2012

Rules for the Classification of Steel Ships

Part 7 Ships of Special Service (Ch 5, 6)

Rules

2012

Guidance Relating to the Rules for the Classification of Steel ships

Part 7 Ships of Special Service (Ch 5, 6)

Guidance

2012

Rules for the Classification of Steel Ships

Part 7

Ships of Special Service

Chapter 5 Ships Carrying Liquefied Gases in Bulk
Chapter 6 Ships Carrying Dangerous Chemicals in Bulk

RA-07B-E

KOREAN REGISTER OF SHIPPING

APPLICATION OF PART 7 "SHIPS OF SPECIAL SERVICE(CH 5, 6)"

1. Unless expressly specified otherwise, the requirements in the Rules apply to ships for which contracts for construction are signed on or after 1 July 2012.

2. The amendments to the Rules for 2011 edition and their effective date are as follows;

Effective Date 1 July 2012

No Revision(Re-printed).

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CHAPTER 5 SHIPS CARRYING LIQUEFIED GASES IN BULK

Section 1 General

101. Application (IGC Code 1.1)

1. The requirements in this Chapter apply to ships constructed on or after 1 July 1998. Ships constructed before 1 July 1998 are subject to the requirements of IMO Res. MSC. 5(48) adopted on 17 June 1983 and its additional amendments. Ships constructed before 1 July 1986 are subject to the requirements of IMO Res. A. 328(IX) and its additional amendments and ships constructed before 1 November 1976 are to comply with the requirements of IMO Res. A. 329(IX). **802. 18** and **Sec 15** apply to all ships carrying liquefied gases in bulk regardless of the date of construction. Ships constructed before 1 July 1986 and not having the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, are to comply with the special requirements given by the Society.

2. The requirements in this Chapter apply to ships carrying liquefied gases in bulk (hereinafter referred to as a "ship" in this Chapter) intended to be registered and classed with the Society. The term "liquefied gases" means liquefied gases having an absolute vapour pressure exceeding 0.28 MPa at a temperature of 37.8°C, and other similar flammable products as shown in **Sec 19.**

3. The construction and equipment of ships for carriage of such liquefied gases which are not designated in **Sec 19** are to be to the satisfaction of the Society.

4. For ships to be classed for restricted service and ships not provided with propulsive machinery, the requirements may be modified as appropriate.

5. The ship's hull, machinery and equipment not specified in this Chapter are generally to comply with the requirements in the relevant Chapters of these Rules.

6. When it is intended to carry products covered by this Chapter and products covered by **Ch 6,** the ship should comply with the requirements of both Chapters appropriate to the products carried. However, when a ship is designed and constructed for the carriage of the products listed exclusively in **Sec 19,** the requirements of this Chapter should take precedence.

7. The Society may be subject to IMO decisions which would be different from the requirements of this Chapter.

102. Approval for plans

For classification survey during construction, the following plans and documents as may be required depending upon the products intended to be loaded, condition of cargo storage, construction of cargo containment system and other design conditions are to be submitted in triplicate before the work is commenced.

1. Plans and data for approval

(1) Manufacturing specifications for cargo tanks, insulations and secondary barriers (including welding procedures, inspection and testing procedures for weld and cargo tanks, properties of insulation materials and secondary barriers and their processing manual and working standards)
(2) Details of cargo tank construction
(3) Arrangement of cargo tank accessories including details of fittings inside the tanks
(4) Details of cargo tank supports, deck portions through which cargo tanks penetrate, and their sealing devices
(5) Details of secondary barriers
(6) Specifications and standards of materials (including insulations) used for cargo piping system in connection with design pressure and/or temperature
(7) Specifications and standards of materials of cargo tanks, insulations, secondary barriers and cargo tank supports
(8) Layout and details of attachment for insulations
(9) Constructions of cargo pumps, cargo compressors and their prime movers
(10) Constructions of main parts of refrigeration systems

(11) Piping diagrams of cargo and instrument
(12) Piping diagrams of refrigerant for refrigeration systems
(13) Bilge arrangements and ventilation systems in hold spaces or interbarrier spaces, cargo pump room, cargo compressor room and cargo control room
(14) Arrangement of sensors for gas detectors, temperature indicators, and pressure gauges
(15) Diagrams of inert gas lines and details of pressure adjusting devices, where hold spaces or interbarrier spaces are filled by inert gases
(16) Details of pressure relief devices and drainage systems for leakage of liquefied cargo in hold spaces or interbarrier spaces
(17) Sectional assembly, details of nozzles, fitting arrangement and details of fittings for various pressure vessels
(18) Details of valves for special purpose, cargo hoses, expansion joints, filters, etc., for cargo piping system
(19) Piping diagram, constructions and particulars of utilization units, where cargo is used as fuel
(20) Electric wiring plans and a table of electrical equipment in dangerous spaces
(21) Arrangement of earth connections for cargo tanks, pipe lines, machinery, equipment, etc.
(22) Plans showing dangerous spaces
(23) Fire extinguishing system stipulated in **Sec 11.**

2. Plans and data for reference

(1) Principal basic design and technical reports of cargo containment systems
(2) Data of test method and its result, where model test is carried out in compliance with the requirements of **Sec 4.**
(3) Data for notch toughness, corrosiveness, physical and mechanical properties of materials and welded parts at the minimum design temperature and room temperature, where new materials or welding methods are adopted for constructing the cargo tanks, secondary barriers, insulations and others
(4) Data of design loads stipulated in **403.**
(5) Calculation sheets of cargo tanks and supports stipulated in **404.** to **406.**
(6) Data of the test method and the results, where model tests were carried out to demonstrate the strength and performance of cargo tanks, insulations, secondary barriers, cargo tank supports
(7) Calculation sheets of heat transfer on the main parts of cargo tank under various condition of loading, where considered necessary by the Society.
(8) Calculation sheets of the thermal stress on the main parts of cargo tank at the condition of the temperature distribution stipulated in (7), where considered necessary by the Society
(9) Calculation sheets of temperature distribution on hull structure, where considered necessary by the Society
(10) Specifications of cargo handling systems
(11) Composition and physical properties of cargoes (including a saturated vapour pressure diagram within the necessary temperature range)
(12) Calculation sheets of relieving capacity for pressure relief valves of cargo tank (including calculation of the back pressure in cargo vent system)
(13) Calculation sheets for capacity of refrigeration systems
(14) Cargo piping arrangement
(15) Calculation sheets of filling limits for cargo tanks
(16) Arrangement of access manholes stipulated in **305.** in cargo tank area and the guide for access through these manholes.
(17) Operation manual stipulated in **Sec 18.**
(18) Calculation for ship survival capability stipulated in **Sec 2.**
(19) Equipment for personnel protection stipulated in **Sec 14.**

103. Equivalents

The construction and equipment, etc. which do not fall under the provisions of this Chapter but are considered to be equivalent to those required in this Chapter will be accepted by the Society.

104. National regulations

For the construction and equipment of the ship, attention is to be paid to the requirements of the national regulations of the country in which the ship is registered and/or of the port which the ship intendes to visit.

105. Hazards (IGC Code 1.2)

Hazards of gases covered by this Chapter include fire, toxicity, corrosivity, reactivity, low temperature and pressure.

106. Definitions (IGC Code 1.3)

The definitions of terms are to be as specified in the following and **Sec 4,** unless otherwise specified elsewhere.

1. "**Accommodation spaces**" are those spaces used for public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, games and hobbies rooms, barber shops, pantries containing no cooking appliances and similar spaces. Public spaces are those portions of the accommodation which are used for halls, dining rooms, lounges and similar permanently enclosed spaces.

2. "**A class divisions**" are those divisions formed by bulkheads and decks which comply with the following criteria:

(1) they are constructed of steel or other equivalent material;
(2) they are suitably stiffened;
(3) they are insulated with approved non-combustible materials such that the average temperature of the unexposed side will not rise more than 140 ℃ above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180 ℃ above the original temperature, within the time listed below:

class "A-60" 60 min
class "A-30" 30 min
class "A-15" 15 min
class "A-0" 0 min

(4) they are constructed as to be capable of preventing the passage of smoke and flame to the end of the one-hour standard fire test; and
(5) the Society has required a test of a prototype bulkhead or deck in accordance with the Fire Test Procedures Code to ensure that it meets the requirements above for integrity and temperature rise.

3. (1) "**Administration**" means the Government of the State whose flag the ship is entitled to fly.

(2) "**Port Administration**" means the appropriate authority of the country in the Port of which the ship is loading or unloading.

4. "**Boiling point**" is the temperature at which a product exhibits a vapour pressure equal to the atmospheric pressure.

5. "**Breadth (B)**" means the maximum breadth of the ship, measured amidships to the moulded line of the frame in a ship with a metal shell and to the outer surface of the hull in a ship with a shell of any other material. The breadth (B) should be measured in metres.

6. "**Cargo area**" is that part of the ship which contains the cargo containment system and cargo pump and compressor rooms and includes deck areas over the full length and breadth of the part of the ship over the above-mentioned spaces. Where fitted, 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.

7. "**Cargo containment system**" is the arrangement for containment of cargo including, where fitted, a primary and secondary barrier, associated insulation and any intervening spaces, and adjacent structure if necessary for the support of these elements. If the secondary barrier is part of the hull structure it may be a boundary of the hold space.

8. "**Cargo control room**" is a space used in the control of cargo handling operations and complying with the requirements of **304.**

9. "**Cargoes**" are products listed in **Sec 19** carried in bulk by ships subject to this Chapter.

10. "**Cargo service spaces**" are spaces within the cargo area used for workshops, lockers and store-rooms of more than 2 m^2 in area, used for cargo handling equipment.

11. "**Cargo tank**" is the liquid-tight shell designed to be the primary container of the cargo and includes all such containers whether or not associated with insulation or secondary barriers or both.

12. "**Cofferdam**" is the isolating space between two adjacent steel bulkheads or decks. This space may be a void space or a ballast space.

13. "**Control stations**" are those spaces in which ships" radio or main navigating equipment or the emergency source of power is located or where the fire-recording or fire-control equipment is centralized. This does not include special fire-control equipment which can be most practically located in the cargo area.

14. "**Flammable products**" are those identified by an "F" in column "f" in the table of **Sec 19.**

15. "**Flammability limits**" are the conditions defining the state of fuel-oxidant mixture at which application of an adequately strong external ignition source is only just capable of producing flammability in a given test apparatus.

16. "**Gas carrier**" is a cargo ship constructed or adapted and used for the carriage in bulk of any liquefied gas or other products listed in the table of **Sec 19.**

17. "**Gas-dangerous space or zone**" is:

(1) a space in the cargo area which is not arranged or equipped in an approved manner to ensure that its atmosphere is at all times maintained in a gas-safe condition;
(2) an enclosed space outside the cargo area through which any piping containing liquid or gaseous products passes, or within which such piping terminates, unless approved arrangements are installed to prevent any escape of product vapour into the atmosphere of that space;
(3) a cargo containment system and cargo piping;
(4) (a) a hold space where cargo is carried in a cargo containment system requiring a secondary barrier;
(b) a hold space where cargo is carried in a cargo containment system not requiring a secondary barrier;
(5) a space separated from a hold space described in (4) (a) by a single gastight steel boundary;
(6) a cargo pump room and cargo compressor room;
(7) a zone on the open deck, or semi-enclosed space on the open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo pipe flange or cargo valve or of entrances and ventilation openings to cargo pump rooms and cargo compressor rooms;
(8) the open deck over the cargo area and 3 m forward and aft of the cargo area on the open deck up to a height of 2.4 m above the weather deck;
(9) a zone within 2.4 m of the outer surface of a cargo containment system where such surface is exposed to the weather;
(10) an enclosed or semi-enclosed space in which pipes containing products are located. A space which contains gas detection equipment complying with **1306. 5** and a space utilizing boil-off gas as fuel and complying with **Sec 16** are not considered gas-dangerous spaces in this context;
(11) a compartment for cargo hoses; or
(12) an enclosed or semi-enclosed space having a direct opening into any gas-dangerous space or zone.

18. "**Gas-safe space**" is a space other than a gas-dangerous space.

19. "**Hold space**" is the space enclosed by the ship's structure in which a cargo containment system is situated.

20. "**Independent**" means that a piping or venting system, for example, is in no way connected to another system and there are no provisions available for the potential connection to other systems.

21. "**Insulation space**" is the space, which may or may not be an interbarrier space, occupied wholly or in part by insulation.

22. "**Interbarrier space**" is the space between a primary and a secondary barrier, whether or not completely or partially occupied by insulation or other material.

23. "**Length (L)**" means 96 % of the total length on a waterline at 85 % of the least moulded depth measured from the top of the keel, or the length from the foreside of the stem to the axis of the rudder stock on that waterline, if that be greater. In ships designed with a rake of keel, the waterline on which this length is measured should be parallel to the designed waterline. The length (L)

should be measured in metres.

24. "**Machinery spaces of category A**" are those spaces and trunks to such spaces which contain:

(1) internal combustion machinery used for main propulsion; or
(2) internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW; or
(3) any oil-fired boiler or oil fuel unit.

25. "**Machinery spaces**" are all machinery spaces of category A and all other spaces containing propelling machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces; and trunks to such spaces.

26. "**MARVS**" is the maximum allowable relief valve setting of a cargo tank.

27. "**Oil fuel unit**" is the equipment used for the preparation of oil fuel for delivery to an oil-fired boiler, or equipment used for the preparation for delivery of heated oil to an internal combustion engine, and includes any oil pressure pumps, filters and heaters dealing with oil at a pressure of more than 0.18 MPa gauge.

28. "**Organization**" is the International Maritime Organization (IMO).

29. "**Permeability**" of a space means the ratio of the volume within that space which is assumed to be occupied by water to the total volume of that space.

30. (1) "**Primary barrier**" is the inner element designed to contain the cargo when the cargo containment system includes two boundaries.

(2) "**Secondary barrier**" is the liquid-resisting outer element of a cargo containment system designed to afford temporary containment of any envisaged leakage of liquid cargo through the primary barrier and to prevent the lowering of the temperature of the ship's structure to an unsafe level. Types of secondary barrier are more fully defined in **Sec 4.**

31. "**Relative density**" is the ratio of the mass of a volume of a product to the mass of an equal volume of fresh water.

32. "**Separate**" means that a cargo piping system or cargo vent system, for example, is not connected to another cargo piping or cargo vent system. This separation may be achieved by the use of design or operational methods. Operational methods should not be used within a cargo tank and should consist of one of the following types:

(1) removing spool pieces or valves and blanking the pipe ends;
(2) arrangement of two spectacle flanges in series with provisions for detecting leak age into the pipe between the two spectacle flanges.

33. "**Service spaces**" are those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, store-rooms, workshops other than those forming part of the machinery spaces and similar spaces and trunks to such spaces.

34. "**SOLAS**" means the International Convention for the Safety of Life at Sea,1974, as amended.

35. "**1983 SOLAS amendments**" means amendments to the 1974 SOLAS Convention adopted by the Maritime Safety Committee of the Organization at its forty-eighth session on 17 June 1983 by resolution MSC. 6(48).

36. "**Tank cover**" is the protective structure intended to protect the cargo containment system against damage where it protrudes through the weather deck or to ensure the continuity and integrity of the deck structure.

37. "**Tank dome**" is the upward extension of a portion of a cargo tank. In the case of below-deck cargo containment systems the tank dome protrudes through the weather deck or through a tank cover.

38. "**Toxic products**" are those identified by a "T" in column "f" in the table of **Sec 19.**

39. "**Vapour pressure**" is the equilibrium pressure of the saturated vapour above the liquid expressed in bar absolute at a specified temperature.

40. "**Void space**" is an enclosed space in the cargo area external to a cargo containment system, other than a hold space, ballast space, fuel oil tank, cargo pump or compressor room, or any space in normal use by personnel.

41. "**Recognized standards**" are applicable international or national standards acceptable to the Society or standards laid down and maintained by the Society which complies with the standards adopted by the organization.

Section 2 Ship Survival Capability and Location of Cargo Tanks

201. General (IGC Code 2.1)

1. Ships subject to this Chapter should survive the normal effects of flooding following assumed hull damage caused by some external force. In addition, to safeguard the ship and the environment, the cargo tanks should be protected from penetration in the case of minor damage to the ship resulting, for example, from contact with a jetty or tug, and given a measure of protection from damage in the case of collision or stranding, by locating them at specified minimum distances inboard from the ship's shell plating. Both the damage to be assumed and the proximity of the tanks to the ship's shell should be dependent upon the degree of hazard presented by the product to be carried.

2. Ships subject to this Chapter should be designed to one of the following standards:

(1) A type 1 G ship is a gas carrier intended to transport products indicated in **Sec 19** which require maximum preventive measures to preclude the escape of such cargo.
(2) A type 2 G ship is a gas carrier intended to transport products indicated in **Sec 19** which require significant preventive measures to preclude the escape of such cargo.
(3) A type 2 PG ship is a gas carrier of 150 m in length or less intended to transport products indicated in Sec 19 which require significant preventive measures to preclude escape of such cargo, and where the products are carried in independent type C tanks designed (see **402. 4** (4)) for a MARVS of at least 0.7 MPa gauge and a cargo containment system design temperature of -55°C or above. Note that a ship of this description but over 150 m in length is to be considered a type 2 G ship.
(4) A type 3 G ship is a gas carrier intended to carry products indicated in **Sec 19** which require moderate preventive measures to preclude the escape of such cargo.

Thus a type 1 G ship is a gas carrier intended for the transportation of products considered to present the greatest overall hazard and types 2 G/2 PG and type 3 G for products of progressively lesser hazards. Accordingly, a type 1 G ship should survive the most severe standard of damage and its cargo tanks should be located at the maximum prescribed distance inboard from the shell plating.

3. The ship type required for individual products is indicated in column "c" in the table of **Sec 19.**

4. If a ship is intended to carry more than one product listed in **Sec 19,** the standard of damage should correspond to that product having the most stringent ship type requirement. The requirements for the location of individual cargo tanks, however, are those for ship types related to the respective products intended to be carried.

202. Freeboard and intact stability (IGC Code 2.2)

1. Ships subject to this Chapter may be assigned the minimum freeboard permitted by the International Convention on Load Lines in force. However, the draught associated with the assignment should not be greater than the maximum draught otherwise permitted by this Chapter.

2. The stability of the ship in all seagoing conditions and during loading and unloading cargo should be to a standard which is acceptable to the Society.

3. When calculating the effect of free surfaces of consumable liquids for loading conditions it should be assumed that, for each type of liquid, at least one transverse pair or a single centre tank has a free surface and the tank or combination of tanks to be taken into account should be those where the effect of free surfaces is the greatest. The free surface effect in undamaged compartments should be calculated by a method acceptable to the Society.

4. Solid ballast should not normally be used in double bottom spaces in the cargo area. Where, however, because of stability considerations, the fitting of solid ballast in such spaces becomes unavoidable, then its disposition should be governed by the need to ensure that the impact loads resulting from bottom damage are not directly transmitted to the cargo tank structure.

5. The master of the ship should be supplied with a Loading and Stability Information booklet. This booklet should contain details of typical service conditions, loading, unloading and ballasting operations, provisions for evaluating other conditions of loading and a summary of the ship's survival capabilities. In addition, the booklet should contain sufficient information to enable the master to load and operate the ship in a safe and seaworthy manner.

203. Shipside discharges below the freeboard deck (IGC Code 2.3)

1. The provision and control of valves fitted to discharges led through the shell from spaces below the freeboard deck or from within the superstructures and deckhouses on the freeboard deck fitted with weathertight doors should comply with the requirements of the relevant regulation of the International Convention on Load Lines in force, except that the choice of valves should be limited to:

(1) one automatic non-return valve with a positive means of closing from above the freeboard deck; or

(2) where the vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0.01 L, two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination under service conditions.

2. For the purpose of this Section "**summer load waterline**" and "**freeboard deck**", have the meanings defined in the International Convention on Load Lines in force.

3. The automatic non-return valves referred to in **Par 1** (1) and (2) should comply with recognized standards and should fully effective in preventing admission of water into the ship, taking into account the sinkage, trim and heel in survival requirements in **209.**

204. Conditions of loading (IGC Code 2.4)

Damage survival capability should be investigated on the basis of loading information submitted to the Society for all anticipated conditions of loading and variations in draught and trim. The survival requirements need not be applied to the ship when in the ballast condition, provided that any cargo retained on board is solely used for cooling, circulation or fuelling purposes.

205. Damage assumptions (IGC Code 2.5)

1. The assumed maximum extent of damage should be:

(1) Side damage:
- (a) Longitudinal extent: 1/3 $L^{2/3}$ or 14.5 m, whichever is less
- (b) Transverse extent: B/5 or 11.5 m, whichever is less
  measured inboard from the ship's side at right angles to the centreline at the level of the summer load line
- (c) Vertical extent: upwards without limit
  from the moulded line of the bottom shell plating at centreline.

(2) Bottom damage:

	For 0.3 L from the forward perpendicular of the ship	Any other part of the ship
(a) Longitudinal extent:	1/3 $L^{2/3}$ or 14.5 m, whichever is less	1/3$L^{2/3}$ or 5 m, whichever is less
(b) Transverse extent:	B/6 or 10 m, whichever is less	B/6 or 5 m, whichever is less
(c) Vertical extent:	B/15 or 2 m, whichever is less measured from the moulded line of the bottom shell plating at centreline. (see **206. 3**)	B/15 or 2 m, whichever is less measured from the moulded line of the bottom shell plating at centreline. (see **206. 3**)

2. Other damage:

(1) If any damage of a lesser extent than the maximum damage specified in **Par 1** would result in a more severe condition, such damage should be assumed.

(2) Local side damage anywhere in the cargo area extending inboard 760 mm measured normal to the hull shell should be considered and transverse bulkheads should be assumed damaged when also required by the applicable subparagraphs of **208.1.**

206. Location of cargo tanks (IGC Code 2.6)

1. Cargo tanks should be located at the following distances inboard:

(1) Type 1 G ships: from the side shell plating not less than the transverse extent of damage specified in **205.1** (1) (b) and from the moulded line of the bottom shell plating at centreline not less than the vertical extent of damage specified in **205.1** (2) (c) and nowhere less than 760 mm from the shell plating.

(2) Types 2 G/2 PG and 3 G ships: from the moulded line of the bottom shell plating at centre-line not less than the vertical extent of damage specified in **205. 1** (2) (c) and nowhere less than 760 mm from the shell plating.

2. For the purpose of tank location, the vertical extent of bottom damage should be measured to the inner bottom when membrane or semi-membrane tanks are used, otherwise to the bottom of the cargo tanks. The transverse extent of side damage should be measured to the longitudinal bulkhead when membrane or semi-membrane tanks are used, otherwise to the side of the cargo tanks (see **Fig 7.5.1**). For internal insulation tanks the extent of damage should be measured to the supporting tank plating.

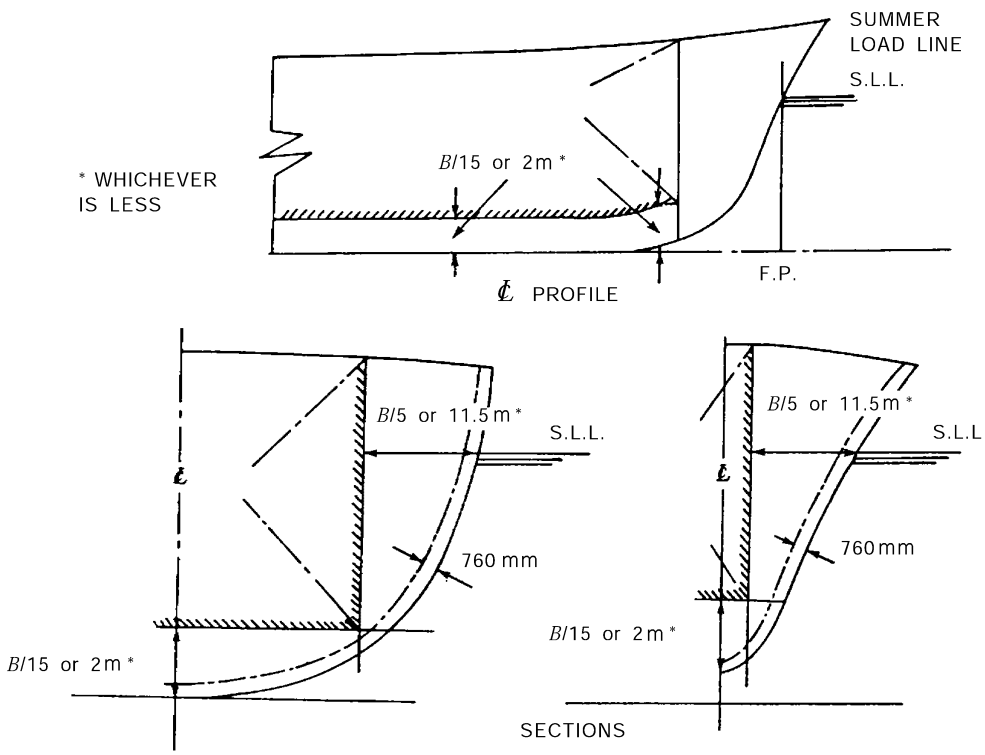


Fig 7.5.1 Tank location requirements as set out in 206.

