during intermediate stages of flooding.

In the absence of information regarding the above maximum angle of heel, the water pressure relevant to the transverse location of the ventilation trunk is to be linearly interpolated between 0,5 m at the centreline and a height corresponding to an angle of 15° from the bulkhead deck plus 0.5 m at the side shell.

2.2.5 Additional requirements

In addition to 2.2.1 to 2.2.4, the requirements reported in 2.4.3 are to be complied with.

2.3 Openings in bulkheads above the bulkhead deck

2.3.1 General

Measures such as the fitting of partial bulkheads or webs are to be taken to limit the entry and spread of water above the bulkhead deck. When partial watertight bulkheads and webs are fitted on the bulkhead deck, above or in the immediate vicinity of watertight bulkheads, their connections with the shell and bulkhead deck are to be watertight so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the partial watertight bulkhead does not line up with the bulkhead below, the bulkhead deck between is to be made effectively watertight. Where openings, pipes, scuppers, electric cables etc. are carried through the partial watertight bulkheads or decks within the immersed part of the bulkhead deck, arrangements are to be made to ensure the watertight integrity of the structure above the bulkhead deck.

The coamings of all openings in the exposed weather deck are to be of ample height and strength and are to be provided with efficient means for expeditiously closing them weathertight. Freeing ports, open rails and scuppers are to be fitted as necessary for rapidly cleaning the weather deck of water under all weather conditions.

Sidescuttles, gangway, cargo and fuelling ports and other means for closing openings in the shell plating above the bulkhead deck are to be of efficient design and construction and of sufficient strength having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision load line.

Efficient inside deadlights, so arranged that they can be easily and effectively closed and secured watertight, are to be provided for all sidescuttles to spaces below the first deck above the bulkhead deck.

2.3.2 Watertight integrity from the ro-ro deck (bulkhead deck) to spaces below

In ships subject to the provisions of 2.3.3, the lowest point of all accesses that lead to spaces below the bulkhead deck is not to be less than 2.5 m above the bulkhead deck.

2.3.3 Vehicle ramps and other accesses

Where vehicle ramps are installed to give access to spaces below the bulkhead deck, their openings are to be closed weathertight to prevent ingress of water below, alarmed and indicated to the navigation bridge.

The Society may permit the fitting of particular accesses to spaces below the bulkhead deck provided they are necessary for the essential working of the ship, e.g. the movement of machinery and stores, subject to such accesses being made watertight, alarmed and indicated on the navigation bridge.

2.3.4 Open end of air pipes

The open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15 degrees, or the maximum angle of heel during intermediate stages of flooding, as determined by direct calculation, whichever is the greater. Where no information regarding the above angle of heel is available, the open end of air pipes terminating within a superstructure is to be at least 1 m above the waterline when the ship heels to an angle of 15° or 0.5 m above the waterline when the ship heels to an angle of 15° from the bulkhead deck, whichever is the greater.

Alternatively, air pipes from tanks other than oil tanks may discharge through the side of the superstructure. The provisions of this paragraph are without prejudice to the provisions of the International Convention on Load Lines in force.

2.3.5 Additional requirements

In addition to 2.3.1 to 2.3.4, the requirements in 2.4.4 are to be complied with.

Table 2.1 : Doors

			Sliding Type			Hinged type			Rolling Type (cargo between deck spaces)
			Remote operation indication on the bridge	Indicator on the bridge	Local operation only	Remote operation indication on the bridge	Indicator on the bridge	Local operation only	
Watertight	below the bulkhead deck	open at sea	X						
		normally closed (4)	X						
		remain closed (4)					X (1)		X(1) (3)
Weathertight/ semiwatertight (2)	above the bulkhead deck	open at sea	X			X			
		normally closed (4)		X			X		
		remain closed (4)						X	

(1) The door is to be closed before the voyage commences.

(2) Semi-watertight doors are required when they are located below the waterline at the equilibrium of the intermediate stages of flooding.

(3) If the door is accessible during the voyage, a device which prevents unauthorised opening is to be fitted.

(4) Notice to be affixed on both sides of the door: بto be kept closed at seaپ

2.4 Doors

2.4.1 Requirements for doors

The requirements relevant to the degree of tightness, as well as the operating systems, for doors complying with the prescriptions in 2.4.2 and 2.4.3 are specified in Tab 2.1.

2.4.2 Construction of watertight doors

The design, materials and construction of all watertight doors are to be to the satisfaction of the Society.

Such doors are to be suitably marked to ensure that they may be properly used to provide maximum safety.

The frames of vertical watertight doors are to have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

2.4.3 Doors in watertight bulkheads below the bulkhead deck

a) Watertight doors, except as provided in 2.2.2 paragraph 1 and 2.2.3, are to be capable of being closed simultaneously from the central operating console at the navigation bridge in not more than 60 s with the ship in the upright position.

b) The means of operation whether by power or by hand of any power-operated sliding watertight door are to be capable of closing the door with the ship listed to 15° either way. Consideration is to also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door.

c) Watertight door controls, including hydraulic piping and electrical cables, are to be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimise the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls are to be such that if the ship sustains damage within one fifth of the breadth of the ship, such distance being measured at right angles to the centreline at the level of the deepest subdivision load line, the operation of the watertight doors clear of the damaged portion of the ship is not impaired.

d) All power-operated sliding watertight doors are to be provided with means of indication which show at all remote operating positions whether the doors are open or closed. Remote operating positions are only to be located at the navigating bridge and at the location where hand operation above the bulkhead deck is required by e).

e) Each power-operated sliding watertight door:

- is to move vertically or horizontally;
- is to be normally limited to a maximum clear opening width of 1,20 m. The Society may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:
  - special consideration is to be given to the strength of the door and its closing appliances in order to prevent leakages;
  - the door is to be located outside the damage zone B/5;
- is to be fitted with the necessary equipment to open and close the door using electrical power, hydraulic power, or any other form of power that is acceptable to the Society;
- is to be provided with an individual hand-operated mechanism. It is to be possible to open and close the door by hand at the door itself from either side and, in addition, close the door from an accessible position above the bulkhead deck with an all round crank motion or some other movement providing the same degree of safety acceptable to the Society.

Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, may not exceed 90 s with the ship in the upright position;

- is to be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console at the navigation bridge;
- is to be provided with an audible alarm, distinct from any other alarm in the area, which is to sound whenever the door is closed remotely by power and which is to sound for at least 5 s but no more than 10 s before the door begins to move and is to continue sounding until the door is completely closed.

In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving. Additionally, in passenger areas and areas of high ambient noise, the Society may require the audible alarm to be supplemented by an intermittent visual signal at the door;

- is to have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position, is to in no case be less than 20 s or more than 40 s with the ship in the upright position.

f) The electrical power required for power-operated sliding watertight doors is to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck.

The associated control, indication and alarm circuits are to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by a transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power.

The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to control, indication and alarm circuits at least for half an hour.

g) Power-operated sliding watertight doors are to have either:

- a centralised hydraulic system with two independent power sources each consisting of a motor and pump capable of simultaneously closing all doors. In addition, there are to be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closedopen-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure.

The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. The power operating system is to be designed to minimise the possibility of having a single failure in the hydraulic piping adversely affect the operation of more than one door. The hydraulic system is to be provided with a low-level alarm for hydraulic fluid reservoirs serving the power-operated system and a low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators.

These alarms are to be audible and visual and are tobe situated on the central operating console at the navigating bridge; or

- an independent hydraulic system for each door with each power source consisting of a motor or pump capable of opening and closing the door. In addition, there is to be a hydraulic accumulator of sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°. This operating cycle is to be capable of being carried out when the accumulator is at the pump cut-in pressure. The fluid used is to be chosen considering the temperatures liable to be encountered by the installation during its service. A low gas pressure group alarm or other effective means of monitoring loss of stored energy in hydraulic accumulators is to be provided at the central operating console on the navigation bridge. Loss of stored energy indication at each local operating position is to also be provided; or
- an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source is to be capable of being automatically supplied by the transitional source of emergency electrical power in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed, against an adverse list of 15°.

The transitional source of emergency electrical power is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be of sufficient capacity and so arranged as to supply power automatically, in the event of failure of either the main or emergency source of electrical power, to watertight doors, but not necessarily all of them simultaneously, unless an independent source of stored energy is provided.

For the systems specified above, provision is to be made as follows:

Power systems for power-operated watertight sliding doors are to be separate from any other power system.

A single failure in the electrical or hydraulic power-operated systems excluding the hydraulic actuator is not to prevent the hand operation of any door.

h) Control handles are to be provided at each side of the bulkhead at a minimum height of 1,6 m above the floor and are to be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidentally. The direction of movement of the handles in opening and closing the door is to be in the direction of door movement and is to be clearly indicated.

i) As far as practicable, electrical equipment and components for watertight doors are to be situated above the bulkhead deck and outside hazardous areas and spaces.

j) The enclosures of electrical components necessarily situated below the bulkhead deck are to provide suitable protection against the ingress of water.

k) Electric power, control, indication and alarm circuits are to be protected against faults in such a way that a failure in one door circuit is not to cause a failure in any other door circuit. Short-circuits or other faults in the alarm or indicator circuits of a door are not to result in a loss of power operation of that door. Arrangements are to be such that leakage of water into the electrical equipment located below the bulkhead deck is not to cause the door to open.

l) A single electrical failure in the power operating or control system of a power-operated sliding watertight door is not to result in a closed door opening. Availability of the power supply is to be continuously monitored at a point in the electric circuit as near as practicable to each of the motors required in g). Loss of any such power supply is to activate an audible and visual alarm at the central operating console at the navigation bridge.

m) The central operating console at the navigation bridge is to have a بmaster modeپ switch with two modes of control:

- a بlocal controlپmode which is to allow any door to be locally opened and locally closed after use without automatic closure, and
- a بdoors closedپmode which is to automatically close any door that is open. The بdoors closedپ mode is to permit doors to be opened locally and is to automatically reclose the doors upon release of the local control mechanism.

The بmaster modeپswitch is to normally be in the بlocal controlپmode. The بdoors closedپmode is to only be used in an emergency or for testing purposes.

Special consideration is to be given to the reliability of the بmaster modeپswitch.

n) The central operating console at the navigation bridge is to be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light is to indicate a door is fully open and a green light is to indicate a door is fully closed. When the door is closed remotely the red light is to indicate the intermediate position by flashing. The indicating circuit is to be independent of the control circuit for each door.

o) It is not to be possible to remotely open any door from the central operating console.

p) All watertight doors are to be kept closed during navigation.

Certain watertight doors may be permitted to remain open during navigation only if considered absolutely necessary; that is, being open is determined essential to the safe and effective operation of the ship's machinery or to permit passengers normally unrestricted access throughout the passenger area. Such determination is to be made by the Society only after careful consideration of the impact on ship operations and survivability. A watertight door permitted to remain thus open is to be clearly indicated in the ship's stability information and the damage control documentation and is always to be ready for immediate closure.

2.4.4 Doors in bulkheads above the bulkhead deck

a) General

Doors are to be capable of being opened and closed by hand locally from both sides of the doors with the ship listed to 15° to either side. If the ship is allowed to heel up to

20°, during intermediate stages of flooding, then the doors are to be capable of operation by hand with the ship listed to 20° to either side.

Position indicators are to be provided on the bridge as well as locally on both side of the doors to show that the doors are open or closed and that the dogs are fully and properly engaged.

Where the doors also serve as fire doors they are to be provided with position indicators at the fire control station and audible alarms as required for fire doors, as well as for weathertight doors. Where two doors are fitted they must be capable of independent operation remotely and from both sides of each door.

b) Doors normally closed at sea

In addition to a), doors not required for frequent access while at sea are to be kept normally closed and may be of either hinged or sliding type.

Doors kept normally closed are to have local operation from both sides of the doors and are to be labelled on both sides: ِto be kept closed at seaپ

c) Doors normally open at sea

Where fitted in public space for the passage of passengers and crew, the doors may be kept normally open at sea and may be either hinged or sliding type.

In addition to a), doors kept normally open at sea are to have local power operation from both sides of the door and remote closing from the bridge. Operation of these doors is to be similar to that specified in Pt IV, Ch 4, Sec 5 where, using a ِmaster modeپswitch on the bridge, local control can override the remote closing feature after which the door is automatically remotely reclosed upon release of the local control mechanism.

Doors kept normally open at sea are to have audible alarms, distinct from any other alarm in the area, which sound whenever the doors are closed remotely. The alarms are to sound for at least 5 s but not more than 10 s before the doors begins to move and continue sounding until the doors are completely closed. In passenger areas and areas of high ambient noise, the audible alarms are to be supplemented by visual signals at both sides of the doors.

d) The following doors, located above the bulkhead deck, are to be provided with adequate means of closure and locking devices according to a) and b) above and the requirements of PtIII, Ch 2, Sec 16:

- cargo loading doors in the shell or the boundaries of enclosed superstructures,
- bow visors fitted in the shell or the boundaries of enclosed superstructures,
- cargo loading doors in the collision bulkhead,
- weathertight ramps forming an alternative closure to those previously defined.

2.5 Integrity of the hull and superstructure, damage prevention and control

2.5.1 Indicators are to be provided on the navigation bridge for all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Society, lead to flooding of a special category space or ro-ro cargo space. The indicator system is to be designed on the fail-safe principle and is to show by visual alarms if the door is not fully closed or if any of the securing arrangements are not in place and fully locked and by audible alarms if such door or closing appliances become open or the securing arrangements become unsecured. The indicator panel on the navigation bridge is to be equipped with a mode selection function “harbour/ sea voyage” so arranged that an audible alarm is given on the navigation bridge if the ship leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator system is to be independent of the power supply for operating and securing the doors.

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

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

2.5.2 Television surveillance and a water leakage detection system are to be arranged to provide an indication to the navigation bridge and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors which could lead to flooding of special category spaces or ro-ro cargo spaces.

2.5.3 Special category spaces and ro-ro cargo spaces are to be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorized access by passengers thereto can be detected whilst the ship is underway.

2.5.4 Documented operating procedures for closing and securing all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Society, lead to flooding of a special category space or ro-ro cargo space, are to be kept on board and posted at an appropriate place. The operating procedures may be included in the stability information or in the damage control booklet.

2.5.5 A closing indicator is to be fitted for the inner bow doors which constitute a prolongation of the collision bulkhead above the bulkhead deck as requested in 2.5.1.

2.6 Ballast compartment arrangement

2.6.1 Water ballast is not to, in general, be carried in tanks intended for fuel oil. In ships in which it is not practicable to avoid putting water in fuel oil fuel, oily-water separating equipment to the satisfaction of the Society is to be fitted, or other alternative means, such as discharge to shore facilities, acceptable to the Society is to be provided for disposing of the oily-water ballast (see Pt IV, Ch 1, Sec 11, 7).

2.7 Double bottom arrangement

2.7.1 A double bottom is to be fitted extending from the collision bulkhead to the after peak bulkhead, as far as this is practicable and compatible with the design and proper working of the ship.

2.7.2 Where a double bottom is required to be fitted, the inner bottom is to be continued out to the ship's sides in such a manner as to protect the bottom to the turn of the bilge. Such protection is to be deemed satisfactory if the inner bottom is not lower at any part than a plane parallel with the keel line and which is located not less than a vertical distance h measured from the keel line, as calculated by the formula:

$h = B/20$

However, in no case is the value of h to be less than 760 mm, and need not to be taken as more than 2 m.

2.7.3 Small wells constructed in the double bottom, in connection with the drainage arrangements of holds, are not to extend downward more than necessary. A well extending to the outer bottom, is, however, permitted at the after end of the shaft tunnel of the ship. Other wells may be permitted by the Society if it is satisfied that the arrangements give protection equivalent to that afforded by a double bottom complying with 2.7. In no case, the vertical distance from the bottom of such a well to a plane coinciding with the keel line is to be less than 500 mm.

2.7.4 A double bottom need not be fitted in way of watertight tanks, including dry tanks of moderate size, provided the safety of the ship is not impaired in the event of bottom or side damage as defined in Pt III, Ch 4, Sec 3, 3.4.

2.7.5 Any part of a ship that is not fitted with a double bottom in accordance with 2.7.1 or 2.7.4 is to be capable of withstanding bottom damages, as specified in Pt III, Ch 4, Sec 3, 3.4, in that part of the ship.

2.7.6 In the case of unusual bottom arrangements, it is to be demonstrated that the ship is capable of withstanding bottom damages, as specified in Pt III, Ch 4, Sec 3, 3.4.

2.7.7 In case of large lower holds in passenger ships, the Society may require an increased double bottom height of not more than B/10 or 3 m, whichever is less, measured from the keel line. Alternatively, bottom damages may be calculated for these areas, in accordance with Pt III, Ch 4, Sec 3, 3.4 but assuming an increased vertical extent.

2.8 Machinery compartment arrangement

2.8.1 When longitudinal bulkheads are fitted in the machinery space, adequate self-operating arrangements are to be provided in order to avoid excessive heel after damage.

Where such arrangements are cross-flooding systems, their area is to be calculated in accordance with the requirements in Ch8, App 1. In addition, such systems are to comply with the criteria for the maximum time necessary to cross flood according to Sec 3, 1.3.5 c).

2.9 Passenger spaces in ro-ro ships

2.9.1 No passenger spaces are permitted within the enclosed ro-ro decks.

Section 3 Hull and Stability

1 Stability

1.1 Definitions

1.1.1 Deepest subdivision draught

The deepest subdivision draught (d_S) is the waterline which corresponds to the summer load line draught of the ship.

1.1.2 Light service draught

Light service draught (d_L) is the service draught corresponding to the lightest anticipated loading and associated tankage, including, however, such ballast as may be necessary for stability and/or immersion.

1.1.3 Partial subdivision draught

The partial subdivision draught (d_P) is the light service draught plus 60% of the difference between the light service draught and the deepest subdivision draught.

1.1.4 Subdivision length L_s

The subdivision length L_s is the greatest projected moulded length of that part of the ship at or below deck or decks limiting the vertical extent of flooding with the ship at the deepest subdivision draught.

1.1.5 Machinery space

Machinery spaces are spaces between the watertight boundaries of a space containing the main and auxiliary propulsion machinery, including boilers, generators and electric motors primarily intended for propulsion. In the case of unusual arrangements, the Society may define the limits of the machinery spaces.

1.1.6 Other definitions

Mid-length is the mid point of the subdivision length of the ship.

Aft terminal is the aft limit of the subdivision length.

Forward terminal is the forward limit of the subdivision length.

Breadth B is the greatest moulded breadth, in m, of the ship at or below the deepest subdivision draught.

Draught d is the vertical distance, in m, from the moulded baseline at mid-length to the waterline in question.

Permeability □of a space is the proportion of the immersed volume of that space which can be occupied by water.

1.2 Intact stability

1.2.1 General

Every passenger ship regardless of size is to be inclined upon its completion and the elements of its stability determined.

The Master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service.

A copy of the stability information is to be furnished to the Society.

Where any alterations are made to a ship so as to materially affect the stability information supplied to the Master, amended stability information is to be provided. If necessary the ship is to be re-inclined.

1.2.2 Periodical lightweight check

At periodical intervals not exceeding five years, a lightweight survey is to be carried out on all passenger ships to verify any changes in lightship displacement and longitudinal centre of gravity. The ship is to be re-inclined whenever, in comparison with the approved stability information, a deviation from the lightship displacement exceeding 2% or a deviation of the longitudinal centre of gravity exceeding 1% of Ls is found, or anticipated.

1.2.3 Standard requirements

In addition to Pt III, Ch 4, Sec 2, 2 the requirements in 1.2.4 to 1.2.6 are to be complied with for the loading conditions defined in Pt III, Ch 4, App 2, 1.2.1 and 1.2.9.

1.2.4 Crowding of passengers

The angle of heel on account of crowding of passengers to one side as defined below may not exceed 10°:

- a minimum weight of 75 kg is to be assumed for each passenger except that this value may be increased subject to the approval of the Society. In addition, the mass and distribution of the luggage is to be approved by the Society;
- the height of the centre of gravity for passengers is to be assumed equal to:
  - 1 m above deck level for passengers standing upright. Account may be taken, if necessary, of camberand sheer of deck; and
  - 0.3 m above the seat in respect of seated passengers.
- passengers and luggage are to be considered to be in the spaces normally at their disposal;
- passengers without luggage are to be considered as distributed to produce the most unfavourable combination of passenger heeling moment and/or initial metacentric height, which may be obtained in practice. In this connection, a value higher than four persons per square metre is not necessary.

1.2.5 Maximum turning angle

The angle of heel on account of turning may not exceed 10° when calculated using the following formula:

$$M_R = 0.02 \frac{V_0^2}{L_s} \Delta (KG - T_1 / 2)$$

where:

M_R : Heeling moment, in t.m

V_0 : Service speed, in m/s

T_1 : Mean draught, in m

KG : Height of centre of gravity above keel, in m.

1.2.6 Where anti-rolling devices are installed in a ship, the Society is to be satisfied that the above criteria can be maintained when the devices are in operation.

1.2.7 Stability booklet for ro-ro ships

The stability booklet of ro-ro ships is to contain information concerning the importance of securing and maintaining all closure watertight integrity, due to the rapid loss of stability which may result when water enters the vehicle deck and the fact capsize can rapidly occur.

1.3 Damage stability for ships where SDS notation has been required

1.3.1 General

The requirements of this Section are to be applied to passenger ships in conjunction with the exploratory notes as set out by the IMO Resolution MSC 281(85).

1.3.2 Required subdivision index R

These regulations are intended to provide ships with a minimum standard of subdivision. In addition to these requirements, the requirements of 1.3.12 are to be complied with.

$$R = 1 - \frac{5000}{L_s + 2.5N + 15.225}$$

where: $N = N_1 + 2N_2$

N_1 : Number of persons for whom lifeboats are provided

N_2 : Number of persons (including officers and crew) the ship is permitted to carry in excess of N_1.

Where the conditions of service are such that compliance with $N = N_1 + 2N_2$ is impracticable and where the Society considers that a suitably reduced degree of hazard exists, a lesser value of N may be taken but in no case less than $N = N_1 + N_2$. The reduced value of N is also to be subject to the agreement of the flag administration.

1.3.3 Attained subdivision index A

The attained subdivision index A is to be calculated in accordance with Pt III, Ch 4, App 3, 1.4.

The partial indices A_s, A_p and A_L are not to be less than 0.9 R.

1.3.4 Calculation of the factor p_i

The factor p_i is to be calculated in accordance with Pt III, Ch 4, App 3, 1.5.

1.3.5 Calculation of the factor s_i

The factor s_i is to be determined for each case of assumed flooding, involving a compartment or group of compartments, in accordance with the following notations and the provisions in this regulation.

θ_e: The equilibrium heel angle in any stage of flooding, in degrees

θ_v: The angle, in any stage of flooding, where the righting lever becomes negative, or the angle at which an opening incapable of being closed weathertight becomes submerged

GZ_{max} : The maximum positive righting lever, in metres, up to the angle θ_v

Range : The Range of positive righting levers, in degrees, measured from the angle θ_e. The positive range is to be taken up to the angle θ_v Flooding stage is any discrete step during the flooding process, including the stage before equalization (if any) until final equilibrium has been reached.

The factor s_i, for any damage case at any initial loading condition, d_i, shall be obtained from the formula:

s_i = minimum $\{s_{intermediate,i}$ or $s_{final,i} \times s_{mom,i}\}$

where:

$s_{intermediate,i}$: The probability to survive all intermediate flooding stages until the final equilibrium stage, and is calculated in accordance with item a)

$s_{final,i}$: The probability to survive in the final equilibrium stage of flooding. It is calculated in accordance with item b)

$s_{mom,i}$: The probability to survive heeling moments, and is calculated in accordance with item c)

a) Calculation of $s_{intermediate}$:

The factor $s_{intermediate,i}$ is to be taken as the least of the sfactors obtained from all flooding stages including the stage before equalization, if any, and is to be calculated as follows:

$$s_{intermediate,i} = \left[\frac{GZ_{max}}{0.05} \frac{Range}{7} \right]^{0.25}$$

where GZ_{max} is not to be taken as more than 0.05 m and Range as not more than 7°. sintermediate = 0, if the intermediate heel angle exceeds 15° Where cross-flooding fittings are required, the time for equalization is not to exceed 10 min. The time for equalization is to be calculated in accordance with Ch 8, App 1

b) Calculation of s_{final}:

The factor $s_{final,i}$ is to be obtained from the formula:

$$s_{final,i} = K \left[\frac{GZ_{max}}{0.12} \frac{Range}{16} \right]^{0.25}$$

where:

GZ_{max} is not to be taken as more than 0.12 m

Range is not to be taken as more than 16°.

K = 1 if $\theta_e \le \theta_{min}$

K = 0 if $\theta_e \ge \theta_{max}$

where:

$$K = \sqrt{\frac{\theta_{max} - \theta_e}{\theta_{max} - \theta_{min}}} \text{ otherwise}$$

θ_{min} is equal to 7°

θ_{max} is equal to 15°.

c) Calculation of s moment:

The factor smom,i is to be calculated at the final equilibrium from the formula:

$$s_{mom,i} = \frac{(GZ_{max} - 0.04)\text{Displacement}}{M_{heel}}$$

where:

Displacement is the intact displacement at the subdivision draught

M_{heel} is the maximum assumed heeling moment as calculated as follows :

M_{heel} = maximum {$M_{passenger}$ or M_{wind} or $M_{Survivalcraft}$}

where the heeling moments $M_{passenger}$, M_{wind} and $M_{survivalcraft}$ are calculated in 1.3.11.

$s_{mom,i} \le 1$

1.3.6 Equalization arrangements

Unsymmetrical flooding is to be kept to a minimum consistent with the efficient arrangements. Where it is necessary to correct large angles of heel, the means adopted shall, where practicable, be self-acting, but in any case where controls to equalization devices are provided they are to be operable from above the bulkhead deck. These fittings together with their controls are to be acceptable to the Society. Suitable information concerning the use of equalization devices are to be supplied to the master of the ship.

Tanks and compartments taking part in such equalization are to be fitted with air pipes or equivalent means of sufficient cross-section to ensure that the flow of water into the equalization compartments is not delayed.

1.3.7 Cases where si is to be equal to zero

In all cases, si is to be taken as zero in those cases where the final waterline, taking into account sinkage, heel and trim, immerses:

- the lower edge of openings through which progressive flooding may take place and such flooding is not accounted for in the calculation of factor si. Such openings are to include air-pipes, ventilators and openings which are closed by means of weathertight doors or hatch covers, but the openings closed by means of watertight manhole covers and flush scuttles, small watertight hatch covers, remotely operated sliding watertight doors, side scuttles of the non-opening type as well as watertight access doors and hatch covers required to be kept closed at sea need not be considered.

- any part of the bulkhead deck considered a horizontal evacuation route.
- The factor si is to be taken as zero if, taking into account sinkage, heel and trim, any of the following occur in any intermediate stage or in the final stage of flooding:
- immersion of any vertical escape hatch in the bulkhead deck intended for compliance with the applicable requirements of Pt IV, Ch 4, Sec 8
- any controls intended for the operation of watertight doors, equalization devices, valves on piping or on ventilation ducts intended to maintain the integrity of watertight bulkheads from above the bulkhead deck become inaccessible or inoperable
- immersion of any part of piping or ventilation ducts carried through a watertight boundary that is located within any compartment included in damage cases contributing to the attained index A, if not fitted with watertight means of closure at each boundary.

1.3.8 Calculation of the factor ν_i

Where horizontal watertight boundaries are fitted above the waterline under consideration the s-value calculated for the lower compartment or group of compartments is to be obtained by multiplying the value as determined in 1.3.5 by the reduction factor νm defined below, which represents the probability that the spaces above the horizontal subdivision will not be flooded.

The factor ν_i is to be calculated in accordance with Pt III, Ch 4, App 3, 1.6.7 and Pt III, Ch 4, App 3, 1.6.8.

1.3.9 Contribution dA to the index A

The contribution dA to the index A is to be calculated in accordance with Pt III, Ch 4, App 3, 1.6.9.

1.3.10 Permeability

For the purpose of the subdivision and damage stability calculations of the regulations, the permeability of each general compartment or part of a compartment is to be according to Tab 1.1.

Other figures for permeability may be used if substantiated by calculations.

The permeability of the Ro-Ro space is to be as per Tab 1.2

Table 1.1 : Values of permeability

Spaces	Permeability
Appropriated to stores	0.60
Occupied by accommodation or voids	0.95
Occupied by machinery	0.85
Intended for liquids	0 or 0.95 (1)

(1) whichever results in the more severe requirements.

Table 1.2 : Permeability of Ro-Ro spaces

	Ro-Ro Spaces
Permeability at draught d_S	0.90
permeability at draught d_P	0.90
permeability at draught d_L	0.95

1.3.11 Inclining moments

The following inclining moments are to be taken into account:

a) Moment due to the crowding of passengers:

Mpassenger is the maximum assumed heeling moment resulting from movement of passengers, and is to be obtained as follows:

$M_{passenger} = (0.075\ N_p)\ (0.45\ B)$ (tm)

where:

N_p : maximum number of passengers permitted to be on board in the service condition corresponding to the deepest subdivision draught under consideration; and

B : beam of the ship.

Alternatively, the heeling moment may be calculated assuming the passengers are distributed with 4 persons per square metre on available deck areas towards one side of the ship on the decks where muster stations are located and in such a way that they produce the most adverse heeling moment. In doing so, a weight of 75 kg per passenger is to be assumed.

b) Moment due to launching of all fully loaded davitlaunched survival craft on one side:

$M_{Survivalcraft}$ is the maximum assumed heeling moment due to the launching of all fully loaded davit-launched survival craft on one side of the ship. It shall be calculated using the following assumptions:

- all lifeboats and rescue boats fitted on the side to which the ship has heeled after having sustained damage are to be assumed to be swung out fully loaded and ready for lowering

- for lifeboats which are arranged to be launched fully loaded from the stowed position, the maximum heeling moment during launching is to be taken
- a fully loaded davit-launched liferaft attached to each davit on the side to which the ship has heeled after having sustained damage is to be assumed to be swung out ready for lowering
- persons not in the life-saving appliances which are swung out are not to provide either additional heeling or righting moment
- life-saving appliances on the side of the ship opposite to the side to which the ship has heeled are to be assumed to be in a stowed position.

c) Moment due to wind pressure:

M_{wind} is the maximum assumed wind force acting in a damage situation:

$M_{wind} = (P\ A\ Z) / 9.806\ \ 10^3$ (tm)

P : Wind pressure

$P = 120\ N/m^2$

A : Projected lateral area above waterline

z : Distance from centre of lateral projected area above waterline to T/2; and

T : Ship's draught, d_i

1.3.12 Special requirements concerning stability

A passenger ship intended to carry 400 or more persons is to have watertight subdivision abaft the collision bulkhead so that $s_i = 1$ for the three loading conditions on which is based the calculation of the subdivision index and for a damage involving all the compartments within $0.08L_{LL}$ measured from the forward perpendicular.

A passenger ship intended to carry 36 or more persons is to be capable of withstanding damage along the side shell to an extent specified below. Compliance with this regulation is to be achieved by demonstrating that si, as defined in 1.3.5, is not less than 0.9 for the three loading conditions on which is based the calculation of the subdivision index.

The damage extent to be assumed when demonstrating compliance with the above paragraph, is to be dependent on both N as defined in 1.3.2, and Ls as defined 1.1, such that:

- the vertical extent of damage is to extend from the ships moulded baseline to a position up to 12.5 m above the position of the deepest subdivision draught as defined in 1.1, unless a lesser vertical extent of damage were to give a lower value of si in which case this reduced extent is to be used
- where 400 or more persons are to be carried, a damage length of 0.03Ls but not less than 3 m is to be assumed at any position along the side shell, in conjunction with a penetration inboard of 0.1B but not less than 0.75 m measured inboard from the ship side, at right angle to the centreline at the level of the deepest subdivision draught

- where less than 400 persons are carried, damage length is to be assumed at any position along the shell side between transverse watertight bulkheads provided that the distance between two adjacent transverse watertight bulkheads is not less than the assumed damage length.

If the distance between adjacent transverse watertight bulkheads is less than the assumed damage length, only one of these bulkheads is to be considered effective for the purpose of demonstrating compliance with the criteria si □0.9

- where 36 persons are carried, a damage length of 0.015Ls but not less than 3 m is to be assumed, in conjunction with a penetration inboard of 0.05B but not less than 0.75 m
- where more than 36, but fewer than 400 persons are carried the values of damage length and penetration inboard, used in the determination of the assumed extent of damage, are to be obtained by linear interpolation between the values of damage length and penetration which apply for ships carrying 36 persons and 400 persons.

1.3.13 Documents to be supplied

The master is to be supplied with such information satisfactory to the Society as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under varying conditions of service. A copy of the stability information shall be furnished to the Society.

The information should include:

- curves or tables of minimum operational metacentric height (GM) versus draught which assures compliance with the relevant intact and damage stability requirements, alternatively corresponding curves or tables of the maximum allowable vertical centre of gravity (KG) versus draught, or with the equivalents of either of these curves
- instructions concerning the operation of cross-flooding arrangements
- all other data and aids which might be necessary to maintain the required intact stability and stability after damage.

The stability information is to show the influence of various trims in cases where the operational trim range exceeds +/- 0.5% of L_s.

The above information is determined from considerations related to the subdivision index, in the following manner:

Minimum required GM (or maximum permissible vertical position of centre of gravity KG) for the three draughts ds, dp and dl are equal to the GM (or KG values) of corresponding loading cases used for the calculation of survival factor s_i.

For intermediate draughts, values to be used are to be obtained by linear interpolation applied to the GM value only between the deepest subdivision draught and the partial subdivision draught and between the partial load line and the light service draught respectively. Intact stability criteria will also be taken into account by retaining for each draft the maximum among minimum required GM values or the minimum of maximum permissible KG values for both criteria. If the subdivision index is calculated for different trims, several required GM curves will be established in the same way.

When curves or tables of minimum operational metacentric height (GM) versus draught are not appropriate, the master is to ensure that the operating condition does not deviate from a studied loading condition, or verify by calculation that the stability criteria are satisfied for this loading condition.

1.3.14 Damage control documentation

Plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding are to be permanently exhibited for the guidance of the officer in charge of the ship. In addition, booklets containing the aforementioned information are to be made available to the officers of the ship.

Watertight doors which may be permitted to remain open during navigation as reported in Ch 11, Sec 2, 2.3.3 p) are to be clearly indicated in the damage control plan with the indication that ـِdoors are always to be ready for immediate closureپ

Detailed description of the information to be included in the damage control documentation is reported in Pt III, Ch 4, Sec 3, 4.

2 Structure design principles

2.1 General

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

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

2.2 Hull structure

2.2.1 Framing

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

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

2.2.2 Side structures

Where decks are fitted with ramp openings adjacent to the shipـِs side, special consideration is to be given to the supports for the side framing.

3 Design loads

3.1 Wheeled loads

3.1.1 The wheeled loads induced by vehicles are defined in Pt III, Ch 2, Sec 3.

3.2 Accommodation

3.2.1 Lowest 0.5 m of bulkheads forming vertical division along escape routes

The still water and inertial pressures transmitted to the structures belonging to lowest 0.5 m of bulkheads and other partitions forming vertical divisions along escape routes are to be obtained, in kN/m^2, where the value p_S is to be taken not less than 1.5 kN/m^2 to allow them to be used as walking surfaces from the side of the escape route with the ship at large angles of heel.

4 Hull girder strength

4.1 Basic criteria

4.1.1 Strength deck

In addition to the requirements in Pt II, the contribution of the hull structures up to the strength deck to the longitudinal strength is to be assessed through a finite element analysis of the whole ship in the following cases:

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

5 Hull scantlings

5.1 Plating

5.1.1 Minimum net thicknesses

The net thickness of the inner bottom, side and weather strength deck plating is to be not less than the values given in Tab 5.1.

If a complete deck does exist at a distance from the freeboard deck exceeding 2 times the standard height of superstructures as defined in Pt III, the side shell plating located between this complete deck and the strength deck may be taken not greater than the thickness of deckhouse sides.

Table 3 : Minimum net thickness of the inner bottom, side and weather strength deck plating

Plating	Min. net thickness (mm)
Inner bottom outside engine room	$2.0 + 0.02\ L\ k^{1/2} + 4.5\ s$
Side - below freeboard deck - between freeboard deck and strength deck	$2.1 + 0.028\ L\ k^{1/2} + 4.5\ s$
Weather strength deck and trunk deck	$2.2\ k^{1/2} + 2.1 + s$

Note 1:

k : Material factor for steel, defined in Pt III.

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

5.1.2 Plating under wheeled loads

The net thickness of plating subjected to wheeled loads is to be obtained according to Pt III, Ch 2,as applicable.

5.1.3 Lowest 0.5 m of bulkheads forming vertical division along escape routes

The net thickness of plating belonging to the lowest 0.5 m of bulkheads and other partitions forming vertical divisions along escape routes is to be obtained according to Pt III, Ch 2, as applicable.

5.2 Ordinary stiffeners

5.2.1 Stiffeners under wheeled loads

The scantlings of ordinary stiffeners subjected to wheeled loads are to be obtained according to Pt III, Ch 2, as applicable.

5.2.2 Lowest 0.5 m of bulkheads forming vertical division along escape routes

The net scantlings of ordinary stiffeners belonging to the lowest 0.5 m of bulkheads and other partitions forming vertical divisions along escape routes are to be obtained according to Pt III, Ch 2, as applicable, where the loads are defined in Part III, Chapter 2, as applicable, and in 3.2.1.

5.3 Primary supporting members

5.3.1 Double bottom structures

In ships where pillars are widely spaced and transmit very high loads to the double bottom, the net scantlings of double bottom structures are to be considered by the Society on a case-by-case basis, taking into account the results of direct calculations to be carried out according to the criteria in Pt III, Ch 2.

Where deemed necessary, on the basis of the above results, additional floors and bottom girders may be required.

5.3.2 Primary supporting members under wheeled loads

The net scantlings of primary supporting members subjected to wheeled loads are to be obtained according to Pt III, Ch 2, as applicable.

5.3.3 Lowest 0.5 m of bulkheads forming vertical division along escape routes

The net scantlings of primary supporting members belonging to the lowest 0.5 m of bulkheads and other partitions forming vertical divisions along escape routes are to be obtained according to Pt III, Ch 3, as applicable, where the loads are defined in Part III, Chapter 2, as applicable, and in 3.2.1.

6 Other structures

6.1 Superstructures and deckhouses

6.1.1 Where a ventilation trunk passing through a structure penetrates the bulkhead deck, the trunk is to be capable of withstanding the water pressure that may be present within the trunk, after having taken into account the maximum heeling angle allowable during intermediate stages of flooding, in accordance with the criteria in 1.3.5 c).

6.1.2 Where all or part of the penetration of the bulkhead deck is on the main ro-ro deck, the trunk is to be capable of withstanding impact pressure due to internal water motions(sloshing) of water trapped in the ro-ro deck

6.2 Bow doors and inner doors

6.2.1 The requirements applicable to bow doors and inner doors are defined in Pt III, Ch 2, Sec 16.

6.3 Side doors and stern doors

6.3.1 Side doors may be either below or above the freeboard deck.

Stern doors are to be situated above the freeboard deck.

6.3.2 The requirements applicable to side doors and stern doors are defined in Pt III, Ch 2, Sec 16.

6.3.3 The requirements in 6.3.4 to 6.3.7 apply to doors in the boundary of ro-ro spaces or special category spaces, as defined in Sec 2, 1.2.3 and 1.2.4 respectively, through which such spaces may be flooded.

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

The indication panel is to be provided with a lamp test function.

It is not to be possible to turn off the indicator light.

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

The power supply for the indicator system is to be independent of the power supply for operating and closing the doors and is to be provided with a backup power supply.