3. Except for type 1 G ships, suction wells installed in cargo tanks may protrude into the vertical extent of bottom damage specified in **205. 1** (2) (c) provided that such wells are as small as practicable and the protrusion below the inner bottom plating does not exceed 25 % of the depth of the double bottom or 350 mm, whichever is less. Where there is no double bottom, the protrusion below the upper limit of bottom damage should not exceed 350 mm. Suction wells installed in accordance with this paragraph may be ignored in determining the compartments affected by damage.

207. Flooding assumptions (IGC Code 2.7)

1. The requirements of **209.** should be confirmed by calculations which take into consideration the design characteristics of the ship; the arrangements, configuration and contents of the damaged compartments; the distribution, relative densities and the free surface effects of liquids; and the draught and trim for all conditions of loading.

2. The permeabilities of spaces assumed to be damaged should be as follows:

Spaces	Permeabilities
Appropriated to stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Voids	0.95
Intended for consumable liquids	0 to 0.95
Intended for other liquids	0 to 0.95

3. Wherever damage penetrates a tank containing liquids, it should be assumed that the contents are completely lost from that compartment and replaced by salt water up to the level of the final plane of equilibrium.

4. Where the damage between transverse watertight bulkheads is envisaged as specified in **208. 1** (4), (5) and (6), transverse bulkheads should be spaced at least at a distance equal to the longitudinal extent of damage specified in **205. 1** (1) (a) 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 should be assumed as non-existent for the purpose of determining flooded compartments. Further, any portion of a transverse bulkhead bounding side compartments or double bottom compartments should be assumed damaged if the watertight bulkhead boundaries are within the extent of vertical or horizontal penetration required by **205.** Also, any transverse bulkhead should be assumed damaged if it contains a step or recess of more than 3 m in length located within the extent of penetration of assumed damage. The step formed by the after peak bulkhead and after peak tank top should not be regarded as a step for the purpose of this paragraph.

5. The ship should be so designed as to keep unsymmetrical flooding to the minimum consistent with efficient arrangements.

6. Equalization arrangements requiring mechanical aids such as valves or cross-levelling pipes, if fitted, should 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 **209. 1** and sufficient residual stability should be maintained during all stages where equalization is used. Spaces which are linked by ducts of large cross-sectional area may be considered to be common.

7. If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in **205.,** arrangements should be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

8. The buoyancy of any superstructure directly above the side damage should be disregarded. The unflooded parts of superstructures beyond the extent of damage, however, may be taken into consideration provided that:

(1) they are separated from the damaged space by watertight divisions and the requirements of **209. 1** (1) in respect of these intact spaces are complied with; and

(2) openings in such divisions are capable of being closed by remotely operated sliding watertight doors and unprotected openings are not immersed within the minimum range of residual stability required in **209. 2** (1); however the immersion of any other openings capable of being closed weathertight may be permitted.

208. Standard of damage (IGC Code 2.8)

1. Ships should be capable of surviving the damage indicated in **205.** with the flooding assumptions in **207.** to the extent determined by the ship's type according to the following standards:

(1) A type 1 G ship should be assumed to sustain damage anywhere in its length;

(2) A type 2 G ship of more than 150 m in length should be assumed to sustain damage anywhere in its length;

(3) A type 2 G ship of 150 m in length or less should be assumed to sustain damage anywhere in

its length except involving either of the bulkheads bounding a machinery space located aft;

(4) A type 2 PG ship should be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage as specified in **205. 1** (1) (a);

(5) A type 3 G ship of 125 m in length or more should be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage specified in **205. 1** (1) (a);

(6) A type 3 G ship less than 125 m in length should be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage specified in **205.1** (1) (a) and except damage involving the machinery space when located aft. However, the ability to survive the flooding of the machinery space should be considered by the Society.

2. In the case of small type 2 G/2 PG and 3G ships which do not comply in all respects with the appropriate requirements of **Par 1** (3), (4) and (6), special dispensations may only be considered by the Society provided that alternative measures can be taken which maintain the same degree of safety. The nature of the alternative measures should be approved and clearly stated and be available to the Port Administration. Any such dispensation should be duly noted on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

209. Survival requirements (IGC Code 2.9)

Ships subject to this Chapter should be capable of surviving the assumed damage specified in **205.** to the standard provided in **208.** in a condition of stable equilibrium and should satisfy the following criteria.

1. In any stage of flooding:

(1) the waterline, taking into account sinkage, heel and trim, should be below the lower edge of any opening through which progressive flooding or downflooding may take place. Such openings should include air pipes and openings which are closed by means of weathertight doors or hatch covers and may exclude those openings closed by menas of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated watertight sliding doors, and sidescuttles of the non-opening type;

(2) the maximum angle of heel due to unsymmetrical flooding should not exceed 30°; and

(3) the residual stability during intermediate stages of flooding should be to the satisfaction of the Society. However, it should never be significantly less than that required by **Par 2** (1).

2. At final equilibrium after flooding:

(1) the righting lever curve should have a minimum range of 20° beyond the position of equilibrium in association with a maximum residual righting lever of at least 0.1 m within the 20° range; the area under the curve within this range should not be less than 0.0175 m·rad. Unprotected openings should not be immersed within this range unless the space concerned is assumed to be flooded. Within this range, the immersion of any of the openings listed in **Par 1** (1) and other openings capable of being closed weathertight may be permitted; and

(2) the emergency source of power should be capable of operating.

Section 3 Ship Arrangements

301. Segregation of the cargo area (IGC Code 3.1)

1. Hold spaces should be segregated from machinery and boiler spaces, accommodation spaces, service spaces and control stations, chain lockers, drinking and domestic water tanks and from stores. Hold spaces should be located forward of machinery spaces of category A, other than those deemed necessary by the Society for the safety or navigation of the ship.

2. Where cargo is carried in a cargo containment system not requiring a secondary barrier, segregation of hold spaces from spaces referred to in **Par 1** or spaces either below or outboard of the hold spaces may be effected by cofferdams, fuel oil tanks or a single gastight bulkhead of all-welded construction forming an A-60 class division. A gastight A-0 class division is satisfactory if there is no source of ignition or fire hazard in the adjoining spaces.

3. Where cargo is carried in a cargo containment system requiring a secondary barrier, segregation of hold spaces from spaces referred to in **Par 1** or spaces either below or outboard of the hold spaces which contain a source of ignition or fire hazard should be effected by cofferdams or fuel oil tanks. If there is no source of ignition or fire hazard in the adjoining space, segregation may be by a single A-0 class division which is gastight.

4. When cargo is carried in a cargo containment system requiring a secondary barrier:

(1) at temperatures below -10°C, hold spaces should be segregated from the sea by a double bottom; and

(2) at temperatures below -55°C, the ship should also have a longitudinal bulkhead forming side tanks.

5. Any piping system which may contain cargo or cargo vapour should:

(1) be segregated from other piping systems, except where inter-connections are required for cargo-related operations such as purging, gas-freeing or inerting. In such cases, precautions should be taken to ensure that cargo or cargo vapour cannot enter such other piping systems through the inter-connections;

(2) except as provided in **Sec 16,** not pass through any accommodation space, service space or control station or through a machinery space other than a cargo pump room or cargo compressor space;

(3) be connected into the cargo containment system directly from the open deck except that pipes installed in a vertical trunk-way or equivalent may be used to traverse void spaces above a cargo containment system and except that pipes for drainage, venting or purging may traverse cofferdams;

(4) except for bow or stern loading and unloading arrangements in accordance with **308.** and emergency cargo jettisoning piping systems in accordance with **Par 6,** and except in accordance with **Sec 16,** be located in the cargo area above the open deck; and

(5) except for thwartship shore connection piping not subject to internal pressure at sea or emergency cargo jettisoning piping systems, be located inboard of the transverse tank location requirements of **206.1.**

6. Any emergency cargo jettisoning piping system should comply with **Par 5** as appropriate and may be led aft externally to accommodation spaces, service spaces or control stations or machinery spaces, but should not pass through them. If an emergency cargo jettisoning piping system is permanently installed a suitable means of isolation from the cargo piping should be provided within the cargo area.

7. Arrangements should be made for sealing the weather decks in way of openings for cargo containment systems.

302. Accommodation, service and machinery spaces and control stations (IGC Code 3.2)

1. No accommodation space, service space or control station should be located within the cargo area. The bulkhead of accommodation spaces, service spaces or control stations which face the cargo area should be so located as to avoid the entry of gas from the hold space to such spaces through a single failure of a deck or bulkhead on a ship having a containment system requiring a secondary barrier.

2. In order to guard against the danger of hazardous vapours, due consideration should be given to the location of air intakes and openings into accommodation, service and machinery spaces and control stations in relation to cargo piping, cargo vent systems and machinery space exhausts from gas burning arrangements.

3. Access through doors, gastight or otherwise, should not be permitted from a gas-safe space to a gas-dangerous space, except for access to service spaces forward of the cargo area through air-locks as permitted by **306. 1** when accommodation spaces are aft.

4. Entrances, air inlets and openings to accommodation spaces, service spaces, machinery spaces and control stations should not face the cargo area. They should be located on the end bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse or on both at a distance of at least 4 % of the length (L) of the ship but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area. This distance, however, need not exceed 5 m. Windows and sidescuttles facing the cargo area and on the sides of the superstructure or deckhouse within the distance mentioned above should be of the fixed (non-opening) type. Wheelhouse windows may be non-fixed and wheelhouse doors may be located within the above limits so long as they are so designed that a rapid and efficient gas and vapour tightening of the wheelhouse can be ensured. For ships dedicated to the carriage of cargoes which have neither flammable nor toxic hazards, the Society may approve relaxations from the above requirements.

5. Sidescuttles in the shell below the uppermost continuous deck and in the first tier of the superstructure or deckhouse should be of the fixed (non-opening) type.

6. All air intakes and openings into the accommodation spaces, service spaces and control stations should be fitted with closing devices. For toxic gases they should be operated from inside the space.

303. Cargo pump rooms and cargo compressor rooms (IGC Code 3.3)

1. (1) Cargo pump rooms and cargo compressor rooms should be situated above the weather deck and located within the cargo area unless specially approved by the Society. Cargo compressor rooms should be treated as cargo pump rooms for the purpose of fire protection according to SOLAS chapter II-2/9.2.4.

(2) When cargo pump rooms and cargo compressor rooms are permitted to be fitted above or below the weather deck at the after end of the aftermost hold space or at the forward end of the forwardmost hold space, the limits of the cargo area as defined in **106. 6** should be extended to include the cargo pump rooms and cargo compressor rooms for the full breadth and depth of the ship and deck areas above those spaces.

(3) Where the limits of the cargo area are extended by (2), the bulkhead which separates the cargo pump rooms and cargo compressor rooms from accommodation and service spaces, control stations and machinery spaces of category A should be so located as to avoid the entry of gas to these spaces through a single failure of a deck or bulkhead.

2. Where pumps and compressors are driven by shafting passing through a bulkhead or deck, gastight seals with efficient lubrication or other means of ensuring the permanence of the gas seal should be fitted in way of the bulkhead or deck.

3. Arrangements of cargo pump rooms and cargo compressor rooms should be such as to ensure safe unrestricted access for personnel wearing protective clothing and breathing apparatus, and in the event of injury to allow unconscious personnel to be removed. All valves necessary for cargo handling should be readily accessible to personnel wearing protective clothing. Suitable arrangements should be made to deal with drainage of pump and compressor rooms.

304. Cargo control rooms (IGC Code 3.4)

1. Any cargo control room should be above the weather deck and may be located in the cargo area. The cargo control room may be located within the accommodation spaces, service spaces or control stations provided the following conditions are complied with:

(1) the cargo control room is a gas-safe space; and

(2) (a) if the entrance complies with **302. 4,** the control room may have access to the spaces de-

scribed above;

(b) if the entrance does into comply with **302. 4,** the control room should have no access to the spaces described above and the boundaries to such spaces should be insulated to A-60 class integrity

2. If the cargo control room is designed to be a gas-safe space, instrumentation should, as far as possible, be by indirect reading systems and should in any case be designed to prevent any escape of gas into the atmosphere of that space. Location of the gas detector within the cargo control room will not violate the gas-safe space if installed in accordance with **1306. 5.**

3. If the cargo control room for ships carrying flammable cargoes is a gas-dangerous space, sources of ignition should be excluded. Consideration should be paid to the safety characteristics of any electrical installations.

305. Access to spaces in the cargo area (IGC Code 3.5)

1. Visual inspection should be possible of at least one side of the inner hull structure without the removal of any fixed structure or fitting. If such a visual inspection, whether combined with those inspections required in **Par 2, 407. 7** or **410. 16** or not, is only possible at the outer face of the inner hull, the inner hull should not be a fuel-oil tank boundary wall.

2. Inspection of one side of any insulation in hold spaces should be possible. If the integrity of the insulation system can be verified by inspection of the outside of the hold space boundary when tanks are at service temperature, inspection of one side of the insulation in the hold space need not be required.

3. Arrangements for hold spaces, void spaces and other spaces that could be considered gas-dangerous and cargo tanks should be such as to allow entry and inspection of any such space by personnel wearing protective clothing and breathing apparatus and in the event of injury to allow unconscious personnel to be removed from the space and should comply with the following:

(1) Access should be provided:

(A) to cargo tanks direct from the open deck;

(B) through horizontal openings, hatches or manholes, the dimensions of which should be sufficient to allow a person wearing a breathing apparatus 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; and

(C) through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening of which should be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom plating unless gratings or other footholds are provided.

(2) the dimensions referred to in (1) (B) and (C) may be decreased if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

(3) The requirements of (1) (B) and (C) do not apply to spaces described in **106. 17** (5). Such spaces should be provided only with direct or indirect access from the open weather deck, not including an enclosed gas-safe space.

4. Access from the open weather deck to gas-safe spaces should be located in a gas-safe zone at least 2.4 m above the weather deck unless the access is by means of an air-lock in accordance with **306.**

306. Air locks (IGC Code 3.6)

1. An air-lock should only be permitted between a gas-dangerous zone on the open weather deck and a gas-safe space and should consist of two steel doors substantially gastight spaced at least 1.5 m but not more than 2.5 m apart.

2. The doors should be self-closing and without any holding back arrangements.

3. An audible and visual alarm system to give a warning on both sides of the air lock should be provided to indicate if more than one door is moved from the closed position.

4. In ships carrying flammable products, electrical equipment which is not of the certified safe type in spaces protected by air locks should be de-energized upon loss of overpressure in the space (see also **1001.** 4). Electrical equipment which is not of the certified safe type for manoeuvring, anchoring and mooring equipment as well as the emergency fire pumps should not be located in spaces to be protected by air locks.

5. The air lock space should be mechanically ventilated from a gas-safe space and maintained at an overpressure to the gas-dangerous zone on the open weather deck.

6. The air-lock space should be monitored for cargo vapour.

7. Subject to the requirements of the International Convention on Load Lines in force, the door still should not be less than 300 mm in height.

307. Bilge, ballast and fuel oil arrangements (IGC Code 3.7)

1. (1) Where cargo is carried in a cargo containment system not requiring a secondary barrier, hold spaces should be provided with suitable drainage arrangements not connected with the machinery space. Means of detecting any leakage should be provided.

(2) Where there is a secondary barrier, suitable drainage arrangements for dealing with any leakage into the hold or insulation spaces through adjacent ship structure should be provided. The suction should not be led to pumps inside the machinery space. Means of detecting such leakage should be provided.

2. (1) The hold or interbarrier spaces of Type A independent tank ships should be provided with a drainage system suitable for handling liquid cargo in the event of cargo tank leakage or rupture. Such arrangements should provide for the return of any cargo leakage to the liquid cargo piping.

(2) Arrangements referred to in (1) should provided with a removable spool piece. This paragraph applies to ships constructed on or after 1 July 2002.

3. In case of internal insulation tanks, means of detecting leakage and drainage arrangements are not required for interbarrier spaces and spaces between the secondary barrier and the inner hull or independent tank structure which are completely filled by insulation material complying with **409. 7** (2).

4. Ballast spaces, including wet duct keels used as ballast piping, fuel-oil tanks and gas-safe spaces may be connected to pumps in the machinery spaces. Dry duct keels with ballast piping passing through, may be connected to pumps in the machinery spaces, provided the connections are led directly to the pumps and the discharge from the pumps lead directly overboard with no valves or manifolds in either line which could connect the line from the duct keel to lines serving gas-safe spaces. Pump vents should not be open to machinery spaces.

308. Bow or stern loading and unloading arrangements (IGC Code 3.8)

1. Subject to the requirements in **308.,** cargo piping may be arranged to permit bow or stern loading and unloading.

Bow or stern loading and unloading lines which are led past accommodation spaces, service spaces or control stations should not be used for the transfer of products requiring a type 1 G ship. Bow or stern loading and unloading lines should not be used for the transfer of toxic products as specified in **106. 38** unless specifically approved by the Society.

2. Portable arrangements should not be permitted.

3. In addition to the requirements of **Sec 5** the following provisions apply to cargo piping and related piping equipment:

(1) Cargo piping and related piping equipment outside the cargo area should have only welded connections. The piping outside the cargo area should run on the open deck and should be at least 760 mm inboard except for thwartships shore connection piping. Such piping should be clearly identified and fitted with a shutoff valve at its connection to the cargo piping system within the cargo area. At this location, it should also be capable of being separated by means of a removable spool piece and blank flanges when not in use.

(2) The piping is to be full penetration butt welded, and fully radiographed regardless of pipe diameter and design temperature. Flange connections in the piping are only permitted within the cargo area and at the shore connection.

(3) Arrangements should be made to allow such piping to be purged and gas-freed after use When not in use, the spool pieces should be removed and the pipe ends be blank-flanged. The vent pipes connected with the purge should be located in the cargo area.

4. Entrances, air inlets and openings to accommodation spaces, service spaces, machinery spaces and control stations should not face the cargo shore connection location of bow or stern loading and unloading arrangements. They should 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 superstructure or deck house 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 should 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 should be kept closed. Where, in the case of small ships, compliance with **302. 4** and this paragraph is not possible, the Society may approve relaxations from the above requirements.

5. Deck openings and air inlets to spaces within distances of 10 m from the cargo shore connection location should be kept closed during the use of bow or stern loading or unloading arrangements.

6. Electrical equipment within a zone of 3 m from the cargo shore connection location should be in accordance with **Sec 10.**

7. Fire-fighting arrangements for the bow or stern loading and unloading areas should be in accordance with **1103. 1** (3) and **1104. 7.**

8. Means of communication between the cargo control station and the shore connection location should be provided and if necessary certified safe.

Section 4 Cargo Containment

401. General (IGC Code 4.1)

1. The Society should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this Section.

2. In addition to the definitions in **106.**, the definitions given in this Section apply throughout this Chapter.

402. Definitions (IGC Code 4.2)

1. Integral tanks

(1) Integral tanks form a structural part of the ship's hull and are influenced in the same manner and by the same loads which stress the adjacent hull structure.

(2) The design vapour pressure P_0 as defined in **Par 6** should not normally exceed 0.025 MPa. If, however, the hull scantlings are increased accordingly, P_0 may be increased to a higher value but less than 0.007 MPa.

(3) Integral tanks may be used for products provided the boiling point of the cargo is not below -10°C. A lower temperature may be accepted by the Society subject to special consideration.

2. Membrane tanks

(1) Membrane tanks are non-self-supporting tanks which consist of a thin layer (membrane) supported through insulation by the adjacent hull structure. The membrane is designed in such a way that thermal and other expansion or contraction is compensated for without undue stressing of the membrane.

(2) The design vapour pressure P_0 should not normally exceed 0.025 MPa. If, however, the hull scantlings are increased accordingly and consideration is given, where appropriate, to the strength of the supporting insulation, P_0 may be increased to a higher value but less than 0.07 MPa.

(3) The definition of membrane tanks does not exclude designs such as those in which nonmetallic membranes are used or in which membranes are included or incorporated in insulation. Such designs require, however, special consideration by the Society. In any case the thickness of the membranes should normally not exceed 10 mm.

3. Semi-membrane tanks

(1) Semi-membrane tanks are non-self-supporting tanks in the loaded condition and consist of a layer, parts of which are supported through insulation by the adjacent hull structure, whereas the rounded parts of this layer connecting the above-mentioned supported parts are designed also to accommodate the thermal and other expansion or contraction.

(2) The design vapour pressure P_0 should not normally exceed 0.025 MPa. If, however, the hull scantlings are increased accordingly, and consideration is given, where appropriate, to the strength of the supporting insulation, P_0 may be increased to a higher value but less than 0.07 MPa.

4. Independent tanks

(1) Independent tanks are self-supporting; they do not form part of the ship's hull and are not essential to the hull strength. There are three categories of independent tanks referred to in (2) to (4).

(2) Type A independent tanks are tanks which are designed primarily using recognized standards of classical ship-structural analysis procedures. Where such tank are primarily constructed of plane surfaces (gravity tanks), the design vapour pressure P_0 should be less than 0.07 MPa.

(3) Type B independent tanks are tanks which are designed using model tests, refined analytical tools and analysis methods to determine stress levels, fatigue life and crack propagation characteristics. Where such tanks are primarily constructed of plane surfaces (gravity tanks) the design vapour pressure P_0 should be less than 0.07 MPa.

(4) Type C independent tanks (also referred to as pressure vessels) are tanks meeting pressure vessel criteria and having a design vapour pressure not less than:

$$P_0 = 0.2 + AC(\rho_r)^{\frac{3}{2}} \ (\mathrm{MPa})$$

where : $A = 0.00185\left(\dfrac{\sigma_m}{\triangle\sigma_A}\right)^2$

with

σ_m = design primary membrane stress

$\triangle\sigma_A$ = allowable dynamic membrane stress (double amplitude at probability level $Q=10^{-8}$)

55 $\mathrm{N/mm^2}$ for ferritic-perlitic, martensitic and austenitic steels

25 $\mathrm{N/mm^2}$ for aluminium alloy (5083-0)

C = a characteristic tank dimension to be taken as the greatest of the following:

h, $0.75b$ or $0.45l$

with

h = height of tank (dimension in ship's vertical direction) (m)

b = width of tank (dimension in ship's transverse direction) (m)

l = length of tank (dimension in ship's longitudinal direction) (m)

ρ_r = the relative density of the cargo (ρ_r = 1 for fresh water) at the design temperature.

However, the Society may allocate a tank complying with the criterion of this subparagraph to type A or type B, dependent on the configuration of the tank and the arrangement of its supports and attachments.

5. Internal insulation tanks

(1) Internal insulation tanks are non-self-supporting and consist of thermal insulation materials which contribute to the cargo containment and are supported by the structure of the adjacent inner hull or of an independent tank. The inner surface of the insulation is exposed to the cargo.

(2) The two categories of internal insulation tanks are:

(a) Type 1 tanks which are tanks in which the insulation or a combination of the insulation and one or more liners functions only as the primary barrier. The inner hull or an independent tank structure should function as the secondary barrier when required.

(b) Type 2 tanks which are tanks in which the insulation or a combination of the insulation and one or more liners functions as both the primary and the secondary barrier and where these barriers are clearly distinguishable.

The terms "liner" means a thin, non-self-supporting, metallic, nonmetallic or composite material which forms part of an internal insulation tank in order to enhance its fracture resistance or other mechanical properties. A liner differs from a membrane in that it is not intended to function alone as a liquid barrier.

(3) Internal insulation tanks should be of suitable materials enabling the cargo containment system to be designed using model tests and refined analytical methods as required in **404. 7.**

(4) The design vapour pressure P_0 should not normally exceed 0.025 MPa. If, however, the cargo containment system is designed for a higher vapour pressure, P_0 may be increased to such higher value, but not exceeding 0.07 MPa if the internal insulation tanks are supported by the inner hull structure. However, a design vapour pressure of more than 0.07 MPa may be accepted by the Society provided the internal insulation tanks are supported by suitable independent tank structures.