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

6.3.6 The indication panel on the navigation bridge is to be equipped with a mode selection function ِharbour/sea voyageپ so arranged that an audible alarm is given if the vessel leaves harbour with the doors not closed and with any of the securing devices not in the correct position.

6.3.7 A water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the doors.

6.5 External ramps

6.5.1 The requirements applicable to external ramps are defined in Pt III, Ch 2, Sec 16.

7 Hull outfitting

7.1 Equipment

7.1.1 Number of mooring lines

The mooring lines are given as a guidance, but are not required as a condition of classification (see also Pt III, Ch 5).

7.1.2 Ships having L □30 m and navigation notation other than unrestricted navigation

For ships having L □30 m and navigation notation other than unrestricted navigation:

- the equipment in mooring lines of wire or natural fibre may be obtained fromTab 7.1
- the equipment in anchors and chain cables (or ropes according to Pt III, Ch 5) may be obtained from Tab 5.

Table 7.1 : Mooring lines

Equipment number EN A < EN □B		Mooring lines **(1)**		
A	B	N	Length of each line, in m	Breaking load, in kN
19	50	2	40	32
50	70	3	40	34
70	90	3	50	37
90	110	3	55	39
110	130	3	55	44
130	150	3	60	49
150	175	3	60	54

(1) The mooring lines are given as a guidance, but are not required as a condition of classification.

Table 7.2 : Equipment

Equipment number EN A < EN ☐B		Stockless anchors		Stud link chain cables for anchors			
		N	Mass per anchor, in kg	Total length, in m	Diameter, in mm		
A	B				Q1	Q2	Q3
19	22	1	21	65	7		
22	25	1	27	70	7		
25	30	1	32	70	8		
30	35	1	37	75	8		
35	40	1	43	75	9		
40	45	1	53	80	10		
45	50	1	64	82,5	11		
50	60	1	80	82,5	11	10	
60	70	1	90	82,5	12,5	11	
70	80	1	100	110	12,5	11	10
80	90	1	120	110	14	12,5	11
90	100	1	140	110	14	12,5	11
100	110	1	160	110	16	14	12,5
110	120	1	180	110	16	14	12,5
120	130	1	200	110	16	14	12,5
130	140	1	240	110	17,5	16	14
140	150	1	260	137,5	17,5	16	14
150	175	1	300	137,5	19	17,5	16
175	205	1	360	137,5	20,5	17,5	16
205	240	1	420	137,5	22	19	17,5
240	280	1	480	137,5	24	20,5	19
280	320	1	575	165	26	22	20,5
320	360	1	660	165	28	24	22
360	400	1	700	165	30	26	22
400	450	1	780	165	30	26	24
450	500	1	900	192,5	32	28	26
500	550	1	1020	192,5	34	30	26
550	600	1	1140	192,5	36	32	28
600	660	2	1200	385	38	32	30
660	720	2	1295	385	40	34	30
720	780	2	1440	440	42	36	32
780	840	2	1500	440	42	36	32
840	910	2	1595	440	44	38	34
910	980	2	1740	440	46	40	36
980	1060	2	1920	440	48	42	36

Section 4 Electrical Installations

1 General

1.1 Applicable requirements

1.1.1 In addition to the relevant requirements of Part IV, Chapter 2 and Ch 8, Sec 5 and those contained in this Section, electrical installations in spaces intended for the carriage of motor vehicles with fuel in their tanks for their propulsion are to comply with those of Part IV, Chapter 4.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt IV, Ch 2, the following are to be submitted for approval:

a) plan of hazardous areas

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

c) diagrams of indicator systems for shell doors, loading doors and similar appliances, television surveillance or water leakage detection systems

d) diagrams of the supplies to the supplementary emergency lighting systems.

1.3 Safety characteristics

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

2 Supplementary emergency lighting

2.1

2.1.1 In addition to the emergency lighting required in Ch 8, Sec 5, 2.2, on every passenger ship with ro-ro cargo spaces or special category spaces:

a) all passenger public spaces and alleyways shall be provided with supplementary electric lighting that can operate for at least three hours when all other sources of electrical power have failed and under any condition of heel. The illumination provided shall be such that the approach to the means of escape can be readily seen.

The source of power for the supplementary lighting shall consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard. Alternatively, any other means of lighting which is at least as effective may be accepted by the Society. The supplementary lighting shall be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided shall be replaced at intervals having regard to the specified service life in the ambient conditions that they are subject to in service;

b) a portable rechargeable battery operated lamp shall be provided in every crew space alleyway and recreational space and every working space which is normally occupied unless supplementary emergency lighting, as required in (a), is provided.

3 Installation

3.1 Installations in special category spaces situated above the bulkhead deck

3.1.1 On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment and cables are to be installed at least 450 mm above the deck or platform.

Electrical equipment is to be as stated in Pt IV, Ch 2 and electrical cables as stated in Pt IV, Ch 2, Sec 9.

3.1.2 Where the installation of electrical equipment and cables at less than 450 mm above the deck or platform is deemed necessary for the safe operation of the ship, the electrical equipment is to be of a certified safe type as stated in Pt IV, Ch 2 and the electrical cables are to be as stated in Pt IV, Ch 2, Sec 9.

3.1.3 Electrical equipment and cables in exhaust ventilation ducts are to be as stated in3.1.2.

3.1.4 The requirements in this item are summarised in Tab 3.1.

3.2 Installations in special category spaces situated below the bulkhead deck

3.2.1 Any electrical equipment installed is to be as stated in Pt IV, Ch 2 and electrical cables are to be as stated in Pt IV, Ch 2, Sec 9.

3.2.2 Electrical equipment and cables in exhaust ventilation ducts are to be as stated in 3.2.1.

3.2.3 The requirements in this item are summarised in Tab 3.2 .

Table 3.1 : Electrical equipment permitted in special category spaces above the bulkhead deck

No	Description of spaces	Electrical equipment	Hazardous area
1	Areas at less than 450 mm above the deck or platforms for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category ﺑibپ not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and acceptable to the appropriate authority d) certified flameproof Ex(d) e) certified pressurised Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: ﭙ a non-metallic impervious sheath in combination with braiding or other metallic covering ﭙ copper or stainless steel sheath (for mineral insulated cables only).	Zone 1
2	Exhaust ventilation ducts	As stated under item 1.	Zone 1
3	ﭙ areas above a height of 450 mm from the deck ﭙ areas above a height of 450 mm from each platform for vehicles, if fitted, without openings of sufficient size permitting penetration of petrol gases downward ﭙ areas above platforms for vehicles, if fitted, with openings of sufficient size permitting penetration of petrol gases downward	a) any type that may be considered for zone 1 b) tested specially for zone 2 (e.g. type ﺑnپprotection) c) pressurised, and acceptable to the appropriate authority d) encapsulated, and acceptable to the appropriate authority e) the type which ensures the absence of sparks and arcs and of ﺑhot spotsپ during its normal operation (minimum class of protection IP55) f) cables sheathed with at least a non-metallic external impervious sheath.	Zone 2

Table 3.2 : Electrical equipment permitted in special category spaces below the bulkhead deck

No	Description of spaces	Electrical equipment	Hazardous area
1	Special category spaces	a) any type that may be considered for zone 0 b) certified intrinsically safe apparatus Ex(ib) c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category ﺑ ibپnot capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and acceptable to the appropriate authority d) certified flameproof Ex(d) e) certified pressurised Ex(p) f) certified increased safety Ex(e) g) certified encapsulated Ex(m) h) certified sand filled Ex(q) i) certified specially Ex(s) j) cables sheathed with at least one of the following: ﭺ a non-metallic impervious sheath in combination with braiding or other metallic covering ﭺ copper or stainless steel sheath (for mineral insulated cables only).	
2	Exhaust ventilation ducts	As stated under item 1.	Zone 1

3.3 Installations in cargo spaces other than special category spaces intended for the carriage of motor vehicles

3.3.1 The requirements for installations in special category spaces situated below the bulkhead deck, as stated in 3.2, apply.

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

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

4 Type approved components

4.1

4.1.1 Accumulator lamps for the supplementary electric lighting, alarm systems for closing devices of openings and water leakage detection systems if of electronic type, and television surveillance systems are to be type approved or in accordance with 4.1.2.

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

Chapter 10 Tugs

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of one of the following service notations:

- Tug
- Salvage tug
- Escort tug,

as defined in Pt I.

1.1.2 Ships dealt with in this Chapter and which are covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I, II, III and IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to tugs.

1.1.3 Ships dealt with in this Chapter and which are not covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I and IV, as applicable, and with the requirements of this Chapter, which are specific to tugs.

Section 2 Hull and Stability

1 General

1.1 Application

1.1.1 The requirements of this Section apply to ships with one of the following service notations:

- tug, mainly intended for towing services, which are to comply with the requirements in 2
- salvage tug, having specific equipment for salvage services, which are to comply with the requirements in 2 and 3
- escort tug, mainly intended for escort services such as for steering, braking and otherwise controlling escorted ships, which are to comply with the requirements in 2 and 4.

Ships with the additional service feature barge combined are to comply with the applicable requirements in Sec 3.

2 Tugs, salvage tugs and escort tugs

2.1 General

2.1.1 In general, tugs are completely decked ships provided with an ample drift surface and, where intended for service outside sheltered areas, with a forecastle or half forecastle, or at least with a large sheer forward.

Tugs of unusual design are to be considered by the Society on a case-by-case basis.

2.2 Stability

2.2.1 Intact stability

The stability of the ship for the loading conditions in Pt III, Ch 4, App 2, 1.2.11 is to be in compliance with the requirements in Pt III, Ch 4, Sec 2.

2.2.2 Additional intact stability criteria

All the loading conditions reported in the trim and stability booklet, with the exception of lightship, are also to be checked in order to investigate the ship's capability to support the effect of the towing force in the beam direction.

A tug may be considered as having sufficient stability, according to the effect of the towing force in the beam direction, if the following condition is complied with:

$A \geq 0.011$

where:

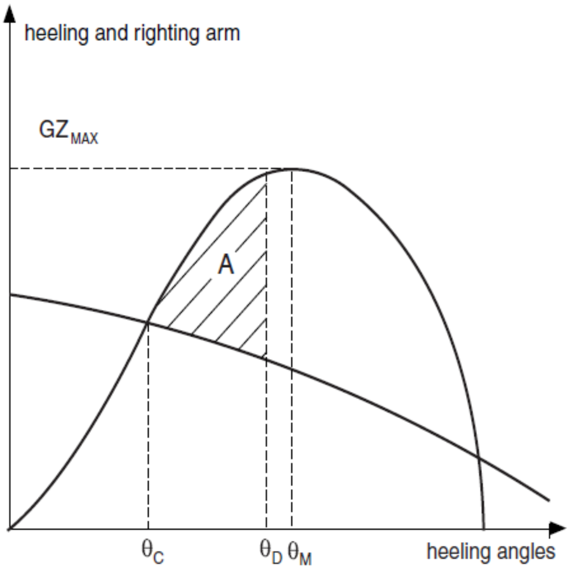
A : Area, in m. rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_C to the heeling angle θ_D

θ_C : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms

□$_D$: Heeling angle, to be taken as the lowest of:

- the angle □$_M$, corresponding to the position of GZ_{MAX} (see Fig 2.1)
- the angle of down flooding
- 40°.

Figure 2.1 : Heeling and righting arms curves



The heeling arm curve is to be calculated as follows:

$$b_H = \frac{THc}{9.81\Delta}\cos\theta$$

where:

b_H : Heeling arm, in m

T : Maximum bollard pull, in kN

Where this force is unknown, it can be assumed equal to:

- T = 0.179 P for propellers not fitted with nozzles
- T = 0.228 P for propellers fitted with nozzles

P : Maximum continuous power, in kW, of the propulsion engine

H : Vertical distance, in m, between the towing hook, or equivalent fitting, and half draught corresponding to □

c : Coefficient to be taken equal to:

- c = 1.00 for ships with azimuth propulsion
- c = 0.65 for ships with non-azimuth propulsion

□ Loading condition displacement, in t.

2.3 Structure design principles

2.3.1 Bollards

For tugs equipped for side towing, the relevant bollards are to be effectively fixed on the deck in way of side transverses and deck beams or bulkheads.

2.3.2 Fenders

A strong fender for the protection of the tug's sides is to be fitted at deck level.

Alternatively, loose side fenders may be fitted, provided that they are supported by vertical ordinary stiffeners extending from the lightship waterline to the fenders themselves.

2.3.3 Floors

Floors are to be arranged with a welded face plate in the machinery space; elsewhere, floor flanging may be accepted as an alternative to the fitting of welded face plates.

2.3.4 Shaft tunnels

For tugs having small depth, the shaft tunnel may be omitted.

In this case, access to the shaft line is to be given through the floor of the space above.

2.4 Hull scantlings

2.4.1 General

The net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with Part III, Chapter 2, as applicable, where the hull girder loads and the local loads are defined in Part III, Chapter 2, as applicable, to be calculated for a moulded draught T not less than 0.85 D.

2.4.2 Side plating thickness for tugs with $L < 65$ m

For tugs with $L < 65$ m, the net thickness of the side plating is to be increased by 1 mm with respect to that calculated, without being greater than that of the adjacent bottom plating calculated for the same panel dimensions.

2.5 Other structures

2.5.1 Machinery casings

Exposed machinery casings are to be not less than 900 mm in height, measured from the upper surface of the deck, and provided with weathertight means of closure.

In general, the longitudinal sides of the machinery casings are to be extended downwards by a deck girder to which the deck beams are to be connected.

Side ordinary stiffeners are to be connected to the deck.

Their spacing is to be not greater than 0.75 m.

2.5.2 Emergency exits from machinery space

Emergency exits from the machinery space to the upper deck are to be located as high as possible above the waterline and in way of the ship's centreline, so that they may be used even at extreme angles of heel.

Escape hatch coaming heights are to be not less than 600 mm above the upper surface of the deck.

Escape hatch covers are to have hinges fitted such that the predominant direction of green sea will cause the cover to close and are to be capable of being opened and closed watertight from either side.

2.5.3 Height of hatchway coamings

The height of the hatchway coamings is to be not less than 300 mm. Hatch covers are to be fitted with efficient securing devices.

2.6 Rudder and bulwarks

2.6.1 Rudder

For tugs, the rudder stock diameter is to be increased by 5% with respect to that calculated according to Pt III, Ch 2, Sec 14.

2.6.2 Bulwarks

The bulwarks are to be sloped inboard to avoid distortions likely to occur during contact. Their height may be reduced where required by operational necessities.

2.7 Equipment

2.7.1 General

The mooring lines are given as a guidance, but are not required as a condition of classification.

2.7.2 Equipment number

The equipment number EN is to be obtained from the following formula:

$EN = K (L\ B\ D)^{2/3}$

where:

- K : K = 1.30 for tugs with the navigation notation unrestricted navigation
- K = 1.20 for tugs with the navigation notation coastal area or sheltered area.

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

2.7.3 Anchors, chain cables and ropes

Tugs are to be provided with equipment in stockless anchors, chain cables and ropes.

This equipment is to be obtained as a function of the Equipment Number EN, determined according to 2.7.2, from:

- Tab 2.1 and Tab 2.2 where EN □600
- Pt III, Ch 5 where EN > 600.

In that case, the value of EN to be used in Pt III, Ch 5 is the greater of the one calculated according to 2.7.2 and the one calculated according to Pt B, Ch 5, 2.

2.7.4 Fenders

Fenders are to be fitted at the deck level on the ship side, extending on the whole length of the ship.

Table 2.1 : Equipment for tugs

Equipment number EN A < EN □B		Stockless anchors		Stud link chain cables for anchors		
A	B	N	Mass per anchor, in kg	Total length, in m (1)	Diameter, in mm	
					mild steel	high strength steel
0	43	2	100	100,0	12,5 (2)	□
43	50	2	120	100,0	14,0 (2)	12,5
50	57	2	140	110,0	14,0 (2)	12,5
57	64	2	160	110,0	16,0 (2)	14,0
64	70	2	180	110,0	16,0 (2)	14,0
70	76	2	200	137,5	16,0 (2)	14,0
76	83	2	220	137,5	19,0	17,5
83	90	2	240	137,5	19,0	17,5
90	96	2	260	137,5	19,0	17,5
96	105	2	280	165,0	19,0	17,5
105	117	2	300	192,5	19,0	17,5
117	130	2	350	192,5	20,5	17,5
130	141	2	400	192,5	20,5	17,5
141	158	2	450	220,0	22,0	19,0
158	170	2	500	220,0	22,0	19,0
170	192	2	550	247,5	24,0	20,5
192	208	2	600	275,0	26,0	22,0
208	225	2	650	275,0	26,0	22,0
225	242	2	700	275,0	28,0	24,0
242	258	2	750	302,5	28,0	24,0
258	275	2	800	302,5	30,0	26,0
275	292	2	850	330,0	30,0	26,0
292	308	2	900	330,0	30,0	26,0
308	325	2	950	357,5	32,0	28,0
325	342	2	1000	357,5	32,0	28,0
342	358	2	1050	357,5	34,0	30,0
358	383	2	1100	385,0	34,0	30,0
383	416	2	1200	385,0	36,0	32,0
416	450	2	1300	385,0	36,0	32,0
450	483	2	1400	385,0	38,0	34,0
483	516	2	1500	385,0	40,0	34,0
516	600	2	1600	385,0	40,0	34,0

(1) Where the total length required for chain cables is less than 220 m, one only of the two anchors may be linked with the chain cable and arranged in a hawse pipe. In this case, the second anchor is to be stowed such that it can be easily joined to the chain cable and dropped overboard in the event of loss of the first anchor.

(2) These diameters are applicable to studless chain cables.

2.8 Towing arrangements

2.8.1 General

In general, towing hooks and winches are to be arranged in way of the shipۥs centreline, in such a position as to minimize heeling moments in normal working conditions.

2.8.2 Hooks and winches

The hook and the winch materials are to comply with the applicable requirements of Pt II.

The maximum bollard pull T, in kN, defined in 2.2.2, is to be specified in the structural arrangement plans of the hook and the winch.

The hooks and the winches are to be subjected to a static test, where the testing force C_T is to be not less than that obtained from Tab 2.3 as a function of T.

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

2.8.3 Hook quick-release device

The quick-release device is to be capable of being operated from a remote control device on the bridge, or as near as practicable, while the hook is under load. It is required that, in the case of a critical situation, the towline can be immediately released regardless of the angle of heel and the direction of the towline.

The quick-release device is to be tested both at maximum bollard pull T and testing force C_T, defined above. The force necessary to open the hook under load is to be not greater than 150 N.

After installation on board, an unhooking trial under load is to be carried out by means of the above remote control device. This trial may be performed with a test load less than the maximum bollard pull T.

Table 2.2 : Mooring lines for tugs

Equipment number EN A < EN □B		Mooring lines **(1)**			Equipment number EN A < EN □B		Mooring lines **(1)**		
A	B	N	Breaking load, in kN	Length of each line, in m	A	B	N	Breaking load, in kN	Length of each line, in m
0	43	2	55,0	80	192	208	2	78	110
43	50	2	57,0	80	208	225	2	82	110
50	57	2	59,0	90	225	242	2	84	135
57	64	2	61,0	90	242	258	2	86	135
64	70	2	63,0	90	258	275	2	88	135
70	76	2	65,0	90	275	292	2	90	135
76	83	2	65,5	110	292	308	2	91	135
83	90	2	66,0	110	308	325	2	93	135
90	96	2	66,5	110	325	342	2	94	135
96	105	2	67,0	110	342	358	2	96	135
105	117	2	67,3	110	358	383	2	98	135
117	130	2	68,5	110	383	416	2	101	160
130	141	2	71,5	110	416	450	2	104	160
141	158	2	73,5	110	450	483	2	107	160
158	170	2	75,5	110	483	516	2	112	160
170	192	2	77,0	110	516	600	3	117	160

(1) The mooring lines are given as a guidance, but are not required as a condition of classification.

Table 2.3 : Testing force CT

Bollard pull T, in kN	Testing force C_T, in kN
T < 400	2 T
400 □T □1200	T + 400
T > 1200	1.33 T

2.8.4 Winch slip device

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

2.8.5 Winch quick-release device

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

2.8.6 Connection with the hull structures

The structures intended to connect the towing arrangements to the hull are to be suitably reinforced to withstand the testing force C_T obtained from Tab 2.3 and, in such condition, to meet the following strength criteria:

$$\tau \le 0.65 \frac{R_\gamma}{\gamma_R \gamma_m}$$

and

$$\sigma_E \le \frac{R_\gamma}{\gamma_R \gamma_m}$$

where:

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

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

γ_R : Resistance partial safety factor, to be taken equal to 1.25

γ_m : Material partial safety factor, to be taken equal to 1.02

R_y : Minimum yield stress, in N/mm², of the material, to be taken equal to 235/k N/mm², unless otherwise specified.

2.9 Construction and testing

2.9.1 Bollard pull test

At the request of the interested parties, tugs may be subjected to a bollard pull test. The value of the bollard pull is indicated in a declaration enclosed with the Certificate of Classification.

The bollard pull test is to be carried out, in the presence of a Surveyor of the Society, using suitable equipment (e.g. electrical load cell equipment) capable of providing, at any time during the test, a readout of the bollard pull developed by the tug and a record, in numerical or graphical form, of the values measured. The test procedure location and conditions (environmental conditions, tug trim, etc.) are to be agreed with the Society.

In the case of sister ships, the Society may assign the bollard pull on the basis of the results obtained from the tests carried out on the prototype ship.

3 Additional requirements for salvage tugs

3.1 General

3.1.1 Application

The requirements of this Article apply to ships with the service notation salvage tug and specify the criteria these ships are to satisfy in addition to those in 2.

3.2 Equipment

3.2.1 Additional equipment

Ships with the navigation notation salvage tug are to be fitted with the additional equipment specified in Tab 3.1.

Table 3.1 : Additional equipment for salvage tugs

Arrangement or equipment	Number of items
Fixed or movable drainage pumps having approximately the same capacity (1) (2) (3)	2 or more pumps of total capacity □400 m^3/h
Fire pumps each capable of throwing two simultaneous jets of water having a horizontal reach not less than 30 m (4)	2 pumps, each having acapacity □60 m^3/h
Breathing apparatuses for divers	2
Gas masks with filter	2
Cargo boom	1, with service load □ t
Power operated winch capable of producing an adequate pull	1
Water stops to stop leaks of approximately 1 x 2 m	4
Complete set of equipment for flame cutting with at least 25 metres of flexible piping	1
Drain hoses	at least 20 m per pump
Fire hoses	10
Connections for fire main	at least 3
Power operated diver's compressor, with associated equipment (5)	1
Additional towline equipment	1
Lamps for underwater operation	2
Floodlight of power □500 W	1
Working lamps	2
Winding drums with wire ropes	see (6)
Electrical cables, each not less than 100 metres long and capable of supplying at least 50kW	3
Tackles with lifting capacity of 1 t	2
Tackles with lifting capacity of 3 t	2
Radar with a range not less than 24 nautical miles	1
Echo-sounding device with a range of 100 m	1
Hydraulic jackets with lifting capacity of 10 t	2
Hydraulic jackets with lifting capacity of 20 t	2
Portable electrical drill with a set of twist bits having diameters up to 20 mm	1

(1) For each pump fitted on board, a suction strainer and, in the case of non self-priming pumps, a foot valve, are also to be provided.

(2) Where portable pumps are used, they are to be capable of effectively operating even with transverse and longitudinal inclinations up to 20o.

(3) These pumps are additional to the drain pumps intended for the drainage service of the ship.

(4) These pumps may be the same required for drainage purposes provided they have an adequate head.

(5) As an alternative, a compressor for recharging the oxygen tanks of divers may be provided together with two complete sets of equipment for divers.

(6) Winding drums fitted on board are to be capable of housing wire ropes of suitable size and length not normally less than 350 m.

4 Additional requirements for escort tugs

4.1 General

4.1.1 Application

The requirements of this Article apply to ships with the service notation escort tug and specify the criteria these tugs are to satisfy in addition to those in 2.

4.1.2 Characteristics of escort tugs

For classification purposes, the following characteristics are to be specified by the Designer:

- the maximum steering force TY, in kN, applied by the tug on the stern of the escorted ship, which is the transverse component of the maximum bollard pull T with respect to the longitudinal axis of the escorted ship. This force is to be calculated at speeds V, to be defined by the Designer (see Fig 4.1) and in general to be comprised between 8 and 10 knots.

If the tug escort service is carried out within a certain speed range, the maximum steering forces TY at the minimum and maximum service speeds VMIN and VMAX, respectively, are to be calculated by the Designer.

- the manoeuvring time t, in s, used by the tug to pass from the position which provides the maximum steering force TY on one side of the escorted ship to the mirror position on the other side, with respect to the longitudinal axis of the escorted ship (see Fig 4.1). The towline angle □need not be taken greater than 60o, where □is defined in Fig 4.1.
- the manoeuvrability coefficient M of the tug:

$M = m\, T_Y$

where:

m : Coefficient, to be taken as the lesser of:

- m = 31 / t
- 1.0.

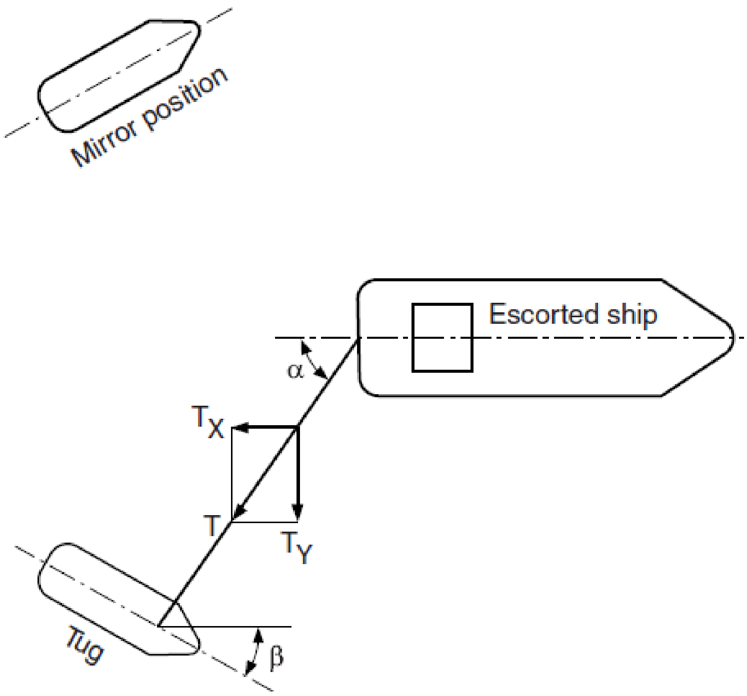
The above characteristics are to be obtained on the basis of the results of full scale tests, to be carried out at speed V or, as applicable, at speeds V_{MIN} and V_{MAX}, defined above (see 4.5).

4.1.3 Documentation

In addition to the documents defined in Pt III, Ch 1, the following plans are to be submitted to the Society for information:

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

Figure 4.1 : Typical escort configuration



4.1.4 Propulsion forces

The hydrodynamic forces acting on the tug, the towline pull and the tug propulsion force are to be so designed that these forces are in equilibrium thereby minimising the required propulsion force itself.

However, the engine is to ensure a sufficient thrust for manoeuvring the tug quickly for any angular position □,

where □ is defined in Fig 4.1.

4.1.5 Loss of propulsion

In the case of propulsion loss, the heeling moment due to the remaining forces is to lead to a safe equilibrium position of the tug with reduced heel.

4.2 Stability

4.2.1 Intact stability

The two following intact stability criteria are to be complied with:

$A \geq 1.25\,B$

$C \geq 1.40\,D$

where:

A : Righting lever curve area, in m.rad, measured from the heeling angle θ_C to a heeling angle of 20^o see Fig 4.2)

B : Heeling arm curve area, in m.rad, measured from the heeling angle θ_C to a heeling angle of 20^o see Fig 4.2)

C : Righting lever curve area, in m·rad, measured from the angle 0^o heel to the heeling angle θ_D see Fig 4)

D : Heeling arm curve area, in m·rad, measured from the angle 0^o heel to the heeling angle θ_D see Fig 4)

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

θ_D : Heeling angle, to be taken as the lesser of:

- the angle of downflooding
- 40 o

The heeling arm curve is to be obtained from the full scale tests (see 4.5), for the maximum steering force T_Y.

Moreover, the heeling arm is to be assumed constant from the angle of equilibrium θ_C to an angle equal to 20^o

4.3 Structural design principles

4.3.1 Hull shape

The hull shape is to be such as to provide adequate hydrodynamic lift and drag forces and to avoid excessive trim angles for large heeling angles.

4.3.2 Bulwark

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

Figure 4.1 : Definition of the areas A and B

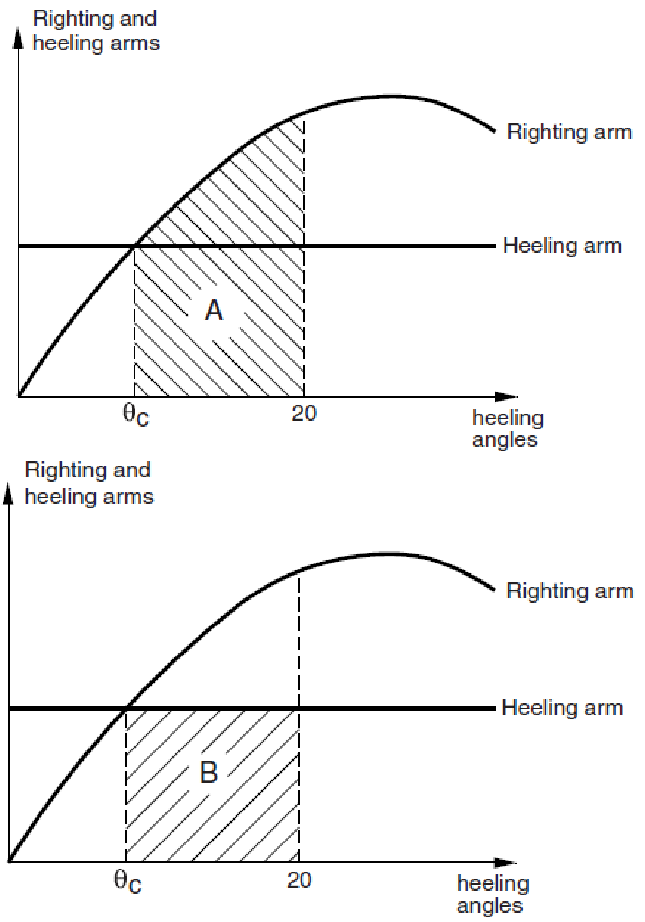
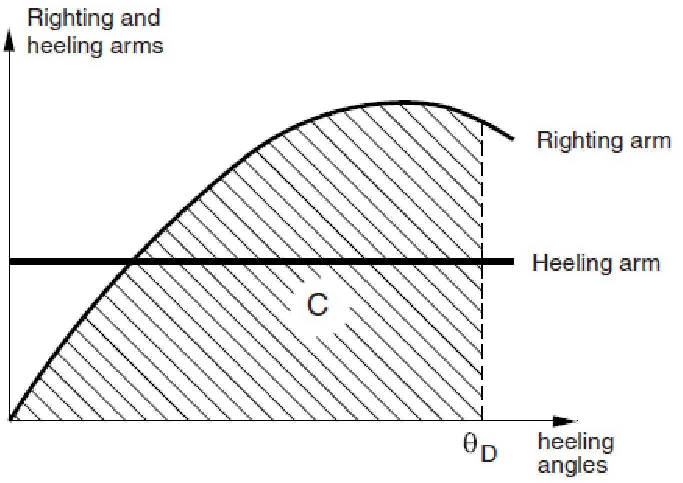
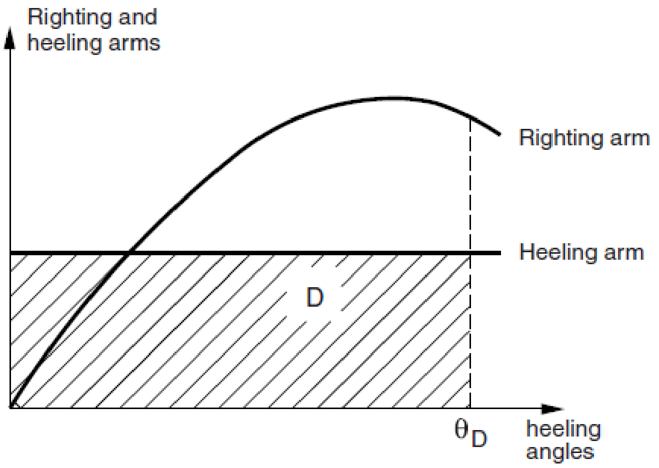


Figure 4.2 : Definition of the areas C and D





4.4 Equipment

4.4.1 Towline breaking load

The towline breaking load is to be not less than SF.T, where:

T : Maximum mean bollard pull, in kN, measured during the tests (see 4.5)

SF : Safety factor, to be taken equal to:

- SF = 3 for T $\le$ 600
- SF = 6 $-$ 0.005 T for 600 < T $\le$ 800
- SF = 2 for T > 800

4.4.2 Towing winches

The towing winch is to be fitted with a system suitable to reduce the load in order to avoid overload due to dynamic oscillations of the towline. It is to be able to release the towline when the pull is greater than 50% of the towline breaking load.

Normal escort services may not be based on use of the towing winch brakes.

4.5 Construction and testing

4.5.1 Testing

Requirements 4.5.2 and 4.5.3 apply to full scale tests to be carried out in order to obtain the values of the characteristics of the tug defined in 4.1.2.

If such full scale tests cannot be carried out, an equivalent method may be considered by the Society on a case by case basis.

4.5.2 Full scale tests

The following documentation is to be submitted to the Society for information prior to testing:

- test speed of the tug; the speed is to be intended as relative speed with respect to the sea motions, therefore the effects of any possible current are to be taken into account

- main propulsion characteristics (power, maximum orientation angle of the rudder)
- preliminary calculation of the maximum steering force TY at the test speed
- calculation of the route deviation of the escorted ship (for the tests, the escorted ship is to be selected so that the route deviation induced by the tug is not too large)
- preliminary stability calculation in the above conditions
- towing arrangement plan, including the load cell and the specification of the breaking loads of the towline components
- documentation relevant to the bollard pull test (see 2.9.1).

4.5.3 Data to be collected during tests

During the tests, all data needed to define the characteristics of the tug are to be collected, e.g. the relative position ship-tug, their heading and speed, the towline length, the towline angle □(see Fig 4.1), the maximum bollard pull T, the ship rudder position, the heeling angle of the tug and any other parameter used in the preliminary calculation.

Section 3 Integrated Tug/Barge Combination

Symbols

R_y : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

k : Material factor for steel, defined in Pt III, Ch 2

R_{eH} : Yield stress, in N/mm^2, of the steel used, and not exceeding the lower of 0.7 R_m and 450 N/mm^2

R_m : Minimum ultimate tensile stress, in N/mm^2, of the steel used.

1 General

1.1 Application

1.1.1 General

The requirements of this Section apply to the integrated tug/barge combinations constituted by:

- a tug, to which the additional service feature barge combined is assigned
- a barge, to which the additional service feature tug combined is assigned and specify the criteria these combinations are to satisfy in addition to those in:
- Sec 2, 2, for the tug
- Ch 15, Sec 2, for the barge.

1.1.2 When a series of barges may be operated in combination with a specific tug, the identification numbers of such barges are to be indicated in the tug class certificate.

1.1.3 When a series of tugs may be operated in combination with a specific barge, the identification numbers of such tugs are to be indicated in the barge Certificate of Classification.

1.2 Permanent connections

1.2.1 An integrated tug/barge combination is connected with permanent connection if the tug and the barge cannot be disconnected in open sea. The connection is such that no relative motion between the tug and the barge is permitted.

1.3 Removable connections

1.3.1 General

An integrated tug/barge combination is connected with removable connection if the tug and the barge can be disconnected in open sea. The disconnecting procedure is to be performed safely by one man and is to take less than 5 min. After disconnection in open sea, the tug is to be arranged to tow the barge by hawser.

The procedure for disconnecting and reconnecting at sea the integrated tug/barge combination is to be made available for guidance to the Master.

1.3.2 Types of removable connections

The removable connection is classed in the two following types:

- rigid connection, if no relative motion between the tug and the barge is permitted
- flexible connection, if relative motion between the tug and the barge is permitted (e.g. the tug is free to pitch with respect to the barge).

1.3.3 Tug

The tug is to have the capability of separating from the barge and shifting to tow it by hawser.

2 General arrangement design

2.1 Bulkhead arrangement

2.1.1 Number and disposition of tug transverse watertight bulkheads

The tug is to be fitted with transverse watertight bulkheads according to Pt III, Ch 2.

2.1.2 Number and disposition of barge transverse watertight bulkheads

In applying the criteria in Pt III, Ch 2, the barge is to be fitted at least with an aftermost transverse watertight bulkhead located forward of the connection area and extended from side to side.

The cargo spaces are to be separated from the other spaces not used for cargo by watertight bulkheads.

2.1.3 Barge collision bulkhead

The collision bulkhead of the barge is to be located at a distance, in m, from the fore end of L of not less than 0.05 L_{LLC} or 10 m, whichever is the lesser, and not more than 0.08 L_{LLB}, where:

L_{LLC} : Ship's length, in m, measured between the aft and fore ends of L of the integrated tug/barge combination, taken at the fore and aft ends of the load line length

L_{LLB} : Ship's length, in m, measured between the aft and fore ends of L of the barge considered as an individual ship, taken at the fore and aft ends of the load line length.

3 Integrated tug/barge combinations with permanent connection: stability, freeboard, design loads, hull scantlings and equipment

3.1 Stability calculations

3.1.1 The integrated tug/barge combination is to comply with the applicable intact and, where additional notation SDS is requested, damage stability requirements in Part III, Chapter 4 considering the integrated tug/barge combination as a ship of the size of the combination.

3.2 Freeboard calculation

3.2.1 The freeboard is to be taken as the greatest of:

- the freeboard of the tug, considered as an individual ship
- the freeboard of the barge, considered as an individual ship

- the freeboard of the integrated tug/barge combination, considered as a ship of the size of the combination. For the freeboard calculation the barge is to be considered as being manned.

3.3 Still water hull girder loads

3.3.1 The still water hull girder loads and the forces transmitted through the connection are to be calculated for each loading condition considering the integrated tug/barge combination as a ship of the size of the combination.

3.4 Wave hull girder loads

3.4.1 The wave hull girder loads and the forces transmitted through the connection are to be calculated according to Pt III, Ch 2 considering the integrated tug/barge combination as a ship of the size of the combination.

3.4.2 Direct calculation

When deemed necessary by the Society, the wave hull girder loads and the forces transmitted through the connection are to be obtained from a complete analysis of the integrated tug/barge combination motion and acceleration in irregular waves, unless such data are available from similar ships.

These loads are to be obtained as the most probable the integrated tug/barge combination, considered as a ship of the size of the combination, may experience during its operating life for a probability level of 10-8. For this calculation, the wave statistics relevant to the area of navigation and/or worst weather condition expressed by the navigation notation assigned to the integrated tug/barge combination are to be taken into account. For unrestricted navigation, the wave statistics relevant to the North Atlantic are to be taken into account.

When the difference between the tug and the barge depths is not considered negligible by the Society, its effects are to be considered in evaluating the buoyancy force distributions and the corresponding hull girder loads on the tug structures immediately aft of the connection section, for the different wave encountering conditions.