6. Design vapour pressure

(1) The design vapour pressure P_0 is the maximum gauge pressure at the top of the tank which has been used in the design of the tank.

(2) For cargo tanks where there is no temperature control and where the pressure of the cargo is dictated only by the ambient temperature, P_0 should not be less than the gauge vapour pressure of the cargo at a temperature of 45°C. However, lesser values of this temperature may be accepted by the Society for ships operating in restricted areas or on voyages of restricted duration and account may be taken in such cases of any insulation of the tanks. Conversely, higher values of this temperature may be required for ships permanently operating in areas of high am-

bient temperature.

(3) In all cases, including (2), P_0 should not be less than MARVS.

(4) Subject to special consideration by the Society and to the limitations given in **Pars 1** to **5** for the various tank types, a vapour pressure higher than P_0 may be accepted in harbour conditions, where dynamic loads are reduced.

7. Design temperature

The design temperature for selection of materials is the minimum temperature at which cargo may be loaded or transported in the cargo tanks. Provision to the satisfaction of the Society should be made to ensure that the tank or cargo temperature cannot be lowered below the design temperature.

403. Design loads (IGC Code 4.3)

1. General

(1) Tanks together with their supports and other fixtures should be designed taking into account proper combinations of the following loads:
- internal pressure
- external pressure
- dynamic loads due to the motions of the ship
- thermal loads sloshing loads
- loads corresponding to ship deflection
- tank and cargo weight with the corresponding reactions in way of supports
- insulation weight
- loads in way of towers and other attachment

The extent to which these loads should be considered depends on the type of tank, and is more fully detailed in the following paragraphs.

(2) Account should be taken of the loads corresponding to the pressure test referred to in **410.**

(3) Account should be taken of an increase of vapour pressure in harbour conditions referred to in **402. 6** (4).

(4) The tanks should be designed for the most unfavourable static heel angle within the range 0° to 30° without exceeding allowable stresses given in **405. 1.**

2. Internal pressure

(1) The internal pressure P_{eq} in bars gauge resulting from the design vapour pressure P_0 and the internal liquid pressure P_{gd} defined in (2), but not including effects of liquid sloshing, should be calculated as follows:

$$P_{eq} = P_0 + (P_{gd})\,\mathrm{max} \quad (\mathrm{MPa})$$

Equivalent calculation procedures may be applied.

(2) The internal liquid pressures are those created by the resulting acceleration of the centre of gravity of the cargo due to the motions of the ship referred to in **Par 4** (1). The value of internal liquid pressure P_{gd} resulting from combined effects of gravity and dynamic accelerations should be calculated as follows:

$$P_{gd} = a_\beta Z_\beta \frac{\rho}{1.02 \times 10^5} \quad (\mathrm{MPa})$$

where:

a_β = dimensionless acceleration (i.e. relative to the acceleration of gravity), resulting from gravitational and dynamic loads, in an arbitrary direction β (see **Fig 7.5.2**).

Z_β = largest liquid height (m) above the point where the pressure is to be determined measured from the tank shell in the β direction (see **Fig 7.5.3**). Tank domes considered to be part of the accepted total tank volume should be taken into account when determining Z_β unless the total volume of tank domes V_d does not exceed the following value:

$$V_d = V_t\left(\frac{100 - FL}{FL}\right)$$

where:

V_t = tank volume without any domes.

FL = filling limit (%) according to **Sec 15**

ρ = maximum cargo density ($\mathrm{kg/m^3}$) at the design temperature.

The direction which gives the maximum value $(P_{gd})\max$ of P_{gd} should be considered. Where acceleration components in three directions need to be considered, an ellipsoid should be used instead of the ellipse in **Fig. 7.5.2.** The above formula applies only to full tanks.

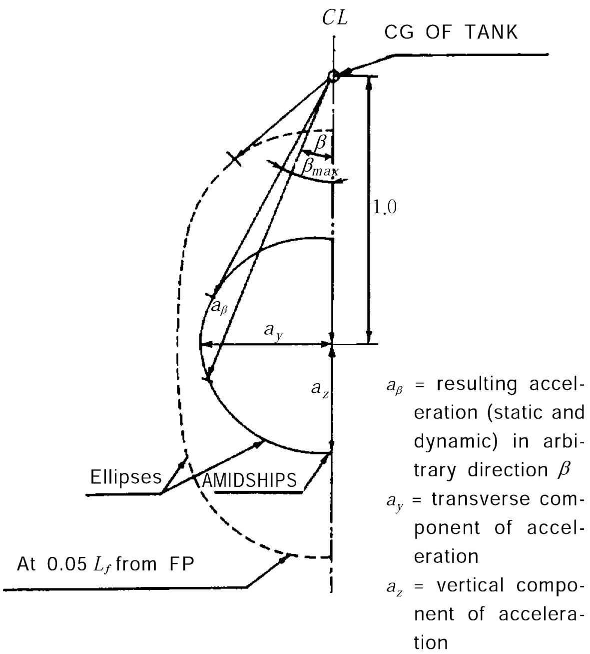


Fig. 7.5.2 Acceleration Ellipse

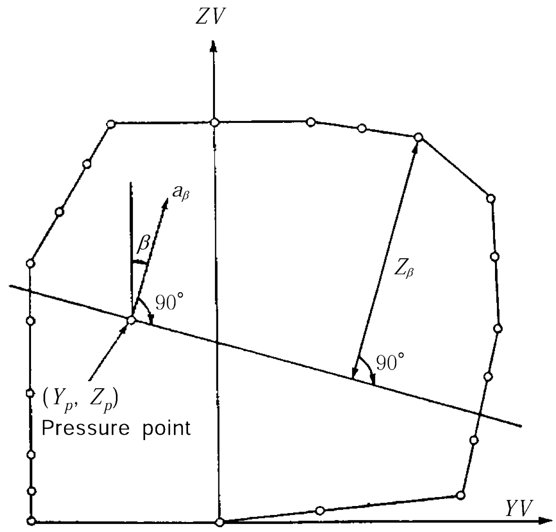


Fig. 7.5.3 Determination of Internal Pressure Heads

3. External pressure

External design pressure loads should be based on the difference between the minimum internal pressure (maximum vacuum) and the maximum external pressure to which any portion of the tank may be subjected simultaneously.

4. Dynamic loads due to ship motions

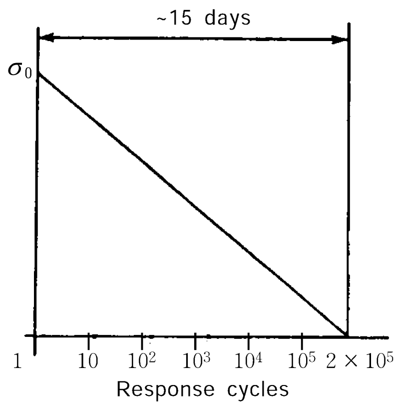
(1) The determination of dynamic loads should take account of the long-term distribution of ship motions, including the effects of surge, sway, heave, roll, pitch and yaw on irregular seas which the ship will experience during its operating life (normally taken to correspond to 10^8 wave encounters). Account may be taken of reduction in dynamic loads due to necessary speed reduction and variation of heading when this consideration has also formed part of the hull strength assessment.

(2) For design against plastic deformation and buckl ing the dynamic loads should be taken as the most probable largest loads the ship will encounte during its operating life (normally taken to correspond to a probability level of 10^{-8}). Guidance formulae for acceleration components are

given in **412.**

(3) When design against fatigue is to be considered the dynamic spectrum should be determined by long-term distribution calculation based on the operating life of the ship (normally taken to correspond to 10^8 wave encounters). If simplified dynamic loading spectra are used for the estimation of the fatigue life, those should be specially considered by the Society.

(4) For practical application of crack propagation estimates, simplified load distribution over a period of 15 days may be used. Such distributions may be obtained as indicated in **Fig 7.5.4.**



σ_0 = most probable maximum stress over the life of the ship

Response cycle scale is logarithmic; the value of 2 x 10^5 is given as an example of estimate.

Fig 7.5.4 Simplified Load Ditribution

(5) Ships for restricted service may be given special consideration.

(6) The accelerations acting on tanks are estimated at their centre of gravity and include the following components :

vertical acceleration : motion accelerations of heave, pitch and, possibly, roll (normal to the ship base);

transverse acceleration : motion accelerations of sway, yaw and roll; and gravity component of roll;

longitudinal acceleration : motion accelerations of surge and pitch; and gravity component of pitch.

5. Sloshing loads

(1) When partial filling is contemplated, the risk of significant loads due to sloshing induced by any of the ship motions referred to in **Par 4** (6) should be considered.

(2) When risk of significant sloshing-induced loads in found to be present, special tests and calculations should be required.

6. Thermal loads

(1) Transient thermal loads during cooling down periods should be considered for tanks intended for cargo temperatures below -55°C.

(2) Stationary thermal loads should be considered for tanks where design supporting arrangement and operating temperature may given rise to significant thermal stresses.

7. Loads on supports

The loads on supports are covered by **406.**

404. Structural analyses (IGC Code 4.4)

1. Integral tanks

The structural analysis of integral tanks should be in accordance with the requirements of **Pt 3, Ch 15** of the Rules. The tank boundary scantlings should meet at least the requirements for deep tanks taking into account the internal pressure as indicated in **403. 2,** but the resulting scantlings should not be less than normally required by such standards.

2. Membrane tanks

(1) For membrane tanks, the effects of all static and dynamic loads should be considered to determine the suitability of the membrane and of the associated insulation with respect to plastic deformation and fatigue.
(2) Before approval is given, a model of both the primary and secondary barriers, including corners and joints, should normally be tested to verify that they will withstand the expected combined strains due to static, dynamic and thermal loads. Test conditions should represent the most extreme service conditions the cargo containment system will see in its life. Material tests should ensure that ageing is not liable to prevent the materials from carrying out their intended function.
(3) For the purpose of the test referred to in (2), a complete analysis of the particular motions, accelerations and response of ships and cargo containment systems should be performed, unless these data are available from similar ships.
(4) Special attention should be paid to the possible collapse of the membrane due to an overpressure in the interbarrier space, to a possible vacuum in the cargo tank, to the sloshing effects and to hull vibration effects.
(5) A structural analysis of the hull should be to the satisfaction of the Society, taking into account the internal pressure as indicated in **403. 2.** Special attention, however, should be paid to deflections of the hull and their compatibility with the membrane and associated insulation. Inner hull plating thickness should meet at least the requirements of **Pt 3, Ch 15** of the Rules for deep tanks taking into account the internal pressure as indicated in **403. 2.** The allowable stress for the membrane, membrane-supporting material and insulation should be determined in each particular case.

3. Semi-membrane tanks

A structural analysis should be performed in accordance with the requirements for membrane tanks or independent tanks as appropriate, taking into account the internal pressure as indicated in **403. 2.**

4. Type A independent tanks

(1) A structural analysis should be performed to the satisfaction of the Society taking into account the internal pressure as indicated in **403. 2.** The cargo tank plating thickness should meet at least the requirements of **Pt 3, Ch 15** of the Rules for deep tanks taking into account the internal pressure as indicated in **403. 2** and any corrosion allowance required by **405. 2.**
(2) For parts such as structure in way of supports not otherwise covered by the requirements of **Pt 3, Ch 15** of the Rules, stresses should be determined by direct calculations, taking into account the loads referred to in **403.** as far as applicable, and the ship deflection in way of supports.

5. Type B independent tanks

For tanks of this type the following applies :

(1) The effects of all dynamic and static loads should be used to determine the suitability of the structure with respect to:
- plastic deformation
- buckling
- fatigue failure
- crack propagation

Statistical wave load analysis in accordance with **403. 4,** finite element analysis or similar methods and fracture mechanics analysis or an equivalent approach, should be carried out.
(2) A three-dimensional analysis should be carried out to evaluate the stress levels contributed by the ship's hull. The model for this analysis should include the cargo tank with its supporting and keying system as well as a reasonable part of the hull.

(3) A complete analysis of the particular ship accelerations and motions in irregular waves and of the response of the ship and its cargo tanks to these forces and motions should be performed unless these data are available from similar ships.
(4) A buckling analysis should consider the maximum construction tolerances.
(5) Where deemed necessary by the Society, model tests may be required to determine stress concentration factors and fatigue life of structural elements.
(6) The cumulative effect of the fatigue load should comply with:

$$\Sigma \frac{n_i}{N_i} + \frac{10^3}{N_j} \leq C_w$$

where:

n_i = number of stress cycles at each stress level during the life of the ship

N_i = number of cycles to fracture for the respective stress level according to the Wöhler ($S-N$) curve

N_j = number of cycles to fracture for the fatigue loads due to loading and unloading

C_w should be less than or equal to 0.5, except that the Society may give special consideration to the use of a value greater than 0.5 but not greater than 1.0, dependent on the test procedure and data used to establish the Wöhler ($S-N$) curve.

6. Type C independent tanks

(1) Scantlings based on internal pressure should be calculated as follows :
(a) The thickness and form of pressure-containing parts of pressure vessels under internal pressure, including flanges should be determined according to the requirements of **Pt 5, Ch 5** of the Rules. These calculations in all cases should be based on generally accepted pressure vessel design theory, Openings in pressure-containing parts of pressure vessels should be reinforced in accordance with the requirements of **Pt 5, Ch 5** of the Rules.
(b) The design liquid pressure defined in **403. 2** should be taken into account in the above calculations.
(c) The welded joint efficiency factor to be used in the calculation according to (a) should be 0.95 when the inspection and the non-destructive testing referred to in **410. 9** are carried out. This figure may be increased up to 1.0 when account is taken of other considerations, such as the material used, type of joints, welding procedure and type of loading. For process pressure vessels the Society may accept partial nondestructive examinations, but not less than those of **410. 9** (2) (b) depending on such factors as the material used, the design temperature, the nil ductility transition temperature of the material as fabricated, the type of joint and welding procedure, but in this case an efficiency factor of not more than 0.85 should be adopted. For special materials, the above-metioned factors should be reduced depending on the specified mechanical properties of the welded joint.
(2) Buckling criteria should be as follows:
(a) The thickness and form of pressure vessels subject to external pressure and other loads causing compressive stresses should be to a standard acceptable to the Society. These calculations in all cases should be based on generally accepted pressure vessel buckling theory and should adequately account for the difference in theoretical and actual buckling stress as a result of plate edge misalignment, ovality and deviation from true circular form over a specified arc or chord length.
(b) The design external pressure P_e used for verifying the buckling of the pressure vessels should not be less than that given by:

$$P_e = P_1 + P_2 + P_3 + P_4 \, (\mathrm{MPa})$$

where:

P_1 = setting value of vacuum relief valves. For vessels not fitted with vacuum relief valves P_1 should be specially considered, but should not in general be taken as less than 0.025 MPa.

P_2 = the set pressure of the pressure relief valves for completely closed spaces containing pressure vessels or parts of pressure vessels; elsewhere P_2 = 0.

P_3 = compressive actions in the shell due to the weight and contraction of insulation, weight of shell, including corrosion allowance, and other miscellaneous external pressure loads to which the pressure vessel may be subjected. These include, but are not limited to, weight of domes, weight of towers and piping, effect of product in the partially filled condition, accelerations and hull deflection. In addition the local effect of external or internal pressure or both should be taken into account.

P_4 = external pressure due to head of water for pressure vessels or part of pressure vessels on exposed decks;
elsewhere P_4 = 0.

(3) Stress analysis in respect of static and dynamic loads should be performed as follows:
(a) Pressure vessel scantlings should be determined in accordance with (1) and (2).
(b) Calculations of the loads and stresses in way of the supports and the shell attachment of the support should be made. Loads referred to in **403.** should be used, as applicable. Stresses in way of the supports should be to a standard acceptable to the Society. In special cases a fatigue analysis may be required by the Society.
(c) If required by the Society, secondary stresses and thermal stresses should be specially considered.

(4) For pressure vessels, the thickness calculated according to (1) or the thickness required by (2) plus the corrosion allowance, if any, should be considered as a minimum without any negative tolerance.

(5) For pressure vessels, the minimum thickness of shell and heads including corrosion allowance, after forming, should not be less than 5 mm for carbon-manganese steels and nickel steels, 3 mm for austenitic steels or 7 mm for aluminium alloys.

7. Internal insulation tanks

(1) The effects of all static and dynamic loads should be considered to determine the suitability of the tank with respect to:
- fatigue failure
- crack propagation from both free and supported surfaces
- adhesive and cohesive strength
- compressive, tensile and shear strength.

Statistical wave load analysis in accordance with **403. 4,** finite element analysis or similar methods and fracture mechanics analysis or an equivalent approach should be carried out.

(2) (a) Special attention should be given to crack resistance and to deflections of the inner hull or independent tank structure and their compatibility with the insulation materials. A three-dimensional structural analysis should be carried out to the satisfaction of the Society. This analysis is to evaluate the stress levels and deformations contributed either by the inner hull or by the independent tank structure or both and should also take into account the internal pressure as indicated in **403. 2.** Where water ballast spaces are adjacent to the inner hull forming the supporting structure of the internal insulation tank, the analysis should take account of the dynamic loads caused by water ballast under the influence of ship motions.
(b) The allowable stresses and associated deflections for the internal insulation tank and the inner hull structure or independent tank structure should be determined in each particular case.
(c) Thicknesses of plating of the inner hull or of an independent tank should at least comply with the requirements of Recognized Standards, taking into account the internal pressure as indicated in **403. 2.** Tanks constructed of plane surfaces should at least comply with the requirements of **Pt 3, Ch 15** of the Rules for deep tanks.

(3) A complete analysis of the response of ship, cargo and any ballast to accelerations and motions in irregular waves of the particular ship should be performed to the satisfaction of the Society unless such analysis is available for a similar ship.

(4) (a) In order to confirm the design principles, prototype testing of composite models including

structural elements should be carried out under combined effects of static, dynamic and thermal loads.

(b) Test conditions should represent the most extreme service conditions the cargo containment system will be exposed to during the lifetime of the ship, including thermal cycles. For this purpose, 400 thermal cycles are considered to be a minimum, based upon 19 round voyages per year; where more than 19 round voyages per year are expected, a higher number of thermal cycles will be required. These 400 thermal cycles may be divided into 20 full cycles (cargo temperature to 45°C) and 380 partial cycles (cargo temperature to that temperature expected to be reached in the ballast voyage).

(c) Models should be representative of the actual construction including corners, joints, pump mounts, piping penetrations and other critical areas, and should take into account variations in any material properties, workmanship and quality control.

(d) Combined tension and fatigue tests should be carried out to evaluate crack behaviour of the insulation material in the case where a through crack develops in the inner hull or independent tank structure. In these tests, where applicable the crack area should be subjected to the maximum hydrostatic pressure of the ballast water.

(5) The effects of fatigue loading should be determined in accordance with **Par 5** (6) or by an equivalent method.

(6) For internal insulation tanks, repair procedures should be developed during the prototype testing programme for both the insulation material and the inner hull or the independent tank structure.

405. Allowable stresses and corrosion allowances (IGC Code 4.5)

1. Allowable stresses

(1) For integral tanks, allowable stresses should normally be those given for hull structure in the requirements of **Pt 3, Ch 1, 206.** of the Rules.

(2) For membrane tanks, reference is made to the requirements of **404. 2.** (5).

(3) For type A independent tanks primarily constructed of plane surfaces, the stresses for primary and secondary members (stiffeners, webframes, stringers, girders) when calculated by classical analysis procedures should not exceed the lower of $R_m/2.66$ or $R_e/1.33$ for carbon-manganese steels and aluminium alloys, where R_m and R_e are defined in (7). However, if detailed calculations are carried out for the primary members, the equivalent stress σ_c as defined in (8) may be increased over that indicated above to a stress acceptable to the Society; calculations should take into account the effects of bending, shear, axial and torsional deformation as well as the hull/cargo tank interaction forces due to the deflection of the double bottom and cargo tank bottoms.

(4) For type B independent tanks, primarily constructed of bodies of revolution, the allowable stresses should not exceed:

$$\sigma_m \le f$$

$$\sigma_L \le 1.5f$$

$$\sigma_b \le 1.5F$$

$$\sigma_L + \sigma_b \le 1.5F$$

$$\sigma_m + \sigma_b \le 1.5F$$

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 R_m/A or R_e/B

F = the lesser of R_m/C or R_e/D

with R_m and R_e as defined in (7). With regard to the stresses σ_m, σ_L and σ_b see also the definition of stress categories in **413.** The values of A, B, C and D should be shown on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and should have at least the minimum values of **Table 7.5.1.**

(5) For type B independent tanks, primarily constructed of plane surfaces, the Society may require compliance with additional or other stress criteria.

(6) For type C independent tanks the maximum allowable membrane stress to be used in calculation according to **404. 6** (1) (a) should be the lower of:

R_m/A or R_e/B

where:

R_m and R_e are as defined in (7).

The values of A and B should be shown on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, and should have at least the minimum values indicated in the **Table 7.5.1.**

Table 7.5.1 Values of A, B, C and D

	Nickel steels and carbon-manganese steels	Austenitic steels	Aluminium alloys
A	3	3.5	4
B	2	1.6	1.5
C	3	3	3
D	1.5	1.5	1.5

(7) For the purpose of (3), (4) and (6) the following apply:

(a) R_e = specified minimum yield stress at room temperature ($\mathrm{N/mm^2}$). If the stress strain curve does not show a defined yield stress, the 0.2 % proof stress applies.

R_m = specified minimum tensile strength at room temperature ($\mathrm{N/mm^2}$).

For welded connections in aluminium alloys the respective values of R_e or R_m in annealed conditions should be used.

(b) The above properties should correspond to the minimum specified mechanical properties of the material, including the weld metal in the as-fabricated condition. Subject to special consideration by the Society, account may be taken of enhanced yield stress and tensile strength at low temperature. The temperature on which the material properties are based should be shown on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

(8) The equivalent stress σ_c (von Mises, Huber) should be determined by:

$$\sigma_c = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\tau_{xy}^2}$$

where:

σ_x = total normal stress in x-direction

σ_y = total normal stress in y-direction

τ_{xy} = total shear stress in x-y plane.

(9) When the static and dynamic stresses are calculated separately and unless other methods of calculation are justified, the total stresses should be calculated according to:

$$\sigma_x = \sigma_{x \cdot st} \pm \sqrt{\Sigma(\sigma_{x \cdot dyn})^2}$$

$$\sigma_y = \sigma_{y \cdot st} \pm \sqrt{\Sigma(\sigma_{y \cdot dyn})^2}$$

$$\tau_{xy} = \tau_{xy \cdot st} \pm \sqrt{\Sigma(\tau_{xy \cdot dyn})^2}$$

where:

$\sigma_{x \cdot st}$, $\sigma_{y \cdot st}$ and $\tau_{xy \cdot st}$ = static stresses

$\sigma_{x \cdot dyn}$, $\sigma_{y \cdot dyn}$ and $\tau_{xy \cdot dyn}$ = dynamic stresses

all determined separately from acceleration components and hull strain components due to deflection and torsion.

(10) For internal insulation tanks, reference is made to the requirements of **404. 7** (2).

(11) Allowable stresses for materials other than those covered by **Sec 6** should be subject to approval by the Society in each case.

(12) Stresses may be further limited by fatigue analysis, crack propagation analysis and buckling criteria.

2. Corrosion allowances

(1) No corrosion allowance should generally be required in addition to the thickness resulting from the structural analysis. However, where there is no environmental control around the cargo tank, such as inerting, or where the cargo is of a corrosive nature, the Society may require a suitable corrosion allowance.

(2) For pressure vessels no corrosion allowance is generally required if the contents of the pressure vessel are non-corrosive and the external surface is protected by inert atmosphere or by an appropriate insulation with an approved vapour barrier. Paint or other thin coatings should not be credited as protection. Where special alloys are used with acceptable corrosion resistance, no corrosion allowance should be required. If the above conditions are not satisfied, the scantiings calculated according to **404. 6** should be increased as appropriate.

406. Supports (IGC Code 4.6)

1. Cargo tanks should be supported by the hull in a manner which will prevent bodily movement of the tank under static and dynamic loads while allowing contraction and expansion of the tank under temperature variation sand hull deflections without undue stressing of the tank and of the hull.

2. The tanks with supports should also be designed for a static angle of heel of 30° without exceeding allowable stresses given in **405. 1.**

3. The supports should be calculated for the most probable largest resulting acceleration, taking into account rotational as well as translational effects. This acceleration in a given direction may be determined as shown in **Fig 7.5.2.** The half axes of the "**acceleration ellipse**" should be determined according to **403. 4** (2).

4. Suitable supports should 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 without deformation likely to endanger the tank structure.