3.5 Still water local loads

3.5.1 The still water local loads are to be calculated according to Pt III, Ch 2 for each loading condition and draught of the integrated tug/barge combination. The draught of the integrated tug/barge combination is to be taken not less than 0.85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

3.6 Wave local loads

3.6.1 The wave local loads are to be calculated according to Pt III, Ch 2, considering the integrated tug/barge combination as a ship of the size of the combination. The draught of the integrated tug/barge combination is to be taken not less than 0.85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

3.7 Hull girder strength

3.7.1 Strength check

The longitudinal strength is to comply with Part III, Ch 2, Sec1 where the hull girder loads are those defined in 3.3 and 3.4.

3.7.2 Loading manual

The loading manual is to include the (cargo and ballast) loading conditions of the integrated tug/barge combination at sea and in port conditions on the basis of which the approval of its hull structural scantlings is based.

The manual is to indicate the still water bending moment and shear force along the length of the integrated tug/barge combination as well as the permissible values at each hull section.

Information on loading and unloading sequences is to be provided for guidance to the Master.

3.8 Scantlings of plating, ordinary stiffeners and primary supporting members

3.8.1 The net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with Part III, Chapter 2, where the hull girder and local loads are those defined in 3.3 to 3.6.

In any case, the net scantlings of plating, ordinary stiffeners and primary supporting members of the tug and the barge are to be not less than those obtained according to Sec 2 and Ch 15, Sec 2 for the tug alone and the barge alone, respectively.

3.9 Equipment

3.9.1 The equipment is to be in accordance with the requirements in both

- Sec 2, for the tug, and
- Ch 15, Sec 2, for the barge, considering the barge as a ship of the size of the integrated tug/barge combination.

4 Integrated tug/barge combination with removable connection: stability, freeboard, design loads, hull scantlings and equipment

4.1 Stability calculations

4.1.1 The integrated tug/barge combination is to comply with the applicable intact stability requirement in Part III, Chapter 4, considering the integrated tug/barge combination as a ship of the size of the combination.

4.2 Freeboard calculation

4.2.1 The freeboard is to be calculated for the tug and the barge considered as individual ships.

4.3 Still water hull girder loads

4.3.1 General

The still water hull girder loads and the forces transmitted through the connection are to be calculated for each loading condition considering the integrated tug/barge combination as a ship of the size of the combination.

4.3.2 Integrated tug/barge combination with removable flexible connection

For integrated tug/barge combinations with removable flexible connection, the effect of the degrees of freedom of the connection on the still water hull girder loads in the combination may be taken into account (e.g. free pitch of the tug with respect to the barge implies vertical bending moment equal to zero in the connection).

4.4 Wave hull girder loads

4.4.1 The wave hull girder loads and the forces transmitted through the connection are to be calculated according to 3.4.

4.4.2 Integrated tug/barge combination with Removable flexible connection

For integrated tug/barge combinations with removable flexible connection, the effect of the degrees of freedom of the connection on the wave hull girder loads in the combination may be taken into account (e.g. free pitch of the tug with respect to the barge implies vertical bending moment equal to zero in the connection).

4.5 Still water local loads

4.5.1 The still water local loads are to be calculated according to Pt III, Ch 2 for each loading condition and draught of the integrated tug/barge combination. The draught of the integrated tug/barge combination is to be taken not less than 0.85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

4.6 Wave local loads

4.6.1 The wave local loads are to be calculated according to Pt III, Ch 2, considering the integrated tug/barge combination as a ship of the size of the combination. The draught of the integrated tug/barge combination is to be taken not less than 0.85 D, where D is the greater of the tug and the barge depths and not greater than the draught of the barge.

4.7 Hull girder strength

4.7.1 The longitudinal strength is to comply with Part III, Ch2, Sec 1, where the hull girder loads are those defined in 4.3 and 4.4.

4.7.2 Loading manual

The loading manual is to include the items specified in 3.7.2.

4.8 Scantlings of plating, ordinary stiffeners and primary supporting members

4.8.1 Integrated tug/barge combinations with removable rigid connection

For integrated tug/barge combinations with removable rigid connection, the net scantlings of plating, ordinary stiffeners and primary supporting members are to be in accordance with Pt III, Ch 2, where the hull girder and local loads are those defined in 4.3 to 4.6.

In any case, the net scantlings of plating, ordinary stiffeners and primary supporting members of the tug and the barge are to be not less than those obtained according to Sec 2 and Ch 15, Sec 2 for the tug alone and the barge alone, respectively.

4.8.2 Integrated tug/barge combinations with removable flexible connection

For integrated tug/barge combinations with removable flexible connection, the net scantlings of plating, ordinary stiffeners and primary supporting members of the tug and the barge are to be not less than those obtained according to Sec 2 and Ch 15, Sec 2 for the tug alone and the barge alone, respectively.

4.9 Equipment

4.9.1 The equipment is to be in accordance with 3.9.1.

5 Connection

5.1 General

5.1.1 The components of the connecting/disconnecting system are to be fitted on the tug.

Where the connecting system is located on a tug superstructure, this is to be checked according to Pt III, Ch 2. The efficiency of the structural connection between this superstructure and the underlying hull structures is to be ensured.

5.1.2 The connecting system is to comply with the following requirements:

- it is to be permanently locked in position, at sea, with remote indication and control on the bridge
- it is to remain locked in the event of damage to the control system. A local control is to be provided for enabling the disconnection from the coupler machinery room.

5.2 Scantlings

5.2.1 General

The bow of the tug and the stern of the barge are to be reinforced in order to withstand the connection forces.

The structure reinforcements are to be continued in aft and fore directions of the integrated tug/barge combination in order to transmit the connection forces to the hull structure of the tug and the barge.

5.2.2 Calculation of stresses in the connection

The stresses in the connection are to be obtained by means of direct calculations, where the connection forces are to be obtained according to 3.3 and 3.4 or 4.3 and 4.4, as applicable, and the partial safety factors specified in Tab 5.1 are to be applied.

When calculating the stresses in the connection, pre-loading from locking devices, if any, is to be taken into account.

For notch type connections, the analysis of the barge wing walls is to take into account the effects of bending moment, shear force and torque.

Table 5.1 : Partial safety factors

Partial safety factors covering uncertainties regarding	Symbol	Partial safety factor value
Still water hull girder loads	γ_{S1}	1.00
Wave hull girder loads	γ_{w1}	1.15
Still water pressure	γ_{S2}	1.00
Wave pressure	γ_{w2}	1.20
Material	γ_m	1.02
Resistance	γ_R	1.25

5.2.3 Shear check of the structural elements of the connection

The shear stresses in the structural elements of the connection are to comply with the following formula:

$$\tau \le 0.65 \frac{R_\gamma}{\gamma_R \gamma_m}$$

where:

τ: Shear stress, in N/mm^2, to be obtained as a result of direct calculations

γ_R : Resistance partial safety factor, defined in Tab 5.1

γ_m : Material partial safety factor, defined in Tab 5.1.

5.2.4 Yielding check of the structural elements of the connection

The Von Mises equivalent stresses in the structural elements of the connection are to comply with the following formula:

$$\sigma_E \le \frac{R_\gamma}{\gamma_R \gamma_m}$$

where:

σ_E : Von Mises equivalent stress, in N/mm^2, to be obtained as a result of direct calculations

γ_R : Resistance partial safety factor, defined in Tab 5.1

γ_m : Material partial safety factor, defined in Tab 5.1.

5.2.5 Deflections

Deflections of the structural elements in the connection are to be obtained from direct calculations, to be carried out in accordance with 5.2.2 and submitted to the Society for review.

Deflection and pre-loading of the connection, if any, are to be considered in order to avoid hammering in the connection area.

6 Other structures

6.1 Tug fore part

6.1.1 General

For integrated tug/barge combinations with permanent connection or removable rigid connection, the tug fore structure is to be aligned with the barge aft structure in way of the notch or the dock bottom.

6.1.2 Scantlings

The net scantlings of the fore part of the tug are to be in accordance with Part III, Ch 2, considering the hull girder loads, the local loads and the connection forces defined in 3.3 to 3.6 for integrated tug/barge combinations with permanent connection or 4.3 to 4.6 for integrated tug/barge combinations with removable connection.

6.2 Tug aft part

6.2.1 Scantlings for integrated tug/barge combinations with permanent or removable rigid connections

The net scantlings of the aft part of the tug are to be in accordance with Pt III, Ch 2, considering this part as belonging to a ship of the size of the integrated tug/barge combination.

6.2.2 Scantlings for integrated tug/barge combinations with removable flexible connections

The net scantlings of the aft part of the tug are to be in accordance with Pt III, Ch 2, considering the tug as an individual ship.

6.3 Barge fore part

6.3.1 Scantlings for integrated tug/barge combinations with permanent or removable rigid connections

The net scantlings of the fore part of the barge are to be in accordance with Pt III, Ch 2, considering this part as belonging to a ship of the size of the integrated tug/barge combination.

6.3.2 Scantlings for integrated tug/barge combinations with removable flexible connections

The net scantlings of the fore part of the barge are to be in accordance with Pt III, Ch 2, considering the barge as an individual ship.

6.4 Barge aft part

6.4.1 General

For integrated tug/barge combinations with permanent connection or removable rigid connection, the barge aft structure is to be aligned with the tug fore structure in way of the notch or the dock bottom.

6.4.2 Scantlings

The net scantlings of the aft part of the barge are to be in accordance with Part III, Chapter 2, considering the hull girder loads, the local loads and the connection forces defined in 3.3 to 3.6 for integrated tug/barge combinations with permanent connection or 4.3 to 4.6 for integrated tug/barge combinations with removable connection.

7 Hull outfitting

7.1 Rudder and steering gear

7.1.1 The tug rudder and steering gear are to be in accordance with Pt III, Ch 2, Sec 14 and Pt IV, Ch 1, Sec 12, respectively, considering the maximum service speed (in ahead and astern condition) of the tug as an individual ship and the maximum service speed (in ahead and astern condition) of the integrated tug/barge combination.

The characteristics and performance of the rudder and the steering gear are to ensure the manoeuvrability of the integrated tug/barge combination.

8 Construction and testing

8.1 Test of the disconnection procedure of removable connection

8.1.1 Tests are to be carried out in order to demonstrate the capability of the tug to be safely disconnected from the barge within 5 min by one man.

These tests may be performed in harbour. However, additional information is to be submitted to the Society in order to demonstrate the capability of the tug and the barge of being safely disconnected and reconnected at sea. The operating procedure, indicating the maximum or pre-fixed sea states, is to be made available for guidance to the Master, as indicated in 1.3.1.

Chapter 11 Supply Vessels

Section 1 General

1 General

1.1 Application

1.1.1 Service notation supply vessel

Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation supply vessel, as defined in Pt I, Ch 1, Sec 3.

For ship carrying oil products and not complying with 1.1.2 the service notation supply vessel cannot be assigned to the ship.

For ship carrying the products listed in 1.1.3 and not complying with 1.1.3 or 1.1.4, the service notation supply vessel cannot be assigned to the ship.

1.1.2 Additional service feature oil product

For ships designed to carry oil products with any flashpoint in bulk in its cargo spaces and having a maximum cargo tank capacity as required in 1.2.1, the service notation supply vessel is to be completed by the additional service feature oil product.

1.1.3 Additional service feature LHNS

For ships, other than well stimulation vessels, carrying amounts of hazardous and noxious liquid substances in

bulk not exceeding the maximum specified in [1.2.2], the service notation supply vessel is to be completed by the additional service feature LHNS.

The products which may be carried are:

- hazardous and noxious liquids listed in Tab 1.1 and those other products which may be assigned to this list
- any flammable liquid.

Table 1.1 : Hazardous and noxious permitted products

Name	Flammability
Oil based mud containing mixtures of products listed in Chapters 17 and 18 of the IBC Code and the MEPC.2/Circular	No
Water based mud containing mixtures of products listed in Chapters 17 and 18 of the IBC Code and the MEPC.2/Circular	No
Drilling brines, including: - Sodium chloride solution - Calcium bromide solution - Calcium chloride solution	No
Calcium nitrate / Magnesium nitrate / Potassium chloride solution	No
Calcium nitrate solution (50% or less)	No
Drilling brines (containing zinc salts)	No
Potassium formate solution	No
Potassium chloride solution	No
Ethyl alcohol	Yes
Ethylene glycol	No
Ethylene glycol monoalkyl ether	Yes
Methyl alcohol	Yes
Acetic acid	Yes
Formic acid	Yes
Hydrochloric acid	No
Hydrochloric-hydrofluoric mixtures containing 3% or less Hydrofluoric acid	No
Sulfuric acid	No
Toluene	Yes
Xylene	Yes
Liquid carbon dioxide	No
Liquid nitrogen	No
Noxious liquid, NF, (7) n.o.s (trade name ..., contains ...) ST3, Cat. Y	No
Noxious liquid, F, (8) n.o.s (trade name ..., contains ...) ST3, Cat. Y	Yes
Noxious liquid, NF, (9) n.o.s (trade name ..., contains ...) ST3, Cat. Z	No
Noxious liquid, F, (10) n.o.s (trade name ..., contains ...) ST3, Cat. Z	Yes
Noxious liquid, F, (11) n.o.s (trade name ..., contains ...) Cat. Z	No
Non-noxious liquid, F, (12) n.o.s (trade name ..., contains ...) Cat. OS	No

1.1.4 Additional service feature WS

For well stimulation vessels, the service notation supply vessel is to be completed by the additional service feature WS.

Well stimulation vessels are allowed to carry amounts of liquid substances listed in Tab 1.1 more than the maximum specified in 1.2.2.

1.1.5 Assignment of different additional service feature

A supply vessel may be assigned two different additional service features as:

- oil product and LHNS
- oil product and WS.

In such case, the specific rule requirements applicable to each additional service feature are to be complied with.

1.1.6 Supply vessels covered by the SOLAS Convention

Ships dealt with in this Chapter and which are covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I, II, III and IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to supply vessels.

1.1.7 Supply vessels not covered by SOLAS Convention

Ships dealt with in this Chapter and which are not covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I and IV, as applicable, and with the requirements of this Chapter, which are specific to supply vessels.

1.2 Applicability of additional service features

1.2.1 Cargo tank capacity for ships with additional service feature oil product

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

1.2.2 Maximum amount of bulk liquids for ships with additional service feature LHNS

The aggregate quantity of bulk liquids identified in 1.1.3 is to be less than 800m^3 and not to exceed a volume in m^3 equal to 40% of the ship's deadweight calculated at a cargo density of 1.0.

The Society may permit carriage of more than the maximum amount specified above, provided that the survival capability requirements of Ch 5, Sec 2 or Ch 6, Sec 2 are complied with.

1.2.3 Applicability of additional service features LHNS and WS

The requirements of this Chapter regarding the additional service features LHNS and WS apply only in the case of carriage involving transfer of the cargo to or from its containement which forms parts of the ship or remains on board.

1.3 Definitions

1.3.1 Flammable liquids

A flammable liquid is any liquid (hydrocarbons included) having a flashpoint (closed cup test) not exceeding 60°C.

1.3.2 Oil product

Oil product means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products (other than the petrochemicals which are subject to the provisions of Annex II of MARPOL 73/78, as amended).

1.3.3 Well stimulation vessel

A well stimulation vessel is a ship designed and equipped for the stimulation of wells for production of oil and/or gas.

Section 2 Hull and Stability

Symbols

k : Material factor for steel, defined in Pt III, Ch 2

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

1 General

1.1 Application

1.1.1 This Section applies to ships having the following service notations:

- supply vessel
- supply vessel oil product
- supply vessel LHNS
- supply vessel WS.

1.2 Definitions

1.2.1 Integral tank

Integral tank means a cargo containment envelope which forms part of the ship's hull and which may be stressed in the same manner and by the same loads which stress the contiguous hull structure and which is normally essential to the structural completeness of the ship's hull.

1.2.2 Independent tank

Independent tank means a cargo-containment envelope which is not contiguous with, or part of, the hull structure.

An independent tank is built and installed so as to eliminate whenever possible (or in any event to minimize) its stressing as a result of stressing or motion of the adjacent hull structure.

An independent tank is not essential to the structural completeness of the shipۥs hull.

1.2.3 Gas-dangerous spaces

Gas-dangerous spaces include the spaces listed in Ch 4, Sec 5, corresponding to hazardous area zones 0, 1 and 2.

1.2.4 Cargo area

Cargo area is that part of the ship where cargo and cargo vapours are likely to be present and includes cargo tanks, cargo pump rooms, hold spaces in which independent tanks are located, cofferdams, ballast or void spaces surrounding integral tanks and the following deck areas:

- within 3 m of a cargo tank installed on deck
- within 3 m of a cargo tank outlet in case of independent tanks installed below deck
- within 3 m of a cargo tank outlet in case of integral tanks installed below deck and separated from the weather deck by a cofferdam

- the deck area above an integral tank without an overlaying cofferdam plus the deck area extending transversely and longitudinally for a distance of 3 m beyond each side of the tank
- within 3 m of any cargo liquid or vapour pipe, flange, cargo valve, gas or vapour outlet, or entrance or ventilation opening to a cargo pump-room.

1.2.5 Pollution hazard only substance

Pollution hazard only substance is a substance included in the list of IBC Code, Ch 17, as amended, with an entry “P” in “hazard” column (column d).

2 General arrangement design

2.1 Compartment arrangement for all ships

2.1.1 Watertight integrity

The machinery spaces and other working and living spaces in the hull should be separated from other compartments by watertight bulkheads.

2.1.2 Afterpeak bulkhead

An afterpeak bulkhead should be fitted and made watertight up to the freebord deck. The afterpeak bulkhead may, however, be stepped below the freebord deck, provided the degree of safety of the ship as regards subdivision is not thereby diminished.

2.1.3 Location of cargo tanks and cargo storage vessels

All cargo tanks and cargo storage vessels are to be located aft of the collision bulkhead and forward of the aft peak.

2.2 Compartment arrangement for ships with additional service feature oil product

2.2.1 Cargo tank capacity

The total capacity of cargo tanks designed to carry oil products is to comply with the requirements stipulated in Sec 1, 1.2.1.

2.2.2 Length of cargo tanks

The length of each cargo tank may not exceed 10 metres or one of the values of Tab 2.1, as applicable, whichever is the greater.

Table 2.1 : Length of cargo tanks

Longitudinal bulkhead	Type of cargo tank	bi /B (1)	Centreline bulkhead	Length (m)
No bulkhead	-	-	-	$(0.5\ b_i /B + 0.1)\ L$ (2)
Centreline bulkhead	-	-	-	$(0.25\ b_i /B + 0.15)\ L$
Two or more bulkheads	Wing cargo tank	-	-	0.2 L
	Centre cargo tank	if bi /B >1/5	-	0.2 L
		if bi /B <1/5	No	$(0.5\ b_i /B + 0.1)\ L$
			Yes	$(0.25\ b_i /B + 0.15)\ L$

(1) Where bi is the minimum distance from the ship side to the outer longitudinal bulkhead of the tank in question measured inboard at right angles to the centreline at the level corresponding to the assigned summer freeboard.

(2) Not to exceed 0.2 L.

2.3 Compartment arrangement for ships with additional service feature LHNS

2.3.1 Location of cargo tanks and cargo storage vessels

Cargo tanks containing products as listed in Sec 1, 1.1.3 are to be located at least 760 mm measured inboard from the side of the vessel perpendicular to the centreline at the level of the summer load waterline.

2.3.2 Location of accommodation or service spaces and control stations

Accommodation or service spaces, or control stations may not be located within the cargo area.

2.3.3 Cargo tank extension

Cargo tanks may extend to the deck plating, provided dry cargo is not handled in that area. Where dry cargo is handled on the deck area above a cargo tank, the cargo tank may not extend to the deck plating unless a continuous, permanent deck sheathing of wood or other suitable material of appropriate thickness and construction is fitted to the satisfaction of the Society.

Cargoes may not be carried in either the fore or aft peak tanks.

2.3.4 Cargo segregation with fuel oils or other cargoes

Cargoes which react in a hazardous manner with other cargoes or fuel oils are to:

- be segregated from such other cargoes or fuel oils by means of a cofferdam, void space, cargo pump room, pump room, empty tank, or tank containing a mutually compatible cargo
- have separate pumping and piping systems which may not pass through other cargo tanks containing such cargoes, unless encased in a tunnel; and
- have separate tank venting systems.

2.3.5 Cargo segregation with other spaces

Tanks containing cargo or residues of cargo listed in Sec 1, 1.1.3 are to be segregated from machinery spaces, propeller shaft tunnels, if fitted, dry cargo spaces, accommodation and service spaces and from drinking water and stores for human consumption, by means of a cofferdam, void space, cargo pump room, empty tank, fuel oil tank, or other similar space. On-deck stowage of independent tanks or installation of independent tanks in otherwise empty hold spaces is to be considered as satisfactory.

2.3.6 Substances with a flashpoint exceeding 60°C

For pollution hazard only substances having a flashpoint exceeding 60°C (closed cup test), the Society may waive the arrangements referred to in 2.3.5 and 2.3.9 provided that the segregation requirements for accommodation spaces, drinking water and stores for human consumption are observed. Additionally, 2.3.10 and 2.7.1 need not be applied.

2.3.7 Tank openings and connections

Except for the tank connections to cargo pump rooms, all tank openings and connections to the tank are to terminate above the weather deck and are to be located in the tops of the tanks. Where cofferdams are provided over integral tanks, small trunks may be used to penetrate the cofferdam.

2.3.8 Openings to accommodation, service and machinery spaces and control stations

a) Unless they are spaced at least 7 m away from the cargo area containing flammable products, entrances, air inlets and openings to accommodation, service and machinery spaces and control stations may not face the cargo area. Doors to spaces not having access to accommodation, service and machinery spaces and control stations, such as cargo control stations and storerooms, may be permitted by the Society within the 7 m zone specified above, provided the boundaries of the spaces are insulated to A-60 standard. When arranged within the 7 m zone specified above, windows and sidescuttles facing the cargo area are to be of a fixed type. Such sidescuttles in the first tier on the main deck are to be fitted with inside covers of steel or equivalent material.

b) In order to guard against the danger of hazardous vapours, due consideration is to be given to the location of air intakes and openings into accommodation, service and machinery spaces and control stations in relation to cargo piping and cargo vent systems.

c) For pollution hazard only substances having a flashpoint exceeding 60°C, the arrangements referred to in a) and b) may be waived.

2.3.9 Openings for pipes

Cargo piping may not pass through any accommodation, service or machinery space other than cargo pump rooms or pump rooms.

2.3.10 Cofferdams

Where not bounded by bottom shell plating, fuel oil tanks, a cargo pump room or a pump room, the cargo tanks are to be surrounded by cofferdams. Tanks for other purposes (except fresh water and lubricating oils) may be accepted as cofferdams for these tanks.

2.4 Compartment arrangement for ships with additional service feature WS

2.4.1 General

Compartment arrangement of supply vessels with additional service feature WS is to comply with the requirements of 2.3.

2.5 Access arrangement for all ships

2.5.1 Access to spaces below the freeboard deck

Access to the areas below the freeboard deck is, in general, to be provided from a position above the deck of a first tier superstructure.

As an alternative, indirect access may be provided from a space fitted with an outer door having a sill not less than 600 mm high and a self-closing, gas-tight inner door having a sill not less than 380 mm high.

2.5.2 Access to cargo pump rooms

Access to cargo pump rooms is only to be provided from an open position on the weather deck.

2.5.3 Acces to the machinery space

Access to the machinery space is, as far as practicable, to be arranged within the forecastle. Any access to the machinery space from the exposed cargo deck is to be provided with two weathertight closures. Access to spaces below the exposed cargo deck is preferably to be from a position within or above the superstructure deck.

2.6 Access arrangement for ships with additional service feature oil product

2.6.1 Access to spaces within the cargo area

The access to spaces within the cargo area is to meet the requirements of 2.7.2.

2.6.2 Access to the gas-safe spaces

Gas-safe spaces such as accommodation, service, machinery and other similar spaces may not have any direct communication with gas-dangerous spaces defined in 1.2.3.

Nevertheless, access openings to gas-safe spaces below the weather deck, which are located less than 10 metres but not less than 3 metres from the outlets of gas vents in cargo tanks and cargo storage vessels, may be permitted where they are intended as emergency means of escape from normally attended spaces or as access to normally unattended spaces, provided that the relevant doors are kept permanently closed when the ship is not gas-freed.

Suitable warning plates are to be fixed in the proximity of such openings.

2.7 Access arrangement for ships with additional service feature LHNS

2.7.1 Access to spaces

For access to all spaces, the minimum spacing between cargo tank boundaries and adjacent ship's structures, other than the side shell, is to be 600 mm.

2.7.2 Access to spaces in the cargo area

a) Access to cofferdams, ballast tanks, cargo tanks and other spaces in the cargo area should be direct from the open deck and such as to ensure their complete inspection.

Acces to double bottom spaces may be through a cargo pump-room, pump-room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

b) For acces through horizontal openings, hatches or manholes, the dimensions should be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening should be not less than 600 mm by 600 mm.

c) For acces through vertical openings, or manholes providing passage through the length and breath of the space, the minimum clear opening should be not less than 600 mm by 800 mm at a height of not more than600 mm from the bottom shell plating unless gratings or other footholds are provided.

d) Smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

2.8 Access arrangement for ships with additional service feature WS

2.8.1 General

The access arrangement of supply vessels with additional service feature WS is to comply with the requirements of 2.7;

3 Stability

3.1 General

3.1.1 Application

Every decked offshore supply vessel of 24 metres and over but not more than 100 metres in length is to comply with the provisions of 3.2 and 3.4. The intact and damage stability of a vessel of more than 100 metres in length should be to the satisfaction of the Society.

3.1.2 Relaxation

Relaxation in the requirements of 3.2 and 3.4 may be permitted by the Society for vessels engaged in near-coastal voyages provided the operating conditions are such as to render compliance with 3.2 and 3.4 unreasonable or unnecessary.

3.2 Intact stability for all ships

3.2.1 General stability criteria

The stability of the ship, for the loading conditions defined in Pt III, Ch 4, App 2, 1.2.1 and Pt III, Ch 4, App 2, 1.2.12 with the assumptions in 3.2.5, is to be in compliance with the requirements of Pt III, Ch 4, Sec 2, 2.1 or as an alternative with the requirements of 3.2.2. The additional criteria of 3.2.3 are also to be complied with.

3.2.2 Alternative stability criteria

The following equivalent criteria are recommended where a vessel's characteristics render compliance with Pt III, Ch 4, Sec 2, 2.1 impracticable:

پ The area, in m.rad, under the curve of righting levers (GZ curve) may not be less than 0.070 up to an angle of 15° when the maximum righting lever (GZ) occurs at 15° and 0.055 up to an angle of 30° when the maximum righting lever (GZ) occurs at 30° or above. Where the maximum righting lever (GZ) occurs at angles of between 15خ and 30خ, the corresponding area بAپ in m.rad, under the righting lever curve is to be:

$A = 0.055 + 0.001(30° - \theta_{max})$

where θ_{max} is the angle of heel, in degrees, at which the righting lever curve reaches its maximum

- The area, in m.rad, under the righting lever curve (GZ curve) between the angles of heel of 30° and 40°, or between 30° and θ_f if this angle is less than 40°, may not be less than 0.03, where θ_f is defined in Pt III, Ch 4, Sec 2, 2.1.2
- The righting lever (GZ), in m, is to be at least 0.20 at an angle of heel equal to or greater than 30°
- The maximum righting lever (GZ) is to occur at an angle of heel not less than 15°
- The initial transverse metacentric height (GM), in m, may not be less than 0.15 m.

3.2.3 Additional criteria

A minimum freeboard at the stern of at least 0.005 L is to be maintained in all operating conditions.

3.2.4 Factors of influence

The stability criteria mentioned in 3.2.1 and 3.2.2 are minimum values; no maximum values are recommended. It is advisable to avoid excessive values, since these might lead to acceleration forces which could be prejudicial to the vessel, its complement, its equipment and the safe carriage of cargo.

Where anti-rolling devices are installed, the stability criteria indicated in 3.2.1 and 3.2.2 are to be maintained when the devices are in operation.

3.2.5 Assumptions for calculating loading conditions

If a vessel is fitted with cargo tanks, the fully loaded conditions of Pt III, Ch 4, App 2, 1.2.12 are to be modified, assuming first the cargo tanks full and then the cargo tanks empty.

If in any loading condition water ballast is necessary, additional diagrams are to be calculated, taking into account the water ballast, the quantity and disposition of which are to be stated in the stability information.

In all cases when deck cargo is carried, a realistic stowage weight is to be assumed and stated in the stability information, including the height of the cargo and its centre of gravity.

Where pipes are carried on deck, a quantity of trapped water equal to a certain percentage of the net volume of the pipe deck cargoes is to be assumed in and around the pipes. The net volume is to be taken as the internal volume of the pipes, plus the volume between the pipes. This percentage is 30 if the freeboard amidships is equal to or less than 0.015 L and 10 if the freeboard amidships is equal to or greater than 0.03 L. For intermediate values of the freeboard amidships, the percentage may be obtained by linear interpolation. In assessing the quantity of trapped water, the Society may take into account positive or negative sheer aft,

actual trim and area of operation.

If a vessel operates in zones where ice accretion is likely to occur, allowance for icing should be made in accordance with the provisions of Pt III, Ch 4, Sec 2, 6.

A vessel, when engaged in towing operations, may not carry deck cargo, except that a limited amount, properly secured, which would neither endanger the safe working of the crew nor impede the proper functioning of the towing equipment, may be accepted.

3.3 Intact stability for ships with additional service feature oil product

3.3.1 Liquid transfer operations

Ships with particular internal subdivision may be subjected to lolling during liquid transfer operations such as loading, unloading or ballasting. In order to prevent the effect of lolling, the design of ships of 5000 t deadweight and above is to be such that the following criteria are complied with:

a) The intact stability criteria reported in b) are to be complied with for the worst possible condition of loading and ballasting as defined in c), consistent with good operational practice, including the intermediate stages of liquid transfer operations. Under all conditions the ballast tanks are to be assumed slack.

b) The initial metacentric height GMo, in m, corrected for free surface measured at 0° heel, is to be not less than 0.15. For the purpose of calculating GMo, liquid surface corrections are to be based on the appropriate upright free surface inertia moment.

c) The vessel is to be loaded with:

- all cargo tanks filled to a level corresponding to the maximum combined total of vertical moment of volume plus free surface inertia moment at 0° heel, for each individual tank
- cargo density corresponding to the available cargo deadweight at the displacement at which transverse KM reaches a minimum value
- full departure consumable
- 1% of the total water ballast capacity. The maximum free surface moment is to be assumed in all ballast tanks.

3.3.2 Alternative requirements for liquid transfer operation

As an alternative to the requirements in 3.3.1, simple supplementary operational procedures are to be followed when the ship is carrying oil cargoes or during liquid transfer operations.

Simple supplementary operational procedures for liquid transfer operations means written procedures made available to the Master which:

- are approved by the Society
- indicate those cargo and ballast tanks which may, under any specific condition of liquid transfer and possible range of cargo densities, be slack and still allow the stability criteria to be met. The slack tanks may vary during the liquid transfer operations and be of any combination provided they satisfy the criteria

- are to be readily understandable to the officer-in-charge of liquid transfer operations
- provide for planned sequences of cargo/ballast transfer operations
- allow comparisons of attained and required stability using stability performance criteria in graphical or tabular form
- require no extensive mathematical calculations by the officer-in-charge
- provide for corrective actions to be taken by the officerin- charge in the event of departure from the recommended values and in case of emergency situations, and
- are prominently displayed in the approved trim and stability booklet and at the cargo/ballast transfer control station and in any computer software by which stability calculations are performed.

3.4 Damage stability for all ships where the additional class notation SDS has been requested

3.4.1 General

Taking into account as initial conditions before flooding, the standard loading conditions as referred to in Pt III, Ch 4, App 2, 1.2.1 and Pt III, Ch 4, App 2, 1.2.12, the vessel is to comply with the damage stability criteria as specified in 3.4.7 .

3.4.2 Damage dimensions

The assumed extent of damage of supply vessels is to be asindicated in Tab 3.1.

Table 3.1 : Extent of damage

Longitudinal extent	Transverse extent	Vertical extent
3L/100 + 3 for L>43 m (1) L/10 for L□43 m (1)	760 mm (2)	Full depth (3)

(1) Anywhere in the ship's length between any transverse watertight bulkhead

(2) Measured inboard from the side of the vessel perpendicularly to the centreline at the level of the summer load waterline.

(3) From the underside of the cargo deck, or the continuation thereof.

3.4.3 Consideration of transverse watertight bulkheads for flooding

A transverse watertight bulkhead extending from the vessel's side to a distance inboard of 760 mm or more at the level of the summer load line joining longitudinal watertight bulkheads may be considered as a transverse watertight bulkhead for the purpose of the damage calculations.

Where a transverse watertight bulkhead is located within the transverse extent of assumed damage and is stepped in way of a double bottom or side tank by more than 3.05 m, the double bottom or side tank adjacent to the stepped portion of the bulkhead is to be considered as flooded simultaneously.

If the distance between adjacent transverse watertight bulkheads or the distance between the transverse planes passing through the nearest stepped portions of the bulkheads is less than the longitudinal extent of damage given in 3.4.2

3.4.4 Progressive flooding

If pipes, ducts or tunnels are situated within the assumed extent of damage, arrangements are to be made to ensure that progressive flooding cannot thereby extend to compartments other than those assumed to be floodable for each case of damage. The progressive flooding is to be considered in accordance with Pt III, Ch 4, Sec 3, 3.3.

3.4.5 Minor damage

If damage of a lesser extent than that specified in 3.4.2 results in a more severe condition, such lesser extent is to be assumed.

3.4.6 Permeability

The permeability of spaces assumed to be damaged is to be as indicated in Tab 3.2.

Table 3.2 : Values of permeability

Spaces	Permeability
Appropriated for stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Void spaces, empty tanks	0.95
Intended for dry cargo	0.95
Intended for liquids	(1)

(1) The permeability of tanks is to be consistent with the amount of liquid carried.

3.4.7 Survival requirements

Compliance with the requirements of 3.4.8 is to be confirmed by calculations which take into consideration the design characteristics of the vessel, the arrangements, configuration and permeability of the damaged compartments and the distribution, specific gravities and free surface effect of liquids.

3.4.8 Damage stability criteria

a) The final waterline, taking into account sinkage, heel and trim, is to be below the lower edge of any opening through which progressive flooding may take place. The progressive flooding is to be considered in accordance with Pt III, Ch 4, Sec 3, [3.3].

b) In the final stage of flooding, the angle of heel due to unsymmetrical flooding may not exceed 15°. This angle may be increased up to 17° if no deck immersion occurs.

c) The stability in the final stage of flooding is to be investigated and may be regarded as sufficient if the righting lever curve has at least a range of 20° beyond the position of equilibrium in association with a maximum residual righting lever of at least 100 mm within this range.

Unprotected openings may not become immersed at an angle of heel within the prescribed minimum range of residual stability unless the space in question has beenincluded as a floodable space in calculations for damage stability. Within this range, immersion of any of the openings referred to in a) and any other openings capable of being closed weathertight may be authorised.

d) The stability is to be sufficient during intermediate stages of flooding. In this regard the Society applies the same criteria relevant to the final stage of flooding also during the intermediate stages of flooding.

3.5 Damage stability for ships with additional service feature oil product where the additional class notation SDS has been requested

3.5.1 General

In addition to the requirements of 3.4, supply vessels are to comply with the requirements of 3.5.2 to 3.5.9.

3.5.2 Damage dimensions

The assumed extent of damage is to be as defined in Tab 3.3.

The transverse extent of damage is measured inboard the ship side at right angles to the centreline at the level of the summer load line.

For the purpose of determining the extent of assumed damage, suction wells may be neglected, provided such wells are not excessive in area and extend below the tank for a minimum distance and in no case more than half the height of the double bottom.

The vertical extent of damage is measured from the moulded line of the bottom shell plating at centreline.

If any damage of a lesser extent than the maximum extent of damage specified in Tab 3.3 would result in a more severe condition, such damage is to be considered.

3.5.3 Standard of damage

The damage in 3.5.2 is to be applied anywhere in the shipﹶs length between adjacent transverse bulkheads with the exception of the machinery space. For ships of 100 m or less in length where all the requirements of 3.5.6 cannot be fulfilled without materially impairing the operational qualities of the ship, the Society may allow relaxation from these requirements.

3.5.4 Calculation method

The metacentric heights (GM), the stability levers (GZ) and the centre of gravity positions (KG) for judging the final survival conditions are to be calculated by the constant displacement method (lost buoyancy).

3.5.5 Flooding assumptions

The requirements of 3.5.6 are to be confirmed by calculations which take into consideration the design characteristics of the ship, the arrangements, configuration and contents of the damaged compartments and the distribution, specific gravities and free surface effect of liquids.

For the damage as specified in 3.5.3, no main transverse bulkhead bounding side tanks or double bottom tanks is to be assumed damaged, unless:

- the spacing of the adjacent bulkheads is less than the longitudinal extent of assumed damage specified in 3.5.2, or
- there is a step or a recess in a transverse bulkhead of more than 3.05 metres in length, located within the extent of penetration of assumed damage. The step formed by the after peak bulkhead and after peak tank top may not be regarded as a step.

3.5.6 Survival requirements

Combination carriers are to be regarded as complying with the damage stability criteria if the requirements of 3.5.7 and 3.5.8 are met.

Table 3.3 : Extent of damage

Damage		Longitudinal extent	Transverse extent	Vertical extent
Side		l_C = 1/3 $L^{2/3}$ or 14.5m(1)	t_C = B/5 or 11.5 m (1)	v_C = without limit
Bottom	For 0.3 L from the forward perpendicular	l_S = 1/3 $L^{2/3}$ or 14.5m(1)	t_S = B/6 or 10.0 m (1)	v_S = B/15 or 6,0 m (1)
	Any other part	l_S = 1/3 $L^{2/3}$ or 5.0 m (1)	t_S = B/6 or 5.0 m (1)	v_S = B/15 or 6.0 m (1)

(1) Whichever is the lesser

3.5.7 Final stage of flooding

a) The final waterline, taking into account sinkage, heel and trim, is to be below the lower edge of any opening through which progressive flooding may take place. The progressive flooding is to be considered in accordance with Pt III, Ch 4, Sec 3, 3.3.

b) The angle of heel due to unsymmetrical flooding may not exceed 25°, except that this angle may be increased up to 30° if no deck edge immersion occurs.

c) The stability is to be investigated and may be regarded as sufficient if the righting lever curve has at least a range of 20° beyond the position of equilibrium in association with a maximum residual righting lever, in m, of at least 0,1 within the 20° range; the area, in m.rad, under the curve within this range is to be not less than 0.0175.

3.5.8 Intermediate stage of flooding

The Society is to be satisfied that the stability is sufficient during the intermediate stages of flooding. In this regard the Society applies the same criteria relevant to the final stage of flooding also during the intermediate stages of flooding.

3.5.9 Equalisation arrangements

Equalisation arrangements requiring mechanical aids such as valves or cross levelling pipes, if fitted, may not be considered for the purpose of reducing an angle of heel or attaining the minimum range of residual stability to meet the requirements of 3.5.7 and sufficient residual stability is to be maintained during all stages where equalisation is used.

Compartments which are linked by ducts of a large crosssectional area may be considered to be common.

3.6 Damage stability for ships with additional service feature WS where the additional class notation SDS has been requested

3.6.1 General

Supply vessels with additional service feature WS carrying substances listed in Sec 1, 1.1.3 more than the maximum amounts specified in Sec 1, 1.2.2 are to comply with the requirements of 3.4 considering the damage dimensions as specified in Tab 3.4.

Table 3.4 : Extent of damage

Longitudinal extent	Transverse extent	Vertical extent
3L/100 + 3 for L >43 m (1) L/10 for L □43 m (1)	760 mm (2)	Full depth (3)

(1) Anywhere in the ship's length at any transverse watertight bulkhead

(2) Measured inboard from the side of the vessel perpendicularly to the centreline at the level of the summer load waterline.