5. The loads mentioned in **Pars 2** and **4** need not be combined with each other or with wave-induced loads.

6. For independent tanks and, where appropriate, for membrane and semi-membrane tanks, provision should be made to key the tanks against the rotational effects referred to in **Par 3.**

7. Antiflotation arrangements should be provided for independent tanks. The antiflotation arrangements should 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, without plastic deformation likely to endanger the hull structure.

407. Secondary barrier (IGC Code 4.7)

1. Where the cargo temperature at atmospheric pressure is below -10°C, a secondary barrier should be provided when required by **Par 3** to act as a temporary containment for any envisaged leakage of liquid cargo through the primary barrier.

2. Where the cargo temperature at atmospheric pressure is not below -55°C, the hull structure may act as a secondary barrier. In such a case:

(1) the hull material should be suitable for the cargo temperature at atmospheric pressure as required by **409. 2;** and
(2) the design should be such that this temperature will not result in unacceptable hull stresses.

3. Secondary barriers in relation to tank types should normally be provided in accordance with **Table 7.5.2.** For tanks which differ from the basic tank types as defined in **402.** the secondary barrier requirements should be decided by the Society in each case.

Table 7.5.2 Secondary Barriers in Relation to Tank Types

<table>
<tr><td>Cargo temperature at atmospheric pressure</td><td>-10°C and above</td><td>Below -10°C down to -55°C</td><td>Below -55°C</td></tr>
<tr><td>Basic tank type</td><td>No secondary barrier required</td><td>Hull may act as secondary barrier</td><td>Separate secondary barrier where required</td></tr>
<tr><td>Integral</td><td rowspan="10"></td><td colspan="2">Tank type not normally allowed(1)</td></tr>
<tr><td>Membrane</td><td colspan="2">Complete secondary barrier</td></tr>
<tr><td>Semi-membrane</td><td colspan="2">Complete secondary barrier(2)</td></tr>
<tr><td>Independent</td><td colspan="2"></td></tr>
<tr><td>Type A</td><td colspan="2">Complete secondary barrier</td></tr>
<tr><td>Type B</td><td colspan="2">Partial secondary barrier</td></tr>
<tr><td>Type C</td><td colspan="2">No secondary barrier required</td></tr>
<tr><td>Internal insulation</td><td colspan="2"></td></tr>
<tr><td>Type 1</td><td colspan="2">Complete secondary barrier</td></tr>
<tr><td>Type 2</td><td colspan="2">Complete secondary barrier is incorporated</td></tr>
<tr><td colspan="4">Notes:
(1) A complete secondary barrier should normally be required if cargoes with a temperature at atmospheric pressure below -10° are permitted in accordance with 402.1(3).
(2) In the case of semi-membrane tanks which comply in all respects with the requirements applicable to type independent tanks, except for the manner of support the Society may, after special consideration, accept a partial secondary barrier.</td></tr>
</table>

4. The secondary barrier should be so designed that:
(1) it is capable of containing any envisaged leakage of liquid cargo for a period of 15 days, unless different requirements apply for particular voyages, taking into account the load spectrum referred to in **403. 4** (4);
(2) it will prevent lowering of the temperature of the ship structure to an unsafe level in the case of leakage of the primary barrier as indicated in **408. 2;** and
(3) the mechanism of failure for the primary barrier does not also cause the failure of the secondary barrier and vice versa.

5. The secondary barrier should fulfil its functions at a static angle of heel of 30°.

6. (1) Where a partial secondary barrier is required, its extent should be determined on the basis of cargo leakage corresponding to the extent of failure resulting from the load spectrum referred to in **403. 4** (4) after the initial detection of a primary leak. Due account may be taken of liquid evaporation, rate of leakage, pumping capacity and other relevant factors. In all cases, however, the inner bottom adjacent to cargo tanks should be protected against liquid cargo.
(2) Clear of the partial secondary barrier, provision such as a spray shield should be made to deflect any liquid cargo down into the space between the primary and secondary barriers and to keep the temperature of the hull structure to a safe level.

7. The secondary barrier should be capable of being periodically checked for its effectiveness, by means of a pressure/vacuum test, a visual inspection or another suitable method acceptable to the Society. The method should be submitted to the Society for approval.

408. Insulation (IGC Code 4.8)

1. Where a product is carried at a temperature below -10°C suitable insulation should be provided to ensure that the temperature of the hull structure does not fall below the minimum allowable design temperature given in **Sec 6** for the grade of steel concerned, as detailed in **409.,** when the cargo tanks are at their design temperature and the ambient temperatures are 5°C for air and 0°C for seawater. These conditions may generally be used for world-wide service. However, higher values of the ambient temperatures may be accepted by the Society for ships operated in restricted areas. Conversely, lesser values of the ambient temperatures may be fixed by the Society for ships trading occasionally or regularly to areas in latitudes where such lower temperatures are expected during the winter months. The ambient temperatures used in the design should be shown on the International Certificate of Fitness for the Carriage of Liquefied Gases on Bulk.

2. Where a complete or partial secondary barrier is required, calculations should be made with the assumptions in **Par 1** to check that the temperature of the hull structure does not fall below the minimum allowable design temperature given in **Sec 6** for the grade of steel concerned, as detailed in **409.** The complete or partial secondary barrier should be assumed to be at the cargo temperature at atmospheric pressure.

3. Calculations required by **Pars 1** and **2** should be made assuming still air and still water, and except as permitted by **Par 4,** no credit should be given for means of heating. In the case referred to in **Par 2,** the cooling effect of the rising boil-off vapour from the leaked cargo should be considered in the heat transmission studies. For structural members connecting inner and outer hulls, the mean temperature may be taken for determining the steel grade.

4. In all cases referred to in **Pars 1** and **2** and for ambient temperature conditions of 5°C for air and 0°C for seawater, approved means of heating transverse hull structural material may be used to ensure that the temperatures of this material do not fall below the minimum allowable values. If lower ambient temperatures are specified, approved means of heating may also be used for longitudinal hull structural material, provided this material remains suitable for the temperature conditions of 5°C for air and 0°C for seawater without heating. Such means of heating should comply with the following requirements:

(1) sufficient heat should be available to maintain the hull structure above the minimum allowable temperature in the conditions referred to in **Pars 1** and **2;**
(2) the heating system should be so arranged that, in the event of a failure in any part of the system, stand-by heating could be maintained equal to not less than 100 % of the theoretical heat load;
(3) the heating system should be considered as an essential auxiliary; and
(4) the design and construction of the heating system should be to the satisfaction of the Society.

5. In determining the insulation thickness, due regard should be paid to the amount of acceptable boil-off in association with the reliquefaction plant on board, main propulsion machinery or other temperature control system.

409. Materials (IGC Code 4.9)

1. The shell and deck plating of the ship and all stiffeners attached thereto should be in accordance with the requirements of **Pt 3** of the Rules, unless the calculated temperature of the material in the design condition is below -5°C due to the effect of the low temperature cargo, in which case the material should be in accordance with **Table 7.5.7** assuming the ambient sea and air temperature of 0°C and 5°C respectively. In the design condition, the complete or partial secondary barrier should be assumed to be at the cargo temperature at atmospheric pressure and for tanks without secondary barriers, the primary barrier should be assumed to be at the cargo temperature.

2. Hull material forming the secondary barrier should be in accordance with **Table 7.5.4.** Metallic materials used in secondary barriers not forming part of the hull structure should be in accordance with **Table 7.5.4** or **7.5.5** as applicable. Insulation materials forming a secondary barrier should comply with the requirements of **Par 7.** Where the secondary barrier is formed by the deck or side shell plating, the material grade required by **Table 7.5.4** should be carried into the adjacent deck or side shell plating, where applicable, to a suitable extent.

3. Materials used in the construction of cargo tanks should be in accordance with **Table 7.5.3, 7.5.4** or **7.5.5.**

4. Materials other than those referred to in **Pars 1, 2** and **3** used in the construction of the ship which are subject to reduced temperature due to the cargo and which do not form part of the secondary barrier should be in accordance with **Table 7.5.7** for temperatures as determined by **408.** This includes inner bottom plating, longitudinal bulkhead plating, transverse bulkhead plating, floors, webs, stringers and all attached stiffening members.

5. The insulation materials should be suitable for loads which may be imposed on them by the adjacent structure.

Table 7.5.3

PLATES, PIPES (SEAMLESS AND WELDED)(1), SECTIONS AND FORGINGS FOR CARGO TANKS AND PROCESS PRESSURE VESSELS FOR DESIGN TEMPERATURES NOT LOWER THAN 0°C.		
CHEMICAL COMPOSITION AND HEAT TREATMENT		
CARBON-MANGANESE STEEL	Fully killed	
Fine grain steel where thickness exceeds 20 mm		
Small additions of alloying elements by agreement with the Society Composition limits to be approved by the Society		
Normalized, or quenched and tempered(2)		
TENSILE AND TOUGHNESS (IMPACT) TEST REQUIREMENTS		
Plates	Each "piece" to be tested	
Sections and forgings	Batch test	
Tensile properties	Specified minimum yield stress not to exceed 410 N/mm^2 (3)	
CHARPY V-NOTCH TEST		
Plates	Transverse test pieces. Minimum average energy value (E) 27 J	
Sections and forgings	Longitudinal test pieces. Minimum average energy value (E) 41 J	
Test temperature	Thickness t (mm)	Test temperature (°C)
	$t \leq 20$	0
	$20 < t \leq 40$	-20

Notes:

(1) For seamless pipes and fittings normal practice applies. The use of longitudinally and spirally welded pipes should be specially approved by the Society.

(2) A controlled rolling procedure may be used as an alternative to normalizing or quenching and tempering, subject to special approval by the Society.

(3) Materials with specified minimum yield stress exceeding 410 N/mm^2 may be specially approved by the Society. For these materials, particular attention should be given to the hardness of the weld and heat affected zone.

Table 7.5.4

PLATES, SECTIONS AND FORGINGS[(1)] FOR CARGO TANKS, SECONDARY BARRIERS AND PROCESS PRESSURE VESSELS FOR DESIGN TEMPERATURES BELOW 0°C AND DOWN TO -55°C
Maximum thickness 25 mm[(2)]

CHEMICAL COMPOSITION AND HEAT TREATMENT
CARBON-MANGANESE STEEL Fully killed Aluminium treated fine grain steel

Chemical composition (ladle analysis)

C	Mn	Si	S	P
0.16 % max.[(3)]	0.70 -1.60 %	0.10-0.50 %	0.035 % max.	0.035 % max.

Optional additions: Alloys and grain refining elements may be generally in accordance with the following:

Ni	Cr	Mo	Cu	Nb	V
0.80 % max.	0.25 % max.	0.08 % max.	0.35 % max	0.05 % max.	0.10 % max.

Normalized or quenched and tempered[(4)]

TENSILE AND TOUGHNESS (IMPACT) TEST REQUIREMENTS

Plates	Each "piece" to be tested
Sections and forgings	Batch test
CHARPY V-NOTCH TEST	Test temperature 5°C below the design temperature or -20°C whichever is lower
Plates	Transverse test pieces. Minimum average energy value (E) 27 J
Sections and forgings[(1)]	Longitudinal test pieces. Minimum average energy value (E) 41 J

Notes:

(1) The Charpy V-notch and chemistry requirements for forgings may be specially considered by the Society.

(2) For material thickness of more than 25 mm, Charpy V-notch tests should be conducted as follows:

Material thickness(mm)	Test temperature
$25 < t \leq 30$	10°C below design temperature or -20°C whichever is lower
$30 < t \leq 35$	15°C below design temperature or -20°C whichever is lower
$35 < t \leq 40$	20°C below design temperature

The impact energy value should be in accordance with the table for the applicable type of test specimen. For material thickness of more than 40 mm, the Charpy V-notch values should be specially considered.
Materials for tanks and parts of tanks which are completely thermally stress relieved after welding may be tested at a temperature 5°C below design temperature or-20°C whichever is lower.
For thermally stress relieved reinforcements and other fittings, the test temperature should be the same as that required for the adjacent tank-shell thickness.

(3) By special agreement with the Society, the carbon content may be increased to 0.18 % maximum provided the design temperature is not lower than -40°C.

(4) A controlled rolling procedure may be used as an alternative to normalizing or quenching and tempering, subject to special approval by the Society.
Guidance: For materials exceeding 25 mm in thickness for which the test temperature is -60°C or lower, the application of specially treated steels or steels in accordance with **Table 7.5.5** may be necessary.

Table 7.5.5

PLATES, SECTIONS AND FORGINGS(1) FOR CARGO TANKS, SECONDARY BARRIERS AND PROCESS PRESSURE VESSELS FOR DESIGN TEMPERATURES BELOW -55°C AND DOWN TO -165°C(2)
Maximum thickness 25 mm(3)

Minimum design temp. (°C)	Chemical composition(4) and heat treatment	Impact test temp.(°C)
-60	1.5 % nickel steel-normalized	-65
-65	2.25 % nickel steel-normalized or normalized and tempered(5)	-70
-90	3.5 % nickel steel-normalized or normalized and tempered(5)	-95
-105	5 % nickel steel-normalized or normalized and tempered(5)(6)	-110
-165	9 % nickel steel-double normalized and tempered or quenched and tempered	-196
-165	Austenitic steels, such as types 304, 304 L, 316, 316 L, 321 and 347 solution treated(7)	-196
-165	Aluminium alloys; such as type 5083 annealed	Not required
-165	Austenitic Fe-Ni alloy (36 % nickel).Heat treatment as agreed	Not required

TENSILE AND TOUGHNESS (IMPACT) TEST REQUIREMENTS

Plates	Each "piece" to be tested
Sections and forgings	Batch test

CHARPY V-NOTCH TEST

Plates	Transverse test pieces. Minimum average energy value (E) 27 J
Sections and forgings	Longitudinal test pieces. Minimum average energy value (E) 41 J

Notes:

(1) The impact test required for forgings used in critical applications should be subject to special consideration by the Society.

(2) The requirements for design temperatures below -165°C should be specially agreed with the Society.

(3) For materials 1.5 % Ni, 2.25 % Ni, 3.5 % Ni and 5 % Ni, with thicknesses greater than 25 mm, the impact tests should be conducted as follows:

Material thickness (mm)	Test temperature
$25 < t \leq 30$	10°C below design temperature
$30 < t \leq 35$	15°C below design temperature
$35 < t \leq 40$	20°C below design temperature

In no case should the test temperature be above that indicated in this table. The energy value should be in accordance with this table for the applicable type of test specimen. For material thickness of more than 40 mm, the Charpy V-notch values should be specially considered. For 9 % Ni, austenitic stainless steels and aluminium alloys, thicknesses greater than 25 mm may be used at the discretion of the Society.

(4) The chemical composition limits should be approved by the Society.

(5) A lower minimum design temperature for quenched and tempered steels may be specially agreed with the Society.

(6) A specially heat treated 5 % nickel steel, for example triple heat treated 5 % nickel steel, may be used down to -165°C upon special agreement with the Society, provided that the impact tests are carried out at -196°C.

(7) The impact test may be omitted subject to agreement with the Society.

Teble 7.5.6

PIPES (SEAMLESS AND WELDED)(1), FORGINGS(2) AND CASTINGS(2) FOR CARGO AND PROCESS PIPING FOR DESIGN TEMPERATURES BELOW 0°C AND DOWN TO -165°C(3) Maximum thickness 25 mm			
Minimum design temp. (°C)	Chemical composition(5) and heat treatment	Impact test	
		Test temp.(°C)	Minimum average energy (E)(J)
-55	Carbon-manganese steel. Fully killed fine grain. Normalized or as agreed(6)	(4)	27
-65	2.25 % nickel steel. Normalized or normalized and tempered(6)	-70	34
-90	3.5 % nickel steel. Normalized or normalized and tempered(6)	-95	34
-165	9 % nickel steel(7) Double normalized and tempered or quenched and tempered	-196	41
	Austenitic steels, such as types 304, 304 L, 316, 316 L, 321 and 347. Solution treated(8)	-196	41
	Aluminium alloys, such as type 5083 annealed	-	Not required
TENSILE AND TOUGHNESS (IMPACT) TEST REQUIREMENTS Each batch to be tested IMPACT TEST Longitudinal test pieces			
Notes: (1) The use of longitudinally or spirally welded pipes should be specially approved by the Society. (2) The requirements for forgings and castings may be subject to special consideration by the Society. (3) The requirements for design temperatures below-165°C should be specially agreed with the Society. (4) The test temperature should be 5°C below the design temperature or -20°C whichever is lower. (5) The composition limits should be approved by the Society. (6) A lower design temperature may be specially agreed with the Society for quenched and tempered materials. (7) This chemical composition is not suitable for castings. (8) Impact tests may be omitted subject to agreement with the Society.			

Table 7.5.7

PLATES AND SECTIONS FOR HULL STRUCTURES REQUIRED BY **409. 1** AND **409. 4**							
Minimum design temperature of hull structure (°C)	Maximum thickness (mm) for steel grades in accordance with **601. 9**						
	A	B	D	E	AH	DH	EH
0 and above(1) -5 and above(2)	Normal practice						
down to -5	15	25	30	50	25	45	50
down to -10	×	20	25	50	20	40	50
down to -20	×	×	20	50	×	30	50
down to -30	×	×	×	40	×	20	40
Below -30	In accordance with **Table 7.5.4** except that the thickness limitation given in **Table 7.5.4** and in footnote (2) of that table does not apply.						
Notes: "x" means steel grade not to be used. (1) For the purpose of **409. 4** (2) For the purpose of **409. 1**							

6. Where applicable, due to location or environmental conditions, insulation materials should have suitable properties of resistance to fire and flame spread and should be adequately protected against penetration of water vapour and mechanical damage.

7. (1) Materials used for thermal insulation should be tested for the following properties as applicable, to ensure that they are adequate for the intended service:

(a) compatibility with the cargo
(b) solubility in the cargo
(c) absorption of the cargo
(d) shrinkage
(e) ageing
(f) closed cell content
(g) density
(h) mechanical properties
(i) thermal expansion
(j) abrasion
(k) cohesion
(I) thermal conductivity
(m) resistance to vibrations
(n) resistance to fire and flame spread

(2) In addition to meeting the above requirements, insulation materials which form part of the cargo containment as defined in **402. 5** should be tested for the following properties after simulation of ageing and thermal cycling to ensure that they are adequate for the intended service:

(a) bonding (adhesive and cohesive strength)
(b) resistance to cargo pressure
(c) fatigue and crack propagation properties
(d) compatibility with cargo constituents and any other agent expected to be in contact with the insulation in normal service.
(e) where applicable the influence of presence of water and water pressure on the insulation properties should be taken into account.
(f) gas de-absorbing.

(3) The above properties, where applicable, should be tested for the range between the expected maximum temperature in service and 5°C below the minimum design temperature, but not lower than -196°C.

8. The procedure for fabrication, storage, handling, erection, quality control and control against harmful exposure to sunlight of insulation materials should be to the satisfaction of the Society.

9. Where powder or granulated insulation is used, the arrangements should be such as to prevent compacting of the material due to vibrations. The design should incorporate means to ensure that the material remains sufficiently buoyant to maintain the required thermal conductivity and also prevent any undue increase of pressure on the cargo containment system.

410. Construction and testing (IGC Code 4.10)

1. (1) All welded joints of the shells of independent tanks should be of the butt weld, full penetration type. For dome-to-shell connections, the Society may approve tee welds of the full penetration type. Except for small penetrations on domes, nozzle welds are also generally to be designed with full penetration.

(2) Welding joint details for type C independent tanks should be as follows:

(a) All longitudinal and circumferential joints of pressure vessels should be of butt welded, full penetration, double vee or single vee type. Full penetration butt welds should be obtained by double welding or by the use of backing rings. If used, backing rings should be removed, unless specifically approved by the Society for very small process pressure vessels. Other edge preparations may be allowed by the Society depending on the results of the tests carried out at the approval of the welding procedure.
(b) The bevel preparation of the joints between the pressure vessel body and domes and between domes and relevant fittings should be designed according to a standard for pressure vessels acceptable to the Society. All welds connecting nozzles, domes or other penetrations of the vessel and all welds connecting flanges to the vessel or nozzles should be full pene-

tration welds extending through the entire thickness of the vessel wall or nozzle wall, unless specially approved by the Society for small nozzle diameters.

2. Workmanship should be to the satisfaction of the Society. Inspection and non-destructive testing of welds for tanks other than type C independent tanks should be in accordance with the requirements of **603. 7.**

3. For membrane tanks, quality assurance measures, weld procedure qualification, design details, materials, construction, inspection and production testing of components, should be to standards developed during the prototype testing programme.

4. For semi-membrane tanks the relevant requirements in this Article for independent tanks or for membrane tanks should be applied as appropriate.

5. (1) For internal insulation tanks, in order to ensure uniform quality of the material, quality control procedures including environmental control, application procedure qualification, corners, penetrations and other design details, materials specification, installation and production testing of components should be to standards developed during the prototype test programme.

(2) A quality control specification including maximum permissible size of constructional defects, tests and inspections during the fabrication, installation and also sampling tests at each of these stages should be to the satisfaction of the Society.

6. Integral tanks should be hydrostatically or hydropneumatically tested to the satisfaction of the Society. The test in general should be so performed that the stresses approximate, as fas as practicable, to the design stresses and that the pressure at the top of the tank corresponds at least to the MARVS.

7. In ships fitted with membrane or semi-membrane tanks, cofferdams and all spaces which may normally contain liquid and are adjacent to the hull structure supporting the membrane should be hydrostatically or hydropneumatically tested in accordance with Recognized Standards. In addition, any other hold structure supporting the membrane should be tested for tightness. Pipe tunnels and other compartments which do not normally contain liquid need not be hydrostatically tested.

8. (1) In ships fitted with internal insulation tanks where the inner hull is the supporting structure, all inner hull structure should be hydrostatically or hydropheumatically tested in accordance with Recognized Standards, taking into account the MARVS.

(2) In ships fitted with internal insulation tanks where independent tanks are the supporting structure, the independent tanks should be tested in accordance with **Par 10** (1).

(3) For internal insulation tanks where the inner hull structure or an independent tank structure acts as a secondary barrier, a tightness test of those structures should be carried out using techniques to the satisfaction of the Society.

(4) These tests should be performed before the application of the materials which will form the internal insulation tank.

9. For type C independent tanks, inspection and nondestructive testing should be as follows:

(1) Manufacture and workmanship - The tolerances relating to manufacture and workmanship such as out-of-roundness, local deviations from the true form, welded joints alignment and tapering of plates having different thicknesses, should comply with standards acceptable to the Society. The tolerances should also be related to the buckling analysis referred to in **404. 6** (2).

(2) Non-destructive testing - As far as completion and extension of non-destructive testing of welded joints are concerned, the extent of non-destructive testing should be total or partial according to standards acceptable to the Society, but the controls to be carried out should not be less than the following:

(a) Total non-destructive testing referred to in **404. 6** (1) (c):
Radiography : butt welds 100 % and
Surface crack detection : all welds 10 %;
reinforcement rings around holes, nozzles, etc. 100 %.
As an alternative, ultrasonic testing may be accepted as a partial substitute for the radiographic testing, if specially allowed by the Society. In addition, the Society may require total ultrasonic testing on welding of reinforcement rings around holes, nozzles, etc.

(b) Partial non-destructive testing referred to in **404. 6** (1) (c):
Radiography : butt welds: all welded crossing joints and at least 10 % of the full length at selected positions uniformly distributed and

Surface crack detection : reinforcement rings around holes, nozzles, etc. 100 %
Ultrasonic testing : as may be required by the Society in each instance.

10. Each independent tank should be subjected to hydrostatic or hydropneumatic test as follows:

(1) For type A independent tanks, this test should be so performed that the stresses approximate, as far as practicable, to the design stresses and that the pressure at the top of the tank corresponds at least to the MARVS. When a hydropneumatic test is performed, the conditions should simulate, as far as practicable, the actual loading of the tank and of its supports.

(2) For type B independent tanks, the test should be performed as required in (1) for type A independent tanks. In addition, the maximum primary membrane stress or maximum bending stress in primary members under test conditions should not exceed 90 % of the yield strength of the material (as fabricated) at the test temperature. To ensure that this condition is satisfied, when calculations indicate that this stress exceeds 75 % of the yield strength, the prototype test should be monitored by the use of strain gauges or other suitable equipment.

(3) Type C independent tanks should be tested as follows:

(a) Each pressure vessel, when completely manufactured, should be subjected to a hydrostatic test at a pressure measured at the top of the tanks, of not less than 1.5 P_0, but in no case during the pressure test should the calculated primary membrane stress at any point exceed 90 % of the yield stress of the material. The definition of P_0 is given in **402. 6**. To ensure that this condition is satisfied where calculations indicate that this stress will exceed 0.75 times the yield strength, the prototype test should be monitored by the use of strain gauges or other suitable equipment in pressure vessels other than simple cylindrical and spherical pressure vessels.

(b) The temperature of the water used for the test should be at least 30°C above the nil ductility transition temperature of the material as fabricated.

(c) The pressure should be held for 2 h per 25 mm of thickness but in no case less than 2 h.

(d) Where necessary for cargo pressure vessels, and with the specific approval of the Society, a hydropneumatic test may be carried out under the conditions prescribed in (a), (b) and (c).

(e) Special consideration may be given by the Society to the testing of tanks in which higher allowable stresses are used, depending on service temperature. However, the requirements of (a) should be fully complied with.

(f) After completion and assembly, each pressure vessel and its related fittings should be subjected to an adequate tightness test.

(g) Pneumatic testing of pressure vessels other than cargo tanks should be considered on an individual case basis by the Society. Such testing should be permitted only for those vessels which are so designed or supported that they cannot be safely filled with water, or for those vessels which cannot be dried and are to be used in a service where traces of the testing medium cannot be tolerated.

11. All tanks should be subjected to a tightness test which may be performed in combination with the pressure test referred to in **Par 10** or separately.

12. Requirements with respect to inspection of secondary barriers should be decided by the Society in each case.

13. In ships fitted with type B independent tanks, at least one tank and its support should be instrumented to confirm stress levels unless the design and arrangement for the size of ship involved are supported by full-scale experience. Similar instrumentation may be required by the Society for type C independent tanks dependent on their configuration and on the arrangement of their supports and attachments.

14. The overall performance of the cargo containment system should be verified for compliance with the design parameters during the initial cool-down, loading and discharging of the cargo. Records of the performance of the components and equipment essential to verify the design parameters should be maintained and be available to the Society.

15. Heating arrangements, if fitted in accordance with **408. 4,** should be tested for required heat output and heat distribution.

16. The hull should be inspected for cold spots following the first loaded voyage.

17. The insulation materials of internal insulation tanks should be subjected to additional inspection in order to verify their surface conditions after the third loaded voyage of the ship, but not later than the first 6 months of the ship's service after building or a major repair work is undertaken on the internal insulation tanks.

18. For type C independent tanks, the required marking of the pressure vessel should be achieved by a method which does not cause unacceptable local stress raisers.

411. Stress relieving for type C independent tanks (IGC Code 4.11)

1. For type C independent tanks of carbon and carbon-manganese steel, post-weld heat treatment should be performed after welding if the design temperature is below -10°C. Post-weld heat treatment in all other cases and for materials other than those mentioned above should be to the satisfaction of the Society. The soaking temperature and holding time should be to the satisfaction of the Society.

2. In the case of large cargo pressure vessels of carbon or carbon-manganese steel for which it is difficult to perform the heat treatment, mechanical stress relieving by pressurizing may be carried out as an alternative to the heat treatment subject to the following conditions:

(1) Complicated welded pressure vessel parts, such as sumps or domes with nozzles, with adjacent shell plates should be heat treated before they are welded to larger parts of the pressure vessel.

(2) The mechanical stress relieving process should preferably be carried out during the hydrostatic pressure test required by the requirement in **410. 10** (3), by applying a higher pressure than the test pressure required by **410. 10** (3) (a). The pressurizing medium should be water.

(3) For the water temperature, the requirement in **410.10** (3) (b) applies.

(4) Stress relieving should be performed while the tank is supported by its regular saddles or supporting structure or, when stress relieving cannot be carried out on board, in a manner which will give the same stresses and stress distribution as when supported by its regular saddles or supporting structure.

(5) The maximum stress relieving pressure should be held for two hours per 25 mm of thickness but in no case less than two hours.

(6) The upper limits placed on the calculated stress levels during stress relieving should be the following:

- equivalent general primary membrane stress: 0.9 R_e
- equivalent stress composed of primary bending stress plus membrane stress: 1.35 R_e

where Re is the specific lower minimum yield stress or 0.2 % proof stress at test temperature of the steel used for the tank.

(7) Strain measurements will normally be required to prove these limits for at least the first tank of a series of identical tanks built consecutively. The location of strain gauges should be included in the mechanical stress relieving procedure to be submitted in accordance with **411. 2** (14).

(8) The test procedure should demonstrate that a linear relationship between pressure and strain is achieved at the end of the stress relieving process when the pressure is raised again up to the design pressure.

(9) High stress areas in way of geometrical discontinuities such as nozzles and other openings should be checked for cracks by dye penetrant or magnetic particle inspection after mechanical stress relieving. Particular attention in this respect should be given to plates exceeding 30 mm in thickness.

(10) Steels which have a ratio of yield stress to ultimate tensile strength greater than 0.8 should generally not be mechanically stress relieved. If however the yield stress is raised by a method giving high ductility of the steel, slightly higher rates may be accepted upon consideration in each case.

(11) Mechanical stress relieving cannot be substituted for heat treatment of cold formed parts of tanks if the degree of cold forming exceeds the limit above which heat treatment is required.

(12) The thickness of the shell and heads of the tank should not exceed 40 mm. Higher thicknesses may be accepted for parts which are thermally stress relieved.

(13) Local buckling should be guarded against particularly when tori-spherical heads are used for tanks and domes.

(14) The procedure for mechanical stress relieving should be submitted beforehand to the Society for approval.

412. Guidance formulae for acceleration components (IGC Code 4.12)

The following formulae are given as guidance for the components of acceleration due to ship's motions corresponding to a probability level of 10^{-8} in the North Atlantic and apply to ships with a length exceeding 50 m.

Vertical acceleration as defined in **403. 4** (6) : $a_z = \pm a_0 \sqrt{1+\left(5.3-\frac{45}{L_0}\right)^2\left(\frac{x}{L_0}+0.05\right)^2\left(\frac{0.6}{C_b}\right)^{1.5}}$

Transverse acceleration as defined in **403. 4** (6) : $a_y = \pm a_0 \sqrt{0.6+2.5\left(\frac{x}{L_0}+0.05\right)^2+K\left(1+0.6K\frac{z}{B}\right)^2}$

Longitudinal acceleration as defined in **403. 4** (6) : $a_x = \pm a_0 \sqrt{0.06+A^2-0.25A}$

with:

$A=\left(0.7-\frac{L_0}{1200}+5\frac{z}{L_0}\right)\left(\frac{0.6}{C_b}\right)$

where:

L_0 = length of the ship for determination of scantlings as defined in Recognized Standards (m)

C_b = block coefficient

B = greatest moulded breadth of the ship (m)

x = longitudinal distance (m) from amidships to the centre of gravity of the tank with contents; x is positive forward of amidships, negative aft of amidships

z = vertical distance (m) from the ship's actual water-line to the centre of gravity of tank with contents; z is positive above and negative below the waterline.

$$a_0 = 0.2\frac{V}{\sqrt{L_0}}+\frac{34-\frac{600}{L_0}}{L_0}$$

where: V = service speed (knots)

K = 1 in general. For particular loading conditions and hull forms, determination of K according to the formula below may be necessary.

K = 13 GM/B, where $K \geq$ 1.0 and GM = metacentric height (m)

a_x, a_y and a_z = maximum dimensionless accelerations (i.e. relative to the acceleration of gravity) in the respective directions and they are considered as acting separately for calculation purposes. a_z does not include the component due to the static weight, a_y includes the component due to the static weight in the transverse direction due to rolling and a_x includes the component due to the static weight in the longitudinal direction due to pitching.

413. Stress categories (IGC Code 4.13)

For the purpose of stress evaluation referred to in **405. 1** (4), stress categories are defined in this Article.

1. Normall stress is the component of stress normal to the plane of reference.

2. Membrane stress is the component of normal stress which is uniformly distributed and equal to the average value of the stress across the thickness of the section under consideration.

3. Bending stress is the variable stress across the thickness of the section under consideration, after the subtraction of the membrane stress.

4. Shear stress is the component of the stress acting in the plane of reference.

5. Primary stress is a stress produced by the imposed loading and which is necessary to balance the external forces and moments. The basic characteristic of a primary stress is that it is not self-limiting. Primary stresses which considerably exceed the yield strength will result in failure or at least in gross deformations.

6. Primary general membrane stress is a primary membrane stress which is so distributed in the structure that no redistribution of load occurs as a result of yielding.

7. Primary local membrane stress arises where a membrane stress produced by pressure or other mechanical loading and associated with a primary or a discontinuity effect produces excessive distortion in the transfer of loads for other portions of the structure. Such a stress is classified as a primary local membrane stress although it has some characteristics of a secondary stress. A stress region may be considered as local if :

$$S_1 \le 0.5\sqrt{Rt}$$
$$S_2 \ge 2.5\sqrt{Rt}$$

where:

S_1 = distance in the meridional direction over which the equivalent stress exceeds 1.1 f

S_2 = distance in the meridional direction to another region where the limits for primary general membrane stress are exceeded

R = mean radius of the vessel

t = wall thickness of the vessel at the location where the primary general membrane stress limit is exceeded

f = allowable primary general membrane stress.

8. Secondary stress is a normal stress or shear stress developed by constraints of adjacent parts or by self constraint of a structure. The basic characteristic of a secondary stress is that it is self-limiting. Local yielding and minor distortions can satisfy the conditions which cause the stress to occur.

Section 5 Process Pressure Vessels and Liquid, Vapour, and Pressure Piping Systems

501. General (IGC Code 5.1)

1. The Society should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this Section.

2. The requirements for type C independent tanks in **Sec 4** may also apply to process pressure vessels if required by the Society. If so required the term "pressure vessels" as used in **Sec 4** covers both type C independent tanks and process pressure vessels.

502. Cargo and process piping (IGC Code 5.2)

1. General

(1) The requirements of **502.** to **505.** apply to product and process piping including vapour piping and vent lines of safety valves or similar piping. Instrument piping not containing cargo is exempt from these requirements.

(2) Provision should be made by the use of offsets, loops, bends, mechanical expansion joints such as bellows, slip joints and ball joints or similar suitable means to protect the piping, piping system components and cargo tanks from excessive stresses due to thermal movement and from movements of the tank and hull structure. Where mechanical expansion joints are used in piping they should be held to a minimum and, where located outside cargo tanks, should be of the bellows type.

(3) Low-temperature piping should be thermally isolated from the adjacent hull structure, where necessary, to prevent the temperature of the hull from falling below the design temperature of the hull material. Where liquid piping is dismantled regularly, or where liquid leakage may be anticipated, such as at shore connections and at pump seals, protection for the hull beneath should be provided.

(4) Where tanks or piping are separated from the ship's structure by thermal isolation, provision should be made for electrically bonding both the piping and the tanks. All gasketed pipe joints and hose connections should be electrically bonded.

(5) Suitable means should be provided to relieve the pressure and remove liquid contents from cargo loading and discharging crossover headers and cargo hoses to the cargo tanks or other suitable location, prior to disconnecting the cargo hoses.

(6) All pipelines or components which may be isolated in a liquid full condition should be provided with relief valves.

(7) Relief valves discharging liquid cargo from the cargo piping system should discharge into the cargo tanks; alternatively they may discharge to the cargo vent mast if means are provided to detect and dispose of any liquid cargo which may flow into the vent system. Relief valves on cargo pumps should discharge to the pump suction.

2. Scantlings based on internal pressure

(1) Subject to the conditions stated in **Par 4,** the wall thickness of pipes should not be less than:

$$t = \frac{t_0 + b + c}{1 - \frac{a}{100}}$$

where:

t_0 = theoretical thickness (mm)

$$t_0 = \frac{PD}{2Ke + P}$$

with:

P = design pressure (MPa) referred to in **Par 3**

D = outside diameter (mm)

K = allowable stress (N/mm^2) referred to in **Par 4**

e = efficiency factor equal to 1.0 for seamless pipes and for longitudinally or spirally welded pipes, delivered by approved manufacturers of welded pipes, which are considered equivalent to seamless pipes when non-destructive testing on welds is carried out in accordance with Recognized Standards. In other cases an efficiency factor of less than 1.0, in accordance with recognized standards, may be required depending on the manufacturing process.

b = allowance for bending (mm). The value of b should be chosen so that the calculated stress in the bend, due to internal pressure only, does not exceed the allowable stress. Where such justification is not given, b should be:

$$b = \frac{Dt_0}{2.5r}$$

with :

r = mean radius of the bend (mm)

c = corrosion allowance (mm). If corrosion or erosion is expected, the wall thickness of the piping should be increased over that required by other design requirements. This allowance should be consistent with the expected life of the piping.

a = negative manufacturing tolerance of thickness (%).

3. Design pressure

(1) The design pressure P in the formula for t_0 in **Par 2** (1) is the maximum gauge pressure to which the system may be subjected in service.

(2) The greater of the following design conditions should be used for piping, piping systems and components as appropriate:

(a) for vapour piping systems or components which may be separated from their relief valves and which may contain some liquid: the saturated vapour pressure at 45°C, or higher or lower if agreed upon by the Society (see **402. 6** (2));

(b) for systems or components which may be separated from their relief valves and which contain only vapour at all times: the superheated vapour pressure at 45°C or higher or lower if agreed upon by the Society (see **402. 6** (2)), assuming an initial condition of saturated vapour in the system at the system operating pressure and temperature; or

(c) the MARVS of the cargo tanks and cargo processing systems; or

(d) the pressure setting of the associated pump or compressor discharge relief valve; or

(e) the maximum total discharge or loading head of the cargo piping system; or

(f) the relief valve setting on a pipeline system.

(3) The design pressure should not be less than 1.0 MPa gauge except for open ended lines where it should be not less than 0.5 MPa gauge.

4. Permissible stresses

(1) For pipes, the permissible stress to be considered in the formula for t in **Par 2** (1) is the lower of the following values:

$$R_m/A \quad \text{or} \quad R_e/B$$

where:

R_m = specified minimum tensile strength at room temperature (N/mm^2)

R_e = specified minimum yield stress at room temperature (N/mm^2)

If the stress-strain curve does not show a defined yield stress, the 0.2 % proof stress applies.
The values of A and B should be shown on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and have values of at least A = 2.7 and B = 1.8.

(2) The minimum wall thickness should be in accordance with Recognized Standards.

(3) Where necessary for mechanical strength to prevent damage, collapse, excessive sag or buckling of pipes due to superimposed loads from supports, ship deflection or other causes, the wall thickness should be increased over that required by **Par 2,** or, if this is impracticable or would cause excessive local stresses, these loads should be reduced, protected against or eliminated by other design methods.

(4) Flanges, valves and other fittings should comply with recognized standards, taking into account the design pressure defined in **Par 3.** For bellows expansion joints used in vapour service, a lower minimum design pressure may be accepted by the Society.

(5) For flanges not complying with a standard, the dimensions of flanges and related bolts should be to the satisfaction of the Society.

5. Stress analysis

When the design temperature is -110°C or lower, a complete stress analysis, taking into account all the stresses due to weight of pipes, including acceleration loads if significant, internal pressure, thermal contraction and loads induced by hog and sag of the ship for each branch of the piping system should be submitted to the Society. For temperatures of above -110°C, a stress analysis may be required by the Society in relation to such matters as the design or stiffness of the piping system and the choice of materials. In any case, consideration should be given to thermal stresses, even though calculations are not submitted. The analysis may be carried out according to a code of practice acceptable to the Society.

6. Materials

(1) The choice and testing of materials used in piping systems should comply with the requirements of **Sec 6** taking into account the minimum design temperature. However, some relaxation may be permitted in the quality of material of open ended vent piping, provided the temperature of the cargo at the pressure relief valve setting is -55°C or greater and provided no liquid discharge to the vent piping can occur. Similar relaxations may be permitted under the same temperature conditions to open ended piping inside cargo tanks, excluding discharge piping and all piping inside membrane and semi-membrane tanks.

(2) Materials having a melting point below 925°C should not be used for piping outside the cargo tanks except for short lengths of pipes attached to the cargo tanks, in which case fire-resisting insulation should be provided.

503. Tests of piping components and pumps prior to installation on board (IGC Code 5.3)

1. Each type of piping component and pump should be subject to the following tests.

(1) Valves

(A) Type tests

Each size and type of valve intended to be used at a working temperature below -55°C is to be type approved. Type tests to the minimum design temperature or lower and to a pressure not lower than the maximum design pressure foreseen for the valves is to be witnessed in the presence of the Surveyor. Type tests are to include hydrostatic test of the valve body at a pressure equal to 1.5 times the design pressure, seat and stem leakage test at a pressure equal to 1.1 times the design pressure, and cryogenic testing consisting of valve operation and leakage verification at the design temperature.

For valves intended to be used at a working temperature above -55°C, type approval is not required.

(B) Production tests

All valves are to be tested at the plant of manufacturer in the presence of the Surveyor. Testing is to include hydrostatic test of the valve body at a pressure equal to 1.5 times the design pressure, seat and stem leakage test at a pressure equal to 1.1 times the design pressure.

In addition, cryogenic testing consisting of valve operation and leakage verification at the design temperature for a minimum of 10% of each type and size of valve for valves intended to be used at a working temperature below -55°C.

As an alternative to the above, the manufacturer may request the Society to certify a valve subject to the following:

(a) The valve has been type approved as required by **Ch 5, 503. 1** (1) (A) for valves intended to be used at a working temperature below -55°C, and

(b) The manufacturer has a recognized quality system that has been assessed and certified by the Society subject to periodic audits, and

(c) The quality control plan contains a provision to subject each valve to a hydrostatic test of the valve body at a pressure equal to 1.5 times the design pressure and seat and stem leakage test at a pressure equal to 1.1 times the design pressure. The manufacturer is to maintain records of such tests, and

(d) Cryogenic testing consisting of valve operation and leakage verification at the design temperature for a minimum of 10 % of each type and size of valve for valves intended to be used at a working temperature below -55 °C in the presence of the Society' representative.

(2) Expansion Bellows

Each type of expansion bellows intended for use on cargo piping outside the cargo tank and, where required, on those expansion bellows installed within the cargo tanks is to be type approved by the following tests:

(A) A type element of the bellows, not precompressed, should be pressure tested at not less than 5 times the design pressure without bursting. The duration of the test should not be less than 5 min.

(B) A pressure test should be performed on a type expansion joint complete with all the accessories such as flanges, stays and articulations, at twice the design pressure at the extreme displacement conditions recommended by the manufacturer without permanent deformation. Depending on the materials used, the Society may require the test to be at the minimum design temperature.

(C) A cyclic test (thermal movements) should be performed on a complete expansion joint, which is to successfully withstand at least as many cycles, under the conditions of pressure, temperature, axial movement, rotational movement and transverse movement, as it will encounter in actual service. Testing at ambient temperature is permitted, when this testing is at least as severe as testing at the service temperature.

(D) A cyclic fatigue test (ship deformation) should be performed on a complete expansion joint, without internal pressure, by simulating the bellows movement corresponding to a compensated pipe length, for at least 2,000,000 cycles at a frequency not higher than 5 cycles/s. This test is only required when, due to the piping arrangement, ship deformation loads are actually experienced.

(E) The Society may waive performance of the tests referred to in this paragraph provided that complete documentation is supplied to establish the suitability of the expansion joints to withstand the expected working conditions. When the maximum internal pressure exceeds 0.1 MPa gauge this documentation is to include sufficient test data to justify the design method used, with particular reference to correlation between calculation and test results.

(3) Cargo Pumps

(A) Each size and type of pumps is subject to design approval and the tests of following (a) to (c) in the presence of the Surveyor. However, for the pump designed the same as an existing pump approved by the Society and having satisfactory in-service experience, consideration may be given to waiving the tests.

(a) hydrostatic test of the pump body equal to 1.5 times the design pressure

(b) the following capacity tests

(i) For submerged pumps, the capacity test is to be carried out with the design medium or with a medium below the design temperature.

(ii) For deep well pumps, the capacity test may be carried out with water. In addition, for deep well pumps, a spin test to demonstrate satisfactory operation of bearing clearances, wear rings and sealing arrangements is to be carried out at the design temperature.

(c) After completion of tests, the pump is to be opened out for examination.

(B) All pumps of the same size and type which have been granted design approval are subject to the tests of following (a) and (b) at the plant of manufacturer in the presence of the

Surveyor.
(a) hydrostatic test of the pump body equal to 1.5 times the design pressure
(b) the capacity tests in compliance with the special requirements given by the Society.
The manufacturer may request the Society to waive the above tests subject to the following:
(c) The pump has been tested as required by **Ch 5, 503. 1** (3) (A) and
(d) The manufacturer has a recognised quality system that has been assessed and certified by the Society subject to periodic audits, and
(e) The quality control plan contains a provision to subject each pump to a hydrostatic test of the pump body equal to 1.5 times the design pressure and a capacity test. The manufacturer is to maintain records of such tests.

504. Piping fabrication and joining details (IGC Code 5.4)

1. The requirements of this Article apply to piping inside and outside the cargo tanks. Relaxations from these requirements may be accepted, in accordance with recognized standards, for piping inside cargo tanks and open-ended piping.

2. The following direct connection of pipe lengths, without flanges, may be considered:

(1) Butt-welded joints with complete penetration at the root may be used in all applications. For design temperatures below -10°C, butt welds should be either double welded or equivalent to a double welded butt joint. This may be accomplished by use of a backing ring, consumable insert or inert gas back-up on the first pass. For design pressures in excess of 1.0 MPa and design temperatures of -10°C or lower, backing rings should be removed.
(2) Slip-on welded joints with sleeves and related welding, having dimensions in accordance with recognized standards, should only be used for open-ended lines with external diameter of 50 mm or less and design temperatures not lower than -55°C.
(3) Screwed couplings complying with recognized standards only be used for accessory lines and instrumentation lines with external diameters of 25 mm or less.

3. (1) Flanges in flange connections should be of the welded neck, slip-on or socket welded type.

(2) Flanges should comply with recognized standards as to their type, manufacture and test. In particular, for all piping except open ended, the following restrictions apply:
(a) For design temperatures lower than -55°C, only welded neck flanges should be used.
(b) For design temperatures lower than -10°C, slip-on flanges should not be used in nominal sizes above 100 mm and socket welded flanges should not be used in nominal sizes above 50 mm.

4. Piping connections, other than those mentioned in **Pars 2** and **3,** may be accepted by the Society in each case.

5. Bellows and expansion joints should be provided to allow for expansion of piping.

(1) If necessary, bellows should be protected against icing.
(2) Slip joints should not be used except within the cargo tanks.

6. Welding, post-weld heat treatment and non-destructive testing.

(1) Welding should be carried out in accordance with **603.**
(2) Post-weld heat treatment should be required for all butt welds of pipes made with carbon, carbon-manganese and low alloy steels. The Society may waive the requirement for thermal stress relieving of pipes having wall thickness less than 10 mm in relation to the design temperature and pressure of the piping system concerned.
(3) In addition to normal controls before and during the welding and to the visual inspection of the finished welds, as necessary for proving that the welding has been carried out correctly and according to the requirements of this paragraph, the following tests should be required:
(a) 100 % radiographic inspection of butt welded joints for piping systems with design temperatures lower than -10°C and with inside diameters of more than 75 mm or wall thicknesses greater than 10 mm. When such butt welded joints of piping sections are made by automatic welding procedures in the pipe fabrication shop, upon special approval by the Society, the extent of radiographic inspection may be progressively reduced but in no case to less than 10 % of each joint, If defects are revealed, the extent of examination should be increased to 100 % and should include inspection of previously accepted welds. This special

approval can only be granted if well-documented quality assurance procedures and records are available to enable the Society to assess the ability of the manufacturer to produce satisfactory welds consistently.

(b) For other butt-welded joints of pipes not covered by (a), spot radiographic tests or other non-destructive tests should be carried out at the discretion of the Society depending upon service, position and materials. In general, at least 10 % of butt-welded joints of pipes should be radiographed.

505. Testing of piping on board (IGC Code 5.5)

1. The requirements of this Article apply to piping inside and outside the cargo tanks. However, the Society may accept relaxations from these requirements for piping inside cargo tanks and open-ended piping.

2. After assembly, all cargo and process piping should be subjected to a hydrostatic test to at least 1.5 times the design pressure. When piping systems or parts of systems are completely manufactured and equipped with all fittings, the hydrostatic test may be conducted prior to installation aboard ship. Joints welded on board should be hydrostatically tested to at least 1.5 times the design pressure. Where water cannot be tolerated and the piping cannot be dried prior to putting the system into service, proposals for alternative testing fluids or testing means should be submitted to the Society for approval.