(3) From the underside of the cargo deck, or the continuation thereof.

4 Structure design principles

4.1 General

4.1.1 For ships greater than 24 m in length, it is recommended that a double skin is provided to reinforce the protection of the main compartments in the event of contact with pontoons or platform piles.

4.2 Side structure exposed to bumping

4.2.1 Longitudinally framed side

In the whole area where the side of the ship is exposed to bumping, distribution frames are to be provided at midspan, consisting of an intercostal web of the same height as the ordinary stiffeners with a continuous face plate.

Within reinforced areas, scallop welding for all side ordinary stiffeners is forbidden.

4.2.2 Transversely framed side

In the whole area where the side of the ship is exposed to bumping, a distribution stringer is to be fitted at mid-span, consisting of an intercostal web of the same height as the ordinary stiffeners with a continuous face plate.

Side frames are to be fitted with brackets at ends.

Within reinforced areas, scallop welding for all side ordinary stiffeners is forbidden.

4.2.3 Fenders

Efficient fenders, adequately supported by structural members, are to be fitted on the side, including the forecastle, on the full length of the areas exposed to contact.

4.3 Deck structure

4.3.1 Local reinforcements are to be fitted in way of specific areas which are subject to concentrated loads.

4.3.2 Exposed decks carrying heavy cargoes or pipes are to provide protection and means of fastening for the cargo, e.g. inside bulwarks, guide members, lashing points, etc.

4.4 Structure of cement tanks and mud compartments

4.4.1 Cargo tanks and hoppers intended to carry mud or cement are to be supported by structures which distribute the acting forces as evenly as possible on several primary supporting members.

4.5 Acid spill protection for ships with additional service feature LHNS and WS

4.5.1 Floors and decks under acid storage tanks and pumps and piping for acid should have a lining or coating of corrosion resistant material extending up to a minimum height of 500 mm on the bounding bulkheads or coamings. Hatches or other openings in such floors or decks should be raised to a minimum height of 500 mm; where the Society determines that this height is not practicable, a lesser height may be required.

5 Design loads

5.1 Dry uniform cargoes

5.1.1 Still water and inertial pressures

The still water and inertial pressures transmitted to the structure of the upper deck intended to carry loads are to be obtained, in kN/m^2.

6 Hull scantlings

6.1 Plating

6.1.1 Minimum net thicknesses

The net thickness of the side and upper deck plating is to be not less than the values given in Tab 6.1.

Table 6.1 : Minimum net thickness of the side and upper deck plating

Plating	Minimum net thickness, in mm
Side below freeboard deck	The greater of: • $2.1 + 0.031\,L\,k^{0.5} + 4.5\,s$ • $8\,k^{0.5}$
Side between freeboard deck and strength deck	The greater of: • $2.1 + 0.013\,L\,k^{0.5} + 4.5\,s$ • $8\,k^{0.5}$
Upper deck	7.0

6.1.2 Strength deck plating

Within the cargo area, the net thickness of strength deck plating is to be increased by 1.5 mm with respect to that determined according to Pt III, Ch 2.

6.2 Ordinary stiffeners

6.2.1 Longitudinally framed side exposed to bumping

In the whole area where the side of the ship is exposed to bumping, the net section modulus of ordinary stiffeners is to be increased by 15% with respect to that determined according to Pt III, Ch 2.

6.2.2 Transversely framed side exposed to bumping

In the whole area where the side of the ship is exposed to bumping, the net section modulus of ordinary stiffeners, i.e. side, 'tweendeck and superstructure frames, is to be increased by 25% with respect to that determined according to Pt III, Ch2.

6.3 Primary supporting members

6.3.1 Distribution stringers

The net section modulus of the distribution stringer required in 4.2.2 is to be at least twice that calculated in 6.2.2 for ordinary stiffeners.

6.3.2 Cement tanks and mud compartments

The net scantlings of the primary supporting members of cement tanks and mud compartments are to be calculated taking into account high stresses resulting from vertical and horizontal accelerations due to rolling and pitching.

Secondary moments due to the tendency of materials to tip over are to be considered by the Society on a case-by-case basis.

7 Other structure

7.1 Aft part

7.1.1 Rollers

At the transom, local reinforcements are to be fitted in way of rollers and other special equipment intended for cargo handling.

7.1.2 Structures in way of rollers

The structures in way of the stern rollers and those of the adjacent deck are considered by the Society on a case-by case basis, taking into account the relevant loads which are to be specified by the Designer.

7.1.3 Propeller protection

It is recommended that devices should be fitted to protect the propellers from submerged cables.

7.2 Superstructures and deckhouses

7.2.1 Forecastle

The forecastle length may not exceed 0.3 to 0.4 times the length L.

7.2.2 Deckhouses

Due to their location at the forward end of the ship, deckhouses are to be reduced to essentials and special care is to be taken so that their scantlings and connections are sufficient to support wave loads.

7.2.3 Minimum net thicknesses

The net thickness of forecastle aft end plating and of plating of deckhouses located on the forecastle deck is to be not less than the values given, in mm, in Tab 7.1.

Table 7 : Minimum net thickness of forecastle aft end plating and plating of deckhouses located on the forecastle deck

Plating	Minimum net thickness, in mm
Forecastle aft end	1.04 (5 + 0.01 L)
Front of deckhouses located on the forecastle deck	1.44 (4 + 0.01 L)
Sides of deckhouses located on the forecastle deck	1.31 (4 + 0.01 L)
Aft end of deckhouses located on the forecastle deck	1.22 (4 + 0.01 L)

7.2.4 Ordinary stiffeners

The net section modulus of ordinary stiffeners of the forecastle aft end and of deckhouses located on the forecastle deck is to be not less than the value obtained from Tab 7.2.

Ordinary stiffeners of the front of deckhouses located on the forecastle deck are to be fitted with brackets at their ends.

Those of side and aft end bulkheads of deckhouses located on the forecastle deck are to be welded to decks at their ends.

Table 7.2 : Ordinary stiffeners of the forecastle aft end and of deckhouses located on the forecastle deck

Ordinary stiffeners	Net section modulus, in cm^3
Forecastle aft end and front of deckhouses located on the forecastle deck	3 times the value calculated according to Pt III, Ch 2
Sides and aft end of deckhouses located on the forecastle deck	0.75 times that of the forecastle 'tweendeck frames

7.3 Arrangement for hull and superstructure openings

7.3.1 Sidescuttles and windows

Sidescuttles and windows of opening type are, in general, accepted only in unexposed areas of the deckhouses located immediately above the superstructure and the areas above.

7.3.2 Sidescuttles of gas-safe spaces facing gasdangerous spaces

Sidescuttles of gas-safe spaces facing gas-dangerous spaces, excluding those of non-opening type, are to be capable of ensuring an efficient gas-tight closure.

Warning plates are to be fitted on access doors to accommodation and service spaces facing the cargo area indicating that the doors and sidescuttles mentioned above are to be kept closed during cargo handling operations.

7.3.3 Freeing ports

The area of freeing ports is to be increased by 50% with respect to that determined according to Pt III, Ch 2.

Shutters may not be fitted.

7.3.4 Freeing ports through box-bulwarks

Where box-bulwarks the upper level of which extends to the forecastle deck are fitted in way of the loading area, the freeing ports are to pass through these box-bulwarks, and their area is to be increased to take account of the height of the bulwarks.

7.3.5 Miscellaneous

Air pipes, ventilators, small hatchways, fans and control valves are to be located outside the loading area and protected from possible shifting of the deck cargo.

8 Hull outfitting

8.1 Rudders

8.1.1 Rudder stock scantlings

The rudder stock diameter is to be increased by 5% with respect to that determined according to Pt III, Ch 2, Sec 14.

8.2 Bulwarks

8.2.1 Plating

In the case of a high bulwark, fitted with a face plate of large cross-sectional area, which contributes to the longitudinal strength, the net thickness of the plating contributing to the longitudinal strength is to be not less than the value obtained according to Pt III, Ch 2.

8.2.2 Stays

The bulwark stays are to be strongly built with an attachment to the deck reinforced to take account of accidental shifting of deck cargo (e.g. pipes).

8.3 Equipment

8.3.1 Mooring lines

The mooring lines are given as a guidance, but are not required as a condition of classification.

The length of mooring lines may be calculated according to Pt III, Ch 5.

However, in the case of ships provided with devices enabling ample manoeuvring characteristics (e.g. ships provided with two or more propellers, athwartship thrust propellers, etc.), the length of mooring lines, in m, may be reduced to (L+20).

8.3.2 Chain locker

Chain lockers are to be arranged as gas-safe spaces. Hull penetrations for chain cables and mooring lines are to be arranged outside the gas-dangerous spaces specified in 1.2.3.

Section 3 Machinery and Cargo Systems

1 General

1.1 Application

1.1.1 This Section provides, for ships having the service notation supply vessel, requirements for:

- machinery systems
- cargo tanks and piping systems, in particular where the additional service features oil product, LHNS or WS are assigned.

1.2 Documents to be submitted

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

1.3 Definitions

1.3.1 Non-Toxic cargo

A non-toxic cargo is a substance included in the list of IBC Code, Chapter 17 or IGC Code, Chapter 19, with an entry different than "T" or "F-T" in "vapour detection" column.

2 Machinery systems

2.1 Bilge system

2.1.1 General

In supply vessels having the additional service feature oil product, LHNS or WS, cargo pump rooms, duct keels below cargo tanks, hold spaces in which independent cargo tanks are installed and all gas-dangerous spaces, dry cofferdams are to be served by an independent bilge pumping system entirely situated within the cargo area and fitted with pumps or ejectors. No connection is permitted with the bilge system serving gas-safe spaces of the ship.

Atenuations may be considered for ships carrying non-toxic cargoes having a flashpoint above 60°C.

2.1.2 Specific requirement for acids

Spaces for acid storage tanks and acid pumping and piping are to be provided with drainage arrangements of corrosion resistant materials.

2.2 Other piping systems not intended for cargo

2.2.1 Piping systems serving ballast tanks of ships carrying any type of cargo

Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks are to be independent of similar equipment serving cargo tanks.

2.2.2 Piping systems serving spaces adjacent to cargo tanks

Where intended for ballast water (only if cargoes have a flashpoint above 60°C), fuel oil, foam-forming liquids or dispersants, spaces adjacent to cargo tanks may be drained by pumps located in the machinery space, provided that the piping is directly connected to the associated pump and does not run through cargo tanks or cargo storage vessels.

Table 2.1 : Documents to be submitted

Item No	Description of the document (1)	Status of the review
1	Plan of cargo handling systems intended for: - powdery products such as cement, baryte, bentonite, etc. - liquid muds (3) - oil products (2) - chemical products (3)	A
2	Plan of gas vents in cargo tanks and cargo storage vessels (2) (3)	A
3	Plan of level gauging systems in cargo tanks and cargo storage vessels (2) (3)	A
4	Plan of the draining systems serving bilges in the cargo pump room and other gas-dangerous spaces (2) (3)	A
5	Plan of the pumping systems serving non-dry spaces adjacent to cargo tanks and cargo storage vessels (2) (3)	A
6	Constructional plan of the automatic shut-off devices fitted to cargo hose couplings (2)	A
7	Plan of the cargo heating system	A

(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

(2) for ships having the service feature oil product.

(3) for ships having the service feature LHNS and WS.

2.2.3 Air pipes and sounding pipes of gasdangerous cofferdams

Gas-dangerous cofferdams are to be provided with air pipes led to the open and, where not accessible, also with sounding pipes.

2.3 Cargo heating systems

2.3.1 General

Heating media for cargo heating are to be compatible with the cargo itself. Depending on the class temperature of the cargoes beeing carried, the maximum surface temperature of the heating system within enclosed spaces inside the cargo area is not to exceed the values Required in Ch 5, Sec 7.

2.3.2 Use of steam

Where steam is used as a heating medium, the condensate from the cargo heating system is to be led to an observation tank located in an accessible, well-ventilated and well-lit position, well clear of boilers and other heat sources. For ships carrying products listed in Sec 1, Tab 1.1, the observation tank must be located outside the machinery space.

2.3.3 Use of cooling water

Cooling water from machinery in the engine room is not to be used for cargo heating. When it is intended to use the heat from such water, a secondary system outside the engine room is to be provided.

2.4 Exhaust pipes

2.4.1 In supply vessels having the additional service feature oil product, LHNS or WS, the exhaust outlets from engines are to be fitted as high as practicable above the upper deck and are to be provided with spark arresters.

3 Cargo systems for supply vessels with additional service features oil product, LHNS and WS

3.1 Cargo segregation

3.1.1 For cargo handling, a pumping and piping system entirely separate from other pumping and piping systems on board is to be provided. Such systems are not to pass through any accommodation, service or machinery space other than cargo pump rooms.

3.2 Materials

3.2.1 Materials for construction of tanks, piping, fittings and pumps are to be in accordance with Ch 4, Sec 4, 3.3.2, Chapter 6 of the IBC Code, or Chapter 6 of the IGC Code, as applicable.

3.3 Installation of independent portable tanks

3.3.1 Independent portable tanks, to be fitted on the weather deck, may be used as cargo storage vessels subject to the following conditions:

- the portable tanks are to be securely fastened to the hull structure
- in the zone on the weather deck where the portable tanks are arranged, a suitable possibly removable containment coaming is to be fitted such as to prevent any spillage and/or leakages from flowing to gas-safe areas
- a space is to be left between tanks and ship sides sufficient to allow easy passage of ship personnel and transfer of fire-fighting arrangements
- the cargo handling system serving portable tanks is to be such that liquid heads higher than those allowable for cargo tanks, if any, served by the same system cannot occur.

Provisions are to be made such that any portable tank is easily identifiable by means of markings or suitable plates.

4 Cargo systems of ships having the additional service feature oil product

4.1 Cargo pumping system, piping system and pump rooms

4.1.1 General

a) Where cargo handling pumps are installed in a space set aside for that purpose, such space is to comply with the applicable requirements for oil tankers. Refer to Ch 4, Sec 4.

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

4.1.2 Piping system

a) The cargo piping system is to be installed, except as stipulated in 4.1.3, within the cargo tank and cargo storage vessel area and is not to run through tanks, fuel oil tanks and other compartments not belonging to the cargo system.

b) Where necessary, cargo piping is to be provided with joints or expansion bends.

c) Pipe lengths serving tanks are to be provided with shutoff valves operable from the weather deck.

d) In order to prevent any generation of static electricity, the outlets of filling lines are to be led as low as possiblein the tanks.

4.1.3 Loading and unloading connections

a) Pipe ends, valves and other fittings to which hoses for cargo loading and unloading are connected are to be of steel or other ductile material and are to be of solid construction and effectively secured.

b) Connecting couplings for cargo hoses are to be fitted with devices which automatically shut off the cargo piping when the hose is disconnected and with means for quick-release of the hose, to be provided by the installation either of a coupling hydraulically controlled from outside the cargo area or of a weak link assembly which will break when subjected to a pre-determined pull.

c) Where a pipe end to which hoses for cargo loading and unloading are connected is arranged outside the cargo tank area, the connection piping to such end is to be provided, in way of its connection to the manifold in the cargo tank area, with a blank spectacle flange or a spool piece, irrespective of the number and type of valves fitted in way of such connection. The space within a range of 3 metres from the above pipe end is to be considered gas-dangerous as far as electrical installations or other sources of ignition are concerned.

4.2 Cargo tanks and cargo storage vessels

4.2.1 Design and construction of portable tanks

a) The cargo handling system serving portable tanks is to be such that liquid heads higher than those allowable for cargo tanks, if any, served by the same system cannot occur.

b) Scantling of portable tanks is to be in compliance with the provisions of requirements, except that the minimum thickness is not to be less than 5 mm.

c) Provisions are to be made such that any portable tank is easily identifiable by means of markings or suitable plates.

d) Portable tanks are to be provided with appropriate access hatches allowing the use of portable gas-freeing equipment.

4.2.2 Level gauging systems

a) Each cargo tank or cargo storage vessel is to be fitted with at least one level gauging device of the closed type. Refer to Ch 4, Sec 4, 4.4.2.

b) Sounding pipes may be accepted provided that they are so constructed and installed as to minimise the quantity of gas released during sounding operations. Such sounding pipes are not to be arranged within enclosed spaces.

4.2.3 Venting systems

Cargo tanks and cargo storage vessels are to be provided with gas venting systems entirely separate from any vent pipes serving other compartments. Such systems are to comply with the requirements for gas venting systems of cargo tanks of oil tankers. Refer to Ch 4, Sec 4, 4.2.

4.3 Prevention of pollution

4.3.1 Residues of cargo oil, tank washing, other mixtures or ballast water containing cargo oil may be discharged into the sea provided that the discharge is in accordance with the relevant conditions as required under MARPOL 73/78, Annex I. Refer to Ch 4, Sec 4, 5.

5 Cargo systems of ships having the service feature LHNS or WS

5.1 General

5.1.1 Unless otherwise stated, the special requirements for the cargo as referred to in Chapter 17 of the IBC Code or Chapter 19 of the IGC Code are applicable.

5.2 Cargo pumping and piping systems

5.2.1 Segregation

Cargoes which react in a hazardous manner with other cargoes or fuel oils are to have separate pumping and piping systems not passing through other cargo tanks containing such cargoes, unless encased in a tunnel.

5.2.2 Cargo transfer system

a) The cargo transfer system is to comply with the requirements of Chapter 5 of the IBC Code or Chapter 5 of the IGC Code, when applicable.

b) The remote shutdown devices for all cargo pumps and similar equipment, required by 5.6.1.3 of the IBC Code, are to be capable of being activated from a dedicated cargo control location which is manned at the time of cargo transfer and from at least one other location outside the cargo area and at a safe distance from it.

c) In the case of transfer operations involving pressure in excess of 50 bar gauge, arrangements for emergency depressurising and disconnection of the transfer hose are to be provided. The controls for activating emergency depressurisation and disconnection of the transfer hose are to meet the provisions of b) above.

5.2.3 Special requirements for acids

Piping systems intended for acids are to comply with the following provisions:

a) Flanges and other detachable connections are to be covered by spray shields.

b) Portable shield covers protecting the connecting flanges of the loading manifold are to be provided. Drip trays of corrosion-resistant material are to be provided under loading manifolds for acids.

5.3 Cargo tanks

5.3.1 General

a) Cargo tanks are to be of the type required by the IBC Code or IGC Code, as applicable.

b) Portable tanks meeting the requirements of the International Maritime Dangerous Goods Code for the cargo concerned or other portable tanks specifically approved by the Society may be used for cargoes indicated in Sec 1, 1.1.3, provided that they are properly located and secured to the vessel.

5.3.2 Design, construction and testing of the tanks

a) The design of the tanks is to comply with standards acceptable to the Society taking into account the carriage temperature and relative density of cargo. Due consideration is also to be given to dynamic forces and any vacuum pressure to which the tanks may be subjected.

b) Integral and independent gravity tanks are to be constructed and tested according to recognised standards taking into account the carriage temperature and relative density of cargo.

c) The greatest of the following design pressures (gauge) is to be used for determining scantlings of independent pressure tanks:

- 0.7 bar,
- the vapour pressure of the cargo at 45°C,
- the vapour pressure of the cargo at 15°C above the temperature at which it is normally carried, or
- the pressure which occurs in the tank during the loading or unloading.

d) Except for the tank connections to cargo pump rooms, all tank openings and connections to the tank are to terminate above the weather deck and are to be located in the tops of the tanks. Where cofferdams are provided over integral tanks, small trunks may be used to penetrate the cofferdam.

Note 1: This clause need not be applied for pollution hazard only substances having a flashpoint exceeding 60°C.

5.3.3 Level gauging systems and level alarms

a) Each cargo tank is to have a level gauging system and, where required by Chapter 17 of the IBC Code, a level alarm. Such devices are to comply with the relevant requirements of the IBC Code.

Note 1: Requirement 15.19.6 of the IBC Code for a visual and audible high-level alarm may be waived by the Society taking into account the cargo carriage arrangements and cargo loading procedures.

b) Level gauging systems for process tanks on board of ships having the additional service feature WS are to be to the satisfaction of the Society.

5.3.4 Venting systems

a) Venting systems are to comply with the requirements stipulated in 4.2.3.

b) Independent pressure tanks are to be fitted with pressure relief devices which are so designed as to direct the discharge away from personnel and have a set pressure and capacity which is in accordance with standards acceptable to the Society taking into account the design pressure referred to in 5.3.2.

c) Cargo tank vent systems of integral or independent gravity tanks are to meet the requirements of the IBC Code, except that the height specified in IBC 8.3.4 may be reduced to 2 m.

d) The location of cargo tank vent outlets for independent pressure tanks and for cargo tanks used to carry pollution hazard only substances with a flashpoint exceeding 60°C (closed cup test) is to be to the satisfaction of the Society.

e) Cargo tank vent systems of portable tanks allowed under 5.3.1 are to be to the satisfaction of the Society, taking into account the provisions of 5.3.4.

Section 4 Electrical Installations

1 General

1.1 Application

1.1.1 This Section applies to ships having the service notation:

- supply vessel
- supply vessel oil product
- supply vessel LHNS
- supply vessel WS

1.2 Supply vessels

1.2.1 Ships covered by the SOLAS Convention and having the service notation supply vessel are to comply with the requirements of Part IV, Chapter 2.

1.2.2 Ships not covered by the SOLAS Convention and having the service notation supply vessel are to comply with the requirements of Pt IV, Ch 2, as applicable.

1.3 Supply vessels with additional service feature oil product

1.3.1 Supply vessels having the additional service feature oil product are to comply with the requirements of 1.2, and with the requirements of Ch 4, Sec 5.

1.4 Supply vessels with additional service feature LHNS or WS

1.4.1 Supply vessels having the additional service feature LHNS or WS are to comply with the requirements of 1.2, and with the requirements of Ch 5, Sec 10.

Section 5 Fire Prevention, Protection and Extinction

1 General

1.1 Application

1.1.1

a) This Section applies, irrespective of their tonnage, to supply vessels having the additional service feature:

- oil product
- LHNS, when flammable products are carried
- WS, when flammable products are carried.

b) For vessels which carry only liquids identified as nonflammable in Sec 1, Tab 1.1, the fire-fighting requirements are to be to the satisfaction of the Society.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1.1 are to be submitted for approval.

2 Fire prevention and protection

2.1 General

2.1.1 External boundaries of superstructures and deckhouses

External boundaries of superstructures and deckhouses enclosing accommodation and including any overhanging decks which support such accommodation are:

- either to be insulated to A-60 standard for the whole of the portions which face the cargo area and on the outward sides for a distance of 3 m from the end boundary facing the cargo area. In the case of the sides of such superstructures and deckhouses, the insulation is to be carried as high as deemed necessary by the Society
- or to be spaced at least 7 m away from the cargo area.

The insulation of such boundaries is, however, to be to the satisfaction of the Society.

2.1.2 Structure, bulkheads within accommodation and service spaces and details of construction

a) The method of protection adopted in accommodation and service spaces is to be method IC (see Pt IV, Ch 4, Sec 5, 1.4.1). The Society may permit use of another method where considered appropriate.

b) Skylights to cargo pump rooms are to be of steel, are not to contain any glass and are to be capable of being closed from outside the pump room.

2.1.3 Fire integrity of bulkheads and decks

Fire integrity of bulkheads and decks is to comply with the requirements of Pt IV, Ch 4, Sec 5, 1.5.2 or, where considered appropriate by the Society, with the requirements of Pt IV, Ch 4, Sec 5, 1.4.3.

2.2 Additional requirements for ships having the additional service feature oil product

2.2.1 Ventilation

Ventilation systems are to comply with the provisions of Ch 4, App 2, 2.3.

2.2.2 Cargo tank gas-freeing

Fixed or portable equipment for gas-freeing of cargo tanks, cargo storage vessels and adjacent spaces is not required to be installed or stored on board.

2.2.3 Vapour detection

Every supply vessel having the additional service feature oil product is to be provided with at least two portable gas detectors capable of measuring flammable vapour concentrations in air and at least two portable O2 analysers. For ships fitted with inert gas system, at least two portable gas detectors are to be capable of measuring concentrations of flammable vapours in inerted atmosphere.

Table 1 : Documents to be submitted

Item No	Description of the document (1)	Status of the review
1	Plan of the ventilation system serving gas-dangerous spaces	A
2	Plan of fixed systems and mobile arrangements for fire-fighting purposes	A
3	Specification of flammable gas detectors	A

(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

2.3 Additional requirements for ships having the additional service feature LHNS or WS

2.3.1 Ventilation

Ventilation systems are to comply with the provisions of Chapter 12 of the IBC Code. The Society may, however, grant relaxation concerning the distances required in 12.1.5 of the Code.

2.3.2 Cargo tank purging and/or gas-freeing

Where considered appropriate by the Society, the provisions of Chapter 8 of the IBC Code related to cargo tank purging and/or gas-freeing are to be applied.

2.3.3 Vapour detection

a) Vapour detection for the cargoes carried is to be provided in accordance with the requirements contained in the IBC Code.

b) Enclosed and semi-enclosed spaces containing installations for acid are to be fitted with fixed vapour detection and alarm systems which provide visual and audible indication. The vapour detection systems are to be capable of detecting hydrogen except that, in the case where only hydrochloric acid is carried, a hydrogen chloride vapour detection system is to be provided.

c) At least two portable instruments for detecting flammable vapour concentrations are to be provided when cargoes subject to this Chapter with a flashpoint not exceeding 60°C (closed cup test) are carried.

d) At least two portable instruments suitable for measuring the concentration of oxygen in atmospheric air are to be provided.

3 Fire fighting

3.1 General

3.1.1 Fire pumps, fire mains, hydrants and hoses

The following requirements related to fire pumps, fire mains, hydrants and hoses:

- Pt IV, Ch 4, Sec 6, 1
- Pt IV, Ch 4, Sec 6, 3.4,

apply as they would apply to cargo ships of 2000 tons gross tonnage and over.

3.1.2 Fire-extinguishing arrangements in machinery spaces

The following requirements related to fire-extinguishing arrangements in machinery spaces:

- Pt IV, Ch 4, Sec 6, 4.2 to 4.5,

apply as they would apply to cargo ships of 2000 tons gross tonnage and over.

3.2 Additional requirements for ships having the additional service feature oil product

3.2.1 Protection of the deck area above the cargo tanks

a) A foam system capable of covering the entire deck area above the cargo tanks with a foam blanket is to be provided.

b) Foam is to be provided by at least two portable foam applicators units, each fitted with a nozzle for air-foam mixture connected to the main water fire-fighting system of the ship by means of a fire hose, and by portable tanks containing foam-forming liquid.

c) The nozzles are to be of a type recognised as suitable by the Society and capable of supplying the greater of the following amounts of foam:

- 2 m^3/min, or
- the amount required to produce within 5 minutes a blanket of foam at least 150 mm thick covering the entire deck area above the cargo tanks.

d) The foam-forming liquid is to be of a type approved by the Society. The amount available on board is to be the greater of those required:

- to cover with a blanket of foam at least 150 mm thick the entire deck area above the cargo tanks, or
- to cover with the above blanket of foam a surface area 4 times that of the cargo tank having the largesthorizontal sectional area.

e) Hydrants for connection of fire hoses are to be located in positions such that they cannot be rendered inoperable by a fire arising in any part of the cargo area. The length of fire hoses is to be established in relation to the position of hydrants and the throw of foam applicators but in no case is to exceed 20 metres.

3.2.2 Protection of the deck areas where cargo storage vessels are installed

a) In the case of cargo storage vessels installed on the weather deck, in addition to the deck foam system referred to in 3.2.1, a portable foam fire-extinguishing unit is to be provided fitted with a portable tank of foam-forming liquid and a spare tank both having a capacity of 100 litres.

b) The above unit is to be recognised by the Society as suitable to discharge the foam onto the top of the above cargo storage vessels.

c) The above unit may be replaced by the portable foam applicators units required in 3.2.1 for protection of the deck area above the cargo tanks, provided that the required amount of foam-forming liquid is increased by 200 litres and that such applicator units are capable of discharging the foam onto the top of the vessels fitted on the weather deck.

3.2.3 Fire fighting in cargo pump rooms

Each cargo pump room is to be provided with two portable foam fire extinguishers, or equivalent.

3.3 Additional requirements for ships having the additional service feature LHNS

or WS

3.3.1 Fire main and fire hoses

a) During cargo transfer, water pressure is to be maintained on the fire main system.

b) Fire hoses, fitted with approved dual-purpose nozzles (i.e. spray/jet type with a shut-off), are to be attached to each fire hydrant in the vicinity of the flammable liquid to be carried.

3.3.2 Protection of the deck area

a) Either a fixed deck foam system or a fixed fire-extinguishing system of the dry chemical type complying with the following is to be provided:

1) The system is to be located to protect the deck within the cargo area.

2) The system is to be capable of covering the deck within the cargo area without being moved.

3) When a fixed deck foam system is provided, it is to comply with the requirements of 11.3.3 to 11.3.12 of the IBC Code. Only foam suitable for the products carried is to be used.

4) The Society may approve a fixed fire-extinguishing system provided that:

- on a deck area of 45 m2 or less, there are two or more dry chemical extinguishers whose total capacity is not less than 135 kg

- on a deck area of more than 45 m2, there are three or more dry chemical extinguishers whose total capacity of extinguishing agent is not less than:

C = 3.A kg

where A is the deck area, in m^2

- the minimum rate of supply of the extinguishing agent is not less than 3 kg/min per m^2.

b) An alternative to the systems required in item a) may be allowed, provided the Society is satisfied that such system is not less effective.

3.3.3 Fire extinguishing in cargo pump rooms

The cargo pump room where flammable liquids are handled is to be provided with a fixed fire-extinguishing system in accordance with 11.2 of the IBC Code.

Chapter 12 Fire Fighting Ships

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Fire-fighting ship, as defined in Pt I, Ch 1.

1.1.2 Ships dealt with in this Chapter and which are covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I, II, III and IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to fire-fighting ships.

1.1.3 Ships dealt with in this Chapter and which are not covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I and IV, as applicable, and with the requirements of this Chapter, which are specific to fire-fighting ships.

Section 2 Hull and Stability

1 Stability

1.1 Intact stability

1.1.1 General

The stability of the ship for the loading conditions defined in Pt III, Ch 4, App 2, 1.2.11 is to be in compliance with the requirements in Pt III, Ch 4, Sec 2.

1.1.2 Additional criteria

The loading conditions reported in the trim and stability booklet, with the exception of lightship, are also to be checked in order to investigate the ship's capability to support the effect of the reaction force of the water jet in the beam direction due to the monitors fitted on board.

A fire-fighting ship may be considered as having sufficient stability, according to the effect of the reaction force of the water jet in the beam direction due to the monitors fitted on board, if the heeling angle of static equilibrium θ_0, corresponding to the first intersection between heeling and righting arms (see Fig 1.1), is less than 5°.

The heeling arm may be calculated as follows:

$$b_h = \frac{\sum R_i h_i + S(T/2 - e)}{9.81\Delta} \cos\theta$$

where:

b_h : Heeling arm, in m, relevant to the reaction force of the water jet of the monitors fitted on board, and to the effect of transversal manoeuvring thrusters. The monitors are assumed to be oriented in beam direction parallel to the sea surface, so as to consider the most severe situation

R_i : Reaction force, in kN, of the water jet of each monitor fitted on board (see Fig 1.2)

h_i : Vertical distance, in m, between the location of each monitor and half draught (see Fig 1.2)

S : Thrust, in kN, relevant to manoeuvring thruster(s), if applicable (see Fig 1.2)

e : Vertical distance, in m, between the manoeuvring thruster axis and keel (see Fig 1.2)

Δ: Displacement, in t, relevant to the loading condition under consideration

T : Draught, in m, corresponding to Δ(see Fig 1.2).

Figure 1.1 : Heeling and righting arm curves

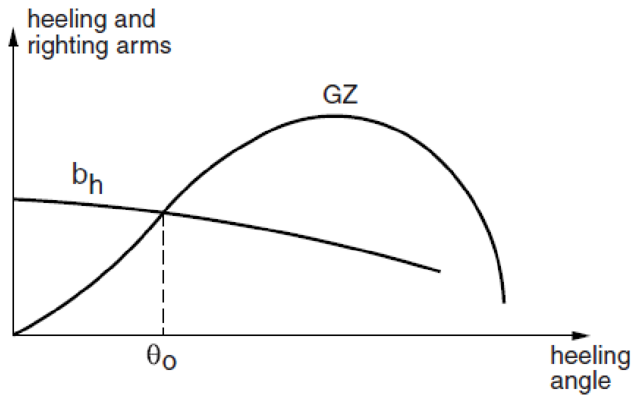
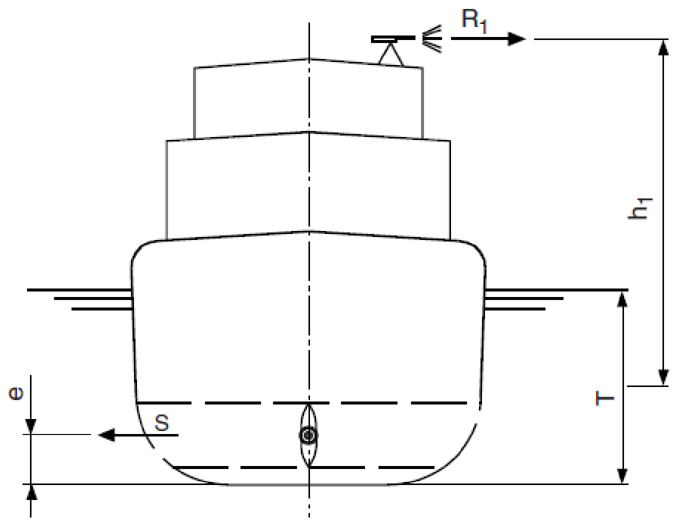


Figure 1.2 : Reaction force of water jet in the beam direction due to monitors



2 Structure design principles

2.1 Hull structure

2.1.1 The strengthening of the structure of the ships, where necessary to withstand the forces imposed by the fire-extinguishing systems when operating at their maximum capacity in all possible directions of use, are to be considered by the Society on a case-by-case basis.

2.2 Water and foam monitors

2.2.1 The seatings of the monitors are to be of adequate strength for all modes of operation.

3 Other structures

3.1 Arrangement for hull and superstructure openings

3.1.1 On ships which are not fitted with a water-spraying system complying with Sec 4, 3, all windows and port lights are to be fitted with efficient deadlights or external steel shutters, except for the wheelhouse.

Section 3 Machinery and Systems

1 General

1.1 Application

1.1.1

a) This Section provides, for ships having the service notations fire-fighting ship E, fire-fighting ship 1, fire-fighting ship 2, and fire-fighting ship 3, specific requirements for:

- machinery systems
- fire-fighting systems installed on board the ship and intended for fighting of external fires.

b) The requirements related to the self-protection waterspraying systems fitted to fire-fighting ships having the additional service feature water spray are given in Sec 4.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1.1 are to be submitted for approval.

2 Design of machinery systems

2.1 Manoeuvrability

2.1.1 General

a) The ratios between the main ship dimensions and the power of propulsion engines and of engines driving side thrusters are to be adequate and such as to ensure an effective manoeuvrability during fire-fighting operations.

b) The side thrusters and the main propulsion system are to be capable of maintaining the ship in position in still water and of withstanding the reaction forces of the water monitors even in the most unfavourable combination of operating conditions of such monitors, without requiring more than 80% of the above propulsive power, to prevent engine overload.

2.1.2 Power control system

An operating control system of the power supplied by the engines is to be provided, including:

- an alarm device operating at 80% of the maximum propulsive power available in free navigation, and
- an automatic reduction of power on reaching 100% of the above propulsive power,

to prevent engine overload.

Note 1: Such operating control system may not be required, at the discretion of the Society, in cases where the installed power is redundant.

Table 1.1 : Documents to be submitted

Item No	Description of the document (1)	Status of the review
1	General arrangement showing the disposition of all fire-fighting equipment	I
2	Details of all fire-fighting equipment such as pumps and monitors, including their capacity, range and trajectory of delivery	A
3	Schematic diagram of the water fire-fighting system	A
4	Plan of the water monitor seating arrangements	A
5	Diagram of local control and remote control system for water monitors	A
6	Schematic diagram of the fixed foam fire-extinguishing system	A
7	Plan of the foam monitor seating arrangements (2)	A
8	Diagram of local control and remote control system for foam monitors (2)	A
9	Specification and plan showing the location of firemen's outfits	A
10	Particulars of the means of keeping the ship in position during fire-fighting operations	A
11	Calculation of the required fuel oil capacity according to [2.2.1] (3)	I
12	Operating manual	I

(1) Diagrams are also to include, where applicable:

- the (local and remote) control and monitoring systems and automation systems
- the instructions for the operation and maintenance of the piping system concerned (for information).

(2) for ships having the service notation fire-fighting ship 3.

(3) for ships having one of the following service notations: fire-fighting ship 1, fire-fighting ship 2, fire-fighting ship 3.

2.2 Fuel oil capacity

2.2.1 All ships are to have fuel oil tanks whose capacity is to be sufficient for continuous fighting of fires whilst all the water monitors are operating for a period of time not less than:

- 24 hours in the case of ships having the service notation fire-fighting ship 1
- 96 hours in the case of ships having the service notation fire-fighting ship 2 or fire-fighting ship 3.

This capacity is to be additional to that provided for the normal operation of the ship (propulsion, etc.).

Note 1: The determination of such required capacity is the responsibility of the Designer.

2.3 Scuppers

2.3.1 When the ship is protected by a water-spraying system, suitable scuppers or freeing ports are to be provided to ensure efficient drainage of water accumulating on deck surfaces when such system is in operation.

3 General requirements for firefighting systems

3.1 General

3.1.1 This Article applies to both water fire-extinguishing systems and fixed foam fire-extinguishing systems.

3.2 Independence of pumping and piping systems

3.2.1 The piping system serving the water and foam monitors are not to be used for other services except for the water-spraying system referred to in Section 7.

3.2.2 Where the water monitor pumps are also used for the water-spraying system referred to in Section 7, it is to be possible to segregate the two systems by means of a valve.

3.2.3 The piping system from the pumps to the water monitors is to be separate from the piping system to the hose connections required for the portable fire-fighting equipment referred to in 6.2.

3.3 Design and construction of piping systems

3.3.1 General

a) Fire-fighting piping systems are to comply with the provisions of Pt iv, Ch 1, Sec 11.

b) The maximum design water velocity is not normally to exceed 2 m/s in the suction line.

3.3.2 Sea suctions

a) Sea suctions for fire-fighting pumps are not to be used for other purposes.

b) Sea suctions and associated sea chests are to be so arranged as to ensure a continuous and sufficient water supply to the fire-fighting pumps, not adversely affected by the ship motion or by water flow to or from bow thrusters, side thrusters, azimuth thrusters or main propellers.

c) Sea suctions are to be located as low as practicable to avoid:

- clogging due to debris or ice
- oil intake from the surface of the sea.

d) Sea water inlets are to be fitted with strainers having a free passage area of at least twice that of the sea suction valve. Efficient means are to be provided for clearing the strainers.

3.3.3 Pumps

a) Means are to be provided to avoid overheating of the fire-fighting pumps when they operate at low delivery rates.

b) The starting of fire-fighting pumps when sea water inlet valves are closed is either to be prevented by an interlock system or to trigger an audible and visual alarm.

3.3.4 Valves

a) A sea water suction valve and water delivery valve with a nominal diameter exceeding 450 mm are to be provided with a power actuation system as well as a manual operation device.

b) The sea water suction valve and water delivery valve and pump prime movers are to be operable from the same position.

3.3.5 Protection against corrosion

Means are to be provided to ensure adequate protection against:

- internal corrosion, for all piping from sea water inlets to water monitors
- external corrosion, for the lengths of piping exposed to the weather.

3.3.6 Piping arrangement

Suction lines are to be as short and straight as practicable.

3.4 Monitors

3.4.1 Design of monitors

a) Monitors are to be of an approved type.

b) Monitors are to be of robust construction and capable of withstanding the reaction forces of the water jet.

3.5 Monitor control

3.5.1 General

Water monitors and foam monitors are to be operated and controlled with a remote control system located in a common control station having adequate overall visibility.

Table 3.1 : Number of pumps and monitors and their characteristics

Required characteristics	Service notations			
	fire-fighting ship 1	fire-fighting ship 2		fire-fighting ship 3
minimum number of water monitors	2	3	4	4
minimum discharge rate per monitor (m^3/h)	1200	2400	1800	2400
minimum number of fire-fighting pumps	1	2		2
minimum total pump capacity (m3/h) (1)	2400	7200		9600
length of throw of each monitor (m) (2) (4)	120	150		150
height of throw of each monitor (m) (3) (4)	45	70		70

(1) Where the water monitor pumps are also used for the self-protection water-spraying system, their capacity is to be sufficient to ensure the simultaneous operation of both systems at the required performances.

(2) Measured horizontally from the monitor outlet to the mean impact area.

(3) Measured vertically from the sea level, the mean impact area being at a distance of at least 70 m from the nearest part of the ship.

(4) The length and height of throw are to be capable of being achieved with the required number of monitors operating simultaneously in the same direction.

3.5.2 Manual control

In addition to the remote control system, a local manual control is to be arranged for each monitor. It is to be possible to:

- disconnect the local manual control from the control station
- disconnect the remote control system, from a position close to each monitor, to allow the operation with the local manual control.

3.5.3 Valve control

The valve control is to be designed so as to prevent pressure hammering.

3.5.4 Control system

a) The control system is to comply with the relevant provisions of Pt IV, Ch 3.

b) The control system is to be designed with a redundancy level such that lost function can be restored within 10 minutes.

c) In the case of a hydraulic or pneumatic control system, the control power units are to be duplicated.

3.5.5 Marking

All control and shut-off devices are to be clearly marked, both locally and in the control station.

4 Water fire-fighting system

4.1 Characteristics

4.1.1

a) For ships having the service notation fire-fighting ship 1, fire-fighting ship 2 or fire-fighting ship 3, the number of pumps and monitors and their characteristics are to be

in accordance with the requirements given in Tab 3.1.

b) For ships having the service notation fire-fighting ship E, the characteristics of the water fire-fighting system will be given special consideration by the Society.

4.2 Monitors

4.2.1 Monitors are to be so arranged as to allow an easy horizontal movement of at least 90° equally divided about the centreline of the ship. The allowed vertical angular movement is to be such that the height of throw required in Tab 3.1 can be achieved.

4.2.2 The monitors are to be located such that the water jet is free from obstacles, including ship's structure and equipment.

4.2.3 The monitors are to be capable of throwing a continuous full water jet without significant pulsations and compacted in such a way as to be concentrated on a limited surface.

4.2.4 At least two monitors are to be equipped with a device to make the dispersion of the water jet (spray jet) possible.

4.3 Piping

4.3.1 The maximum design water velocity is not normally to exceed 4 m/s in the piping between pumps and water monitors.

5 Fixed foam fire-extinguishing system

5.1 General

5.1.1

a) Ships having the service notation fire-fighting ship 3 are to be equipped with a fixed low expansion foam monitor system complying with the provisions of Pt IV, Ch 4, Sec 13, 5 and with those of this Article.

b) For ships having the service notation fire-fighting ship E, some relaxation in the provisions of this Section may be accepted by the Society.

5.2 Characteristics

5.2.1 Foam expansion ratio

The foam expansion ratio is not to exceed 12.

5.2.2 Foam monitors

a) The ship is to be fitted with two foam monitors, each having a foam solution capacity not less than 300 m3/h.

b) The height of throw is to be at least 50 m above the sea level, when both monitors are in operation at the maximum foam production rate.

5.2.3 Foam concentrate capacity

Sufficient foam concentrate is to be available for at least 30 min of simultaneous operation of both monitors at maximum capacity.

Note 1: When determining the necessary quantity of foam concentrate, the concentration rate is assumed to be 5%.

5.3 Arrangement

5.3.1 Foam generating system

The foam generating system is to be of a fixed type with separate foam concentrate tank, foam-mixing units and piping to the monitors.

5.3.2 Pumps

The pumps of the water monitor system may be used for supplying water to the foam monitor system. In such case, it may be necessary to reduce the pump water delivery pressure to ensure correct water pressure for maximum foam generation.

6 Portable fire-fighting equipment

6.1 Portable high expansion foam generator

6.1.1 Ships having the service notation fire-fighting ship 2 or fire-fighting ship 3 are to be equipped with a portable high expansion foam generator having a foam capacity not less than 100 m^3/min for fighting of external fires.

6.1.2 The total capacity of foam concentrate is to be sufficient for 30 min of continuous foam production. The foam concentrate is to be stored in portable tanks of about 20 litres capacity.

6.2 Hydrants and fire hoses

6.2.1 Hydrants

a) Hydrants are to be provided in accordance with Tab 6.1.

b) At least half of the required hydrants are to be arranged on the main weather deck.

c) Where hydrants are fed by the pumps serving the monitor supply lines, provision is to be made to reduce the water pressure at the hydrants to a value permitting safe handling of the hose and the nozzle by one man.

Table 6.1 : Number of hydrants

fire-fighting ship E	fire-fighting ship 1	fire-fighting ship 2	fire-fighting ship 3
4 at each side	4 at each side	8 at each side	8 at each side (1)

(1) May be increased to 10 hydrants at each side, depending on the ship’s length.

6.2.2 Fire hose boxes

a) At least one box containing fire hoses is to be provided for every two hydrants.

b) Each box is to contain two fire hoses complete with dual-purpose (spray/jet) nozzles.

6.2.3 Fire hoses

a) Fire hoses and associated nozzles are to be of a type approved by the Society.

b) Fire hoses are to be of 45 to 70 mm in diameter and generally are to be 20 m in length.

7 Firemen’s outfits

7.1 Number and characteristics

7.1.1 The ship is to be fitted with firemen’s outfits in accordance with Tab 7.1.

Table 7.1 : Number of firemen’s outfits

fire-fighting ship E	fire-fighting ship 1	fire-fighting ship 2	fire-fighting ship 3
4	4	8	8

7.1.2 The air breathing apparatuses, protective clothing and electric safety lamps constituting parts of firemen's outfits are to be of a type approved by the Society.

7.1.3 Breathing apparatuses are to be of the self-contained type. They are to have a capacity of at least 1200 litres of free air.

At least one spare air bottle is to be provided for each apparatus.

7.1.4 The firemen's outfits are to be stored in a safe position readily accessible from the open deck.

7.2 Compressed air system for breathing apparatuses

7.2.1 General

Ships are to be equipped with a high pressure air compressor complete with all fittings necessary for refilling the bottles of air breathing apparatuses. The compressor is to be located in a suitable sheltered location.

7.2.2 Capacity

The capacity of the compressor is to be sufficient to allow the refilling of the bottles of air breathing apparatuses in no more than 30 min. This capacity is not to be less than 75 l/min.

7.2.3 Accessories

a) The compressor is to be fitted on the air suction with a suitable filter.

b) The compressor is to be fitted on the delivery with oil separators and filters capable of preventing passage of oil droplets or vapours to the air bottles.

8 Testing

8.1 General

8.1.1 The provisions of this Article are related to the workshop and on board tests to be carried out for:

- machinery systems
- fire-fighting systems.

They supplement those required in Part IV, Chapter 1 for machinery systems.

8.2 Workshop tests

8.2.1 Tests for material

a) Materials used for the housing of fire-fighting pumps are to be subjected to a tensile test at ambient temperature according to the relevant provisions of Pt II of the rule.

b) Materials used for pipes, valves and other accessories are to be tested in accordance with the provisions of Pt IV, Ch 1, Sec 11, 20.3.

8.2.2 Hydrostatic testing

After completion of manufacture and before installation on board, pipes, valves, accessories and pump housings are to be submitted to a hydrostatic test in accordance with the provisions of Pt IV, Ch 1, Sec 11, 20.4.

8.3 On board tests

8.3.1 Fixed fire-fighting systems

a) After assembly on board, the water fire-fighting system and the fixed foam fire-extinguishing system are to be checked for leakage at normal operating pressure.

b) The water fire-fighting system and fixed foam fire-extinguishing system are to undergo an operational test on board the ship, to check their characteristics and performances.

8.3.2 Propulsion and manoeuvring systems

a) A test is to be performed to check the manoeuvring capability of the ship.

b) The capability of the side thrusters and of the main propulsion system to maintain the ship in position with all water monitors in service without requiring more than 80% of the propulsive power is to be demonstrated.

Section 4 Fire Protection and Extinction

1 General

1.1 Application

1.1.1 This Section provides, for ships having the service notations fire-fighting ship 1, fire-fighting ship 2 and firefighting ship 3, specific requirements for:

- fire protection
- self-protection water-spraying system.

These requirements supplement those given in Part IV, Chapter 4.

1.1.2 For ships having the service notation fire-fighting ship E, fire protection arrangements will be given special consideration by the Society.

1.2 Documents to be submitted

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

2 Fire protection of exposed surfaces

2.1 Structural fire protection

2.1.1

a) On ships having the service notation fire-fighting ship 1, all exterior boundaries above the lightest operating waterline, including superstructures and exposed decks, are to be of steel and are to be internally insulated so as to form A-60 class divisions.

This need not apply to ships granted with the additional service feature water spray.

b) On ships having the service notation fire-fighting ship 2 or fire-fighting ship 3, all exterior boundaries are to be of steel but they need not be insulated.

c) On all ships, other boundaries may be constructed of materials other than steel, subject to special consideration by the Society.

2.2 Deadlights and shutters

2.2.1 On ships for which the additional service feature water spray is not assigned, steel deadlights or external steel shutters are to be provided on all windows, sidescuttles and navigation lights, except for the windows of the navigating bridge.

3 Self-protection water-spraying system

3.1 General

3.1.1 The provisions of this Article apply to the self-protection water-spraying systems fitted to ships having the additional service feature water spray. They supplement those given in Pt IV, Ch 4.

3.2 Capacity

3.2.1 The capacity of the self-protection water-spraying system is to be not less than 10 l/min for each square metre of protected area. In the case of surfaces which are internally insulated, such as to constitute A-60 class divisions, a lower capacity may be accepted, provided it is not less than 5 l/min for each square metre of protected area.

3.3 Arrangement

3.3.1 Areas to be protected

The fixed self-protection water-spraying system is to provide protection for all vertical areas of the hull and superstructures as well as monitor foundations and other fire-fighting arrangements, and is to be fitted in such a way as not to impair the necessary visibility from the wheelhouse and from the station for remote control of water monitors, also during operation of spray nozzles.

3.3.2 Sections

The fixed self-protection water-spraying system may be divided into sections so that it is possible to isolate sections covering surfaces which are not exposed to radiant heat.

Table 3.1 : Documents to be submitted

Item No	Description of the document	Status of the review
1	Plan showing the structural fire division, including doors and other closing devices of openings in A and B class divisions	A
2	Fire test reports for insulating materials	I
3	Schematic diagram of the fixed self-protection water-spraying system	A

3.3.3 Spray nozzles

The number and location of spray nozzles are to be suitable to spread the sprayed water uniformly on areas to be protected.

3.4 Pumps

3.4.1 Use of pumps serving other systems The following pumps may be used for the self-protection water-spraying system:

- fire pumps referred to in Pt IV, Ch 4, Sec 6, 1.3
- water monitor system pumps referred to in Sec 4, 4.

In this case, a shut-off valve is to be provided to segregate the systems concerned.

3.4.2 Capacity of the pumps

a) The pumps of the self-protection water-spraying system are to have a capacity sufficient to spray water at the required pressure from all spray nozzles of the system.

b) Where the pumps serving the self-protection waterspraying systems are also used for another service, their capacity is to be sufficient to ensure the simultaneous operation of both systems at the required performances.

3.5 Piping system and spray nozzles

3.5.1 General

Pipes are to be designed and manufactured according to the requirements of Pt IV, Ch 1, Sec 11.

3.5.2 Protection against corrosion

Steel pipes are to be protected against corrosion, both internally and externally, by means of galvanising or equivalent method.

3.5.3 Drainage cocks

Suitable drainage cocks are to be arranged and precautions are to be taken in order to prevent clogging of spray nozzles by impurities contained in pipes, nozzles, valves and pumps.

Chapter 13 Oil Recovery Ships

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Oil recovery ship, as defined in Pt I.

1.1.2 Ships dealt with in this Chapter and which are covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I, II, III and IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to oil recovery ships.

1.1.3 Ships dealt with in this Chapter and which are not covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I and IV, as applicable, and with the requirements of this Chapter, which are specific to oil recovery ships.

Section 2 Hull and Stability

1 General

1.1 Oil removal

1.1.1 Oil removal is usually performed by conveying with suitable apparatuses the top layers of polluted water collected by the ship moving ahead into separation tanks and/or by skimming mobile belts or rotating disks acting on the oil film and/or by means of floating suction pumps operating on the sea surface.

Alternative methods, equivalent to those mentioned, are to be considered by the Society on a case-by-case basis.

1.2 Definitions

1.2.1 Accumulation tank

An accumulation tank is a tank intended for the retention of oil removed and separated from sea water.

1.2.2 Settling tank

A settling tank is a tank intended for the retention of polluted water and its subsequent separation from oil.

2 General arrangement design

2.1 Segregation of spaces intended for retention of oil

2.1.1 Cofferdam arrangement

Accumulation tanks are to be separated from the engine room, from service spaces and from accommodation spaces by means of a cofferdam or equivalent space. Fuel tanks, settling tanks, tanks for ballast water, tanks for foam-forming liquids used for oil treatment, tanks for anti-pollution liquids, storerooms for oil removal equipment and pump rooms are considered as spaces equivalent to a cofferdam.

2.1.2 Tank arrangement

In the case of tanks for foam-forming liquids used for oil treatment having a bulkhead adjacent to accumulation tanks, fuel oil tanks or dispersing liquid tanks, the scantlings of such bulkhead and associated welds are to be adequately increased.

2.1.3 Openings in accumulation tank ceilings

All openings in accumulation tank ceilings are to lead to the open.

2.1.4 Accumulation tanks

Accumulation tanks are to be located abaft the collision bulkhead.

2.1.5 Movable tanks

In the case of oil collected in movable tanks fitted on the weather deck, the location of such tanks is to be such as to comply with the requirements in Sec 5, 2 relevant to gas vents.

2.2 Dangerous spaces

2.2.1 Dangerous spaces include:

a) accumulation tanks

b) cofferdams and enclosed or partially enclosed spaces adjacent to or immediately above accumulation tanks

c) spaces containing pumps for the handling of oil collected

d) double bottoms or duct keels located under accumulation tanks

e) enclosed or partially enclosed spaces over pump rooms or cofferdams adjacent to accumulation tanks, where not separated from such spaces by means of a gas-tight deck

f) enclosed or partially enclosed spaces containing piping, valves or other equipment for the handling of oil removed

g) zones or partially enclosed spaces on the weather deck , within a range of 3 m from equipment for oil removal, hatches or any other openings in accumulation tanks, and any pump for the handling of oil removed not fitted in a pump room

h) zones of the weather deck over accumulation tanks within a height of 2.4 m above the deck. For ships where length L > 50 m, the above zone is to be extended 3 m beyond the fore and aft end of the tanks

i) storerooms for floating pumps and associated hoses and other equipment which may similarly contain residues of oil removed.

Spaces defined in b), e) and f) above may, however, be considered safe spaces where fitted with forced ventilation capable of giving at least 20 air changes per hour and where having characteristics such as to maintain the effectiveness of such ventilation.

2.3 Access to safe spaces

2.3.1 Safe spaces such as accommodation or service spaces, engine rooms and similar spaces may not have direct communication with dangerous spaces as defined in 2.2.

Such safe spaces may, however, have direct access from dangerous zones defined in 2.2 g) and 2.2 h) provided that the following requirements are complied with:

- safe spaces are to be fitted with forced ventilation in order to maintain an overpressure therein
- access doors, where not fitted with an air-lock, are to be of the self-closing type
- the self-closing device is to be capable of shutting the doors against an inclination of 3.5° opposing closure
- doors may not be fitted with hold-back hooks keeping them in an open position.

3 Stability

3.1 Intact stability

3.1.1 General

The stability of the ship for the loading conditions reported in the trim and stability booklet is to be in compliance with the requirements in Pt III, Ch 4, Sec 2.

4 Design loads

4.1 Oil removal and spraying

4.1.1 The still water and inertial loads transmitted by the operation of apparatuses and/or equipment for oil removal and spraying of any dispersant to the hull structure are to be taken into account.

5 Hull scantlings

5.1 Accumulation tanks

5.1.1 The net scantlings of any accumulation tanks consisting of movable tanks are considered by the Society on a case-by-case basis.

6 Other structures

6.1 Hull and superstructure openings

6.1.1 Windows in safe spaces located in front of dangerous spaces, where not of the fixed type, are to be such as to ensure an efficient gas-tight closure.

7 Construction and testing

7.1 Testing

7.1.1 Oil removal equipment

Tests are to be carried out according to a specification submitted by the interested Party, in order to check the proper operation of the oil recovery equipment These tests may be performed during dock and sea trials.

Section 3 Machinery and Systems

1 General

1.1 Documents to be submitted

1.1.1 The documents listed in Tab 1.1 are to be submitted for approval.

1.2 Definitions

1.2.1 Gas-dangerous areas

Gas-dangerous areas and zones are defined in Sec 2, 2.2.1.

1.2.2 Accumulation and settling tanks

Accumulation and settling tanks are defined in Sec 2, 2.1.2.

2 Machinery installations and piping systems not intended for recovered oil

2.1 Bilge system

2.1.1 Arrangements are to be provided to drain the recovered oil pump room by means of power pumps or a bilge ejector.

Note 1: On oil recovery ships of less than 500 tons gross tonnage, the pump room may be drained by means of hand pumps with a suction diameter of not less than 50 mm.

2.2 Sea water cooling system

2.2.1 One of the suctions serving the sea water cooling system (see Pt IV, Ch 1, Sec 11, 10.7.1) is to be located in the lower part of the hull.

2.3 Water fire-extinguishing system

2.3.1 Sea suctions serving the fire water pumps are to be located as low as possible.

2.4 Exhaust gas systems

2.4.1

a) Exhaust lines from engines, gas turbines, boilers and incinerators are to be led to a gas-safe position as high as practicable above the deck and are to be fitted with a spark arrester.

b) Where the distance between the exhaust lines of engines and the dangerous zones is less than 3 m, the ducts are to be fitted in a position:

- near the waterline if cooled by water injection, or
- below the waterline in other cases.

2.5 Additional requirements for machinery installations in gas-dangerous areas

2.5.1 The risk of ignition in gas-dangerous spaces from sparking due to:

- formation of static electricity, or
- friction between moving parts is to be properly taken into account.

2.5.2 No part having a surface temperature exceeding 220°C is permitted within the gas-dangerous areas.

2.5.3 Where precautions are taken against the risk of ignition, the installation of internal combustion engines may be permitted in zone 2 open gas-dangerous areas, subject to special consideration by the Society.

Table 1.1 : Documents to be submitted

Item No	Description of the document (1)	Status of the review
1	General plan of the system for oil recovery and specification of all relevant apparatuses	I
2	Schematic arrangement of recovered oil piping and pumping systems	A
3	Tank venting arrangement	A
4	Specification of the gas concentration and oil flashpoint measurement equipment	A
5	Specification of the anti-explosion devices (crankcase explosion relief valves, spark arresters) provided for diesel engines	A
6	Location and arrangement of sea chests for engine cooling and fire-fighting purposes	A
7	Procedure and limiting conditions for recovering oil, cargo transfer, tank cleaning, gas freeing and ballasting	I
8	Specification of the oil removal operation test	I

(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

3 Pumping system, piping system and pump rooms intended for recovered oil

3.1 Design of pumping and piping systems

3.1.1 General

a) The relevant provisions of Ch 4, Sec 4, [3] and Pt IV, Ch 1, Sec 11 are to be complied with.

b) Except where otherwise permitted by the Society, pumping and piping systems intended for recovered oil are to be independent from other pumping and piping systems of the ship.

c) Piping is to be permanently installed. However, the use of portable pumps may be permitted, subject to special consideration by the Society.

3.1.2 Systems for oil recovery

Oil recovery is to be performed:

- by conveying with suitable systems the top layers of polluted water collected by the ship moving ahead into separation tanks, and/or
- by skimming mobile belts or rotating disks acting on the oil film, and/or
- by means of floating suction pumps operating on the sea surface.

Alternative methods will be specially considered by the Society.

3.1.3 System for unloading oil residues

Ships fitted with structural accumulation tanks are to be equipped with a system enabling the unloading of oil residues contained in accumulation tanks to shore facilities or to a supply vessel, simultaneously with oil recovery.

3.2 Arrangement of piping systems and pump rooms

3.2.1 Piping systems

a) Piping systems for handling of oil recovered are not to pass through:

- accommodation spaces
- machinery spaces,
- service spaces
- other enclosed gas-safe spaces

However, parts of pipes of entirely welded construction, including the flanges and fittings, may be accepted in an enclosed gas-safe space other than accommodation spaces.

b) Where the transfer of recovered oil into accumulation tanks is carried out by means of flexible hoses or movable piping, only suitable connections are to be used.

Small hatches are not permitted.

3.2.2 Pump rooms

a) Pump rooms containing the pumps for handling the recovered oil are to comply with the provisions given in Chapter 4 for pump rooms of ship having the service notation oil tanker.

b) For draining of pump rooms, see 2.1.1.

c) For ventilation of pump rooms, see Sec 5, 2.

4 Settling and accumulation tanks

4.1 General

4.1.1 The arrangement of settling and accumulation tanks is to comply with the provisions of Sec 2, 2.1.2.

4.2 Vent pipes

4.2.1 Settling tanks

Vent pipes of settling tanks are to be fitted with:

- adequate flameproof wire gauze, and
- closing appliances complying with the provisions of Pt IV, Ch 1, Sec 11, 9.1.

4.2.2 Accumulation tanks

a) Vent pipes of accumulation tanks are to lead to the open at least 2 m above the weather deck and are to be located at least 5 m from ignition sources, openings in accommodation spaces and other safe spaces, and air intakes of ventilation systems for accommodation spaces, engine rooms and other safe spaces in which ignition sources may be present.

b) Openings of vent pipes to the open are to be so arranged as to allow a direct flow upwards and fitted with:

- flameproof wire gauze made of corrosion resistant material easily removable for cleaning, and
- closing appliances complying with the provisions of Pt IV, Ch 1, Sec 11, 9.1.

4.3 Level gauging and overfilling control

4.3.1 Level gauging

a) Accumulation tanks are to be fitted with sounding pipes or other level gauging devices of a type approved by the Society.

b) Sounding pipes in accumulation tanks are to terminate in the open air.

4.3.2 Overfilling control

a) Accumulation tanks are to be fitted with a high level alarm, an overflow control system or equivalent means to prevent the liquid from rising in the vent pipes.

b) The high level alarm is to be of a type approved by the Society and is to give an audible and visual alarm at the control station.

4.4 Heating systems

4.4.1 Heating systems fitted to accumulation tanks are to comply with the provisions of Ch 4, Sec 4, 2.6.

Section 4 Electrical Installations

1 General

1.1 Application

1.1.1 The requirements in this Section apply, in addition to those contained in Part IV, Chapter 2, to oil recovery ships.

1.2 Documentation to be submitted

1.2.1 In addition to the documentation requested in Pt IV, Ch 2, the following is to be submitted for approval:

a) plan of dangerous areas

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

2 Design requirements

2.1 System of supply

2.1.1 The following systems of generation and distribution of electrical energy are acceptable:

a) direct current:

- two-wire insulated

b) alternating current:

- single-phase, two-wire insulated
- three-phase, three-wire insulated.

2.1.2 Earthed systems with hull return are not permitted, with the following exceptions to the satisfaction of the Society:

a) impressed current cathodic protective systems

b) limited and locally earthed systems, such as starting and ignition systems of internal combustion engines, provided that any possible resulting current does not flow directly through any hazardous area

c) insulation level monitoring devices, provided that the circulation current of the device does not exceed 30 mA under the most unfavourable conditions.

2.1.3 Earthed systems without hull return are not permitted, with the following exceptions:

a) earthed intrinsically safe circuits and the following other systems to the satisfaction of the Society;

b) power supplies, control circuits and instrumentation circuits in non-hazardous areas where technical or safety reasons preclude the use of a system with no connection to earth, provided the current in the hull is limited to not more than 5 A in both normal and fault conditions; or

c) earthed systems, provided that any possible resulting hull current does not flow directly through any hazardous area; or

d) isolating transformers or other adequate means, to be provided if the distribution system is extended to areas remote from the machinery space.

2.1.4 In insulated distribution systems, no current carrying part is to be earthed, other than:

a) through an insulation level monitoring device

b) through components used for the suppression of interference in radio circuits.

2.2 Earth detection

2.2.1 The devices intended to continuously monitor the insulation level of all distribution systems are also to monitor all circuits, other than intrinsically safe circuits, connected to apparatus in hazardous areas or passing through such areas. An audible and visual alarm is to be given, at a manned position, in the event of an abnormally low level of insulation.

3 Hazardous locations and types of equipment

3.1 Electrical equipment permitted in hazardous areas

3.1.1 The electrical equipment specified in Tab 3.1 may be installed in the hazardous areas indicated therein.

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

3.1.3 There are normally not to be access doors or other openings between a safe space, such as accommodation or service spaces, engine rooms and similar spaces, and a hazardous area.

Access doors may, however, be accepted between such spaces and hazardous areas, provided that:

a) safe spaces are fitted with forced ventilation in order to maintain an overpressure therein

b) access doors are:

1) of a self-closing type and arranged to swing into the safer space, so that they are kept closed by the overpressure, with the self-closing device capable of shutting the doors against an inclination of 3.5° opposing closure, without hold-back hooks keeping them in an open position, or

2) gas-tight, kept closed during oil recovery operation until gas freeing is carried out, and provided with a warning plate (suitable instructions are given in the oil recovery manual).

Table 3.1 : Electrical equipment permitted in hazardous areas for oil recovery ships

Hazardous area	Spaces		Electrical equipment
	No	Description	
Zone 0	1	Accumulation tanks, settling tanks, pipes and equipment containing the recovered oil.	a) certified intrinsically safe apparatus Ex(ia); b) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, switching devices), included in intrinsically safe circuits of category ۥiaپ not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and acceptable to the appropriate authority; c) equipment specifically designed and certified by the appropriate authority for use in Zone 0.

Zone 1	2	Cofferdams and enclosed or semienclosed spaces adjacent to or immediately above accumulation tanks, unless fitted with forced ventilation capable of giving at least 20 air changes per hour
		and having characteristics such as to maintain the effectiveness of such ventilation.
			a) any type considered for Zone 0;
			b) certified intrinsically safe apparatus Ex(ib);
			c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, switching devices), included in intrinsically safe circuits of category ۥibپ not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and acceptable to the appropriate authority;
			d) certified flameproof Ex(d);
			e) certified pressurised Ex(p);
			f) certified increased safety Ex(e);
			g) certified encapsulated Ex(m);
			h) certified sand filled Ex(q);
			i) certified specially Ex(s);
			j) hull fittings containing the terminals or shell plating penetrations for anodes or electrodes of an impressed current cathodic protection system, or transducers such as those for depth-sounding or log systems, provided that such fittings are of gas-tight construction or housed within a gas-tight enclosure, and are not located adjacent to a cargo tank bulkhead. The design of such fittings or their enclosures and the means by which cables enter, and any testing to establish their gas-tightness, are to be to the satisfaction of the Society;
			k) electrical cables passing through the spaces.

Zone 1	3	Spaces containing pumps for the handling of recovered oil.	As allowed for spaces under item 2.
Zone 1	4	Double bottoms or duct keels located under accumulation tanks.	As allowed for spaces under item 2.

Zone 1	5	Enclosed or semi-enclosed spaces immediately above cargo pump rooms or above vertical cofferdams adjacent to accumulation tanks unless separated by a gas-tight deck and fitted with forced ventilation capable of giving at least 20 air changes per hour having characteristics such as to maintain the effectiveness of such ventilation.	a) any type considered for Zone 0;
			b) certified intrinsically safe apparatus Ex(ib);
			c) simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, switching devices), included in intrinsically safe circuits of category ۥibپ not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules, and acceptable to the appropriate authority;
			d) certified flameproof Ex(d);
			e) certified pressurised Ex(p);
			f) certified increased safety Ex(e);
			g) certified encapsulated Ex(m);
			h) certified sand filled Ex(q);
			i) certified specially Ex(s);
			j) electrical cables passing through the spaces.

Zone 1	6	Enclosed or semi-enclosed spaces containing pipes, valves or other equipment for the handling of recovered oil unless fitted with forced ventilation capable of giving at least 20 air changes per hour and having characteristics such as to maintain the effectiveness of such ventilation.	As allowed for spaces under item 5.

Hazardous area	Spaces		Electrical equipment
	No	Description	
Zone 1	7	Areas on open deck, or semi-enclosed spaces on open deck within 3 m from equipment for oil recovery, hatches or any other openings in accumulation tanks and any pump for the handling of recovered oil not fitted in a pump room.	As allowed for spaces under item 5.
Zone 1	8	Areas on open deck over all accumulation tanks up to a height of 2.4 m above the deck.	As allowed for spaces under item 5.
Zone 1	9	Enclosed or semi-enclosed spaces for floating pumps and associated hoses and other equipment which may similarly contain residues of recovered oil.	As allowed for spaces under item 5.

Section 5 Fire Protection, Detection and Extinction

1 General

1.1 Application

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

- ventilation systems
- gas detection systems
- fire protection and extinguishing systems.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1.1 are to be submitted for approval.

1.3 Definitions

1.3.1

a) Gas-dangerous areas and zones are defined in Sec 2, 2.2.1.

b) Accumulation tanks are defined in Sec 2, 2.1.2.

2 Ventilation systems

2.1 General

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

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

2.1.3 Attention is drawn to the specific ventilation arrangements imposed on certain spaces in order to consider them as safe spaces. Refer to Sec 2, 2.2.1.

2.2 Ventilation of recovered oil pump rooms

2.2.1 Recovered oil pump rooms are to be provided with a mechanical ventilation system of the extraction type capable of giving at least 20 air changes per hour.

Note 1: Where the pump room is not normally entered during oil handling, the mechanical ventilation may be omitted.

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

2.2.3 Ventilation exhaust ducts are to discharge upwards to a gas-safe area on the weather deck in locations at least 3 m from any ventilation intake and opening to gas-safe spaces.

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

2.2.5 Ventilation fans are to be of non-sparking construction as per Ch 4, Sec 1, 1.3.10.

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

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

2.3.1 Enclosed normally entered dangerous spaces are to be provided with a mechanical ventilation system of the extraction type capable of giving at least 8 air changes per hour.

2.3.2 Ventilation intakes are to be located at a distance of not less than 3 m from the ventilation outlets of pump rooms.

Table 1.1 : Documents to be submitted

Item No	Description of the document (1)	Status of the review
1	Diagram of the ventilation systems serving: - dangerous spaces including pump room - machinery spaces - accommodation spaces	A
2	Specification of flammable gas detectors	A
3	Drawing and specification of the fixed and movable fire-fighting systems	A

(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

2.4 Ventilation of enclosed safe spaces adjacent to dangerous areas

2.4.1 Safe spaces adjacent to dangerous areas are to be provided with a mechanical ventilation system capable of maintaining the space with a positive pressure.

2.4.2 Ventilation intakes are to be located in a gas-safe area on the weather deck as far as practicable from the ventilation outlets of gas-dangerous spaces.

3 Fire protection and fighting

3.1 General

3.1.1 Ships having the service notation oil recovery ship are to comply with the provisions for fire protection and fighting stipulated for cargo ships in Part IV, Chapter 4.

3.2 Oil flashpoint and gas measurement systems

3.2.1 General

Where, due to fire or explosion hazards, the ship is required to operate at a safe distance from the source of oil spill, a suitable equipment is to be provided to measure:

- the concentration of flammable gases
- the oil flashpoint.

3.2.2 Gas measurement system

a) A fixed flammable gas detecting system is to be provided in order to check the hydrocarbon gas concentration in the following locations:

- engine room
- open deck (one forward, one astern).

It is to be capable of giving an alarm in the wheelhouse (or other suitable location) and on the open deck when the vapour concentration of hydrocarbons and similar products in the atmosphere exceeds 30% of the lower explosive limit of the mixture of such vapours and air.

b) In addition to the fixed system, at least one portable gas detection instrument is to be provided on board.

3.2.3 Oil flashpoint measurement

The equipment for oil flashpoint measurement may be portable.

3.3 Structural fire protection

3.3.1 Exterior boundaries of superstructures and deckhouses enclosing accommodation and including any overhanging decks which support such accommodation are to be insulated to A-60 standard for the whole of the portions which face the gas-dangerous areas and for a distance of 3 m aft or forward of such areas.

3.3.2 Windows in safe spaces facing gas-dangerous areas, where not of the fixed type, are to be such as to ensure an efficient gas-tight closure.

3.3.3 Windows and sidescuttles in the exterior boundaries specified in 3.3.1 are to be fitted with inside covers of steel or other equivalent material.

3.4 Fire-fighting

3.4.1 For the protection of the deck area in way of accumulation tanks, the following fire-fighting equipment is to be provided:

- two dry powder fire extinguishers, each with a capacity of at least 50 kg
- at least one portable foam extinguishing installation.

3.4.2 The foam installation is to be capable of producing a foam blanket over the accumulation tanks in order to efficiently reduce the emission of flammable gases.

3.4.3 The foam is to be compatible with the powder contained in the fire extinguishers.

Chapter 14 Cable-Laying Ships

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the service notation Cable laying ship, as defined in Pt I.

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts I, II, III, IV of the Rules, as applicable, and with the requirements of this Chapter, which are specific to cable laying ships.

Section 2 Hull and Stability

1 General

1.1 Application

1.1.1 The requirements of this Section apply to ships fitted, in general, with one or more continuous decks, suitable holds for the carriage of cables and superstructures extending for most of the ship's length.

The main characteristics of the ship may vary according to the service primarily performed which may be as follows:

- laying (and possibly burying) submarine cables on the sea bed
- hauling and repairing submarine cables.

2 Stability

2.1 Intact stability

2.1.1 General

The stability, the freeboard and the metacentric radius or roll period are to be such as to ensure:

- satisfactory seakeeping performance in working conditions
- a steady working platform in order to facilitate the performance of cable laying and/or repair operations.

Anti-roll tanks or bilge keels of adequate size may be fitted to meet the above requirements.

2.1.2 Tanks intended for liquid consumable

Special attention is to be paid to the arrangement of tanks intended to contain liquid consumables in order to prevent weight variations during service resulting in excessive changes in the ship's trim.

2.1.3 Intact stability criteria

The stability of the ship for the loading conditions in Pt III, Ch 4, App 2, 1.2.1 and for the (departure and arrival) loading conditions corresponding to the maximum draught is to be in compliance with the requirements in Pt III, Ch 4, Sec 2.

2.2 Damage stability for ships where the notation SDS has been required

2.2.1 Application

The requirements of this item apply to cable laying ships carrying less than 240 persons.

Damage stability criteria for cable laying ships carrying 240 persons and more are to be considered by the Society on a case-by-case basis.

2.2.2 General

Cable laying ships are to comply with the survival requirements specified in Pt III, Ch 4, App 3, where the required index R is to be considered as follows inTab 1 and calculated according to 2.2.3.

Table 1 : Index R

Number of persons: Nb	Index R
Nb □60	0.8 R
60 < Nb < 240	Linear interpolation between 0.,8 R and R (1)

(1) The required index is equal to R for Nb = 240

2.2.3 Calculation of the required index

$R = 1 - 5000/(L_S + 2.5N + 15225)$

where:

$N = N_1 + 2N_2$

N_1 : Number of persons for whom lifeboats are provided

N_2 : Number of persons the ship is permittted to carry in excess of N_1.

Where the conditions of service are such that compliance with R on the basis of $N = N_1 + 2\ N_2$ is inpracticable and where the society considers that a suitable reduced degree of hazard exists, a lesser value of N may be taken, but in no case less than $N = N_1 + N_2$. The reduced value of N is also to be subject to the agreement of the flag administration.

3 Hull scantlings

3.1 Cable tanks

3.1.1 The net scantlings of cable tanks are to be obtained through direct calculations to be carried out according to Pt III, Ch 2, where the still water and wave loads are to be calculated for the most severe condition of use.

3.2 Connection of the machinery and equipment with the hull structure

3.2.1 The net scantlings of the structures in way of the connection between the hull structure and the machinery and equipment, constituting the laying or hauling line for submarine cables, are to be obtained through direct calculation to be carried out according to Pt III, Ch 2, based on the service loads of such machinery and equipment, as specified by the Designer.

In calculating these above service loads, the Designer is to take into account the inertial loads induced by ship motions in the most severe condition of use.

4 Other structures

4.1 Fore part

4.1.1 In general, a high freeboard is needed in the forward area, where most repair work is carried out, in order to provide adequate safety and protection against sea waves.

5 Hull outfitting

5.1 Equipment

5.1.1 Hawse pipes

Hawse pipes are to be integrated into the hull structure in such a way that anchors do not interfere with the cable laying.

5.1.2 Sheaves

Where there is a risk that, in rough sea conditions, sheaves are subjected to wave impact loads, special solutions such as the provision of retractable type sheaves may be adopted.

Section 3 Machinery and Systems

1 General

1.1 Propulsion and manoeuvrability

1.1.1 The main propulsion systems of cable laying and/or repair ships are to be capable of:

a) maintaining an adequate speed during the transit condition

b) ensuring a satisfactory manoeuvrability at the speed assumed by the Designer for the performance of cable laying and/or repair operations.

1.2 Documents to be submitted

1.2.1 Table 1.1 lists the documents which are to be submitted for information in duplicate.

Table 1.1 : Documents to be submitted

No	Document
1	General arrangement of the cable laying equipment
2	Design loads on all components of the cable laying equipment transferred to the ship structure
3	Structural plans of seating components of the cable laying equipment, including gears, pressure vessels, hydraulic systems, etc., as applicable, including details of the deck connection
4	Specification of the cable-laying equipment operation test

2 Arrangements for cable laying, hauling and repair

2.1 Typical machinery and equipment of cable laying ships

2.1.1 Cable laying ships, in relation to the special service to be performed, are generally to be provided with the following machinery and equipment:

a) a main windlass for cable hauling or laying, which generally consists of a drum with a horizontal axis (the surface of which is formed by a series of timed conveyors which fleet the cable axially across the face of the drum) housing the repeaters fitted throughout the cable length without damaging them (see Fig 2.1 (a))

b) a linear tensioner working in conjunction with the main windlass and fitted between it and the cable tank, which maintains the due tension of the cable in relation to the cable type so as to allow effective cable hauling or laying.