3. After assembly on board, each cargo and process piping system should be subjected to a leak test using air, halides, or other suitable medium to a pressure depending on the leak detection method applied.

4. All piping systems including valves, fittings and associated equipment for handling cargo or vapours should be tested under normal operating conditions not later than at the first loading operation.

506. Cargo system valving requirements (IGC Code 5.6)

1. Every cargo piping system and cargo tank should be provided with the following valves, as applicable:

(1) For cargo tanks with a MARVS not exceeding 0.07 MPa gauge, all liquid and vapour connections, except safety relief valves and liquid level gauging devices, should have shutoff valves located as close to the tank as practicable. These valves may be remotely controlled but should be capable of local manual operation and provide full closure. One or more remotely controlled emergency shutdown valves should be provided on the ship for shutting down liquid and vapour cargo transfer between ship and shore. Such valves may be arranged to suit the ship's design and may be the same valve as required in **Par 3** and should comply with the requirements of **Par 4.**

(2) For cargo tanks with a MARVS exceeding 0.07 MPa gauge, all liquid and vapour connections, except safety relief valves and liquid level gauging devices, should be equipped with a manually operated stop valve and a remotely controlled emergency shutdown valve. These valves should be located as close to the tank as practicable. Where the pipe size does not exceed 50 mm in diameter, excess flow valves may be used in lieu of the emergency shutdown valve. A single valve may be substituted for the two separate valves provided the valve complies with the requirements of **Par 4,** is capable of local manual operation and provides full closure of the line.

(3) Cargo pumps and compressors should be arranged to shutdown automatically if the emergency shutdown valves required by **Par 1** (1) and (2) are closed by the emergency shutdown system required by **Par 4.**

2. Cargo tank connections for gauging or measuring devices need not be equipped with excess flow or emergency shutdown valves provided that the devices are so constructed that the outward flow of tank contents cannot exceed that passed by a 1.5 mm diameter circular hole.

3. One remotely operated emergency shutdown valve should be provided at each cargo hose connection in use. Connections not used in transfer operations may be blinded with blank flanges in lieu of valves.

4. The control system for all required emergency shutdown valves should be so arranged that all such valves may be operated by single controls situated in at least two remote locations on the ship.

One of these locations should be the control position required by **1301. 3** or cargo control room. The control system should also be provided with fusible elements designed to melt at temperatures between 98°C and 104°C which will cause the emergency shutdown valves to close in the event of fire. Locations for such fusible elements should include the tank domes and loading stations. Emergency shutdown valves should be of the fail-closed (closed on loss of power) type and be capable of local manual closing operation. Emergency shutdown valves in liquid piping should fully close under all serivce conditions within 30 s of actuation. Information about the closing time of the valves and their operating characteristics should be available on board and the closing time should be verifiable and reproducible. Such valves should close smoothly.

5. The closure time of 30 s for the emergency shutdown valve referred to in **506. 4** should be measured from the time of manual or automatic initiation to final closure. This is called the total shutdown time and is made up of a signal response time and a valve closure time. The valve closure time should be such as to avoid surge pressure in pipelines. Such valves should close in such a manner as to cut off the flows smoothly. This paragraph applies to ships constructed on or after 1 July 2002.

6. Excess flow valves should close automatically at the rated closing flow of vapour or liquid as specified by the manufacturer. The piping including fittings, valves, and appurtenances protected by an excess flow valve, should have a greater capacity than the rated closing flow of the excess flow valve. Excess flow valves may be designed with a bypass not exceeding an area of 1.0 mm diameter circular opening to allow equalization of pressure, after an operating shutdown.

507. Ship's cargo hoses (IGC Code 5.7)

1. Liquid and vapour hoses used for cargo transfer should be compatible with the cargo and suitable for the cargo temperature.

2. Hoses subject to tank pressure, or the discharge pressure of pumps or vapour compressors, should be designed for a bursting pressure not less than 5 times the maximum pressure the hose will be subjected to during cargo transfer.

3. For cargo hoses installed on board ships on or after 1 July 2002, each new type of cargo hose, complete with end-fittings, should be prototype-tested at a normal ambient temperature with 200 pressure cycles from zero to at least twice the specified maximum working pressure. After this cycle pressure test has been carried out, the prototype test should demonstrate a bursting pressure of at least 5 times its specified maximum working pressure at the extreme service temperature. Hoses used for prototype testing should not be used for cargo service. Thereafter, before being placed in service, each new length of cargo hose produced should be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure but not more than two-fifths of its bursting pressure. The hose should be stencilled or otherwise marked with the date of testing, its specified maximum working pressure and, if used in services other than the ambient temperature services, its maximum and minimum service temperature, as applicable. The specified maximum working pressure should not be less than 1.0 MPa gauge.

508. Cargo transfer methods (IGC Code 5.8)

1. Where cargo transfer is by means of cargo pumps not accessible for repair with the tanks in service, at least two separate means should be provided to transfer cargo from each cargo tank and the design should be such that failure of one cargo pump, or means of transfer, will not prevent the cargo transfer by another pump or pumps, or other cargo transfer means.

2. The procedure for transfer of cargo by gas pressurization should preclude lifting of the relief valves during such transfer. Gas pressurization may be accepted as a means of transfer of cargo for those tanks so designed that the design factor of safety is not reduced under the conditions prevailing during the cargo transfer operation.

509. Vapour return connections (IGC Code 5.9)

Connections for vapour return lines to the shore installations should be provided.

Section 6 Materials of Construction

601. General (IGC Code 6.1)

1. The Society should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this Section.

2. This Section gives the requirements for plates, sections, pipes, forgings, castings and weldments used in the construction of cargo tanks, cargo process pressure vessels, cargo and process piping, secondary barriers and contiguous hull structures associated with the transportation of the products. The requirements for rolled materials, forgings and castings are given in **602.** and **Tables 7.5.3** to **7.5.7.** The requirements for weldments are given in **603.**

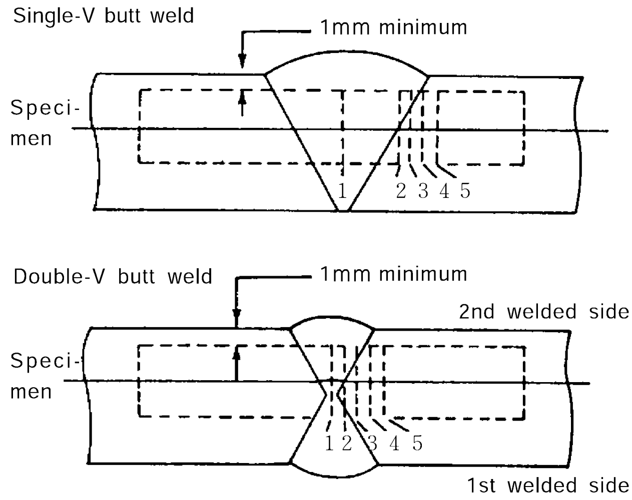
3. The manufacture, testing, inspection and documentation should be in accordance with the requirements of **Pt 2** of the Rules and the specified requirements given in this Chapter.

4. (1) Acceptance tests should include Charpy V-notch toughness tests unless otherwise specified by the Society. The specified Charpy V-notch requirements are minimum average energy values for three full size (10 mm × 10 mm) specimens and minimum single energy values for individual specimens. Dimensions and tolerances of Charpy V-notch specimens should be in accordance with Recognized Standards. The testing and requirements for specimens smaller than 5.0 mm size should be in accordance with the requirements of **Pt 2** of the Rules. Minimum average values for subsized specimens should be:

Charpy V-notch specimen size	Minimum energy average of three specimens
10 x 10 mm	E
10 x 7.5 mm	5/6 E
10 x 5.0 mm	2/3 E
where: E = the energy values (J) specified in **Tables 7.5.3** to **7.5.6**	

Only one individual value may be below the specified average value provided it is not less than 70 % of that value.

(2) In all cases, the largest size Charpy specimens possible for the material thickness should be machined with the specimens located as near as practicable to a point midway between the surface and the centre of the thickness and the length of the notch perpendicular to the suface (see **Fig. 7.5.5**). If the average value of the three initial Charpy V-notch specimens fails to meet the stated requirements, or the value for more than one specimen is below the required average value, or when the value for one specimen is below the minimum value permitted for a single specimen,three additional specimens from the same material may be tested and the results combined with those previously obtained to form a new average. If this new average complies with the requirements and if no more than two individual results are lower than the required average and no more than one result is lower than the required value for a single specimen, the piece or batch may be accepted. At the discretion of the Society other types of toughness tests, such as a drop weight test, may be used. This may be in addition to or in lieu of the Charpy V-notch test.



Notch location:

1. Centre of weld
2. On fusion line
3. In HAZ, 1mm from fusion line
4. In HAZ, 3mm from fusion line
5. In HAZ, 5mm from fusion line

HAZ = heat-affected zone

The largest size Charpy specimens possible for the material thickness should be machined with the centre of the specimens located as near as practicable to a point midway between the surface and the centre of the thickness. In all cases, the distance from the surface of the material to the edge of the specimen should be approximately 1mm or greater In addition for double-V butt welds, specimens should be machined closer to the surface of the second welded side.

Fig 7.5.5 Orientation of Weld Test Specimen

5. Tensile strength, yield stress and elongation should be to the satisfaction of the Society. For carbon-manganese steel and other materials with definitive yield points, consideration should be given to the limitation of the yield to tensile ratio.

6. The bend test may be omitted as a material acceptance test, but is required for weld tests.

7. Materials with alternative chemical composition or mechanical properties may be accepted by the Society.

8. Where post-weld heat treatment is specified or required, the properties of the base material should be determined in the heat treated condition in accordance with the applicable table of this Section and the weld properties should be determined in the heat treated condition in accordance with **603.** In cases where a post-weld heat treatment is applied, the test requirements may be modified at the discretion of the Society.

9. Where reference is made in this Section to *A, B, D, E, AH, DH* and *EH* hull structural steels, these steel grades are the grades of steel according to **Pt 2** of the Rules.

602. Material requirements (IGC Code 6.2)

The requirements for materials of construction are shown in the tables as follows **(Refer to Table 409.)**:

Table 7.5.3: Plates, pipes (seamless and welded), sections and forgings for cargo tanks and process pressure vessels for design temperatures not lower than 0°C.

Table 7.5.4: Plates, sections and forgings for cargo tanks, secondary barriers and process pressure vessels for design temperatures below 0°C and down to -55°C.

Table 7.5.5: Plates, sections and forgings for cargo tanks, secondary barriers and process pressure vessels for design temperatures below -55°C and down to -165°C.

Table 7.5.6: Pipes (seamless and welded), forgings and castings for cargo and process piping for design temperatures below 0°C and down to -165°C.

Table 7.5.7: Plates and sections for hull structures required by **409. 1** and **409. 4.**

603. Welding and non-destructive testing (IGC Code 6.3)

1. General

The requirements of this Article are those generally employed for carbon, carbon-managanese, nickel alloy and stainless steels, and may form the basis for acceptance testing of other material. At the discretion of the Society, impact testing of stainless steel and aluminium alloy weldments may be omitted and other tests may be specially required for any material.

2. Welding consumables

Welding consumables intended for welding of cargo tanks should be in accordance with Recognized Standards unless otherwise agreed with the Society. Deposited weld metal tests and butt weld tests should be required for all welding consumables, unless otherwise specially agreed with the Society. The results obtained from tensile and Charpy V-notch impact tests should be in accordance with Recognized Standards. The chemical composition of the deposited weld metal should be recorded for information and approval.

3. Welding procedure tests for cargo tanks and process pressure vessels

(1) Welding procedure tests for cargo tanks and process pressure vessels are required for all butt welds and the test assemblies should be representative of:
- each base material
- each type of consumable and welding process
- each welding position.

For butt welds in plates, the test assemblies should be so prepared that the rolling direction is parallel to the direction of welding. The range of thickness qualified by each welding procedure test should be in accordance with Recognized Standards. Radiographic or ultrasonic testing may be performed at the option of the fabricator or the Society. Procedure tests for consumables intended for fillet welding procedure tests should be in accordance with Recognized Standards. In such cases consumables should be selected which exhibit satisfactory impact properties.

(2) The following welding procedure tests for cargo tanks and process pressure vessels should be made from each test assembly:

(a) Cross-weld tensile tests.

(b) Transverse bend tests which may be face, root or side bends at the discretion of the Society. However, longitudinal bend test may be required in lieu of transverse bend tests in cases where the base material and weld metal have different strength levels.

(c) One set of three Charpy V-notch impacts, generally at each of the following locations, as shown in **Fig. 7.5.5**:
- Centreline of the welds
- Fusion line (F.L.)
- 1 mm from the F.L.
- 3 mm from the F.L.
- 5 mm from the F.L

(d) Macrosection, microsection and hardness survey may also be required by the Society.

4. Test requirements

(1) Tensile tests: Generally, tensile strength should not be less than the specified minimum tensile strength for the appropriate parent materials. The Society may also require that the transverse weld tensile strength should not be less than the specified minimum tensile strength for the weld metal, where the weld metal has a lower tensile strength than that of the parent metal. In every case, the position of fracture is to be reported for information.

(2) Bend tests: No fracture is acceptable after a 180° bend over a former of a diameter 4 times the thickness of the test pieces, unless otherwise specially required by or agreed with the Society.

(3) Charpy V-notch impact tests: Charpy tests should be conducted at the temperature prescribed for the base material being joined. The results of weld metal impact tests, minimum average energy (E), should be no less than 27 J. The weld metal requirements for subsize specimens and single energy values should be in accordance with **601. 4.** The results of fusion line and heat affected zone impact tests should show a minimum average energy (E) in accordance with the transverse or longitudinal requirements of the base material, whichever is applicable, and for subsize specimens, the minimum average energy (E) should be in accordance with **601. 4.** If the material thickness does not permit machining either full-size or standard subsize specimens, the testing procedure and acceptance standards should be in accordance with Recognized Standards.

5. Welding procedure tests for piping

Welding procedure tests for piping should be carried out and should be similar to those detailed for cargo tanks in **Par 3.** Unless otherwise specially agreed with the Society, the test requirements should be in accordance with **Par 4.**

6. Production weld tests

(1) For all cargo tanks and process pressure vessels except integral and membrane tanks, production weld tests should generally be performed for approximately each 50 m of butt weld joints and should be representative of each welding position. For secondary barriers, the same type production tests as required for primary tanks should be performed except that the number of tests may be reduced subject to agreement with the Society. Tests, other than those specified in (2), (3) and (4), may be required for cargo tanks or secondary barriers at the discretion of the Society.

(2) The production tests for types A and B independent tanks and semi-membrane tanks should include the following tests:

(a) Bend tests, and where required for procedure tests one set of three Charpy V-notch tests should be made for each 50 m of weld. The Charpy V-notch tests should be made with specimens having the notch alternately located in the centre of the weld and in the heat affected zone (most critical location based on procedure qualification results). For austenitic stainless steel, all notches should be in the centre of the weld.

(b) The test requirements are the same as the applicable test requirements listed in **Par 4,** except that impact tests that do not meet the prescribed energy requirements may still be accepted, upon special consideration by the Society, by passing a drop weight test. In such cases, two drop weight specimens should be tested for each set of Charpy specimens that failed and both must show "no break" performance at the temperature at which the Charpy tests were conducted.

(3) In addition to those tests listed in (2) (a) for type C independent tanks and process pressure vessels transverse weld tensile tests are required. The test requirements are listed in **Par 4** except that impact tests that do not meet the prescribed energy requirements may still be accepted upon special consideration by the Society, by passing a drop weight test. In such cases, two drop weight specimens should be tested for each set of Charpy specimens that failed, and both must show "no break" performance at the temperature at which the Charpy tests were conducted.

(4) Production tests for integral and membrane tanks should be in accordance with Recognized Standards.

7. Non-destructive testing

(1) For type A independent tanks and semi-membrane tanks where the design temperature is -20°C or less, and for type B independent tanks regardless of temperature, all full penetration butt welds of the shell plating of cargo tanks should be subjected to 100 % radiographic inspection.

(a) Where the design temperature is higher than -20°C, all full penetration butt welds in way of intersections and at least 10 % of the remaining full penetration welds of tank structures should be subjected to radiographic inspection.

(b) In each case the remaining tank structure including the welding of stiffeners and other fittings and attachments should be examined by magnetic particle or dye penetrant methods as considered necessary by the Society.

(c) All test procedures and acceptance standards should be in accordance with Recognized Standards. The Society may accept an approved ultrasonic test procedure in lieu of radiographic inspection, but may in addition require supplementary inspection by radiography at selected locations. Further, the Society may require ultrasonic testing in addition to normal radiographic inspection.

(2) Inspection of type C independent tanks and process pressure vessels should be carried out in accordance with **410. 9.**

(3) For integral and membrane tanks, special weld inspection procedures and acceptance criteria should be in accordance with Recognized Standards.

(4) The inspection and non-destructive testing of the inner hull or the independent tank structures supporting internal insulation tanks should take into account the design criteria given in **404. 7.** The schedule for inspection and non-destructive testing should be to the satisfaction of the Society.

(5) Inspection of piping should be carried out in accordance with the requirements of **Sec 5.**

(6) The secondary barrier should be radiographed as considered necessary by the Society. Where the outer shell of the hull is part of the secondary barrier, all sheer strake butts and the intersections of all butts and seams in the side shell should be tested by radiography.

Section 7 Cargo Pressure/Temperature Control

701. General (IGC Code 7.1)

1. Unless the entire cargo system is designed to withstand the full gauge vapour pressure of the cargo under conditions of the upper ambient design temperatures, maintenance of the cargo tank pressure below the MARVS should be provided by one or more of the following means, except as otherwise provided in this Article:

(1) a system which regulates the pressure in the cargo tanks by the use of mechanical refrigeration;
(2) a system whereby the boil-off vapours are utilized as fuel for shipboard use or waste heat system subject to the provisions of **Sec 16.** This system may be used at all times, including while in port and while manoeuvring, provided that a means of disposing of excess energy is provided, such as a steam dump system, that is satisfactory to the Society;
(3) a system allowing the product to warm up and increase in pressure. The insulation or cargo tank design pressure or both should be adequate to provide for a suitable margin for the operating time and temperatures involved. The system should be acceptable to the Society in each case;
(4) other systems acceptable to the Society;
(5) in addition to the above means, the Society may permit certain cargoes to be controlled by venting cargo vapours to the atmosphere at sea. This may also be permitted in port with the permission of the port Administration;

2. The systems required by **Par 1** should be constructed, fitted and tested to the satisfaction of the Society. Materials used in their construction should be suitable for use with the cargoes to be carried. For normal service, the upper ambient design temperature should be:

- sea : 32°C
- air : 45°C

For service in especially hot or cold zones these design temperatures should be increased or reduced, as appropriate, by the Society.

3. For certain highly dangerous cargoes specified in **Sec 17,** the cargo containment system should be capable of withstanding the full vapour pressure of the cargo under condition of the upper ambient design temperature irrespective of any system provided for dealing with boil-off gas.

702. Refrigeration systems(IGC Code 7.2)

1. A refrigeration system should consist of one or more units capable of maintaining the required cargo pressure/temperature under conditions of the upper ambient design temperatures. Unless an alternative means of controlling the cargo pressure/temperature is provided to the satisfaction of the Society, a stand-by unit (or units) affording spare capacity at least equal to the largest required single unit should be provided. A stand-by unit should consist of a compressor with its driving motor, control system and any necessary fittings to permit operation independently of the normal service units. A stand-by heat exchanger should be provided unless the normal heat exchanger for the unit has an excess capacity of at least 25 % of the largest required capacity. Separate piping systems are not required.

2. (1) Where two or more refrigerated cargoes which may react chemically in a dangerous manner are carried simultaneously, special consideration should be given to the refrigeration systems to avoid the possibility of mixing cargoes. For the carriage of such cargoes, separate refrigeration systems, each complete with a stand-by unit as specified in **Par 1,** should be provided for each cargo. However, where cooling is provided by an indirect or combined system and leakage in the heat exchangers cannot cause mixing of the cargoes under any envisaged condition, separate refrigeration units need not be fitted.

(2) Where two or more refrigerated cargoes are not mutually soluble under the conditions of carriage, so that their vapour pressures would be additive on mixing, special consideration should be given to the refrigeration systems to avoid the possibility of mixing cargoes.

3. Where cooling water is required in refrigeration systems, an adequate supply should be provided by a pump or pumps used exclusively for this purpose. This pump or these pumps should have at least two sea suction lines, where practicable leading from sea-chests, one port and one starboard.

A spare pump of adequate capacity should be provided, which may be a pump used for other services so long as its use for cooling would not interfere with any other essential service.

4. The refrigeration system may be arranged in one of the following ways:

(1) a direct system where evaporated cargo is compressed, condensed and returned to cargo tanks. For certain cargoes specified in **Sec 17** this system should not be used;

(2) an indirect system where cargo or evaporated cargo is cooled or condensed by refrigerant without being compressed;

(3) a combined system where evaporated cargo is compressed and condensed in a cargo/refrigerant heat exchanger and returned to the cargo tanks. For certain cargoes specified in **Sec 17** this system should not be used.

5. All primary and secondary refrigerants must be compatible with each other and with the cargo with which they come into contact. The heat exchange may take place either remotely from the cargo tank or by cooling coils fitted inside or outside the cargo tank.

Section 8 Cargo Tank Vent Systems

801. General (IGC Code 8.1)

All cargo tanks should be provided with a pressure relief system appropriate to the design of the cargo containment system and the cargo being carried. Hold spaces, interbarrier spaces and cargo piping which may be subject to pressures beyond their design capabilities should also be provided with a suitable pressure relief system. The pressure relief system should be connected to a vent piping system so designed as to minimize the possibility of cargo vapour accumulating on the decks, or entering accommodation spaces, service spaces, control stations and machinery spaces, or other spaces where it may create a dangerous condition. Pressure control systems specified by **Sec 7** should be independent of the pressure relief valves.

802. Pressure relief systems (IGC Code 8.2)

1. Each cargo tank with a volume exceeding 20 m^3 should be fitted with at least two pressure relief valves of approximately equal capacity, suitably designed and constructed for the prescribed service. For cargo tanks with a volume not exceeding 20 m^3, a single relief valve may be fitted.

2. Interbarrier spaces should be provided with pressure relief devices complying with recognized standards.

3. In general, the setting of the pressure relief valves should not be higher than the vapour pressure which has been used in the design of the tank. However, where two or more pressure relief valves are fitted, valves comprising not more than 50 % of the total relieving capacity may be set at a pressure up to 5 % above MARVS.

4. Pressure relief valves should be connected to the highest part of the cargo tank above deck level. Pressure relief valves on cargo tanks with a design temperature below 0°C should be arranged to prevent their becoming inoperative due to ice formation when they are closed. Due consideration should be given to the construction and arrangement of pressure relief valves on cargo tanks subject to low ambient temperatures. Valves should be constructed of materials with a melting point above 925°C. Consideration should be given to lower melting point materials for internal parts and seals if their use will yield a significant improvement in the general operation of the valve.

5. Pressure relief valves should be prototype tested to ensure that the valves have the capacity required. Each valve should be tested to ensure that it opens at the prescribed pressure setting with an allowance not exceeding ±10 % for 0 to 0.15 MPa, ± 6 % for 0.15 to 0.3 MPa, ± 3 % for 0.3 MPa and above. Pressure relief valves should be set and sealed by a competent authority acceptable to the Society and a record of this action, including the values of set pressure, should be retained aboard the ship.

6. In the case of cargo tanks permitted to have more than one relief valve setting this may be accomplished by:

(1) installing two or more properly set and sealed valves and providing means as necessary for isolating the valves not in use from the cargo tank; or

(2) installing relief valves whose settings may be changed by the insertion of previously approved spacer pieces or alternative springs or by other similar means not requiring pressure testing to verify the new set pressure. All other valve adjustment should be sealed.

7. The changing of the set pressure under the provisions of **802. 6**, and the corresponding resetting of the alarms referred to in **1304. 1**, should be carried out under the supervision of the master in accordance with procedures approved by the Society and specified in the ship's operating manual. Changes in set pressures should be recorded in the ship's log and a sign posted in the cargo control room, if provided, and at each relief valve, stating the set pressure.

8. Stop valves or other means of blanking off pipes between tanks and pressure relief valves to facilitate maintenance should not be fitted unless all the following arrangements are provided:

(1) suitable arrangements to prevent more than one pressure relief valve being out of service at the same time;

(2) a device which automatically and in a clearly visible way indicates which one of the pressure relief valves is out of service; and

(3) pressure relief valve capacities such that if one valve is out of service the remaining valves have the combined relieving capacity required by **805.** However, this capacity may be provided by the combined capacity of all valves, if a suitably maintained spare valve is carried on board.