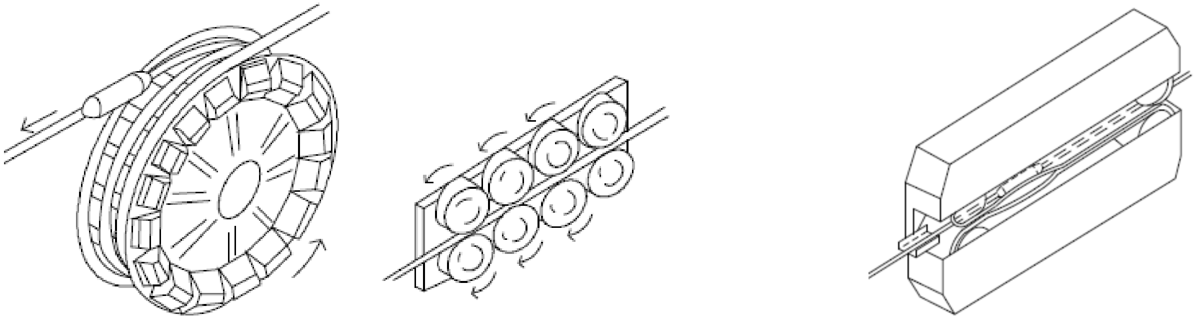
In order to permit the passage of repeaters, the tensioner may be of the type having either a series of double opposed rubber tyres (see Fig 2.1 (b)) or pressurecompensated opposed tracks (see Fig 2.1 (c)).

c) a dynamometer, normally fitted between the main windlass and the bow and stern sheaves, which continuously measures the force required to displace the cable under tension

d) one or more cable transporters, used to move the cable from the tank(s) and the tensioner.

All the above machinery and equipment form the "cable laying or hauling line". More than one line may be fitted on board in the case of special service requirements.

Figure 2.1 : Cable handling machinery



(a) Fleeting cable drum (b) Rubber tyre tensioner (c) Track linear tensioner

2.2 Design of cable handling machinery and equipment

2.2.1 The scantlings of components of machinery and equipment listed in 2.1 and, more generally, of any other machinery and/or equipment to be used for the laying, hauling or repair of submarine cables are outside the scope of classification.

2.3 Safety

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

2.4 Testing of cable handling machinery and equipment

2.4.1 General

Machinery covered by 2.1 is to be tested in compliance with the following requirements, with the exception of prime movers and "hydraulic accumulator" type pressure vessels, which are to be tested in compliance with the applicable requirements of the various Sections of the Rules.

2.4.2 Testing of materials and components of the machinery

a) In general, testing is required for materials intended for shafts, gearing, pressure parts of pumps and hydraulic motors, and plates of foundations of welded construction.

b) As far as mechanical tests of materials are concerned, internal shop testing certificates submitted by the Manufacturer may be accepted by the Society at its discretion; in such cases, testing operations witnessed by the Surveyor may be limited to visual external inspection associated, where necessary, with non-destructive examinations and hardness tests.

2.4.3 Hydrostatic tests

Pressure parts are to be subjected to hydrostatic tests in accordance with the applicable requirements.

2.4.4 Tests on electrical components

The tests required in Part IV, Chapter 2 of the Rules are to be carried out as applicable.

2.4.5 Running tests

a) Running tests of each individual piece of equipment are to be carried out whenever possible at the Manufacturer's works; as an alternative, the above tests may be performed on board during the trials required after installation of machinery.

b) On completion and subject to the result of the above tests, the inspection of components may be required, with dismantling where deemed necessary by the Surveyor in charge of the testing.

3 On board trials

3.1 Ship trials

3.1.1

a) Upon completion of construction, in addition to conventional sea trials, specific tests may be required at the Society's discretion in relation to the particular service for which the ship is intended or the particular characteristics of machinery and equipment fitted on board and according to a test specification submitted by the interested party.

b) In particular, as far as propulsion and steering systems are concerned, tests may be required to check the manoeuvring capability and the speed of the ship whilst operating with only directional propellers or active rudders or a combination thereof.

c) In the case of ships mainly intended for repair of submarine cables, a check of manoeuvring capability whilst running astern or a complete overturning trial may be required to be carried out using the rudder, active rudders or side thrusters only.

d) In the case of ships provided with a dynamic positioning system, tests to check the capability of holding the desired position or heading are requested.

3.2 Equipment trials

3.2.1

a) As far as arrangements for the cable laying, hauling and/or repair lines are concerned, tests are to be carried out to verify the proper operation of all relevant machinery and equipment, by means of the actual hauling and laying of submarine cables, plain or with repeaters, at different ship speeds and, if necessary, in different sea and weather conditions.

b) Special attention is to be paid during such tests so as to prevent cables being forced to reach their minimum allowed bending radius, both inside and outside the ship.

Section 4 Fire Protection

1 Cable tanks

1.1 Means for fire fighting

1.1.1 Depending on any special requirements of the Manufacturers of cables, cable tanks may also be required to be protected by a fixed pressure water-spraying or automatic sprinkler fire-extinguishing system.

Chapter 15 Non-Propelled Units

Section 1 General

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are elligible for the assignment of one of the following notations applicable to non propelled units, as defined in Pt I, Ch 1,Sec 3:

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

1.1.2 Ships dealt with in this Chapter and which are covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I, II, III and IV, as applicable and with the requirements of this Chapter, which are specific to non-propelled units.

1.1.3 Ships dealt with in this Chapter and which are not covered by the SOLAS Convention are to comply with the requirements stipulated in Parts I and IV, as applicable, and with the requirements of this Chapter, which are specific to non-propelled units.

Section 2 Hull and Stability

Symbols

s : Spacing, in m, of ordinary stiffeners.

1 General

1.1 Application

1.1.1 General

Unless otherwise specified, the requirements of this Section apply to ships with one of the service notations barge, pontoon and pontoon - crane.

Specific requirements which apply only to ships with the service notation barge or ships with the service notation pontoon or pontoon- crane are indicated.

Barges with the additional service feature tug combined are also to comply with the applicable additional requirements in Ch 10, Sec 3.

1.1.2 Main characteristics of non-propelled units

The requirements of this Section are based on the following assumptions, relevant to the main characteristics of nonpropelled units:

- the structural configuration and proportions of non-propelled units are similar to those of propelled ships
- the cargo is homogeneously distributed.

The scantlings of non-propelled units with unusual shapes and proportions or carrying cargoes which are not homogeneously distributed, such as containers or heavy loads concentrated in limited areas, are to be considered by the Society on a case-by-case basis, taking into account the results of direct calculations, to be carried out according to Pt III, Ch 2.

1.2 Additional class notations for lifting appliances of ships with service notation pontoon - crane

1.2.1 For ships with service notation pontoon - crane, one of the following additional class notations, defined in Pt I, Ch 1, Sec 3, is generally to be granted:

- ALP or (ALP) for lifting appliances intended to be used in harbours or similary sheltered areas
- ALM or (ALM) for lifting appliances intended to be used in offshore conditions.

Note 1: when the lifting appliance is provided to be used essentially in harbour conditions or similarly sheltered areas and exceptionally in offshore conditions, the additional class notation ALP or (ALP) is generally assigned. For the exceptional using in offshore conditions, the lifting capacity is reduced to a value in accordance with the considered sea conditions.

2 Stability

2.1 Intact stability for ships with service notation pontoon or pontoon - crane

2.1.1 Application

The requirements of this item apply to seagoing ships with one of the service notations pontoon and pontoon –crane with the following characteristics:

- unmanned
- having a block coefficient not less than 0.9
- having a breadth/depth ratio greater than 3.0
- having no hatchways in the deck except small manholes closed with gasketed covers.

2.1.2 Trim and stability booklet

In addition to the information to be included in the trim and stability booklet specified in Pt III, Ch 4, App 2, 1.1, simplified stability guidance, such as a loading diagram, is to be submitted to the Society for approval, so that pontoons may be loaded in compliance with the stability criteria.

2.1.3 Stability calculations

Stability calculations may be carried out according to the following criteria:

- no account is to be taken of the buoyancy of deck cargo (except buoyancy credit for adequately secured timber)
- consideration is to be given to such factors as water absorption (e.g. timber), trapped water in cargo (e.g. pipes) and ice accretion
- in carrying out wind heel calculations:
  - the wind pressure is to be constant and for general operations considered to act on a solid mass extending over the length of the cargo deck and to an assumed height above the deck
  - the centre of gravity of the cargo is to be assumed at a point mid-height of the cargo
  - the wind lever arm is to be taken from the centre of the deck cargo to a point at one half the draught
- calculations are to be carried out covering the full range of operating draughts
- the downflooding angle is to be taken as the angle at which an opening through which progressive flooding may take place is immersed. This would not be an opening closed by a watertight manhole cover or a vent fitted with an automatic closure.

2.1.4 Intact stability criteria

The following intact stability criteria are to be complied with, for the loading conditions specified in Pt III, Ch 4, App 2, 1.2.1 and 1.2.2:

- the area under the righting lever curve up to the angle of maximum righting lever is to be not less than 0.08 m.rad
- the static angle of heel due to a uniformly distributed wind load of 0.54 kPa (wind speed 30 m/s) may not exceed a heeling angle corresponding to half the freeboard for the relevant loading condition, where the lever of wind heeling moment is measured from the centroid of the windage area to half the draught
- The minimum range of stability is to be:

- 20°	for L < 100 m
- 20° □0.1خ(L -100)	for 100 □L □150 m
- 15°	for L > 150 m.

2.2 Additional intact stability criteria for ships with service notation pontoon-crane

2.2.1 Application

The requirements of this sub-article apply to ships with the service notation pontoon-crane and specify the criteria these ships are to satisfy during cargo lifting in addition to those in 2.1.

2.2.2 Intact stability criteria during cargo lifting

The following intact stability criteria are to be complied with:

- $\square_C$ □15خ
- GZ_C □0.6 GZ_{MAX}
- A_1 □0.4 A_{tot}

where:

$\square_C$: Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms (see Fig 2.1)

GZ_C, GZ_{MAX}: Defined in Fig 2.1

A_1 : Area, in m.rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle $\square_C$ to the heeling angle equal to the lesser of:

- heeling angle $\square_R$ of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 2.1)
- heeling angle $\square_F$, corresponding to flooding of unprotected openings as defined in Pt III, Ch 4, Sec 3, 3.3.2 (see Fig 2.1)

A_{TOT} : Total area, in m.rad, below the righting lever curve.

In the above formula, the heeling arm, corresponding to the cargo lifting, is to be obtained, in m, from the following formula:

b= (p d-Z z)/ □

where:

P : Cargo lifting weight, in t

d : Transversal distance, in m, of lifting cargo to the longitudinal plane (see Fig 2.1)

Z : Weight, in t, of ballast used for righting the pontoon, if applicable (see Fig 2.1)

z : Transversal distance, in m, of the centre of gravity of Z to the longitudinal plane (see Fig 2.1)

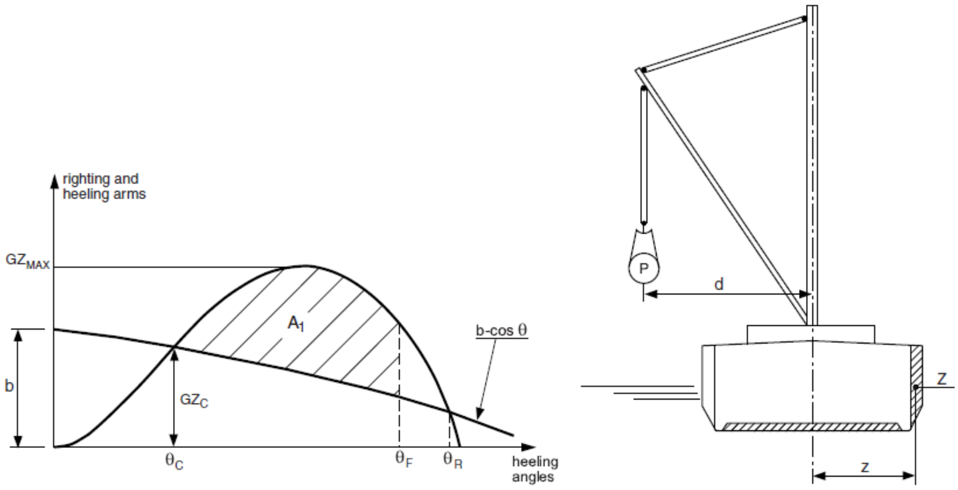
□ Displacement, in t, at the loading condition considered.

The above check is to be carried out considering the most unfavourable situations of cargo lifting combined with the lesser initial metacentric height GM, corrected according to the requirements in Pt III, Ch 4, Sec 2, 4.

The residual freeboard of the unit during lifting operations in the most unfavourable stability condition is to be not less than 0.30 m. However, the heeling of the unit is not to produce in the lifting devices higher loads than those envisaged by the Manufacturer, generally expected to be 5° in the boom plane and 2° transversally in the case of a crane.

The vertical position of the centre of gravity of cargo lifting is to be assumed in correspondence of the suspension point.

Figure 2.1 : Cargo lifting



2.2.3 Intact stability criteria in the event of sudden loss of cargo during lifting

This additional requirement is compulsory when counterweights or ballasting of the ship are necessary or when deemed necessary by the Society taking into account the ship dimensions and the weights lifted.

The case of a hypothetical loss of cargo during lifting due to a break of the lifting cable is to be considered.

In this case, the following intact stability criteria are to be complied with:

ﭘ A_2 / A_1 □1

ﭘ□2 - □3 □20ﺥ

where:

A_1 : Area, in m.rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle □1 to the heeling angle □C (see Fig 2.2)

A_2 : Area, in m.rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_c to the heeling angle θ_2 (see Fig 2.2)

A_3 : Area, in m.rad, contained between the righting lever and the heeling arm curves, measured from the heeling angle θ_c to the heeling angle θ_3 (see Fig 2.2)

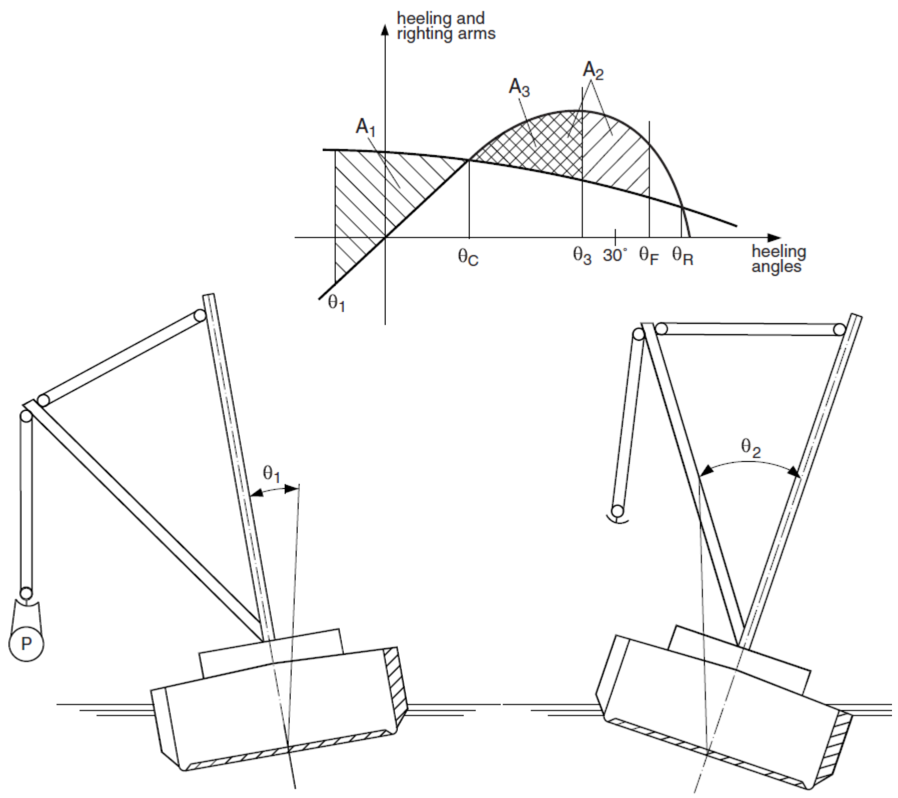
θ_1 : Heeling angle of equilibrium during lifting (see Fig 2.2)

θ_c : Heeling angle of equilibrium, corresponding to the first intersection between heeling and righting arms (see Fig 2.2)

θ_2 : Heeling angle corresponding to the lesser of θ_R and θ_F

θ_3 : Maximum heeling angle due to roll, at which $A_3 = A_1$, to be taken not greater than 30° (angle in correspondence of which the loaded cargo on deck is assumed to shift (see Fig 2.2)

Figure 2.2 : Cargo loss



A_1 : Area between θ_1 and θ_c

A_2 : Area between θ_c and θ_2 (in the Figure, $\theta_2 = \theta_F$)

A_3 : Area between θ_c and θ_3

$A_3 = A_1$

θ_R : Heeling angle of loss of stability, corresponding to the second intersection between heeling and righting arms (see Fig 2.2)

θ_F : Heeling angle at which progressive flooding may occur (see Fig 2.2).

In the above formulae, the heeling arm, induced on the ship by the cargo loss, is to be obtained, in m, from the following formula:

b=Zz cos□/□

where Z, z and □are defined in 2.2.2.

3 Structure design principles

3.1 Hull structure

3.1.1 Framing of ships with one of the service notations pontoon and pontoon - crane

In general, ships with one of the service notations pontoon and pontoon - crane are to be longitudinally framed.

3.1.2 Supports for docked non-propelled units

Adequate supports are to be fitted on the longitudinal centerline in order to carry loads acting on the structure when the non-propelled units are in dry dock.

3.1.3 Truss arrangement supporting deck loads

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

3.2 Lifting appliances

3.2.1 Crane or derrick position during navigation

For ships with the service notation pontoon - crane, it is to be possible to lower the crane boom or the derrick structure and to secure them to the pontoon during the voyage.

4 Hull girder strength

4.1 Yielding check

4.1.1 Small non-propelled units lifted by crane

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

In general, the normal stress □and the shear stress τ induced in the hull girder when lifted by crane are to comply with the following formulae:

□□150/k N/mm^2

□□100/k N/mm^2.

4.1.2 Ships with service notation pontoon carrying special cargoes

For ships with the service notation pontoon intended for the carriage of special cargoes, such as parts of offshore units, the hull girder strength is to be checked through criteria to be agreed with the Society on a case-by-case basis.

Moreover, where these ships are fitted with arrangements for launching the above structures, additional calculations are to be carried out in order to evaluate the stresses during the various stages of launching. The Society may accept stresses higher than those in 4.1.1, to be considered on a case-by-case basis, taking into account favourable sea and weather conditions during launching.

4.1.3 Ships with service notation pontoon - crane

For ships with the service notation pontoon - crane having length greater than 65 m, the hull girder strength is to be checked when the lifting appliance, such as a crane or derrick, is operated, taking into account the various loading conditions considered, through criteria to be agreed with the Society.

5 Hull scantlings

5.1 General

5.1.1 Minimum net thicknesses of ships with service notation barge carrying liquids

For ships with the service notation barge carrying liquid cargo inside tanks, the net thicknesses of cargo tank platings are to be not less than the values given in Tab 5.1.

For other structures or transverse bulkheads not forming boundaries of cargo tanks, the above minimum thicknesses may be reduced by 1 mm.

In pump rooms, the net thicknesses of plating of exposed decks, longitudinal bulkheads and associated ordinary stiffeners and primary supporting members are to be not less than the values given in Tab 5.1.

5.1.2 Minimum net thicknesses of decks forming tank top

Where the decks of non-propelled units form a tank top, the minimum net thicknesses of plating are to be not less than those obtained from Tab 5.1.

5.1.3 Net thickness of strength deck plating

Within the cargo area, the net thickness of strength deck plating is to be increased by 1.5 mm with respect to that calculated according to Pt III, Ch 2, as applicable.

Table 5.1 : Minimum net thickness of plating

Plating	Minimum net thickness, in mm
Decks, sides, bottom, inner bottom, bulkheads, primary supporting members in the cargo area	For L □45 m, the greater of: ﭼ (4.1 + 0.060 L) $k^{0.5}$ ﭼ 2.8 + 0.060 L For 45 m < L □200 m, the greater of: ﭼ (5.9 + 0.023 L) $k^{0.5}$ ﭼ 4.5 + 0.023 L For L > 200 m, the greater of: ﭼ (8.6 + 0.009 L) $k^{0.5}$ ﭼ 7.2 + 0.009 L
Weather deck, within cargo area outside 0.4 L amidships	For L □200 m, the greater of: ﭼ 11.3 s $k^{0.5}$ ﭼ 11.3 s ت1.4 For 200 m < L < 250 m, the greater of: ﭼ (11.3 s + 0.026 (L □200)) $k^{0.5}$ ﭼ 11.3 s + 0.026 s (L □200) ت1.4 For L □250 m, the greater of: ﭼ 12.6 s $k^{0.5}$ ﭼ 12.6 s ت1.4
Web of ordinary stiffeners and other structures of cargo tanks	For L □45 m, the greater of: ﭼ (4.1 + 0.060 L) $k^{0.5}$ ﭼ 2.8 + 0.060 L For 45 m < L □200 m, the greater of: ﭼ (5.9 + 0.023 L) $k^{0.5}$ ﭼ 4.5 + 0.023 L For L > 200 m, the greater of: ﭼ 10.0 $k^{0.5}$ ﭼ 8.6

Note 1:

k : Material factor for steel, defined in Pt III, Ch 2.

5.2 Hull scantlings of non-propelled units with the service notation pontoon fitted with arrangements and systems for launching operations

5.2.1 Additional information

In addition to the documentation specified in Pt III, the following information is to be submitted to the Society:

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

5.2.2 Scantlings of plating, ordinary stiffeners and primary supporting members

In applying the formulae in Part III, Chapter 2, as applicable, T is to be taken equal to the maximum draught during the different stages of launching and taking into account, where appropriate, the differential static pressure.

5.2.3 Deck scantlings

The net scantlings of decks are to be in accordance with Part III, Chapter 2, considering the maximum loads acting on the launching cradle.

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

The scantlings of decks in way of pivoting and end areas of the cradle are to be obtained through direct calculations, to be carried out according to the criteria in Pt III, Ch 2.

5.2.4 Launching cradles

The launching cradles are to be adequately connected to deck structures and arranged, as far as possible, in way of longitudinal bulkheads or at least of girders.

5.3 Hull scantlings of non-propelled units with service notation pontoon - crane

5.3.1 Loads transmitted by the lifting appliances

The forces and moments transmitted by the lifting appliances to the ship's structures, during both lifting service and navigation, are to be submitted to the Society in the initial stage of the design.

5.3.2 Ship's structures

The ship's structures, subjected to the forces transmitted by the lifting appliances, are to be reinforced to the Society's satisfaction.

5.3.3 Lifting appliances

The check of the behaviour of the lifting appliances at sea is outside the scope of the classification and is under the responsibility of the Designer. However, where the requirements in 3.2.1 may not be complied with (i.e. sailing with boom or derrick up) or where, exceptionally, trips with suspended load are envisaged, the Designer is to submit the check of the lifting appliances during navigation to the Society for information.

6 Other structures

6.1 Reinforcement of the flat bottom forward area of ships with one of the service notations pontoon and pontoon - crane

6.1.1 Area to be reinforced

The structures of the flat bottom forward area are to be able to sustain the dynamic pressure due to the bottom impact.

The flat bottom forward area is:

- longitudinally, over the bottom located from the fore end to 0.15 L aft of the fore end
- transversely, over the whole flat bottom, and the adjacent zones up to a height, from the base line, not less than 2L, in mm. In any case, this height need not be greater than 300 mm.

Note 1: The requirements of this sub article 6.1 are not applicable to non-propelled units having the navigation notation sheltered area.

6.1.2 Bottom impact

The bottom dynamic impact pressure is to be considered if:

$T_F < 0.04$ L,

where T_F is the minimum forward draught, in m, among those foreseen in operation in ballast conditions or conditions of partial loading.

If T_F is less than 0.025 L, strengthening of the flat bottom forward is to be considered by the Society on a case-bycase basis.

6.1.3 Partial safety factors

The partial safety factors to be considered for checking the reinforcements of the flat bottom forward area are specified in Tab 6.1.

Table 6.1 : Reinforcements of the flat bottom forward area - Partial safety factors

Partial safety factors covering uncertainties regarding:	Partial safety factors		
	Symbol	Plating	Ordinary stiffeners
Still water pressure	γ_{S2}	1.00	1.00
Wave pressure	γ_{W2}	1.10	1.10
Material	γ_m	1.02	1.02
Resistance	γ_R	1.30	1.15

6.1.4 Scantlings of plating and ordinary stiffeners

Where T_F is less than 0.03 L, the net scantlings of plating and ordinary stiffeners of the flat bottom forward area, as defined in 6.1.1, are to be not less than those obtained according to Pt III, Ch 2 and those obtained from Tab 6.2.

Where T_F is between 0.03 L and 0.04 L, the net scantlings of plating and ordinary stiffeners are to be obtained by linear interpolation between those obtained according to Pt III, Ch 2 and those obtained from Tab 6.2.

6.1.5 Tapering

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

6.1.6 Floor spacing

In the area to be reinforced, defined in 6.1.1, the floor spacing is to be not greater than $0.68L^{1/4}$.

Table 6.2 : Reinforcements of plating and ordinary stiffeners of the flat bottom forward area

Element	Formula	Minimum value
Plating	Net thickness, in mm: $t = 14.9 C_a C_r S \sqrt{\gamma_R \gamma_m \gamma_{W2} P_{BI} / R_y}$	Net minimum thickness, to be taken, in mm, not less than: t = 0.03 L + 5.5 □C_E nor than the lesser of: - t = 16 - t = 6.3 (s □0.228 $L^{1/4}$) + 0.063 L + 3.5 where s is to be taken not less than $0.182L^{1/4}$ Ordinary stiffeners
	Net section modulus, in cm^3: $W = \gamma_R \gamma_m \beta_b \dfrac{\gamma_{S2} T}{6 R_y} S l^2 10^4$ Net shear sectional area, in cm2: $A_{sh} = 10 \gamma_R \gamma_m \beta_s \dfrac{\gamma_{W2} P_{BI}}{R_y} \left(1 - \dfrac{S}{2l}\right) S l$	Web net minimum thickness, in mm, to be not less than the lesser of: - $t = 1.5\,(L_2)^{1/3}$ - the thickness of the attached plating.

Note 1:

C_E : Coefficient, to be taken equal to:

C_E = 1 for L □65 m

C_E = 3 - L / 32.5 for 65 m < L < 90 m

C_E = 0 for L □90 m

C_P : Ratio of the plastic section modulus to the elastic section modulus of the ordinary stiffeners with an attached shell plating, to be taken equal to 1.16 in the absence of more precise evaluation

γ_R, γ_m, γ_{S2}, γ_{W2}: Partial safety factors defined in Tab 6.1

$\square_b$, $\square_s$: Coefficients defined in Ch 6, Sec 4

p_{BI} : Bottom dynamic impact pressure:

$p_{BI} = 12\ L^{0.6}$ kN/m^2

7 Hull outfitting

7.1 Equipment

7.1.1 Manned non-propelled units

The equipment of anchors, chain cables and ropes to be fitted on board manned non-propelled units is to comply with Pt IV, Ch 5.

Chain cables for anchors may be replaced by steel ropes having the same breaking load. The ropes are to be connected to the anchors by approximately 10 m of chain cable complying with Pt IV, Ch 5.

Non-propelled units continuously assisted by a tug may have only one anchor, complying with Pt IV, Ch 5, and a chain rope having length neither less than 75% of the length obtained according to Pt IV, Ch 5, nor less than 220 m.

7.1.2 Unmanned non-propelled units

For unmanned non-propelled units, the equipment is not required for classification purposes. The scantlings of anchors, chain cables and ropes to be fitted on board are the responsibility of the Designer.

7.1.3 Towing arrangements

Non-propelled units are to be fitted with suitable arrangements for towing, with scantlings under the responsibility of the Designer.

The Society may, at the specific request of the interested parties, check the above arrangements and the associated hull strengthening; to this end, the maximum pull for which the arrangements are to be checked is to be specified on the plans.

Section 3 Machinery Systems

1 General

1.1 Application

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

1.2 Documents to be submitted

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

2 Bilge system

2.1 Bilge system in ships having no source of electrical power

2.1.1 General

Where there is no source of electrical power on board, hand pumps are to be provided, in sufficient number and so positioned as to permit an adequate drainage of all the compartments of the ship.

2.1.2 Arrangement of the bilge system

The bilge system is to comply with one of the following arrangements:

a) at least one pump is to be provided for each compartment

b) at least two pumps connected to a bilge main are to be provided. The main is to have branch pipes allowing the draining of each compartment through at least one suction.

2.1.3 Hand pumps

a) Hand pumps are to be capable of being operated from positions above the load waterline and are to be readily accessible at any time.

b) Hand pumps are to have a maximum suction height not exceeding 7.30 m.

2.1.4 Size of bilge pipes

a) The internal diameter, in mm, of suction pipes is not to be less than the diameter given by the following formula:

$d_1 = T/100 + 50$

where:

T : Underdeck tonnage, in t.

b) When the ship is subdivided into small watertight compartments, the diameter of these suctions need not exceed 50 mm.

2.2 Bilge system in ships having a source of electrical power

2.2.1 General

On board ships having no propelling machinery but having a source of electrical power, mechanical pumps are to be provided for draining the various compartments of the ship.

2.2.2 Arrangement of the bilge system

The bilge system is to comply with the provisions of Pt IV, Ch 1, Sec 11, 6.3 to 6.6 applicable to the spaces concerned, except that direct suctions need not be provided.

2.2.3 Bilge pumps

The number and capacity of the bilge pumps are to comply with the relevant requirements of Pt IV, Ch 1, Sec 11, 6.7.

2.2.4 Size of bilge pipes

The size of bilge pipes is to comply with the relevant requirements of Pt IV,Ch 1, Sec 11, 6.8.

Table 2.1 : Documents to be submitted

Item No	Description of the document (1)	Status of the review
1	Diagram of the bilge system	A
2	Diagram of the central priming system intended for the bilge pumps, where provided	A
3	Capacity, prime mover and location of the bilge pumps	A

(1) Diagrams are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems.

Chapter 16 Fishing Vessels

Section 1 General

1 Application

1.1 The requirements of this chapter apply to trawlers and fishing vessels, and are supplementary to those given for the assignment of main characters of class.

For the purpose of this chapter, a fishing vessel is a ship used for fishing operations, but not equipped for trawling.

1.2 Vessels built in compliance with the above requirements will be eligible to be assigned one of the FISHING VESSEL following class notations:

2 Documentation

2.1 Following documents are required to be submitted in addition to those specified in Pt.III.

- Winch and crane foundations along with the winch capacities and wire forces.
- Mast and rigging plans.
- Additional deck loads in way of masts, rigging, heavy machinery and equipment.
- Bilge and drainage arrangement from cargo spaces and working areas.
- Details of insulated compartments.

Section 2 Hull Arrangement and Strength

1 General

1.1 The draught T, used for determination of scantlings is not to be taken less than 0.9D.

1.2 All fishing vessels and trawlers are to have pronounced sheer on the forebody or a forecastle.

2 Longitudinal strength

2.1 The requirements of Pt.3, Ch.2 regarding the loading instruments are not applicable to trawlers and fishing vessels.

3 Bottom and side shell structure

3.1 The thickness of bottom and side shell plating is not to be less than :

$t = 6 + 0.06L$ mm

3.2 In the case of vessels engaged in side trawling, the thickness of sheer strake, side shell and bilge strake are to be increased by 30% over a length of not less than 4 m abaft the forward gallow leg.

3.3 In case of stern trawlers, the thickness of trawl ramp and ramp sides, stern and side shell plating abaft the point where trawling boards are normally taken on board; is to be increased by 30%.

3.4 Bulwark plating between the gallows is to be of the same thickness as the adjacent side shell plating and the bulwark is to be supported by stays at every frame.

3.5 Bulwark, side shell and transom plating where excessive wear could occur, are to be suitably protected with rubbing bars.

3.6 The section modulus of stiffeners in the trawl ramp is not to be less than:

$Z = 0.015\, l^2 s$ cm^3

where,

l,s are the stiffener span m and spacing mm respectively.

4 Deck structure

4.1 The thickness of deck plating under the trawl winch, windlass, mast, bollards and gallows is not to be less than:

$t = 7.5 + 0.05L$ mm

4.2 Adequate scarphing is to be arranged in way of raised decks.

5 Bulkhead structure

5.1 A collision bulkhead located at a distance greater than 0.08L from the forward end may be considered, provided it is shown that flooding of the forepeak spaces would not cause a deleterious effect on the ship's trim and stability.

5.2 Cargo holds designed to carry fish in bulk are to have sufficient number of divisions to ensure that the catch is adequately secured against cargo shifting which could cause dangerous trim or heel of the vessel.

6 Hull openings and their closing appliances

6.1 Hull openings and their closing appliances are to be according to Pt.III, Ch.2 except as specified otherwise.

6.2 Skylights leading to accommodation and machinery spaces below the freeboard deck are to be of substantial construction and capable of being closed weathertight from both sides and be positioned clear of deck working areas. The coaming height of the skylights should be not less than 900 mm; lower coaming height may however be considered depending on the practicability of operations and integrity of the weathertightness. Scuttles may be fitted on skylights for accommodation spaces only and are to be of toughened glass fitted with deadlights.

6.3 Hatchways are to be fitted with steel coamings, complete with all necessary fittings and covers to ensure weathertight closure.

Covers made of materials other than mild steel are to be of equivalent strength. For vessels of $L < 24$ m, hatch coaming and/or sill heights of less than 600 mm may be accepted depending on the location and size of the opening and the construction details of closing appliances.

6.4 Access, loading and discharge hatches on the freeboard deck are to be located along the ship's centreline as far as practicable. Ice scuttles and other small flush type hatches may however, be located away from the centreline, subject to satisfactory means of weathertight closing.

6.5 Openings on the deck sides for fishing lines are to be so constructed as to facilitate quick closing of the weathertight cover by one member of the crew. The sill height of such openings is normally not to be less than 1000 mm. Side ports, if fitted are to have securing devices with a strength equivalent to the structure to which they are fitted. Suitable notices are to be provided to all such openings stating "TO BE KEPT CLOSED AT SEA WHILE NOT ENGAGED IN FISHING".

6.6 Stern trawlers are to be provided with suitable protection such as doors, gates or nets at the top of the stern ramp up to the same height as the adjacent bulwark or guard rail.

Where such protection is not in position, a chain or other means of protection are to be fitted across the ramp.

6.7 Inboard openings for garbage chutes from factory decks and galley are not to be less than 0.7 m above the load waterline and are to be fitted with weathertight covers. The outboard end is to be fitted with watertight screw down non-return valve operable from 1.5 m above the deck.

7 Masts and rigging

7.1 Masts and rigging are to comply with the requirement of Pt.III, Ch.2. Derricks and posts used in conjunction with side trawling are to be approved by ACS.

7.2 Where gallows and/or gantries are fitted, they are to be complete with all necessary leads, cleats, hanging blocks, eyebolts, stopper chains and supporting stays, and arranged to allow safe stowage of the trawl doors.

7.3 Warping bollards and leads are to be provided with guards as far as practicable and are to be located clear of the working areas.

Section 3 Fish Holds

1 Temporary bulkheads in cargo holds

1.1 Generally, for vessels of B □6 m, one longitudinal bulkhead is to be fitted and for vessels of B > 6 m two such bulkheads are to be fitted. Spacing of transverse bulkheads in the cargo holds is normally not to exceed 9 m.

2 Refrigerated fish hold

2.1 Refrigerated fish hold spaces are to be comply with the requirements of Pt.IV, Ch.1, Sec.13.

Section 4 Pumping and Piping Arrangement

1 Piping in way of refrigerated chambers

1.1 Piping in way of refrigerated chambers is to comply with the requirements of Pt.IV, Ch.1 Sec 11; as applicable.

2 Drainage from refrigerated fish hold

2.1 Provision is to be made for adequate and continuous drainage of water, oil and brine from inside of all insulated chambers and cooler trays. The drainage arrangement is to comply with the requirements of Pt.IV, Ch.1, Sec 11.

3 Bilge arrangements of spaces for carriage of fish in bulk

3.1 Each fish hold of length less than 9 m is to have a bilge well of adequate size suitably located to ensure good drainage of water, oil and brine from the cargo.

Fish holds more than 9 m in length are to have minimum two bilge wells.

3.2 Separate branch suction lines are to be led from each of the bilge well to the bilge system valve chest in the engine room. The valve chest collecting branch suction lines from the fish holds is to have no connections to other compartments. All valves in the chest are to be screwdown non-return valves and are to be easily accessible. The valve chest is to be directly connected to the largest bilge pump.

The second bilge pump should also be connected to the system.

3.3 Suitable arrangement is to be made between the bilge suction and the non-return valve to connect a portable water supply to carry out back flushing of each bilge suction.

3.4 Tween deck spaces not exposed to the sea and intended to carry loose fish in bulk may be drained into the engine room bilges provided no processing is carried out in that space requiring supply of water. The drainage pipes are normally not to exceed 50 mm in diameter and are to have self closing valves on the engine room side.

4 Drainage arrangement for working deck

4.1 Vessels with processing facilities on the tween deck requiring supply of water for washing down the remains and vessels with side ports or flush deck hatch covers which remain open while fishing at sea, are to have a substantial bilge system similar to the requirements of 3. For working decks of length greater than 18 m, the number of drainage wells will be specially considered.

4.2 The volume of each drainage well is not to be less than 0.15 m3 and a loose strain-off grating is to be provided on top having clear opening area not less than 3 times the internal sectional area of the bilge suction pipe. The sizes of the bilge suctions are also to be compatible with the capacity of the bilge pumps.

4.3 Where only two bilge wells are provided, additional suctions are to be arranged on each side.

4.4 Each drainage well is to be provided with an independent bilge suction. The piping system is to be so arranged as to ensure alternative drainage facility from other bilge suctions when any one of the bilge suctions may be clogged.

4.5 In addition to the bilge suctions required in 4.3 above, outlets from the bilge wells may be led overboard provided the inboard drainage opening on the deck are situated 0.02L (min. 0.7 m) above the load waterline. Each such outlet is to have an approved type automatic nonreturn valve with manual means of closing, operable from a position 1.5 m above the deck.

In addition, remote closing arrangement is to be provided from the bridge.

The outlet flap opening is to be free from obstructions to prevent clogging by offal that may impair the closability of the flap. Direct overboard discharge may be considered in lieu of the additional suctions required in 4.3.

4.6 Submerged bilge pumps with rotating knife edge blades may be installed in the bilge wells without the strain-off gratings. The discharge from the submerged pump is to be fitted with screw-down non-return valve capable of operating from 1.5 m above the deck. The outboard opening is to be located 0.02L (min. 0.7 m) above the load waterline.

4.7 The bilge pumping capacity for direct suction from each well is not to be less than 1.25 times the available wash down capacity for the deck wash system, nor less than the requirement of bilge pump capacity as per Pt.IV, Ch.1, Sec 11.

4.8 The total capacity Q of bilge pumps for drainage of spaces with side ports is not to be less than:

$Q = 3BA_s \quad m^3/h$

where,

A_s = area of the side port m^2

The total bilge pump capacity, however, need not exceed

$Q = 0.75\ A_D \quad m^3/h$

where,

A_D = deck area of the compartment fitted with side ports m^2.

4.9 Alarms and cutouts

4.9.1 Visual and audible alarms are to be fitted on the bridge for the free water on the working deck.

4.9.2 The pumps for the deckwash system are to be capable of being shut down from the bridge in case of emergency.

Chapter 17 Single Point Mooring

Section 1 General

1 Application

1.1 The requirement of this chapter applies to ships fitted with standardized equipment complying with the recommendations of the Oil Companies International Marine Forum (OCIMF) for mooring at single point mooring or single buoy mooring terminals. Vessels complying with these requirements will be assigned class notation 'SPM' as per Pt.1, Ch.1 of Rules.

1.2 Where some components of mooring equipment are used for both single point mooring and for the bow emergency towing arrangements, the requirements for emergency towing arrangements are also to be complied with.

1.3 Where the mooring components are to be type approved, the requirements given in Certification scheme for type approval of products are also to be complied with.

2 Documentation for approval

2.1 The following plans are to be submitted to ACS for approval:

- General layout of the associated equipment at the forecastle/fore deck.
- Construction drawing of the bow chain stoppers/Smit type brackets, bow fairleads and pedestal roller fairleads, together with material specifications and relevant calculations.
- Plans of the supporting structure in way of chain stoppers/Smit type brackets, fairleads, roller pedestals, winches and capstans.
- Arrangements for pull back from tugs, wherever applicable.

3 Documentation for information

3.1 The following documentation is to be submitted for information.

- Specifications of winches or capstans giving the continuous duty pull and brake holding capacity.
- DWT, in tonnes, of the ship at summer load line.

Section 2 General Arrangement

1 General

1.1 Suitable equipment and arrangements are to be provided near the bow of the vessel for heaving onboard a standard chafing chain of 76 mm diameter using a pick-up rope and for securing the chain to the strong point.

1.2 The strongpoint is to be a chain cable stopper / Smit type bracket.

1.3 A typical schematic layout of the forecastle is shown in Fig. 1.1 for reference.

1.4 Where tugs are used for pull back, suitable arrangements for connecting the lines from tugs are to be provided.

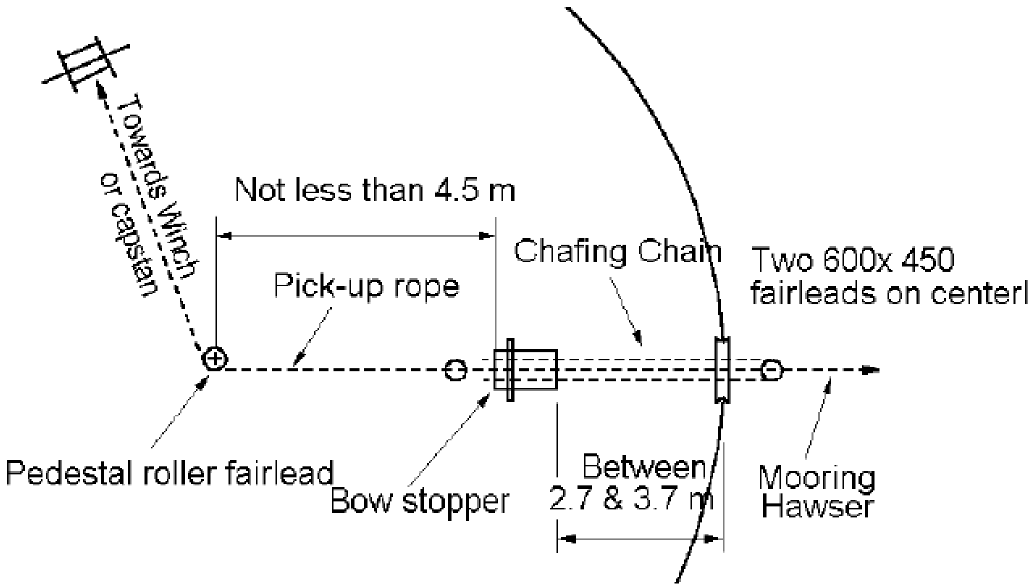
2 Equipment components

2.1 The equipment for mooring is to generally consist of the following components :

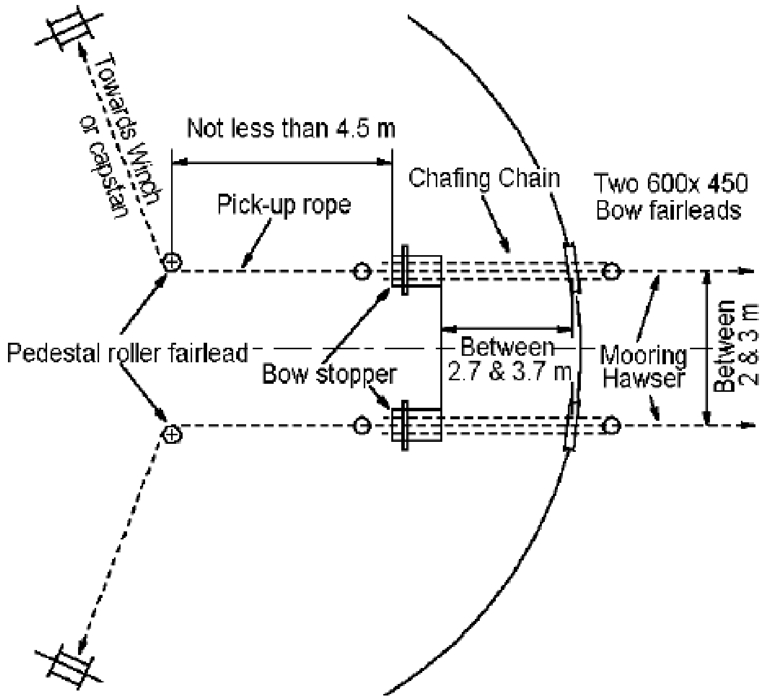
- bow chain stopper or Smit type bracket;
- bow fairlead;
- pedestal roller fairlead;
- winch or capstan.

Fig. 1.1 : Forecastle schematic layout

DWT □150000 t



DWT > 150000 t


Towards Winch or capstan
Not less than 4.5 m
Pick-up rope
Chafing Chain
Two 600x 450 Bow fairleads
Pedestal roller fairlead
Bow stopper
Between 2.7 & 3.7 m
Mooring Hawser
Between 2 & 3 m

Section 3 Mooring Components

1 General

1.1 The ship is to be equipped with bow chain stoppers or Smit type brackets complying with the requirements in Table 1.1 and suitable for a standard chafing chain of 76 mm in diameter.

The requirements for materials, manufacture, testing and certification of the chain are to comply with requirements of Part 2, Chapter 12 and Pt IV, Chapter 5 of the Rules. Grade AC-K3, indicated in Part II, chapter 12 are to be used corresponding to Safe working load of 200 t and 250 t. (See Table 1.1).

Note : Chafing chains are not required to be part of ship's equipment when supplied by the SPM terminal operator.

1.2 Where the safe working loads are increased to take into account the local environmental conditions, the same is to be clearly stated on plans submitted for approval.

Table 1.1 : Required Number and SWL of Chain stoppers/Smit Type Brackets

Deadweight [t]	Number	Safe working load (SWL) [t] (kN)
DWT □150000	1	200 (1961)
150000 < DWT □350000	2	200 (1961)
DWT > 350000	3	250 (2452)

1.3 The scantlings of all parts of bow chain stopper, Smit Type Brackets and bow fairleads are to be in accordance with the strength criteria given in Sec.5.

1.4 The bow chain stoppers, Smit type bracket and bow fairleads are to be made of fabricated steel, steel castings or forgings complying with relevant requirements given in Pt.II, Chapters 3, 4 and 5 respectively.

Use of spheroidal graphite (SG) iron casting may be accepted for the main framing of the chain stopper provided that:

- The part concerned is not intended to be a component part of a welded assembly.
- The SG iron casting is of ferritic structure with an elongation not less than 12%.
- The yield stress at 0.2% strain is to be measured and certified.
- The internal structure of the component is to be inspected by means of non-destructive examination.

The material used for the stopping device (pawl or hinged bar in chain stoppers and the pin in Smit Type Brackets) is to have mechanical properties similar to that of a Grade AC-K3 chain cable or better.

2 Bow chain stopper

2.1 The stoppers are to be capable of securing the common stud links of the chafing chain cable when the stopping device (chain engaging pawl or bar) is in the closed position and of freely passing the chain cable and its associated fittings when the stopping device is in the open position.

2.2 Chain stoppers may be of the hinged bar type or of pawl (tongue) type or of other equivalent design.

Typical arrangements of chain stoppers are shown in Fig. 2.1.

2.3 The stopping device (chain engaging pawl or bar) of the chain stopper is to be so arranged as to prevent it from gradually working to the open position from the closed position which would release the chafing chain and allow it to pay out.

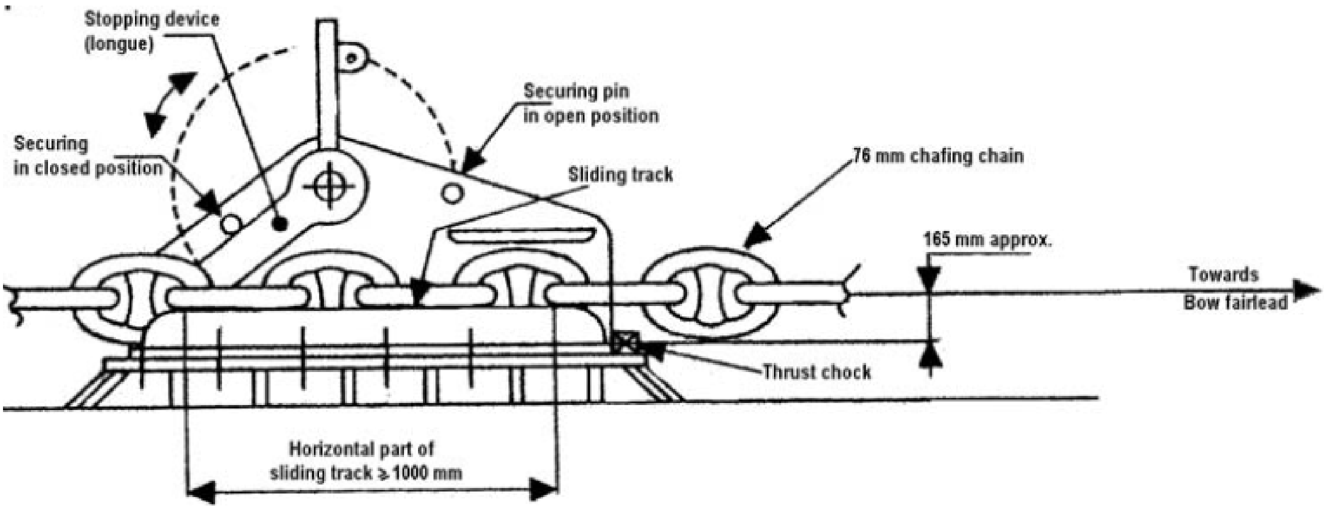
Stopping devices are to be easy and safe to operate and are to be properly secured in the open position.

2.4 Chain stoppers are to be located between 2.7 m and 3.7 m inboard from the bow fairleads (See Sec, Fig. 1.1).

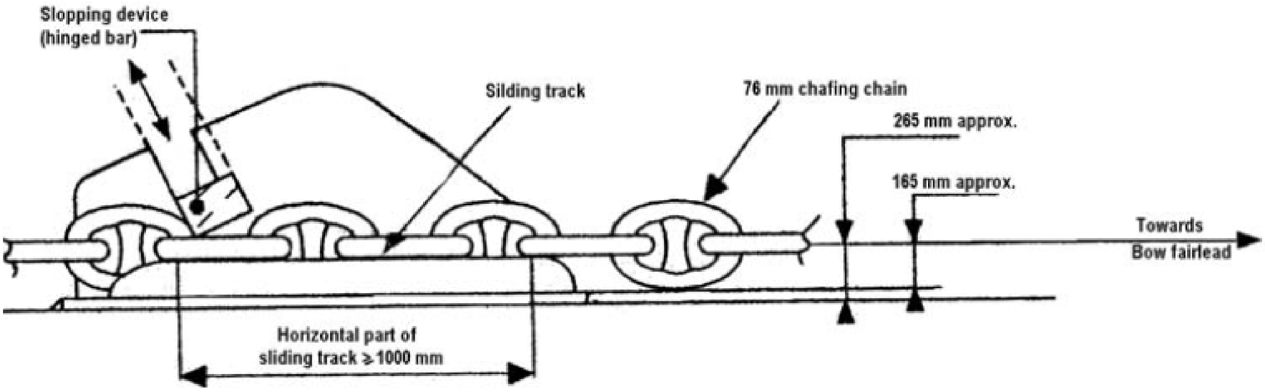
When positioning, due consideration is to be given to the correct alignment of the stopper relative to the direct lead between bow fairlead and pedestal roller fairlead.

Fig. 2.1 : Typical bow chain stoppers

Pawl type Chain stopper



Bar hinged type chain stopper



2.5 Stopper support structures are to be trimmed to compensate for any camber and/or sheer of the deck. The leading edge of the stopper base plate is to be faired to allow for the unimpeded entry of the chafing chain into the stopper.

2.6 Where the chain stopper is bolted to a seating welded to the deck, the bolts are to be relieved from shear force by efficient thrust chocks capable of withstanding horizontal force equal 1.5 times the required working load satisfying the strength criteria specified in Sec.5. Mechanical properties of bolt material are to be not less than Grade 8.8 of ISO standard No.898/1.

3 Smit Type Brackets

3.1 Where fitted, Smit type brackets (Fig. 3.1) are to be located between 2.7 m and 3.7 m aft of the bow fairlead and should be positioned so as to give correct alignment with the bow fairlead and pedestal fairlead or drum end of the winch or capstan. (See Sec 2, Fig. 1.1).

3.2 To facilitate connection to the terminal equipment it is recommended that each Smit type bracket be provided with a length of chain cable comprising a pear link, an open link and a special shackle, see Fig. 3.1. The safe working load is to be as given in Table 1.1 for bow stoppers.

3.3 Adjacent to each Smit type bracket a lug with a recommended safe working load of 490 [kN] (50 tonnes) is to be attached to the doubler plate.

The lug is to be provided with a hole of sufficient size to accept the pin of a 490 [kN] (50 tonnes) SWL shackle and is to be used as a securing point for holding the chain.

4 Bow fairleads

4.1 One bow fairlead is to be fitted for each bow chain stopper or Smit type bracket (See Sec2, Fig. 1.1).

4.2 For ships of more than 150000 t DWT, where two bow fairleads are required, the fairleads are to be spaced 2.0 m centre to centre apart, if practicable and in no case be more than 3.0 m apart.

For ships of 150000 t DWT or less for which only one bow fairlead is required (See Table 1.1), it is in general to be fitted on the centreline.

4.3 Fairleads are normally of a closed type (as Panama chocks) and are to have an opening large enough to pass the largest portion of the chafing gear, pick-up rope and associated fittings.

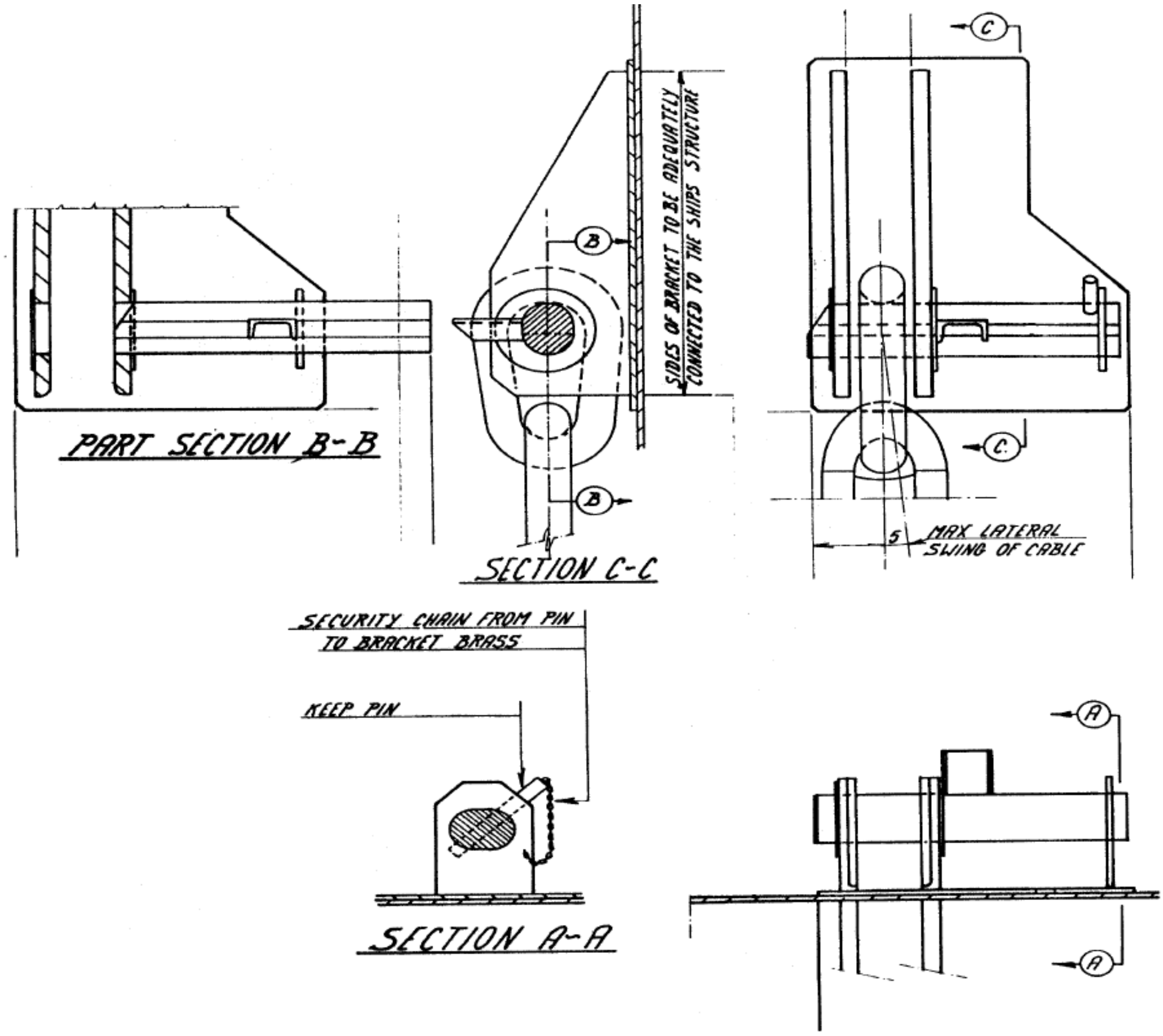
For this purpose, the inner dimensions of the bow fairlead openings are to be at least 600 mm in width and 450 mm in height.

4.4 Fairleads are to be oval or round in shape. The lips of the fairleads are to be suitably faired in order to prevent the chafing chain from fouling on the lower lip when heaving inboard.

The ratio of the diameter of the bearing surface of the fairlead to the diameter of the chafing chain, is to be not less than 7 to 1.

4.5 The fairleads are to be located as close as possible to the deck and, in any case, in such a position that the chafing chain is approximately parallel to the deck when it is under strain between the chain stopper and the fairlead.

Fig. 1.1 : Smit Type Bracket



5 Pedestal roller fairleads

5.1 Pedestal roller fairleads are to be so positioned as to provide a direct lead to bow chain stopper and bow fairlead. (See Sec 2, Fig. 1.1).

They are to be fitted not less than 4.5 m behind the bow chain stopper.

5.2 The pedestal roller fairleads are to be capable to withstand a horizontal force equal to:

– the resultant force due to an assumed pull of 225 [kN] in the pick-up rope; or

– 225 [kN], whichever is greater. Stresses generated by this horizontal force are not to exceed those given in 5.2.

5.3 It is recommended that the fairlead roller is to have a diameter not less than 7 times the diameter of the pick-up rope.

6 Winches or capstans

6.1 Winches or capstans used to handle the mooring gear are to be capable of exerting a continuous duty pull of not less than 150 [kN] and withstanding a braking pull of not less than 225 [kN].

6.2 Winch storage drums used to stow the pick-up rope, are to be of sufficient size to accommodate 150 m of polypropylene rope of 80 mm diameter.

Section 4 Supporting Hull Structures

1 General

1.1 The bulwark plating and stays are to be suitably reinforced in the region of the fairleads.

1.2 Deck structures in way of bow chain stoppers, including deck seatings and deck connections, are to be suitably reinforced to comply with the strength criteria specified in Sec.5.

1.3 The deck structures in way of the pedestal roller fairleads and in way of winches or capstans as well as the deck connections are to be reinforced to withstand, respectively, the horizontal force defined in Sec3, 5.2 or the braking pull defined in Sec 3, 6.1 and to meet the strength criteria specified in Sec.5.

1.4 The deck plating in way of the mooring capacity mentioned in 1.2 and 1.3 is to be increased by means of suitable insert plates.

1.5 Main welds of the bow chain stoppers with the hull structure are to be inspected by means of non-destructive examination for their complete length.

Section 5 Strength Criteria

1 Design loads

1.1 The bow chain stopper, Smit type bracket and the bow fairlead are to be designed considering a horizontal chafing chain tension equal to 1.5 times the SWL given in Sec2, Table 1.1.

2 Allowable stresses

2.1 The equivalent stress, σ_e, induced by the load given in1.1 is not to exceed 0.67 σ_y or 0.4 σ_u whichever is lesser.

where,

$$\sigma_e = \sqrt{\sigma^2 + 3\tau^2}$$

σ = tensile stress

τ = shear stress

σ_y = Minimum yield stress [N/mm^2], of the component material

σ_u = Tensile strength [N/mm^2], of the component material.

Chapter 18 Ice Class (Ice)

Section 1 General

1 General

1.1 Application

1.1.1 The following additional class notations are assigned in accordance with Pt I, Ch 1, Sec 3 to ships strengthened for navigation in ice and complying with the relevant requirements of this Chapter:

- ICE CLASS IA SUPER
- ICE CLASS IA
- ICE CLASS IB
- ICE CLASS IC
- ICE CLASS ID

1.1.2 The ice strengthening requirements in this Chapter, excepting those for ships with the additional class notation ICE CLASS ID are equivalent to those stated in the "Finnish-Swedish Ice Class Rules 1985, as amended, applicable to ships trading in the Northern Baltic Sea in winter.

1.1.3 For the purpose of this Chapter, the notations mentioned in 1.1.1 may be indicated using the following abbreviations:

- IAS for ICE CLASS IA SUPER
- IA for ICE CLASS IA
- IB for ICE CLASS IB
- IC for ICE CLASS IC
- IC for ICE CLASS ID

1.2 Owner's responsibility

1.2.1 It is the responsibility of the Owner to decide which ice class notation is the most suitable in relation to the expected service conditions of the ship.

Nevertheless, it is to be noted that a ship assigned with the ice class notation IA SUPER is not to be considered as a ship suitable for navigation in ice in any environmental condition, such as an icebreaker.

2 Ice class draughts and ice thickness

2.1 Definitions

2.1.1 Upper ice waterline

The upper ice waterline (UIWL) is the highest waterline at which the ship is intended to operate in ice . The line may be a broken line.

2.1.2 Lower ice waterline

The lower ice waterline (LIWL) is the lowest waterline at which the ship is intended to operate in ice.

2.1.3 Load and ballast waterlines

a) The line defined by the maximum draughts fore, amidships and aft (which may be a broken line) is referred to as Upper Ice Waterline (UIWL).

b) The line defined by the minimum draughts fore, amidships and aft is referred to as Lower Ice Waterline (LIWL).

2.1.4 Ice belt

The ice belt is that portion of the side shell which is to be strengthened. Its vertical extension is equal to the required extension of strengthenings.

2.2 Draught limitations in ice

2.2.1 Maximum draught

The draught and trim limited by the UIWL are not to be exceeded when the ship is navigating in ice.

The salinity of the sea water along the intended route is to be taken into account when loading the ship.

2.2.2 Minimum draught

The ship is always to be loaded down to at least the LIWL when navigating in ice. Any ballast tank situated above the LIWL and needed to load down the ship to this waterline is to be equipped with devices to prevent the water from freezing.

2.2.3 Minimum forward draught

In determining the LIWL, due regard is to be paid to the need to ensure a reasonable degree of ice going capability in ballast. The propeller is to be fully submerged, if possible entirely below the ice. The minimum forward draught is to be at least equal to the value TAV, in m, given by the following formula:

$T_{AV} = (2 + 0.00025\ □)\ h_G$

where:

□ : Displacement of the ship, in t, on the maximum ice class draught, as defined in 2.2.1

h_G : Ice thickness, in m, as defined in 2.3.

The draught T_{AV} need not, however, exceed 4 h_G.

2.2.4 Indication of maximum and minimum draughts in ice

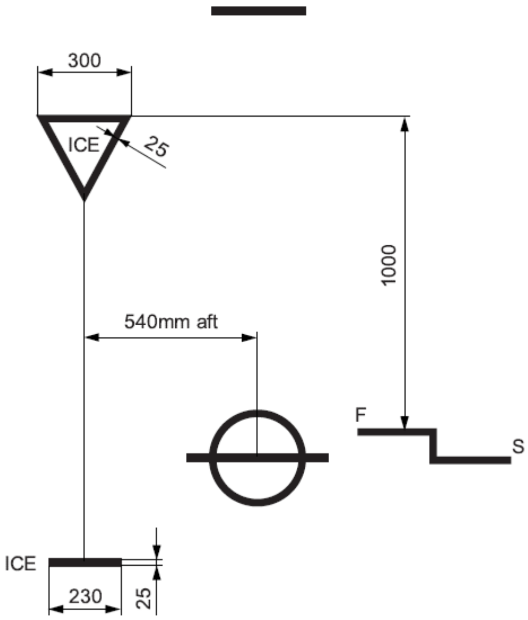
Restrictions on draughts when operating in ice are to be documented and kept on board readily available to the master.

The maximum and minimum ice class draughts fore, amidships and aft are to be specified in the documents submitted for approval to the Society and stated on the Certificate of Classification.

If the summer load line in fresh water is located at a higher level than the UIWL, the shipي sides are to be provided with a warning triangle and with a draught mark at the maximum permissible ice class draught amidships, according to Fig 2.1 .

The purpose of the warning triangle is to provide information on the draught limitation of the vessel when it is sailing in ice for masters of ice breakers and for inspection personnel in ports.

Figure 2.1 : Ice class draught marking



Note 1: The upper edge of the warning triangle is to be located vertically above the بICEپ mark, 1000 mm higher than the Summer Load Line in fresh water but in no case higher than the deck line. The sides of the triangle are to be 300 mm in length.

Note 2: The ice class draught mark is to be located 540 mm abaft the centre of the load line ring or 540 mm abaft the vertical line of the timber load line mark, if applicable.

Note 3: The marks and figures are to be cut out of 5 - 8 mm plate and then welded to the ship's side. The marks and figures are to be painted in a red or yellow reflecting colour in order to make the marks and figures plainly visible even in ice conditions.

Note 4: The dimensions of all figures are to be the same as those used in the load line mark.

Note 5: The upper horizontal line above the triangle represents the ship deck line.

The lower horizontal line below the triangle represents the UIWL.

2.3 Ice thickness

2.3.1

a) An ice strengthened ship is assumed to operate in open sea conditions corresponding to an ice level with a thickness not exceeding the value hG.

b) The design height of the area actually under ice pressure at any time is, however, assumed to be only a fraction h, of the ice thickness hG.

c) The values for hG and h, in m, are given in Tab 2.1.

Table 2.1 :

Ice class notation	hG (m)	h (m)
IAS	1.0	0.35
IA	0.8	0.30
IB	0.6	0.25
IC	0.4	0.22

3 Output of propulsion machinery

3.1 Required engine output for classes IAS, IA, IB, IC

3.1.1 The engine output, P, is the maximum output the propulsion machinery can continuously deliver to the propeller(s). If the output of the machinery is restricted by technical means or by any regulations applicable to the ship, P is to be taken as the restricted output.

The engine output is to be not less than that determined according to 3.1.3 and in no case less than 1000 kW for ice class IA, IB and IC, and not less than 2800kW for IAS.

3.1.2 Definitions

The dimensions of the ship, defined below, are measured on the maximum ice class draught of the ship as defined in 2.2.1. For the symbol definitions, see also Fig 3.1.

L : Length of the ship on the waterline, in m

L_{BOW} : Length of the bow, in m

L_{PAR} : Length of the parallel midship body, in m

B : Maximum breadth of the ship, in m

T : Maximum ice class draught of the ship, in m, according to 2.2.1

A_{wf} : Area of the waterline of the bow, in m^2

□ Angle of the waterline at B/4, in deg

ϕ_1 : Rake of the stem at the centreline, in deg

ϕ_2 : Rake of the bow at B/4, in deg

D_P : Diameter of the propeller, in m

H_M : Thickness of the brash ice in mid-channel, in m

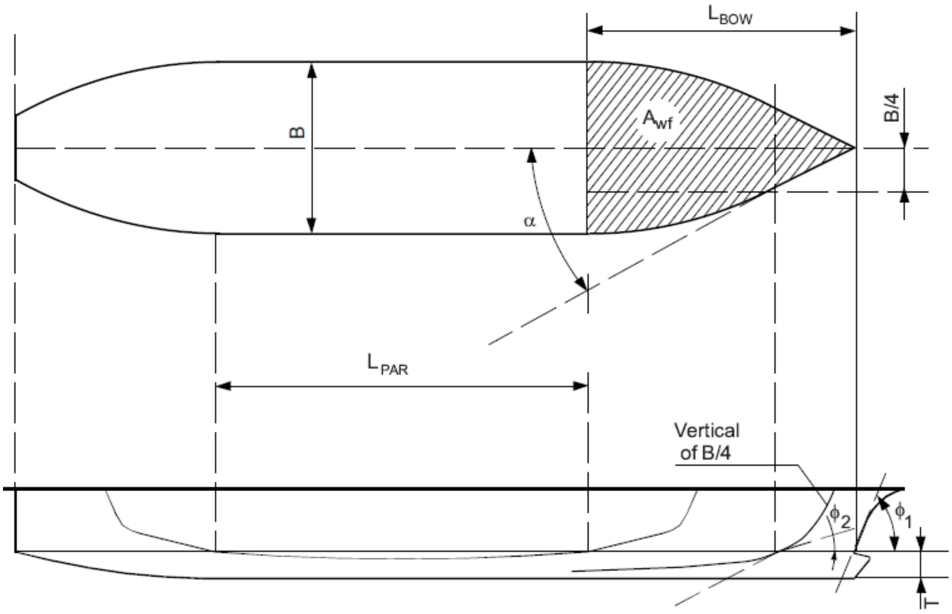
H_B : Thickness of the brash ice layer displaced by the bow, in m.

3.1.3 Minimum required power

The engine output requirement P is to be calculated for two draughts. Draughts to be used are the maximum draught amidship referred to as UIWL and the minimum draught referred to as LIWL, as defined in 2.2. In the calculation the ship's parameters which depend on the draught are to be determined at the appropriate draught, but L and B are to be determined only at the UIWL. The engine output is to be not less than the greater of these two outputs. These two outputs , in kW, are to be determined by the following formula:

$P=K_C(R_{CH}/1000)^{3/2}/D_p$

Figure 3.1 :



where:

K_C : Defined in Tab 3.2

R_{CH} : Resistance of the ship in a channel with brash ice and a consolidated layer, in N, equal to:

$R_{CH}=C_1+C_2+C_3(H_F+H_M)^2(B+C\square H_F)C\square+C_4L_{PAR}(H_F)^2+C_5(L_T/B_2)^3A_{WF}/L$

with:

H_F : $0.26 + (H_MB)^{0.5}$

H_M : Coefficient defined in Tab 3.1

Table 3.1 : Values of HM

Ice classes	H_M
ice class IA and IAS	1.0
ice class IB	0.8
ice class IC	0.6

Table 3.2 : Values of KC

Number of propellers	CP propellers or electric or hydraulic propulsion machinery	FP propellers
1 propeller	2.03	2.26
2 propellers	1.44	1.60
3 propellers	1.18	1.31

C_1 : Coefficient taking into account a consolidated upper layer of the brash ice and to be taken:

- for ice class IA, IB and IC:

C1 = 0

- for ice class IAS:

$C_1=f_1(BL_{PAR})/(2T/B+1)+(1+0.021\phi_1)(f_2B+f_3L_{BOW}+f_4BL_{BOW})$

C_2 : Coefficient taking into account a consolidated upper layer of the brash ice and to be taken:

- for ice class IA, IB and IC:

$C_2 = 0$

- for ice class IAS:

$C_2=((1+0.063\phi_1)(g_1+g_2B)+g_3(1+1.2T/B)(B^2/L^{0.5}))$

where:

ϕ_1 : To be taken equal to 90° for ships with bulbous bow

$f_1 = 23$ N/m^2

$f_2 = 45.8$ N/m

$f_3 = 14.7$ N/m

$f_4 = 29$ N/m^2

$g_1 = 1530$ N

$g_2 = 170$ N/m

$g_3 = 400$ N/m$^{1.5}$

$C_3 = 845$ kg/m^{2}s^2

$C_4 = 42$ kg/m^{2}s^2

$C_5 = 825$ kg/s^2

C□: Coefficient equal to:

- if□ □45خ

C□= 0

- otherwise

C□= 0.047 □ـ2.115

C□: Coefficient equal to:

C□= 0.15 cos ϕ_2 + sin □sin□

without being less than 0.45

□= arctan (tan ϕ_2 / sin □)

The following condition is to be satisfied:

20 □($LT/B^2)^3$ □5

3.1.4 Other methods of determining K_C or R_{CH}

The Society may for an individual ship, in lieu of the K_C or R_{CH} values defined above, approve the use of K_C values

based on more exact calculations or R_{CH} values based on model tests. Such approval will be given on the understanding that it can be revoked if experience of the shipي performance in practice warrants this.

The design requirement for ice classes is a minimum speed of 5 knots in the following brash ice channels.

The values of H_M are those defined in Tab 3.1.

A 0.1 m thick consolidated layer of ice for ice class IAS is to be considered.

Section 2 Hull and Stability

Symbols

UIWL : Upper ice waterline, defined in Sec 1, 2.1.3

LIWL : Lower ice waterline, defined in Sec 1, 2.1.3

s : Spacing, in m, of ordinary stiffeners or primary supporting members, as applicable

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

R_{eH} : Minimum yield stress, in N/mm^2, of the material as defined in Pt II.

1 General

1.1 Application

1.1.1 For the purpose of the assignment of the notations ICE CLASS IA SUPER, ICE CLASS IA, ICE CLASS IB, ICE CLASS IC and ICE CLASS ID, the ship is divided into three regions defined in 1.2.

1.1.2 The area to be strengthened are defined in 1.3 depending on the ice notation.

1.1.3 Additional class notation ICE CLASS ID

Strengthening of ships with additional class notation ICE CLASS ID is that of fore region, rudder and steering arrangements of additional class notation ICE CLASS IC.

1.2 Regions

1.2.1 Fore region

The fore region is the region from the stem to a line parallel to and 0.04L aft of the forward borderline of the part of the hull where the waterlines run parallel to the centerline.

The overlap with the borderline need not exceed:

- 6 m for the notations ICE CLASS IA SUPER and ICE CLASS IA
- 5 m for the notations ICE CLASS IB, ICE CLASS IC and ICE CLASS ID.

1.2.2 Midship region

The midship region is the region from the aft boundary of the fore region to a line parallel to and 0.04 L aft of the aft borderline of the part of the hull where the waterlines run parallel to the centerline.

The overlap with the borderline need not exceed:

- 6 m for the notations ICE CLASS IA SUPER and ICE CLASS IA
- 5 m for the notations ICE CLASS IB and ICE CLASS IC.

1.2.3 Aft region

The aft region is the region from the aft boundary of the midship region to the stern.

1.3 Ice strengthened area

1.3.1 General

The vertical extension of the ice strengthened area (see Fig 1.1) is defined in:

- Tab 1.1 for plating
- Tab 1.2 for ordinary stiffeners and primary supporting members.

Table 1.1 : Vertical extension of ice strengthened area for plating

Notation	Vertical extension of ice strengthened area, in m	
	above UIWL	below LIWL
ICE CLASS IA SUPER	0.6	0.75
ICE CLASS IA	0.5	0.6
ICE CLASS IB	0.4	0.5
ICE CLASS IC ICE CLASS ID	0.4	0.5

Figure 1.1 : Ice strengthened area and regions

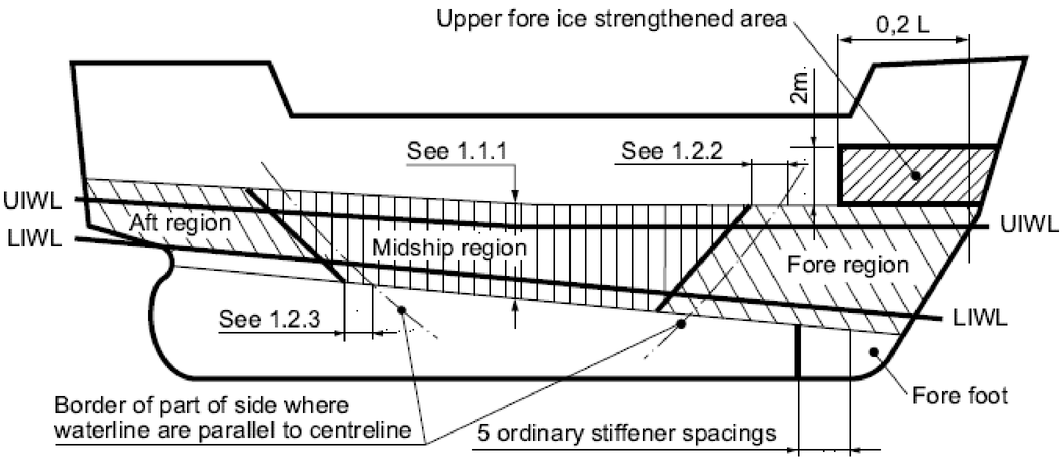


Table 1.2 : Vertical extension of ice strengthening for ordinary stiffeners and primary supporting members

Notation	Region	Vertical extension of ice strengthened area, in m,	
		above UIWL	below UIWL
ICE CLASS IA SUPER	From stem to 0.3L abaft	1.2	to double bottom or below top of floors
	Aft of 0,3L from stem to the aft limit of fore region	1.2	1.6
	Midship region	1.2	1.6
	Midship region	1.2	1.6
ICE CLASS IA ICE CLASS IB ICE CLASS IC	From stem to 0.3L abaft	1.0	1.2
	Aft of 0.3L from stem to the aft limit of the fore region	1.0	1.3
	Midship region	1.0	1.3
	Aft region	1.0	1.0
ICE CLASS ID	From stem to 0.3L abaft	1.0	1.6
	Aft of 0.3L from stem to the aft limit of the fore region	1.0	1.3

Note 1: Where an upper forward ice belt is required (see 4.1.1), the ice-strengthened part of the framing is to be extended at least to the top of this ice belt.

Note 2: Where the ice strengthened area extends beyond a deck or tank top by not more than 250 mm, it may be terminated at that deck or tank top.

1.3.2 Fore foot

The fore foot is the area below the ice strengthened area extending from the stem to a position five ordinary stiffeners spaces aft of the point where the bow profile departs from the keel line (see Fig 1.1).

1.3.3 Upper fore ice strengthened area

The upper fore is the area extending from the upper limit of the ice strengthened area to 2 m above and from the stem to a position at least 0.2 L aft of the forward perpendicular (see Fig 1.1).

2 Structure design principles

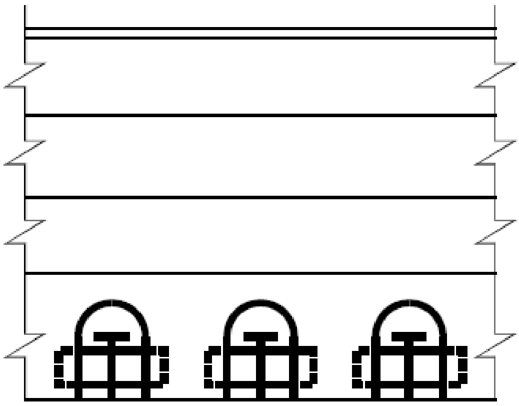
2.1 General framing arrangement

2.1.1 The frame spacings and spans in this Section are normally assumed to be measured in a vertical plane parallel to the centreline of the ship. However, if the shipِs side deviates more than 20° from this plane, the frame distances and spans shall be measured along the side of the ship.