9. Each pressure relief valve installed on a cargo tank should be connected to a venting system, which should be so constructed that the discharge of gas will be unimpeded and directed vertically upwards at the exit and so arranged as to minimize the possibility of water or snow entering the vent system. The height of vent exits should not be less than $B/3$ or 6 m, whichever is the greater, above the weather deck and 6 *m* above the working area, the fore and aft gangway, deck storage tanks and cargo liquid lines.

10. Cargo tank pressure relief valve vent exits should be arranged at a distance at least equal to B or 25 m, whichever is less, from the nearest air intake or opening to accommodation spaces, service spaces and control stations, or other gas-safe spaces. For ships less than 90 m in length, smaller distances may be permitted by the Society. All other vent exits connected to the cargo containment system should be arranged at a distance of at least 10 m from the nearest air intake or opening to accommodation spaces, service spaces and control stations, or other gas-safe spaces.

11. All other cargo vent exits not dealt with in other sections should be arranged in accordance with **Pars 9** and **10.**

12. If cargoes which react in a hazardous manner with each other are carried simultaneously, a separate pressure relief system should be fitted for each cargo carried.

13. In the vent piping system, means for draining liquid from places where it may accumulate should be provided. The pressure relief valves and piping should be so arranged that liquid can under no circumstances accumulate in or near the pressure relief valves.

14. Suitable protection screens should be fitted on vent outlets to prevent the ingress of foreign objects.

15. All vent piping should be so designed and arranged that it will not be damaged by temperature variations to which it may be exposed, or by the ship's motions.

16. The back pressure in the vent lines from the pressure relief valves should be taken into account in determining the flow capacity required by **805.** The pressure drop in the vent line from the tank to the pressure relief valve inlet should not exceed 3 % of the valve set pressure. For unbalanced pressure relief valves the back pressure in the discharge line should not exceed 10 % of the gauge pressure at the relief valve inlet with the vent lines under fire exposure as referred to in **805. 2.**

17. Pressure relief valves should be positioned on the cargo tank so that they will remain in the vapour phase under conditions of 15° list and 0.015 L trim, where L is as defined in **106. 23** at the maximum allowable filling limit(FL).

18. The adequacy of the vent system fitted on tanks loaded in accordance with **1501. 5** is to be demonstrated using the special guidelines. A relevant certificate should be permanently kept on board the ship. For the purposes of this paragraph, vent system means :

(1) the tank outlet and the piping to the pressure relief valve;
(2) the pressure relief valve;
(3) the piping from the pressure relief valve to the location of discharge to the atmosphere and including any interconnections and piping which joins other tanks.

This paragraph may apply to all ships regardless of the date of construction.

803. Additional pressure relieving system for liquid level control (IGC Code 8.3)

1. Where required by **1501. 4** (2), an additional pressure relieving system to prevent the tank from becoming liquid full at any time during relief under the fire exposure conditions referred to in **805.** should be fitted to each tank. This pressure relieving system should consist of:

(1) one or more relief valves set at a pressure corresponding to the gauge vapour pressure of the cargo at the reference temperature defined in **1501. 4** (2); and
(2) an override arrangement, whenever necessary, to prevent its normal operation. This arrangement should include fusible elements designed to melt at temperatures between 98°C and 104°C and to cause relief valves specified in (1) to become operable. The fusible elements should be lo-

cated, in particular, in the vicinity of relief valves. The system should become operable upon loss of system power if provided. The override arrangement should not be dependent on any source of ship's power.

2. The total relieving capacity of the additional pressure relieving system at the pressure mentioned in **Par 1** (1) should not be less than:

$$Q' = FG'A^{0.82}\ (\mathrm{m^3/s})$$

where:

Q' = minimum required rate of discharge of air at standard conditions of 273K and 0.1013MPa.

$$G' = \frac{12.4}{(L+\rho_r m)D}\sqrt{\frac{ZT}{M}}$$

with:

ρ_r : relative density of liquid phase of product at relieving conditions (ρ_r = 1.0 for fresh water)

m = $-di/d\rho_r$: gradient of decrease of liquid phase enthalpy against increase of liquid phase density (KJ/kg) at relieving conditions. For set pressures not higher than 0.2 MPa the value in **Table 7.5.8** may be used. For products not listed in the table and for higher set pressures, the value of m should be calculated on the basis of the thermodynamic data of the product itself

Table 7.5.8 Factor m

Product	$m = -di/d\rho_r$ (KJ/kg)
Ammonia, anhydrous	3,400
Butadiene	1,800
Butane	2,000
Butylenes	1,900
Ethane	2,100
Ethylene	1,500
Methane	2,300
Methyl chloride	816
Nitrogen	400
Propane	2,000
Propylene	1,600
Propylene oxide	1,550
Vinyl chloride	900
The values in this table may be used for set pressures not higher than 0.2 MPa.	

i : enthalpy of liquid (KJ/kg)

T' : temperature in kelvins (K) at relieving conditions, i.e. at the pressure at which the additional pressure relieving system is set

F, A, L, D, Z and M are defined in **805. 2.**

3. Compliance with **Par 1** (1) requires changing of the setting of the relief valves provided for in this Article. This should be accomplished in accordance with the provisions of **802. 6** and **7.**

4. Relief valves mentioned under **Par 1** (1) above may be the same as the pressure relief valves mentioned in **802.,** provided the setting pressure and the relieving capacity are in compliance with the requirements of this Article.

5. The exhaust of such pressure relief valves may be led to the venting system referred to in **802. 9.** If separate venting arrangements are fitted these should be in accordance with the requirements of **802. 9** to **15.**

804. Vacuum protection systems (IGC Code 8.4)

1. Cargo tanks designed to withstand a maximum external pressure differential exceeding 0.025 MPa and capable of withstanding the maximum external pressure differential which can be attained at maximum discharge rates with no vapour return into the cargo tanks, or by operation of a cargo refrigeration system, need no vacuum protection systems.

2. Cargo tanks designed to withstand a maximum external pressure differential not exceeding 0.025 MPa, or tanks which cannot withstand the maximum external pressure differential that can be attained at maximum discharge rates with no vapour return into the cargo tanks, or by operation of a cargo refrigeration system, or by sending boil-off vapour to the machinery spaces, should be fitted with:

(1) two independent pressure switches to sequentially alarm and subsequently stop all suction of cargo liquid or vapour from the cargo tank, and refrigeration equipment if fitted, by suitable means at a pressure sufficiently below the maximum external designed pressure differential of the cargo tank; or

(2) vacuum relief valves with a gas flow capacity at least equal to the maximum cargo discharge rate per cargo tank, set to open at a pressure sufficiently below the external design differential pressure of the cargo tank; or

(3) other vacuum relief systems acceptable to the Society.

3. Subject to the requirements of **Sec 17,** the vacuum relief valves should admit an inert gas, cargo vapour or air to the cargo tank and should be arranged to minimize the possibility of the entrance of water or snow. If cargo vapour is admitted, it should be from a source other than the cargo vapour lines.

4. The vacuum protection system should be capable of being tested to ensure that it operates at the prescribed pressure.

805. Size of valves (IGC Code 8.5)

Pressure relief valves should have a combined relieving capacity for each cargo tank to discharge the greater of the following with not more than a 20 % rise in cargo tank pressure above the MARVS:

1. the maximum capacity of the cargo tank inerting system if the maximum attainable working pressure of the cargo tank inerting system exceeds the MARVS of the cargo tanks; or

2. vapours generated under fire exposure computed using the following formula:

$$Q = FGA^{0.82} \ (\mathrm{m^3/s})$$

where:

Q = minimum required rate of discharge of air at standard conditions of 273 K and 0.1013 MPa.

F = fire exposure factor for different cargo tank types:

F = 1.0 for tanks without insulation located on deck;

F = 0.5 for tanks above the deck when insulation is approved by the Society (Approval will be based on the use of an approved fireproofing material, the thermal conductance of insulation, and its stability under fire exposure);

F = 0.5 for uninsulated independent tanks installed in holds;

F = 0.2 for insulated independent tanks in holds (or uninsulated independent tanks in insulated holds);

F = 0.1 for insulated independent tanks in inerted holds (or uninsulated independent tanks in inerted, insulated holds);

F = 0.1 for membrane and semi-membrane tanks.

For independent tanks partly protruding through the open deck, the fire exposure factor should be determined on the basis of the surface areas above and below deck.

G = gas factor

$$G = \frac{12.4}{LD}\sqrt{\frac{ZT}{M}}$$

with:

T = temperature in kelvins (K) at relieving conditions, i.e. 120 % of the pressure at which the pressure relief valve is set.

L = latent heat of the material being vaporized at relieving conditions, in $\mathrm{KJ/kg}$.

D = constant based on relation of specific heats k, shown in **Table 7.5.9;** if k is not known, D = 0.606 should be used. The constant D may also be calculated by the following formula:

Table 7.5.9 Constant D

k	D	k	D
1.00	0.606	1.52	0.704
1.02	0.611	1.54	0.707
1.04	0.615	1.56	0.710
1.06	0.620	1.58	0.713
1.08	0.624	1.60	0.716
1.10	0.628	1.62	0.719
1.12	0.633	1.64	0.722
1.14	0.637	1.66	0.725
1.16	0.641	1.68	0.728
1.18	0.645	1.70	0.731
1.20	0.649	1.72	0.734
1.22	0.652	1.74	0.736
1.24	0.656	1.76	0.739
1.26	0.660	1.78	0.742
1.28	0.664	1.80	0.745
1.30	0.667	1.82	0.747
1.32	0.671	1.84	0.750
1.34	0.674	1.86	0.752
1.36	0.677	1.88	0.755
1.38	0.681	1.90	0.758
1.40	0.685	1.92	0.760
1.42	0.688	1.94	0.763
1.44	0.691	1.96	0.765
1.46	0.695	1.98	0.767
1.48	0.698	2.00	0.770
1.50	0.701	2.02	0.772
		2.20	0.792

$$D = \sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

Z = compressibility factor of the gas at relieving conditions; if not known, Z = 1.0 should be used.

M = molecular mass of the product

A = external surface area of the tank (m^2) for different tank types :

for body-of-revolution type tanks : A = external surface area;

for other than body-of-revolution type tanks : A = external surface area less the projected bottom surface area ;

for tanks consisting of an array of pressure vessel tanks:

insulation on the ship's structure:

A = external surface area of the hold less its projected bottom area;

insulation on the tank structure:

A = external surface area of the array of pressure vessels excluding insulation, less the projected bottom area as shown in **Fig 7.5.6.**

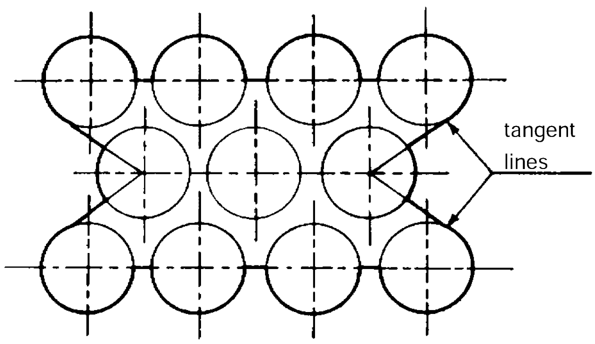


Fig. 7.5.6 Determination of the Projected Bottom Area for Tanks Consisting of an Array

Section 9 Environmental Control

901. Environmental control within cargo tanks and cargo piping systems (IGC Code 9.1)

1. A piping system should be provided to enable each cargo tank to be safely gas-freed, and to be safely purged with cargo gas from a gas-free condition. The system should be arranged to minimize the possibility of pockets of gas or air remaining after gas-freeing or purging.

2. A sufficient number of gas sampling points should be provided for each cargo tank in order to adequately monitor the progress of purging and gas-freeing. Gas sampling connections should be valved and capped above the main deck.

3. For flammable gases, the system should be arranged to minimize the possibility of a flammable mixture existing in the cargo tank during any part of the gas-freeing operation by utilizing an inerting medium as an intermediate step. In addition, the system should enable the cargo tank to be purged with an inerting medium prior to filling with cargo vapour or liquid, without permitting a flammable mixture to exist at any time within the cargo tank.

4. Piping systems which may contain cargo should be capable of being gas-freed and purged as provided in **Pars 1** and **3.**

5. Inert gas utilized in these procedures may be provided from the shore or from the ship.

902. Environmental control within the hold spaces (cargo containment systems other than type C independent tanks) (IGC Code 9.2)

1. Interbarrier and hold spaces associated with cargo containment systems for flammable gases requiring full secondary barriers should be inerted with a suitable dry inert gas and kept inerted with make-up gas provided by a shipboard inert gas generation system, or by shipboard storage which should be sufficient for normal consumption for at least 30 days.

2. (1) Interbarrier and hold spaces associated with cargo containment systems for flammable gases requiring partial secondary barriers should be inerted with suitable dry inert gas and kept inerted with makeup gas provided by a shipboard inert gas generation system or by shipboard storage which should be sufficient for normal consumption for at least 30 days.

(2) Alternatively, subject to the restrictions specified in **Sec 17,** the Society may allow the spaces referred to in (1) to be filled with dry air provided that the ship maintains a stored charge of inert gas or is fitted with an inert gas generation system sufficient to inert the largest of these spaces; and provided that the configuration of the spaces and the relevant vapour detection systems, together with the capability of the inerting arrangements, ensure that any leakage from the cargo tanks will be rapidly detected and inerting effected before a dangerous condition can develop. Equipment for the provision of sufficient dry air of suitable quality to satisfy the expected demand should be provided.

3. For non-flammable gases, the spaces referred to in **Par 1** and **Par 2** (1) may be maintained with a suitable dry air or inert atmosphere.

4. In case of internal insulation tanks, environmental control arrangements are not required for interbarrier spaces and spaces between the secondary barrier and the inner hull or independent tank structures completely filled with insulation materials complying with **409. 7** (2).

903. Environmental control of spaces surrounding type C independent tanks (IGC Code 9.3)

Spaces surrounding refrigerated cargo tanks not having secondary barriers should be filled with suitable dry inert gas or dry air and be maintained in this condition with make-up inert gas provided by a ship-board inert gas generation system, shipboard storage of inert gas, or dry air provided by suitable air drying equipment.

904. Inerting (IGC Code 9.4)

1. Inerting refers to the process of providing a noncombustible environment by the addition of compatible gases, which may be carried in storage vessels or produced on board the ship or supplied from the shore. The inert gases should be compatible chemically and operationally, at all temperatures likely to occur within the spaces to be inerted, with the materials of construction of the spaces and the cargo. The dew points of the gases should be taken into consideration.

2. Where inert gas is also stored for fire-fighting purposes, it should be carried in separate containers and should not be used for cargo services.

3. Where inert gas is stored at temperature below 0°C, either as a liquid or as a vapour, the storage and supply system should be so designed that the temperature of the ship's structure is not reduced below the limiting values imposed on it.

4. Arrangements suitable for the cargo carried should be provided to prevent the backflow of cargo vapour into the inert gas system.

5. The arrangements should be such that each space being inerted can be isolated and the necessary controls and relief valves etc. should be provided for controlling pressure in these spaces.

905. Inert gas production on board (IGC Code 9.5)

1. The equipment should be capable of producing inert gas with an oxygen content at no time greater than 5 % by volume subject to the special requirements of **Sec 17.** A continuous-reading oxygen content meter should be fitted to the inert gas supply from the equipment and should be fitted with an alarm set at a maximum of 5 % oxygen content by volume subject to the requirements of **Sec 17.** Additionally, where inert gas is made by an on-board process of fractional distillation of air which involves the storage of the cryogenic liquefied nitrogen for subsequent release, the liquefied gas entering the storage vessel should be monitored for traces of oxygen to avoid possible initial high oxygen enrichment of the gas when released for inerting purposes.

2. An inert gas system should have pressure controls and monitoring arrangements appropriate to the cargo containment system. A means acceptable to the Society, located in the cargo area, of preventing the backflow of cargo gas should be provided.

3. Spaces containing inert gas generating plants should have no direct access to accommodation spaces, service spaces or control stations, but may be located in machinery spaces. If such plants are located in machinery spaces or other spaces outside the cargo area, two non-return valves, or equivalent devices should be fitted in the inert gas main in the cargo area as required in **Par 2.** Inert gas piping should not pass through accommodation spaces, service spaces or control stations. When not in use, the inert gas system should be made separate from the cargo system in the cargo area except for connections to the hold spaces or interbarrier spaces.

4. Flame burning equipment for generating inert gas should not be located within the cargo area. Special consideration may be given to the location of inert gas generating equipment using the catalytic combustion process.

Section 10 Electrical Installations

1001. General (IGC Code 10.1)

1. The provisions of the Section are applicable to ships carrying flammable products and should be applied in conjunction with part D of chapter II-1 of the 1983 SOLAS amendments.

2. Electrical installations should be such as to minimize the risk of fire and explosion from flammable products. Electrical installations complying with this Section need not be considered as a source of ignition for the purposes of **Sec 3.**

3. The Society should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this Section in respect of electrical installations.

4. Electrical equipment, cables and wiring shall not be installed in hazardous locations unless it conforms with the standards not inferior to those acceptable to the Organization. Refer to the standards published by the International Electrotechnical Commission, IEC 60092-502:1999" Electrical installation in ships - tankers. However, for locations not covered by such standards, electrical equipments, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Society to ensure that an equivalent level of safety is assured.

5. Where electrical equipment is installed in gas dangerous spaces or zones as provided in **Par 4,** it should be to the satisfaction of the Society and approved by the relevant authorities recognized by the Society for operation in the flammable atmosphere concerned.

Section 11 Fire Protection and Fire Extinction

1101. Fire safety requirements (IGC Code 11.1)

1. The requirements for tankers in SOLAS chapter II-2 should apply to ships covered by this Chapter, irrespective of tonnage including ships of less than 500 tons gross tonnage, except that:

(1) regulations 4.5.1.6 and 4.5.10 do not apply ;
(2) regulation 10.2 as applicable to cargo ships and regulations 10.4 and 10.5 should apply as they would apply to tankers of 2,000 gross tonnage and over ;.
(3) regulation 10.5.6 should apply to ships of 2,000 gross tonnage and over ;
(4) the following regulations of SOLAS chapter II-2 related to tankers do not apply and are replaced by Sections and articles of this Chapter as detailed below :

SOLAS Regulation	Replaced by
10.10	**1106.**
4.5.1.1 and 4.5.1.2	**Sec 3**
4.5.5 and 10.8	**1103.** and **1104.**
10.9	**1105.**

(5) regulation 13.3.4 and 13.4.3 should apply to ships of 500 gross tonnage and over ;

2. All sources of ignition should be excluded from spaces where flammable vapour may be present except as otherwise provided in **Secs 10** and **16.**

3. The provisions of this article apply in conjunction with **Sec 3.**

4. For the purposes of fire fighting, any open deck areas above cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forward most hold space should be included in the cargo area.

1102. Fire water main equipment (IGC Code 11.2)

1. All ships, irrespective of size, carrying products which are subject to this Chapter should comply with the requirements of SOLAS regulations II-2/10.2, 10.4 and 10.5, except that the required fire pump capacity and fire main and water service pipe diameter should not be limited by the provisions of regulations II-2/10.2.2.4.1 and II-2/10.2.1.3 when the fire pump and fire main are used as part of the water spray system as permitted by **1103. 3.** In addition, the requirements of regulation II-2/10.2.1.6 should be met at a pressure of at least 0.5 MPa gauge.

2. The arrangements should be such that at least two jets of water can reach any part of the deck in the cargo area and those portions of the cargo containment system and tank covers above the deck. The necessary number of fire hydrants should be located to satisfy the above arrangements and to comply with the requirements of SOLAS regulations II-2/10.2.1.5.1 and II-2/10.2.3.3, with hose lengths as specified in regulation II-2/10.2.3.1.1.

3. Stop valves should be fitted in any crossover provided and in the fire main or mains at the poop front and at intervals of not more than 40 m between hydrants on the deck in the cargo area for the purpose of isolating damaged sections of the main.

4. All water nozzles provided for fire-fighting use should be of an approved dual-purpose type capable of producing either a spray or a jet. All pipes, valves, nozzles and other fittings in the fire-fighting systems should be resistant to the effects of fire and to corrosion by water.

5. Where the ship's engine-room is unattended, arrangements should be made to start and connect to the fire main at least one fire pump by remote control from the navigating bridge or other control station outside the cargo area.

1103. Water spray system (IGC Code 11.3)

1. On ships carrying flammable or toxic products or both, a water spray system for cooling, fire prevention and crew protection should be installed to cover:

(1) exposed cargo tank domes and any exposed parts of cargo tanks;
(2) exposed on-deck storage vessels for flammable or toxic products;
(3) cargo liquid and vapour discharge and loading manifolds and the area of their control valves and any other areas where essential control valves are situated and which should be at least equal to the area of the drip trays provided; and
(4) boundaries of superstructures and deckhouses normally manned, cargo compressors rooms, cargo pump rooms, store-rooms containing high fire risk items and cargo control rooms, all facing the cargo area. Boundaries of unmanned forecastle structures not containing high fire risk items or equipment do not require water spray protection.

2. The system should be capable of covering all areas mentioned in **Par 1** with a uniformly distributed water spray of at least 10 l/m^2 per minute for horizontal projected surfaces and 4 l/m^2 per minute for vertical surfaces. For structures having no clearly defined horizontal or vertical surfaces, the capacity of the water spray system should be the greater of the following:

(1) projected horizontal surface multiplied by 10 l/m^2 per minute; or
(2) actual surface multiplied by 4 l/m^2 per minute.
On vertical surfaces, spacing of nozzles protecting lower areas may take account of anticipated rundown from higher areas. Stop valves should be fitted at intervals in the spray main for the purpose of isolating damaged sections. Alternatively, the system may be divided into two or more sections which may be operated independently provided the necessary controls are located together, aft of the cargo area. A section protecting any area included in **Par 1** (1) and (2) should cover the whole of the athwartship tank grouping which includes that area.

3. The capacity of the water spray pumps should be sufficient to deliver the required amount of water to all areas simultaneously or where the system is divided into sections, the arrangements and capacity should be such as to supply water simultaneously to anyone section and to the surfaces specified in **Par 1** (3) and (4). Alternatively, the main fire pumps may be used for this service provided that their total capacity is increased by the amount needed for the spray system. In either case, a connection, through a stop valve, should be made between the fire main and water spray main outside the cargo area.

4. Subject to the approval of the Society, water pumps normally used for other services may be arranged to supply the water spray main.

5. All pipes, valves, nozzles and other fittings in the water spray systems should be resistant to corrosion by seawater, for which purpose galvanized pipe, for example, may be used, and to the effect of fire.

6. Remote starting of pumps supplying the water spray system and remote operation of any normally closed valves in the system should be arranged in suitable locations outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected.

1104. Dry chemical powder fire-extinguishing systems (IGC Code 11.4)

1. Ships in which the carriage of flammable products is intended should be fitted with fixed dry chemical powder type extinguishing systems for the purpose of fighting fire on the deck in the cargo area and bow or stern cargo handling areas if applicable. The system and the dry chemical powder should be adequate fo this purpose and satisfactory to the Society.

2. The system should be capable of delivering powder from at least two hand hose lines or combination monitor/hand hose lines to any part of the above-deck exposed cargo area including above-deck product piping. The system should be activated by an inert gas such as nitrogen, used exclusively for this purpose and stored in pressure vessels adjacent to the powder containers.

3. The system for use in the cargo area should consist of at least two independent self-contained dry chemical powder units with associated controls, pressurizing medium fixed piping, monitors or hand hose lines. For ships with a cargo capacity of less than 1,000 m^3 only one such unit need be fitted, subject to approval by the Society. A monitor should be provided and so arranged as to protect the cargo loading and discharge manifold areas and be capable of actuation and discharge locally and remotely. The monitor is not required to be remotely aimed if it can deliver the necessary powder to all required areas of coverage from a single position. All hand hose lines and monitors should be capable of actuation at the hose storage reel or monitor. At least one hand hose line or monitor should be situated at the after end of the cargo area.

4. A fire-extinguishing unit having two or more monitors, hand hose lines, or combinations thereof, should have independent pipes with a manifold at the powder container, unless a suitable alternative means is provided to ensure proper performance as approved by the Society. Where two or more pipes are attached to a unit the arrangement should be such that any or all of the monitors and hand hose lines should be capable of simultaneous or sequential operation at their rated capacities.