2.1.2 Within the ice-strengthened area defined in 1.3, all ordinary stiffeners are to be effectively attached to all the supporting structures. A longitudinal ordinary stiffener is to be attached to all the supporting web frames and bulkheads by brackets. When a transverse ordinary stiffener terminates at a stringer or a deck, a bracket or a similar construction is to be fitted. Brackets are to have at least the same thickness as the web plate of the ordinary stiffener and the edge is to be appropriately stiffened against buckling.

When an ordinary stiffener is running through the supporting structure, both sides of the web plate of the ordinary stiffener are to be connected to the structure (by direct welding or collar plate, see example in Fig 2.1).

Figure 2.1 : End connection of ordinary stiffener Two collar plates



2.1.3 For the following regions of ice strengthened area:

- all regions of ships with the notation ICE CLASS IA SUPER
- fore and midship regions of ships with the notation ICE CLASS IA
- fore region of ships with the notations ICE CLASS IB, ICE CLASS IC and ICE CLASS ID, the following requirements are to be complied with:
- ordinary stiffeners which are not at a right angle to the shell are to be supported to prevent tripping by means of brackets, intercostals, stringers or similar at a distance not exceeding 1300 mm
- ordinary stiffeners are to be attached to the shell by double continuous welds; no scalloping is allowed (except when crossing shell plate butts)
- the web thickness of ordinary stiffeners is to be at least half that of the shell plating and in any case not less than 9 mm; where there is a deck, tank top or bulkhead in lieu of an ordinary stiffener, the plate thickness is to be complied with to a depth corresponding to the height of adjacent ordinary stiffeners.

2.2 Transverse framing arrangement

2.2.1 Upper end of transverse framing

The upper end of the strengthened part of a main ordinary stiffener and intermediate ice ordinary stiffener is to be attached to a deck or an ice side girder as required in 4.3.1 and 4.3.2.

Where an intermediate ordinary stiffener terminates above a deck or an ice side girder which is situated at or above the upper limit of the ice strengthened area, the part above the deck or side girder may have the scantlings required for an unstrengthened ship and the upper end may be connected to the adjacent main ordinary stiffeners by a horizontal member of the same scantlings as the main ordinary stiffener.

Such intermediate ordinary stiffener may also be extended to the deck above and, where the latter is situated more than 1.8 m above the ice strengthened area, the intermediate ordinary stiffener need not be attached to the deck in question, except in the fore region.

2.2.2 Lower end of transverse framing

The lower end of the strengthened part of a main ordinary stiffener and intermediate ice ordinary stiffener is to be attached to a deck, a tank top or an ice side girder as required in 4.3.1 and 4.3.2.

Where an intermediate ordinary stiffener terminates below a deck, a tank top or an ice side girder which is situated at or below the lower limit of the ice strengthened area, the lower end may be connected to the adjacent main ordinary stiffeners by a horizontal member of the same scantlings as the ordinary stiffeners.

2.3 Bilge keels

2.3.1 The connection of bilge keels to the hull is to be so designed that the risk of damage to the hull, in the event of a bilge keel being ripped off, is minimised. For this purpose, it is recommended that bilge keels are cut

up into several shorter independent lengths.

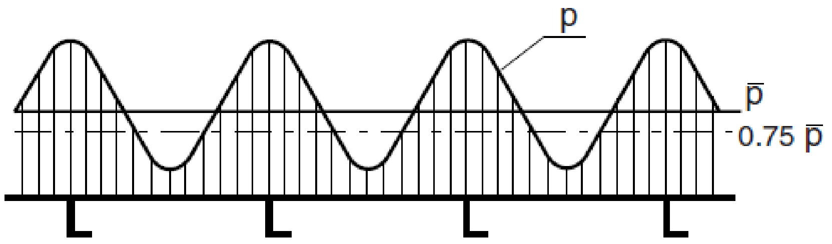
3 Design loads

3.1 General

3.1.1 Because of the different flexural stiffness of plating, ordinary stiffeners and primary supporting members, the ice load distribution is to be assumed to be as shown in Fig 3.1.

3.1.2 For the formulae and values given in this Section for the determination of the hull scantling, more sophisticated methods may be substituted subject to the agreement of the Society on a case-by-case basis.

Figure 3.1 : Ice load distribution on ship side



3.1.3 If scantlings obtained from the requirements of this Section are less than those required for the unstrengthened ship, the latter are to be used.

3.2 Ice loads

3.2.1 Height of load area

The height of the area under ice pressure at any particular point of time is to be obtained, in m, from Tab 3.1 depending on the additional class notation assigned to the ship.

Table 3.1 : Height of load area

Notation	h, in m
ICE CLASS IA SUPER	0.35
ICE CLASS IA	0.30
ICE CLASS IB	0.25
ICE CLASS IC	0.22
ICE CLASS ID	0.22

3.2.2 Design ice pressure

The value of the design ice pressure p, in N/mm^2, to be considered for the scantling check, is obtained from the following formula:

$p = c_d\ c_1\ c_a\ p_o$

where:

c_d : Coefficient taking account of the influence of the size and engine output of the ship, to be obtained from the following formula:

$c_d = (a\ f + b)/1000$

a, b : Coefficients defined in Tab 3.2

Table 3.2 : Coefficients a, b

Region (see 1.2)	Condition	a	B
Fore region	f □12	30	230
	f >12	6	518
Midship and aft regions	f □12	8	214
	f >12	2	286

f : Coefficient to be obtained from the following formula:

$f = \sqrt{\Delta P}/1000$

□ Displacement, in t, at the maximum ice class draught (see Sec 1, 2.1.1)

P : Actual continuous output of propulsion machinery, in kW (see Sec 1, 3)

c_1 : Coefficient taking account of the probability of the design ice pressure occurring in a particular region of the hull for the additional class notation considered, defined in Tab 3.3

Table 3.3 : Coefficient c1

Region (see 1.2)	Notation				
	ICE CLASS IA SUPER	ICE CLASS IA	ICE CLASS IB	ICE CLASS IC	ICE CLASS ID
Fore region	1.0	1.0	1.0	1.0	1.0
Midship region	1.0	0.85	0.70	0.50	not applicable
Aft region	0.75	0.65	0.45	0.25	not applicable

c_a : Coefficient taking account of the probability that the full length of the area under consideration will be under pressure at the same time, to be obtained from the following formula:

$c_a=(47-5l_a)/44$

without being taken less than 0.6 or greater than 1.0

l_a : Distance, in m, defined in Tab 3.4

p_o : Nominal ice pressure, in N/mm^2, to be taken equal to 5.6.

Table 3.4 : Distance la

Structure	Type of framing	*L*a
Shell plating	Transverse	Spacing of ordinary stiffeners
	Longitudinal	Two spacings of ordinary stiffeners
ordinary stiffeners	Transverse	Spacing of ordinary stiffeners
	Longitudinal	Span of ordinary stiffeners
Vertical primary Supporting members		Two spacings of vertical primary supporting members
Ice side girders		Span of side girders

4 Hull scantlings

4.1 Plating

4.1.1 General

The plating thickness is to be strengthened according to 4.1.2 within the strengthened area for plating defined in 1.3.

In addition, the plating thickness is to be strengthened in the following cases:

- For the notation ICE CLASS IA SUPER, the thickness within the fore foot is to be not less than that required for the ice strengthened area in the midship region

- For the notations ICE CLASS IA SUPER or ICE CLASS IA, on ships with an open water service speed equal to or exceeding 18 knots, the thickness of plating within the upper fore ice strengthened area is to be not less than that required for the ice strengthened area in the midship region. A similar strengthening of the bow region is to be considered for a ship with a lower service speed, when it is, e.g. on the basis of the model tests, evident that the ship will have a high bow wave.

4.1.2 Plating thickness in the ice strengthened area

The thickness of the shell plating is to be not less than the value obtained, in mm, from the following formulae:

- for transverse framing:

$$t = 667 s \sqrt{\frac{F_1 P_{PL}}{R_{eH}}} + t_c$$

- for longitudinal framing:

$$t = 667 s \sqrt{\frac{F_1 P_{PL}}{F_2 R_{eH}}} + t_c$$

where:

p_{PL} : Ice pressure on the shell plating to be obtained, in N/mm^2, from the following formula:

$p_{PL} = 0.75$ p

p : Design ice pressure, in N/mm^2, defined in 3.2.2

F_1 : Coefficient to be obtained from the following formula:

$$F_1 = 1.3 - \frac{4.2}{[h/s + 1.8]^2}$$

without being taken greater than 1.0

F_2 : Coefficient to be obtained from the following formulae:

- for h/s □1.0:

$F_2 = 0.6 + 0.4 s/h$

- for 1.0 < h/s < 1.8:

$F_2 = 1.4 - 0.4 h/s$

h : Height, in m, of load area defined in 3.2.1

t_c : Abrasion and corrosion addition, in mm, to be taken equal to 2 mm; where a special surface coating, shown by experience to be capable of withstanding the abrasion of ice, is applied, a lower value may be accepted by the Society on a case-by-case basis.

4.2 Ordinary stiffeners

4.2.1 General

Ordinary stiffeners are to be strengthened according to 4.2.2 within the strengthened area for ordinary stiffeners defined in 1.3.

Where less than 15% of the span l of the ordinary stiffener is situated within the ice-strengthening zone for ordinary stiffeners as defined in Tab 1.2, their scantlings may be determined according to Pt III, Ch 2, as applicable.

4.2.2 Scantlings of transverse ordinary stiffeners

The section modulus of transverse ordinary stiffeners is to be not less than the value obtained, in cm3, from the following formula:

$$w = \frac{7-5(h/l)}{7m_o}\frac{pshl}{R_{eH}}10^6$$

where:

p : Design ice pressure, in N/mm^2, defined in 3.2.2

h : Height, in m, of load area defined in 3.2.1

m_0 : Coefficient defined in Tab 4.1.

4.2.3 Scantlings of longitudinal ordinary stiffeners

The section modulus w, in cm^3 and the shear area A_{Sh} , in cm^2, of longitudinal ordinary stiffeners are to be not less than the values obtained from the following formulae:

$$z = \frac{F_3 F_4 phl^2}{m_1 R_{eH}}10^6$$

$$A_{sh} = \frac{0.87 F_3 phl}{R_{eH}}10^4$$

where:

F_3 : Coefficient, taking account of the load distribution on adjacent ordinary stiffeners, to be obtained from the following formula:

F_3=(1-0.2h/s)

h : Height, in m, of load area defined in 3.2.1

F_4 : Coefficient taking account of the concentration of load on the point of support, to be taken equal to 0.6

p : Design ice pressure, in N/mm^2, defined in 3.2.2

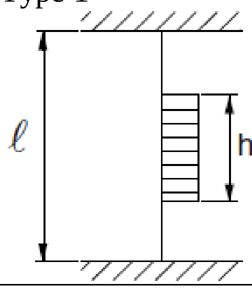
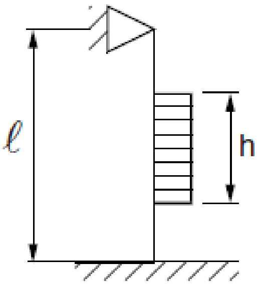
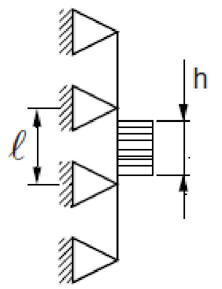
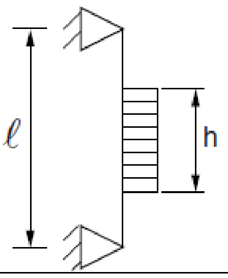
s : Spacing, in m, of longitudinal ordinary stiffeners.

The spacing is not to exceed the following values:

- 0.35m for the notations ICE CLASS IA SUPER and ICE CLASS IA
- 0.45m for the notations ICE CLASS IB, ICE CLASS IC and ICE CLASS ID

m_1 : Boundary condition coefficient for the ordinary stiffener considered, to be taken equal to 13.3 for a continuous beam; where the boundary conditions deviate significantly from those of a continuous beam, e.g. in an end field, a smaller boundary condition coefficient may be required.

Table 4.1 : Coefficient m0

Boundary conditions	Example	m_0
Type 1 	Frames in a bulk carrier with top wing tanks	7.0
Type 2 	Ordinary stiffeners extending from the tank top to a single deck	6.0
Type 3 	Continuous ordinary stiffeners between several decks or side girders	5.7
Type 4 	Ordinary stiffeners extending between two decks only	5.0

Note 1: The boundary conditions are those for the main and intermediate ordinary stiffeners.

Note 2: Load is applied at mid-span.

4.3 Primary supporting members

4.3.1 Ice side girders within the ice strengthened area

The section modulus w, in cm^3 and the section area A_{Sh} , in cm^2, of a side girder located within the ice strengthened area defined in 1.3 are to be not less than the values obtained from the following formulae:

$$w = \frac{F_5 phl^2}{m_s R_{eH}} 10^6$$

$$A_{sh} = \frac{0.87 F_5 phl}{R_{eH}} 10^4$$

where:

p : Design ice pressure, in N/mm^2, defined in 3.2.2

h : Height, in m, of load area defined in 3.2.1, without the product *ph* being taken less than 0.3

m_S : Boundary condition coefficient for the ordinary stiffener considered, to be taken equal to 13.3 for a continuous beam

F_5 : Factor which takes account of the distribution of load to the transverse frames; to be taken as 0.9

l_F : Span of ordinary stiffeners, in m

s_F : Ordinary stiffeners spacing, in m

J_F : Moment of inertia of ordinary stiffeners, in cm^4

J : Moment of inertia of the side girder, in cm^4

n : Number of ordinary stiffeners crossing the ice side girder.

4.3.2 Ice side girders outside the ice strengthened area

The section modulus w, in cm^3 and the section area A_{Sh}, in cm^2, of a side girder located outside the ice strengthened area, defined in 1.3, but supporting ice strengthened ordinary stiffeners are to be not less than the values obtained from the following formulae:

$$w = \frac{F_6 phl^2}{m_s R_{eH}} (1 - h_s / l_s) 10^6$$

$$A_{sh} = \frac{0.87 F_6 phl}{R_{eH}} (1 - h_s / l_s) 10^4$$

where:

p : Design ice pressure, in N/mm^2, defined in 3.2.2

h : Height, in m, of load area defined in 3.2.1, without the product ph being taken less than 0.3

m_S : Coefficient defined in 4.3.1

F_6 : Factor which takes account of load to the transverse frames; to be taken as 0.95

h_S : Distance to the ice strengthened area, in m

l_S : Distance to the adjacent ice side girder, in m.

4.3.3 Vertical primary supporting member checked through simplified model

For vertical primary supporting members which may be represented by the structure model represented in Fig 4.1, the section modulus w, in cm^3, and the shear area A_{Sh}, in cm^2, are to be not less than the values obtained from the following formulae:

$$W = \frac{k_2 F l}{R_{eH}} \left(\frac{1}{1-(\nu A_{sh1}/A_a)^2} \right)^{1/2} 10^3$$

$$A_{sh} = \frac{17.3 \alpha k_1 F}{R_{eH}}$$

where:

k_2 : Coefficient to be obtained from the following formula:

$$k_2 = .5\left(\frac{l_F}{l}\right)^3 - 1.5\left(\frac{l_F}{l}\right)^2 + \left(\frac{l_F}{l}\right)$$

F : Load transferred to a vertical primary supporting member from a side girder or from longitudinal ordinary stiffeners, to be obtained, in kN, from the following formula:

$F = p\ h\ s\ 10^3$

In the case the supported stringer is outside the ice belt, the force F is to be multiplied by:

$(1 - h_S / l_S)$, where h_S and l_S are to be taken as defined in 4.3.2

p : Design ice pressure, in N/mm^2, defined in 3.2.2, where the value of c_a is to be calculated assuming l_a equal to 2s

h : Height, in m, of load area defined in 3.2.1, without the product ph being taken less than 0.3

ν : Coefficient defined in Tab 4.2

ASh1 : Shear area, in cm^2, to be calculated as specified for ASh , taking:

$$k_1 = 1 + 0.5\left(\frac{l_F}{l}\right)^3 - 1.5\left(\frac{l_F}{l}\right)^2$$

A_a : Actual cross-sectional area of the vertical primary supporting member

□: Coefficient defined in Tab 4.2

k_1 : Coefficient to be taken as the greater of the values obtained from the following formulae:

$$k_1 = 1 + 0.5\left(\frac{l_F}{l}\right)^3 - 1.5\left(\frac{l_F}{l}\right)^2$$

$$k_1 = 1.5\left(\frac{l_F}{l}\right)^2 - 0.5\left(\frac{l_F}{l}\right)^3$$

l_F : Distance, in m, as indicated in Fig 4.1; for the lower part of the vertical primary supporting member the smallest l_F within the ice strengthened area is to be used and for the upper part of the vertical primary supporting member the largest l_F within the ice strengthened area is to be used.

Figure 4.1 : Reference structure model

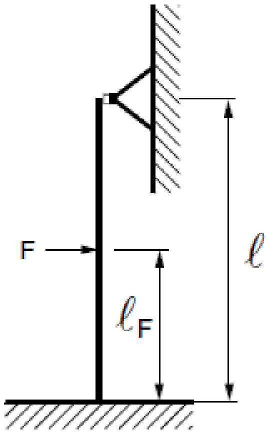


Table 4.2 : Coefficients □, ν

A_F/A_W	□	ν
0.20	1.23	0.44
0.40	1.16	0.62
0.60	1.11	0.71
0.80	1.09	0.76
1.00	1.07	0.80
1.20	1.06	0.83
1.40	1.05	0.85
1.60	1.05	0.87
1.80	1.04	0.88
2.00	1.04	0.89

Note 1:

AF : Cross-sectional area of the face plate,

AW : Cross-sectional area of the web.

4.3.4 Vertical primary supporting member checked through direct calculations

For vertical primary supporting member configurations and boundary conditions other than those indicated in 4.3.3, a direct stress calculation is to be performed where:

- the concentrated load F on the vertical primary supporting member is to be taken as defined in 4.3.3
- the point of application is to be taken so as to obtain the maximum shear and bending moment, according to the arrangement of side girders and longitudinal ordinary stiffeners.

For all types of models, it is to be checked that:

$$\sigma \le R_{eH}$$

$$\tau \le R_{eH} / \sqrt{3}$$

$$\sigma_{VM} \le R_{eH}$$

where:

σ: Calculated normal stress, in N/mm^2

τ: Calculated shear stress, in N/mm^2

σ_{VM} : Calculated combined stress to be obtained, in N/mm^2, from the following formula:

$$\sigma_{VM} = \sqrt{\sigma^2 + 3\tau^2}$$

5 Other structures

5.1 Application

5.1.1 The requirements in 5.3 and 5.4 do not apply for the assignment of the ICE CLASS ID.

5.2 Fore part

5.2.1 Stem

The stem may be made of rolled, cast or forged steel or of shaped steel plates.

A sharp edged stem (see Fig 5.1) improves the manoeuvrability of the ship in ice and is particularly recommended for smaller ships under 150 m in length.

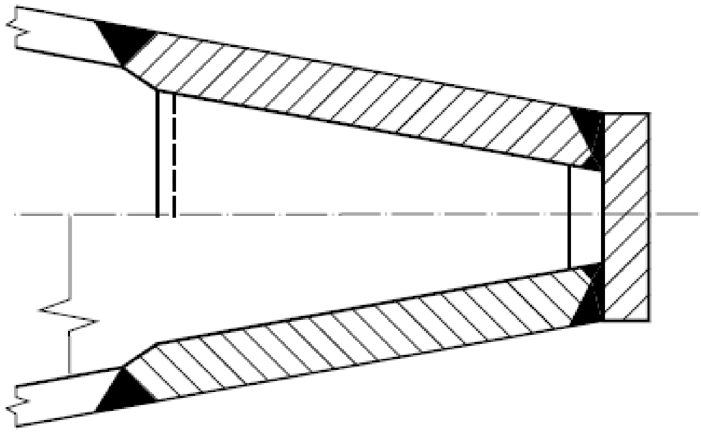
The plate thickness of a shaped plate stem and, in the case of a blunt bow, any part of the shell which forms an angle of 30° or more to the centreline in a horizontal plane, is to be not less than that calculated in 4.1.2 assuming that:

- s is the spacing of elements supporting the plate, in m
- p_{PL} , in N/mm^2, is taken equal to p, defined in 3.2.2, with la being the spacing of vertical supporting elements, in m.

The stem and the part of a blunt bow defined above are to be supported by floors or brackets spaced not more than 600 mm apart and having a thickness at least half that of the plate.

The reinforcement of the stem is to be extended from the keel to a point 0.75 m above the UIWL or, where an upper fore ice strengthened area is required (see 1.3), to the upper limit of the latter.

Figure 5.1 : Sharp edged stem - Example



5.2.2 Arrangements for towing

A mooring pipe with an opening not less than 250 mm by 300 mm, a length of at least 150 mm and an inner surface radius of at least 100 mm is to be fitted in the bow bulwark on the centreline.

A bit or other means of securing a towline, dimensioned to withstand the breaking strength of the shipۑs towline, is to be fitted.

On ships with a displacement less than 30000 t, the part of the bow extending to a height of at least 5 m above the UIWL and at least 3 m back from the stem is to be strengthened to withstand the stresses caused by fork towing. For this purpose, intermediate ordinary stiffeners are be fitted and the framing is to be supported by stringers or decks.

Note 1: It is to be noted that for ships of moderate size (displacement less than 30000 t), fork towing is, in many situations, the most efficient way of assisting in ice. Ships with a bulb protruding more than 2.5 m forward of the forward perpendicular are often difficult to tow in this way. The Administrations reserve the right to deny assistance to such ships if the situation warrants such a decision.

5.3 Aft part

5.3.1 An extremely narrow clearance between the propeller blade tip and the sternframe is to be avoided so as not to generate very high loads on the blade tip.

5.3.2 On twin and triple screw ships, the ice strengthening of the shell and framing is to be extended to the double bottom for at least 1.5 m forward and aft of the side propellers.

5.3.3 Shafting and sterntubes of side propellers are generally to be enclosed within plated bossings. If detached struts are used, their design, strength and attachment to the hull are to be examined by the Society on a case-by-case basis.

5.3.4 A wide transom stern extending below the UIWL seriously impedes the capability of the ship to run astern in ice, which is of paramount importance.

Consequently, a transom stern is not normally to be extended below the UIWL. Where this cannot be avoided, the part of the transom below the UIWL is to be kept as narrow as possible.

The part of a transom stern situated within the ice strengthened area is to be strengthened as required for the midship region.

5.3.5 Where azimuth propulsion systems are fitted, the increase in ice loading of the aft region and the stern area is to be considered in the design of the aft/stern structure, on a case-by-case basis by the Society.

5.4 Deck strips and hatch covers

5.4.1 Narrow deck strips abreast of hatches and serving as ice side girders are to comply with the section modulus and shear area calculated in 4.3.1 and 4.3.2, respectively. In the case of very long hatches, the product ph is to be taken less than 0.30 but in no case less than 0.20. Special attention is to be paid when designing weather deck hatch covers and their fittings to the deflection of the ship sides due to ice pressure in way of very long hatch openings.

5.5 Sidescuttles and freeing ports

5.5.1 Sidescuttles are not to be located in the ice strengthened area.

5.5.2 Freeing ports are to be given at least the same strength as is required for the shell in the ice belt.

6 Hull outfitting

6.1 Rudders and steering arrangements

6.1.1 The scantlings of the rudder post, rudder stock, pintles, steering gear, etc. as well as the capacity of the steering gear are to be determined according to Pt III, Ch 2, Sec 14.

The speed to be used in these calculations is the greater of the maximum ahead service speed and the reference speed indicated in Tab 6.1. When using the reference speed indicated in Tab 6.1, the coefficient k_c, defined in Pt III, Ch 2, Sec 14 is to be taken not greater than 1.1 irrespective of the rudder type profile.

Within the ice strengthened zone, the thickness of rudder plating and diaphragms is to be not less than that required for the shell plating of the aft region.

Table 9 : Reference speed

Notation	Reference speed (knots)
ICE CLASS IA SUPER	20
ICE CLASS IA	18
ICE CLASS IB	16
ICE CLASS IC	14
ICE CLASS ID	14

6.1.2 For the notations ICE CLASS IA SUPER or ICE CLASS IA, the rudder stock and the upper edge of the rudder are to be protected against ice pressure by an ice knife or equivalent means.

6.2 Bulwarks

6.2.1 If the weather deck in any part of the ship is situated below the upper limit of the ice strengthened area (e.g. in way of the well of a raised quarter deck), the bulwark is to be reinforced at least to the standard required for the shell in the ice strengthened area.

Section 3 Machinery

1 Propulsion

1.1 Propulsion machinery performance

1.1.1 The engine output P is the maximum output that the propulsion machinery can continuously deliver. If the output of the machinery is restricted by technical means or by any regulations applicable to the ship, P is to be taken as the restricted output. In no case may P be less than the values calculated in accordance with Sec 1, 3.1.

1.2 Ice torque

1.2.1 For the scantlings of propellers, shafting and reverse and/or reduction gearing, the effect of the impact of the propeller blades against ice is also to be taken into account.

The ensuing torque, hereafter defined as ice torque, is to be taken equal to the value M_G, in Nm, calculated by the following formula:

$M_G = m D^2$

where:

m : Coefficient whose value is given in Tab 1.1, depending upon the class notation requested

D : Propeller diameter, in m.

In cases of propellers with nozzles or of considerably submerged propellers, the value of the ice torque may be taken equal to that corresponding to the next lower ice class notation than that requested for the ship, at the discretion of the Society.

Note 1: In the case of ships with class notation Ice class ID, this requirement does not apply to reduction gears.

Table 1.1 : Coefficient m

Ice class notation	IAS	IA	IB	IC	ID
m	21000	15700	13000	12000	10000 (1)

(1) Except for reduction gears, for which m = 0.

1.3 Starting arrangements for propulsion machinery

1.3.1 In addition to complying with the provisions of Pt IV, Ch 1, Sec 11, 17.3, ships with the ice class notation IAS are to have air starting compressors capable of charging the air receivers in half an hour, where their propulsion engines need to be reversed in order to go astern.

1.4 Propellers

1.4.1 Material

The percentage elongation after fracture, measured with a proportional type tensile specimen, of materials used for propellers is to be not less than 19%. Materials other than copper alloys are to be Charpy V-notch impact tested at a temperature of -10°C with a minimum average energy not less than 21 J, unless otherwise specified in Pt III of the rules.

1.4.2 Scantlings

When one of the notations IAS, IA, IB, IC or ID is requested, the width *l* and the maximum thickness t of the cylindrical sections of the propeller blades are to be such as to satisfy the conditions stated in a), b) and c) below.

a) CYLINDRICAL SECTIONS AT THE RADIUS OF 0.125D, for fixed pitch propellers:

$$lt^2 \geq \frac{26.5}{R_m\left[0.65+(0.7/\rho)\right]}\left(2.85\frac{M_T}{z}+2.24M_G\right)$$

b) CYLINDRICAL SECTIONS AT THE RADIUS OF 0,175D, for controllable pitch propellers:

$$lt^2 \geq \frac{21.1}{R_m\left[0.65+(0.7/\rho)\right]}\left(2.85\frac{M_T}{z}+2.35M_G\right)$$

c) CYLINDRICAL SECTIONS AT THE RADIUS OF 0,3D, both for fixed and controllable pitch propellers:

$$lt^2 \geq \frac{9.3}{R_m\left[0.65+(0.7/\rho)\right]}\left(2.85\frac{M_T}{z}+2.83M_G\right)$$

where:

l : Width of the expanded cylindrical section of the blade at the radius in question, in cm

t : Corresponding maximum blade thickness, in cm

ρ : D/H

D : Propeller diameter, in m

H : Blade pitch of propeller, in m, to be taken equal to:

- the pitch at the radius considered, for fixed pitch propellers
- 70% of the nominal pitch, for controllable pitch propellers

P : Maximum continuous power of propulsion machinery for which the classification has been requested, in kW

n : Speed of rotation of propeller, in rev/min, corresponding to the power P

M_T : Value, in N·m, of torque corresponding to the above power P and speed n, calculated as follows:

M_T =9550.P/n

z : Number of propeller blades

M_G : Value, in N·m, of the ice torque, calculated according to the formula given in 1.2

R_m : Value, in N/mm^2, of the minimum tensile strength of the blade material.

1.4.3 Minimum thickness of blades

When the blade thicknesses, calculated by the formulae given in Pt IV, Ch 1, Sec 8 are higher than those calculated on the basis of the formulae given in 1.4.2, the higher values are to be taken as rule blade thickness.

1.4.4 Minimum thickness at top of blade

The maximum thickness of the cylindrical blade section at the radius 0.475 D is not to be less than the value t_1, in mm, obtained by the following formulae:

a) for ships with the ice class notation IAS:

$$t_1 = (20 + 2D)\left(490 / R_m\right)^{0.5}$$

b) For ships with the ice class notations IA, IB, IC or ID:

$$t_1 = (15 + 2D)\left(490 / R_m\right)^{0.5}$$

In the formulae above, D and Rm have the same meaning as specified in 1.4.2.

1.4.5 Blade thickness at intermediate sections

The thickness of the other sections of the blade is to be determined by means of a smooth curve connecting the points defined by the blade thicknesses calculated by the formulae given in 1.4.2 and 1.4.4.

1.4.6 Thickness of blade edge

The thickness of the whole blade edge, measured at a distance from the edge itself equal to 1.25 t_1 (t_1 being the blade thickness as calculated by the appropriate formula given in 1.4.4), is to be not less than 0.5 t_1.

For controllable pitch propellers, this requirement is applicable to the leading edge only.

1.4.7 Controllable pitch propeller actuating mechanism

The strength of the blade-actuating mechanism located inside the controllable pitch propeller hub is to be not less than 1.5 times that of the blade when a force is applied at the radius 0.45D in the weakest direction of the blade.

1.5 Shafting

1.5.1 Propeller shafts

a) When one of the notations IAS, IA, IB, IC or ID is requested, the diameter of the propeller shaft at its aft bearing is not to be less than the value P , in mm, calculated by the following formula:

$$d_P = K_E \left(\frac{WR_m}{R_{S,MIN}} \right)^{1/3}$$

where:

K_E : K_E = 10.8 for propellers having hub diameter not greater than 0.25 D

- K_E = 11.5 for propellers having hub diameter greater than 0.25 D

W : Value, in cm^3, equal to $l\ t^2$, proposed for the section at the radius:

- - 0.125 D for propellers having the hub diameter not greater than 0.25 D
- - 0.175 D for propellers having the hub diameter greater than 0.25 D

R_m : Value, in N/mm^2, of the minimum tensile strength of the blade material

$R_{S,MIN}$: Value, in N/mm^2, of the minimum yield strength (R_{eH}) or 0.2% proof stress ($R_{p\ 0.2}$) of

the propeller shaft material.

b) Where the diameter of the propeller shaft, as calculated by the formula given in Pt IV, Ch1, Sec 7, is greater than that calculated according to the formula given in a) above, the former value is to be adopted.

c) Where a cone-shaped length is provided in the propeller shaft, it is to be designed and arranged in accordance with the applicable requirements of Pt IV, Ch 1, Sec 7.

d) Propeller shafts are to be of steel having impact strength as specified in Part II of the rules.

1.5.2 Intermediate shafts

a) The diameter of intermediate shafts and thrust shafts outside bearings is not to be less than 1. d for ships with the ice class notation IAS, d being the rule diameter as calculated by the rules in Pt IV, Ch 1, Sec 7.

b) In the case of ships for which one of the other notations IA, IB, IC or ID is requested, no rule diameter increase of intermediate and thrust shafts is generally required.

1.6 Reverse and reduction gearing

1.6.1 Where a reduction gear is provided between the propelling machinery and the propeller, it is to be in accordance with the provisions of Pt IV, Ch 1, Sec 6, and designed to transmit the torque M' in Nm, given by the following formula:

$$M' = M_T + \frac{M_G I_h u^2}{I_l + I_h u^2}$$

where:

M_T : Nominal torque, in Nm, as determined in 1.4.2

M_G : Ice torque, in Nm, as determined in 1.2

u : Gear ratio (pinion speed / wheel speed)

I_h : Mass moment of inertia of machinery components rotating at higher speed

Note 1: where the propulsion line is fitted with a slipping coupling device, the higher speed components to be taken into account could be subject to due consideration.

I_l : Mass moment of inertia of machinery components rotating at lower speed, including propeller with an addition of 30% for entrained water.

I_h and I_l are to be expressed in the same units.

2 Miscellaneous requirements

2.1 Sea inlets, ballast systems and cooling water systems of machinery

2.1.1

a) The cooling water system is to be designed to ensure the supply of cooling water also when navigating in ice.

b) For this purpose, for ships with the notation IA SUPER, IA, IB, IC or ID, at least one sea water inlet chest is to be arranged and constructed as indicated hereafter:

1) The sea inlet is to be situated near the centreline of the ship and as aft as possible.

2) As guidance for design, the volume of the chest is to be about one cubic metre for every 750 kW of the aggregate output of the engines installed on board, for both main propulsion and essential auxiliary services.

3) The chest is to be sufficiently high to allow ice to accumulate above the inlet pipe.

4) A pipe for discharging the cooling water, having the same diameter as the main overboard discharge line, is to be connected to the inlet chest.

5) The area of the strum holes is to be not less than 4 times the inlet pipe sectional area.

c) Where there are difficulties in satisfying the requirements of items b) 2) and b) 3) above, alternatively two smaller chests may be accepted, provided that they are located and arranged as stated in the other provisions above.

d) Heating coils may be installed in the upper part of the chests.

e) Arrangements for using ballast water for cooling purposes may be accepted as a reserve in ballast conditions but are not acceptable as a substitute for the sea inlet chests as described above.

f) Where required by Sec 1, 2.2.2, the ballast tanks are to be provided with suitable devices to prevent the water from freezing, which shall be so designed as to avoid any ice formation in the tank which may be detrimental to the tank. For that purpose, the following may be accepted:

- heating systems by heating coils within ballast tanks
- internal circulating/pumping systems
- bubbling systems
- steam injection systems.

Where bubbling systems are applied, following shall be complied with:

- sufficient number of air nozzles is to be distributed along the shell side bottom
- the maximum air pressure induced in the tank is not to exceed the design pressure of tank structure

- exposed vent pipe and vent heads shall be protected from possible blocking by ice
- if the bubbling systems is not supplied by a dedicated compressed air plant, the general service air system may be used for that purpose if justified that its capacity takes into account the air consumption of the bubbling system.

g) Where ballast water exchange at sea is accepted as a process for the treatment of ballast water, ship side ballast discharge valves are to be protected from freezing in accordance with Pt IV, Ch 1, Sec 11, 7.3.3). Suitable protection shall be provided also for ballast tanks vent heads, as well as for ballast overflows where existing.

2.2 Steering gear

2.2.1

a) In the case of ships with the ice class notations IAS and IA, due regard is to be paid to the excessive loads caused by the rudder being forced out of the centreline position when backing into an ice ridge.

b) Effective relief valves are to be provided to protect the steering gear against hydraulic overpressure.

c) The scantlings of steering gear components are to be such as to withstand the yield torque of the rudder stock.

d) Where possible, rudder stoppers working on the blade or rudder head are to be fitted.

2.3 Fire pumps

2.3.1 The suction of at least one fire pump is to be connected to a sea inlet protected against icing.

2.4 Transverse thrusters

2.4.1 Tunnels of transverse thrusters are to be fitted with grids for protection against ice impacts.

Chapter 20 Additional Class Notations

Section 1 In Water Survey Arrangement (INWATERSURVEY)

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this section are eligible for the assignment of the additional notation INWATERSURVEY.

Underwater Inspection in lieu of drydocking Survey may be restricted or limited where there is record or indication of abnormal deterioration, existing recommendation, or damage to underwater body, rudder, or propeller.

1.1.2 Non-ESP vessels 15 years of age or over applying to maintain their INWATERSURVEY notation are subject to special consideration based on the following review and examination before being permitted to have underwater inspection:

- Review of vessel's records to ensure that no unusual repairs have been required/made
- Internal examination of representative tanks and cargo holds

1.1.3 INWATERSURVEY may not be applicable if there are outstanding recommendations for repairs to propeller, rudder, stern frame, underwater structure, or sea valves. It may also be inapplicable if damage affecting the fitness of the vessel is found during the course of the survey.

1.2 Documentation to be submitted

1.2.1 Plans

Detailed plans of the hull and hull attachments below the waterline are to be submitted to the Society in triplicate for approval. These plans are to indicate the location and/or the general arrangement of:

- all shell openings
- the stem
- rudder and fittings
- the sternpost
- the propeller, including the means used for identifying each blade
- anodes, including securing arrangements
- bilge keels
- welded seams and butts.

The plans are also to include the necessary instructions to facilitate the divers' work, especially for taking clearance measurements.

Documents indicating implementation of appropriate corrosion prevension system e.g. the thickness of coating applied and specification of installed sacrifing anodes.

Moreover, a specific detailed plan showing the systems to be adopted when the ship is floating in order to assess the slack between pintles and gudgeons is to be submitted to the Society in triplicate for approval.

1.2.2 Photographs

As far as practicable, photographic documentation of the following hull parts, used as a reference during the in-water surveys, is to be submitted to the Society:

- the propeller boss
- rudder pintles, where slack is measured
- typical connections to the sea
- directional propellers, if any
- other details, as deemed necessary by the Society on a case-by-case basis.

1.2.3 Documentation to be kept on board

The Owner is to keep on board the ship the plans and documents listed in 1.2.1 and 1.2.2, and they are to be made available to the Surveyor and the divers when an inwater survey is carried out.

2 Structural Features

2.1 Marking

Identification marks and systems are to be supplied to facilitate the in-water survey. In particular, the positions of transverse watertight bulkheads are to be marked on the hull.

2.2 Rudder arrangements

Means and access are to be provided to determine the condition and clearance of the rudder bearings, and verify that all parts of the pintle and gudgeon assemblies are intact and secure. This may require bolted access plates and a measuring arrangement.

Where it is deemed impractical, clearance verification on the rudder pintle may be dispensed with if the attending Surveyor is satisfied with the physical condition and securing arrangements of the pintle, the operating history and the onboard testing. These considerations are to be included in the proposals for INWATERSURVEY.

2.3 Tailshaft arrangements

2.3.1 Tailshaft arrangements are to be such that clearances (or wear down by poker gauge) can be checked.

2.3.2 Stern Bearing

i) Means are to be provided to ascertain that the seal assembly remains intact on oil-lubricated bearings and to verify that the clearance or weardown is within limits on the stern bearing

ii) For oil-lubricated bearings, this may require the review of operating history and onboard testing including accurate oil-loss records and a check of the oil for contamination by sea water or white metal and/or oil sample reports (considerations are to be included in the proposals for NWATERSURVEY). For wood or rubber bearings, an opening in the top of the rope guard and a suitable gauge or wedge is sufficient for checking the clearance.

iii) Any doubt on wear-down of oil-lubricated metal stern bearings from above is to be further checked by external measurements or by the vessel's wear-down gauge, where the gauge wells are located outboard of the seals or the vessel can be tipped. For use of the wear-down gauges, up-to-date records of the base depths are to be maintained onboard the vessel. Whenever the stainless steel seal sleeve is renewed or machined, the base readings for the wear-down gauge are to be re-established and noted in the vessel's records and in the survey report.

2.4 Sea inlets and cooling water systems of machinery

Means should be provided to enable the diver to confirm that the sea suction openings are clear. Hinged sea suction grids will facilitate this operation, preferably with revolving weight balance or with a counter weight, and secured with bolts practical for dismantling and fitting while the ship is afloat.