5. The capacity of a monitor should be not less than 10 kg/sec. Hand hose lines should be non-kinkable and be fitted with a nozzle capable of on/off operation and discharge at a rate not less than 3.5 kg/sec. The maximum discharge rate should be such as to allow operation by one man. The length of a hand hose line should not exceed 33 m. Where fixed piping is provided between the powder container and a hand hose line or monitor, the length of piping should not exceed that length which is capable of maintaining the powder in a fluidized state during sustained or intermittent use, and which can be purged of powder when the system is shut down. Hand hose lines and nozzles should be of weather-resistant construction or stored in water-resistant housing or covers and be readily accessible.

6. A sufficient quantity of dry chemical powder should be stored in each container to provide a minimum 45 seconds discharge time for all monitors and hand hose lines attached to each powder unit. Coverage from fixed monitors should be in accordance with **Table 7.5.10.**

Table 7.5.10 Coverage from Fixed Monitors

Capacity of fixed monitors(kg/sec) each	10	25	45
Maximum distance of coverage(m)	10	30	40

Hand hose lines should be considered to have a maximum effective distance of coverage equal to the length of hose. Special consideration should be given where areas to be protected are substantially higher than the monitor or hand hose reel locations.

7. Ships fitted with bow or stern loading and discharge arrangements should be provided with an additional dry chemical powder unit complete with at least one monitor and one hand hose line complying with the requirements of **Pars 1** to **6.** This additional unit should be located to protect the bow or stern loading and discharge arrangements. The area of the cargo line forward or aft of the cargo area should be protected by hand hose lines.

1105. Cargo compressor and pump rooms (IGC Code 11.5)

1. The cargo compressor and pump rooms of any ship should be provided with a carbon dioxide system as specified in SOLAS regulation II-2/10.9.1.1. A notice should be exhibited at the controls stating that the system is only to be used for fire-extinguishing and not for inerting purposes, due to the electrostatic ignition hazard. The alarms referred to in SOLAS regulation II-2/10.9.1.1.1 should be safe for use in a flammable cargo vapour-air mixture. For the purpose of this requirement, an extinguishing system should be provided which would be suitable for machinery spaces. However, the amount of carbon dioxide gas carried should be sufficient to provide a quantity of free gas equal to 45 % of the gross volume of the cargo compressor and pump rooms in all cases.

2. Cargo compressor and pump rooms of ships which are dedicated to the carriage of a restricted number of cargoes should be protected by an appropriate fire-extinguishing system approved by the Society.

1106. Fire-fighter's outfits (IGC Code 11.6)

1. Every ship carrying flammable products should carry fire-fighter's outfits complying with the requirements of SOLAS regulation II-2/10.10 as follows:

Total cargo capacity	Number of outfits
5,000 m^3 and below	4
above 5,000 m^3	5

2. Additional requirements for safety equipment are given in **Sec 14.**

3. Any breathing apparatus required as part of a fire-fighter's outfit should be a self-contained air-breathing apparatus having a capacity of at least 1,200 l of free air.

Section 12 Mechanical Ventilation in the Cargo Area

The requirements of this Section should be substituted for SOLAS regulations II-2/4.5.2.6 and II-2/4.5.4.

1201. Spaces required to be entered during normal cargo handling operations (IGC Code 12.1)

1. Electric motor rooms, cargo compressor and pump rooms, other enclosed spaces which contain cargo handling equipment and similar spaces in which cargo handling operations are performed should be fitted with mechanical ventilation systems capable of being controlled from outside such spaces. Provision should be made to ventilate such spaces prior to entering the compartment and operating the equipment and a warning notice requiring the use of such ventilation should be placed outside the compartment.

2. Mechanical ventilation inlets and outlets should be arranged to ensure sufficient air movement through the space to avoid the accumulation of flammable or toxic vapours and to ensure a safe working environment, but in no case should the ventilation system have a capacity of less than 30 changes of air per hour based upon the total volume of the space. As an exception, gas-safe cargo control rooms may have eight changes of air per hour.

3. Ventilation systems should be fixed and, if of the negative pressure type, permit extraction from either the upper or the lower parts of the spaces, or from both the upper and the lower parts, depending on the density of the vapours of the products carried.

4. In rooms housing electric motors driving cargo compressors or pumps, spaces except machinery spaces containing inert gas generators, cargo control rooms if considered as gas-safe spaces and other gas-safe spaces within the cargo area, the ventilation should be of the positive pressure type.

5. In cargo compressor and pump rooms and in cargo control rooms if considered gas-dangerous, the ventilation should be of the negative pressure type.

6. Ventilation exhaust ducts from gas-dangerous spaces should discharge upwards in locations at least 10 m in the horizontal direction from ventilation intakes and openings to accommodation spaces, service spaces and control stations and other gas-safe spaces.

7. Ventilation intakes should be so arranged as to minimize the possibility of re-cycling hazardous vapours from any ventilation discharge opening.

8. Ventilation ducts from gas-dangerous spaces should not be led through accommodation, service and machinery spaces or control stations, except as allowed in **Sec 16.**

9. Electric motors driving fans should be placed outside the ventilation ducts if the carriage of flammable products is intended. Ventilation fans should not produce a source of vapour ignition in either the ventilated space or the ventilation system associated with the space. Ventilation fans and fan ducts, in way of fans only, for gas-dangerous spaces should be of non sparking construction defined as:

(1) impellers or housing of nonmetallic construction, due regard being paid to the elimination of static electricity;
(2) impellers and housing of nonferrous materials;
(3) impellers and housing of austenitic stainless steel; and
(4) ferrous impellers and housing with not less than 13 mm design tip clearance.
Any combination or an aluminium or magnesium alloy fixed or rotating component and a ferrous fixed or rotating component, regardless of tip clearance, is considered a sparking hazard and should not be used in these places.

10. Spare parts should be carried for each type of fan on board referred to in this Section.

11. Protection screens of not more than 13 mm square mesh should be fitted in outside openings of ventilation ducts.

1202. Spaces not normally entered (IGC Code 12.2)

Hold spaces, interbarrier spaces, void spaces, cofferdams, spaces containing cargo piping and other spaces where cargo vapour may accumulate, should be capable of being ventilated to ensure a safe environment when entry into the spaces is necessary. Where a permanent ventilation system is not provided for such spaces, approved means of portable mechanical ventilation should be provided. Where necessary owing to the arrangement of spaces, such as hold spaces and interbarrier spaces, essential ducting for such ventilation should be permanently installed. Fans or blowers should be clear of personnel access openings, and should comply with **1201. 9.**

Section 13 Instrumentation (Gauging, Gas Detection)

1301. General (IGC Code 13.1)

1. Each cargo tank should be provided with means for indicating level, pressure and temperature of the cargo. Pressure gauges and temperature indicating devices should be installed in the liquid and vapour piping systems, in cargo refrigerating installations and in the inert gas systems as detailed in this Section.

2. Where a secondary barrier is required, permanently installed instrumentation should be provided to detect when the primary barrier fails to be liquid tight at any location or when liquid cargo is in contact with the secondary barrier at any location. This instrumentation should consist of appropriate gas detecting devices according to **1306.** However, the instrumentation need not be capable of locating the area where liquid cargo leaks through the primary barrier or where liquid cargo is in contact with the secondary barrier.

3. If the loading and unloading of the ship is performed by means of remotely controlled valves and pumps, all controls and indicators associated with a given cargo tank should be concentrated in one control position.

4. Instruments should be tested to ensure reliability in the working conditions and recalibrated at regular intervals. Test procedures for instruments and the intervals between recalibration should be approved by the Society.

1302. Level indicators for cargo tanks (IGC Code 13.2)

1. Each cargo tank should be fitted with at least one liquid level gauging device, designed to operate at pressures not less than the MARVS of the cargo tank and at temperatures within the cargo operating temperature range. Where only one liquid level gauge is fitted it should be so arranged that any necessary maintenance can be carried out while the cargo tank is in service.

2. Cargo tank liquid level gauges may be of the following types subject to any special requirement for particular cargoes shown in column "g" in the table of **Sec 19:**

(1) indirect devices, which determine the amount of cargo by means such as weighing or pipe flow meters;

(2) closed devices, which do not penetrate the cargo tank, such as devices using radioisotopes or ultrasonic devices;

(3) closed devices, which penetrate the cargo tank, but which form part of a closed system and keep the cargo from being released, such as float type systems, electronic probes, magnetic probes and bubble tube indicators. If a closed gauging device is not mounted directly on the tank it should be provided with a shutoff valve located as close as possible to the tank; and

(4) restricted devices, which penetrate the tank and when in use permit a small quantity of cargo vapour or liquid to escape to the atmosphere, such as fixed tube and slip tube gauges. When not in use, the devices should be kept completely closed. The design and installation should ensure that no dangerous escape of cargo can take place when opening the device. Such gauging devices should be so designed that the maximum opening does not exceed 1.5 mm diameter or equivalent area unless the device is provided with an excess flow valve.

3. Sighting ports with a suitable protective cover and situated above the liquid level with an internal scale may be allowed by the Society as a secondary means of gauging for cargo tanks having a design vapour pressure not higher than 0.07 MPa.

4. Tubular gauge glasses should not be fitted. Gauge glasses of the robust type as fitted on high-pressure boilers and fitted with excess flow valves may be allowed by the Society for deck tanks, subject to any provisions of **Sec 17.**

1303. Overflow control (IGC Code 13.3)

1. Except as provided in **Par 2,** each cargo tank should be fitted with a high liquid level alarm operating independently of other liquid level indicators and giving an audible and visual warning when activated. Another sensor operating independently of the high liquid level alarm should automatically actuate a shutoff valve in a manner which will both avoid excessive liquid pressure in the loading line and prevent the tank from becoming liquid full. The emergency shutdown valve referred to in **506. 1** and **506. 3** may be used for this purpose. If another valve is used for this purpose, the same information as referred to in **506. 4** should be available on board.

2. A high liquid level alarm and automatic shutoff of cargo tank filling need not be required when the cargo tank:

(1) is a pressure tank with a volume not more than 200 m^3; or
(2) is designed to withstand the maximum possible pressure during the loading operation and such pressure is below that of the start-to-discharge pressure of the cargo tank relief valve.

3. Electrical circuits, if any, of level alarms should be capable of being tested prior to loading.

1304. Pressure gauges (IGC Code 13.4)

1. The vapour space of each cargo tank should be provided with a pressure gauge which should incorporate an indicator in the control position required by **1301. 3.** In addition, a high-pressure alarm and, if vacuum protection is required, a low-pressure alarm should be provided on the navigating bridge. Maximum and minimum allowable pressures should be marked on the indicators. The alarms should be activated before the set pressures are reached. For cargo tanks fitted with pressure relief valves, which can be set at more than one set pressure in accordance with **802. 6,** high-pressure alarms should be provided for each set pressure.

2. Each cargo pump discharge line and each liquid and vapour cargo manifold should be provided with at least one pressure gauge.

3. Local-reading manifold pressure gauges should be provided to indicate the pressure between stop valves and hose connections to the shore.

4. Hold spaces and interbarrier spaces without open connection to the atmosphere should be provided with pressure gauges.

1305. Temperature indicating devices (IGC Code 13.5)

1. Each cargo tank should be provided with at least two devices for indicating cargo temperatures, one placed at the bottom of the cargo tank and the second near the top of the tank, below the highest allowable liquid level. The temperature indicating devices should be marked to show the lowest temperature for which the cargo tank has been approved by the Society.

2. When a cargo is carried in a cargo containment system with a secondary barrier at a temperature lower than -55°C, temperature indicating devices should be provided within the insulation or on the hull structure adjacent to cargo containment systems. The devices should give readings at regular intervals and, where applicable, audible warning of temperatures approaching the lowest for which the hull steel is suitable.

3. If cargo is to be carried at temperatures lower than -55°C, the cargo tank boundaries, if appropriate for the design of the cargo containment system, should be fitted with temperature indicating devices as follows:

(1) A sufficient number of devices to establish that an unsatisfactory temperature gradient does not occur.
(2) On one tank a number of devices in excess of those required in (1) in order to verify that the initial cool down procedure is satisfactory. These devices may be either temporary or permanent. When a series of similar ships is built, the second and successive ships need not comply with the requirements of this subparagraph.

4. The number and position of temperature indicating devices should be to the satisfaction of the Society.

1306. Gas detection requirements (IGC Code 13.6)

1. Gas detection equipment acceptable to the Society and suitable for the gases to be carried should be provided in accordance with column "f" in the table of **Sec 19.**

2. In every installation, the positions of fixed sampling heads should be determined with due regard to the density of the vapours of the products intended to be carried and the dilution from compartment purging or ventilation.

3. Pipe runs from sampling heads should not be led through gas-safe spaces except as permitted by **Par 5.**

4. Audible and visual alarms from the gas detection equipment, if required by this Article, should be located on the navigating bridge, in the control position required by **1301. 3,** and at the gas detector readout location.

5. Gas detection equipment may be located in the control position required by **1301. 3,** on the navigating bridge or at other suitable locations. When such equipment is located in a gas-safe space the following conditions should be met:

(1) gas-sampling lines should have shutoff valves or an equivalent arrangement to prevent cross-communication with gas-dangerous spaces; and
(2) exhaust gas from the detector should be discharged to the atmosphere in a safe location.

6. Gas detection equipment should be so designed that it may readily be tested. Testing and calibration should be carried out at regular intervals. Suitable equipment and span gas for this purpose should be carried on board. Where practicable, permanent connections for such equipment should be fitted.

7. A permanently installed system of gas detection and audible and visual alarms should be provided for:

(1) cargo pump rooms;
(2) cargo compressor rooms;
(3) motor rooms for cargo handling machinery;
(4) cargo control rooms unless designated as gas-safe;
(5) other enclosed spaces in the cargo area where vapour may accumulate including hold spaces and interbarrier spaces for independent tanks other than type C;
(6) ventilation hoods and gas ducts where required by **Sec 16;** and
(7) air locks.

8. The gas detection equipment should be capable of sampling and analysing from each sampling head location sequentially at intervals not exceeding 30 min, except that in the case of gas detection for the ventilation hoods and gas ducts referred to in **1306. 7** (6) sampling should be continuous. Common sampling lines to the detection equipment should not be fitted.

9. In the case of products which are toxic or both toxic and flammable, the Society except when column "i" in the table of **Sec 19** refers to **1709.,** may authorize the use of portable equipment for detection of toxic products as an alternative to a permanently installed system, if such equipment is used before personnel enter the spaces listed in **Par 7** and at 30 min intervals while they remain therein.

10. For the spaces listed in **Par 7,** alarms should be activated for flammable products when the vapour concentration reaches 30 % of the lower flammable limit.

11. In the case of flammable products, where cargo containment systems other than independent tanks are used, hold spaces and interbarrier spaces should be provided with a permanently installed gas detection system capable of measuring gas concentrations of 0 % to 100 % by volume. The detection equipment, equipped with audible and visual alarms, should be capable of monitoring from each sampling head location sequentially at intervals not exceeding 30 min. Alarms should be activated when the vapour concentration reaches the equivalent of 30 % of the lower flammable limit in air or such other limit as may be approved by the Society in the light of particular cargo containment arrangements. Common sampling lines to the detection equipment should not be fitted.

12. In the case of toxic gases, hold spaces and interbarrier spaces should be provided with a permanently installed piping system for obtaining gas samples from the spaces. Gas from these spaces should be sampled and analysed from each sampling head location by means of fixed or portable equipment at intervals not exceeding 4 h and in any event before personnel enter the space and at 30 min intervals while they remain therein.

13. Every ship should be provided with at least two sets of portable gas detection equipment acceptable to the Society and suitable for the products to be carried.

14. A suitable instrument for the measurement of oxygen levels in inert atmospheres should be provided.

Section 14 Personnel Protection

1401. Protective equipment (IGC Code 14.1)

Suitable protective equipment including eye protection should be provided for protection of crew members engaged in loading and discharging operations, taking into account the character of the products.

1402. Safety equipment (IGC Code 14.2)

1. Sufficient, but not less than two complete sets of safety equipment in addition to the firmen's outfits required by **1106. 1** each permitting personnel to enter and work in a gas-filled space, should be provided.

2. One complete set of safety equipment should consist of:

(1) one self-contained air-breathing apparatus not using stored oxygen, having a capacity of at least 1,200 l of free air;
(2) protective clothing, boots, gloves and tight fitting goggles;
(3) steel-cored rescue line with belt; and
(4) explosion-proof lamp.

3. An adequate supply of compressed air should be provided and should consist either of:

(1) one set of fully charged spare air bottles for each breathing apparatus required by **Par 1;** a special air compressor suitable for the supply of high-pressure air of the required purity; and a charging manifold capable of dealing with sufficient spare breathing apparatus air bottles for the breathing apparatus required by **Par 1;** or
(2) fully charged spare air bottles with a total free air capacity of at least 6,000 l for each breathing apparatus required by **Par 1.**

4. Alternatively, the Society may accept a low-pressure air line system with hose connection suitable for use with the breathing apparatus required by **Par 1.** This system should provide sufficient high-pressure air capacity to supply, through pressure reduction devices, enough low-pressure air to enable two men to work in a gas-dangerous space for at least 1 h without using the air bottles of the breathing apparatus. Means should be provided for recharging the fixed air bottles and the breathing apparatus air bottles from a special air compressor suitable for the supply of high-pressure air of the required purity.

5. Protective equipment required in **1401.** and safety equipment required in **Par 1** should be kept in suitable, clearly marked lockers located in readily accessible places.

6. The compressed air equipment should be inspected at least once a month by a responsible officer and the inspection recorded in the ship's log-book, and inspected and tested by an expert at least once a year.

1403. First-aid equipment (IGC Code 14.3)

1. A stretcher which is suitable for hoisting an injured person from spaces below deck should be kept in a readily accessible location.

2. The ship should have on board medical first-aid equipment, including oxygen resuscitation equipment and antidotes for cargoes to be carried. Medical First Aid Guide for Use in Accidents Involving Dangerous Goods(MFAG) numbers related to products covered by the code are given in the table of minimum requirements(**Sec 19**)

1404. Personnel protection requirements for individual products (IGC Code 14.4)

1. Provisions of **1404.** are applicable to ships carrying products for which those paragraphs are listed in column "i" in the table of **Sec 19.**

2. Respiratory and eye protection suitable for emergency escape purposes should be provided for every person on board subject to the following:

(1) (a) filter type respiratory protection is unacceptable;

(b) self-contained breathing apparatus should normally have a duration of service of at least 15 min;

(2) emergency escape respiratory protection should not be used for fire-fighting or cargo handling purposes and should be marked to that effect;

(3) two additional sets of the above respiratory and eye protection should be permanently located in the navigating bridge.

3. Suitably marked decontamination showers and an eyewash should be available on deck in convenient locations. The showers and eyewash should be operable in all ambient conditions.

4. In ships of a cargo capacity of 2,000 m^3 and over, two complete sets of safety equipment should be provided in addition to the equipment required by **1106. 1** and **1402. 1.** At least three spare charged air bottles should be provided for each self-contained air breathing apparatus required in this paragraph.

5. Personnel should be protected against the effects of a major cargo release by the provision of a space within the accommodation area designed and equipped to the satisfaction of the Society.

6. For certain highly dangerous products, cargo control rooms should be of the gas-safe type only.

Section 15 Filling Limits for Cargo Tanks

1501. General (IGC Code 15.1)

1. No cargo tanks should have a higher filling limit(FL) than 98 % at the reference temperature, except as permitted by **Par 3.**

2. The maximum loading limit(LL) to which a cargo tank may be loaded should be determined by the following formula:

$$LL = FL\frac{\rho_R}{\rho_L}$$

where:

LL = loading limit expressed as a percentage, being the maximum allowable liquid volume relative to the tank volume to which the tank may be loaded(%)

FL = filling limit as specified in **Par 1** or **3**

ρ_R = relative density of cargo at the reference temperature

ρ_L = relative density of cargo at the loading temperature and pressure.

3. The Society may allow a higher filling limit(FL) than the limit of 98 % specified in **Par 1** at the reference temperature, taking into account the shape of the tank, arrangements of pressure relief valves, accuracy of level and temperature gauging and the difference between the loading temperature and the temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valves, provided the conditions in **802. 17** are maintained.

4. For the purposes of this Section only, "reference temperature" means:

(1) the temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valves when no cargo vapour pressure/temperature control as referred to in **Sec 7** is provided.

(2) the temperature of the cargo upon termination of loading, during transport, or at unloading, whichever is the greatest, when a cargo vapour pressure/temperature control as referred to in **Sec 7** is provided. If this reference temperature would result in the cargo tank becoming liquid full before the cargo reaches a temperature corresponding to the vapour pressure of the cargo at the set pressure of the relief valves required in **802**., an additional pressure relieving system complying with **803.** should be fitted.

5. The Society may allow type C tanks to be loaded according to the following formula, provided that the tank vent system has been approved in accordance with **802. 18:**

$$LL = FL\frac{\rho_R}{\rho_L}$$

where:

LL = loading limit as specified in **Par 2;**

FL = filling limit as specified in **Par 1** or **3;**

ρ_R = relative density of cargo at the highest temperature which the cargo may reach upon termination or loading, during transport, or at unloading, under the ambient design temperature conditions described in **701. 2;** and

ρ_L = as specified in **Par 2.**

This paragraph does not apply to products requiring a type 1 G ship.

6. This Section applies to all ships regardless of the date of construction.

1502. Information to be provided to the master (IGC Code 15.2)

The maximum allowable loading limits for each cargo tank should be indicated for each product which may be carried, for each loading temperature which may be applied and for the applicable maximum reference temperature, on a list to be approved by the Society. Pressures at which the pressure relief valves, including those valves required by **803.**, have been set should also be stated on the list. A copy of the list should be permanently kept on board by the master.

Section 16 Use of Cargo as Fuel

1601. General (IGC Code 16.1)

1. Methane (LNG) is the only cargo whose vapour or boil-off gas may be utilized in machinery spaces of category A and in such spaces may be utilized only in boilers, inert gas generators, and combustion engines and gas turbines.

2. These provisions do not preclude the use of gas fuel for auxiliary services in other locations, provided that such other services and locations should be subject to special consideration by the Society.

1602. Arrangement of machinery spaces of category A (IGC Code 16.2)

1. Spaces in which gas fuel is utilized should be fitted with a mechanical ventilation system and should be arranged in such a way as to prevent the formation of dead spaces. Such ventilation should be particularly effective in the vicinity of electrical equipment and machinery or of other equipment and machinery which may generate sparks. Such a ventilation system should be separated from those intended for other spaces.

2. Gas detectors should be fitted in these spaces, particularly in the zones where air circulation is reduced. The gas detection system should comply with the requirements of **Sec 13.**

3. Electrical equipment located in the double wall pipe or duct specified in **1603. 1** should be of the intrinsically safe type.

1603. Gas fuel supply (IGC Code 16.3)

1. Gas fuel piping should not pass through accommodation spaces, service spaces or control stations. Gas fuel piping may pass through or extend into other spaces provided they fulfil one of the following:

(1) the gas fuel piping should be a double wall piping system with the gas fuel contained in the inner pipe. The space between the concentric pipes should be pressurized with inert gas at a pressure greater than the gas fuel pressure. Suitable alarms should be provided to indicate a loss of inert gas pressure between the pipes; or

(2) the gas fuel piping should be installed within a ventilated pipe or duct. The air space between the gas fuel piping and the inner wall of this pipe or duct should be equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour. The ventilation system should be arranged to maintain a pressure less than the atmospheric pressure. The fan motors should be placed outside the ventilated pipe or duct. The ventilation outlet should be placed in a position where no flammable gas-air mixture may be ignited. The ventilation should always be in operation when there is gas fuel in the piping. Continuous gas detection should be provided to indicate leaks and to shut down the gas fuel supply to the machinery space in accordance with **Par 10**. The master gas fuel valve required by **Par 7** should close automatically, if the required air flow is not established and maintained by the exhaust ventilation system.

2. If a gas leak occurs, the gas fuel supply should not be restored until the leak has been found and repaired. Instructions to this effect should be placed in a prominent position in the machinery spaces.

3. The double wall piping system or the ventilated pipe or duct provided for the gas fuel piping should terminate at the ventilation hood or casing required by **Par 4.**

4. A ventilation hood or casing should be provided for the areas occupied by flanges, valves, etc., and for the gas fuel piping, at gas fuel utilization units, such as boilers, diesel engines and gas turbines. If this ventilation hood or casing is not served by the exhaust ventilation fan serving the ventilated pipe or duct as specified in **Par 1** (2), then it should be equipped with an exhaust ventilation system and continuous gas detection should be provided to indicate leaks and to shut down the gas fuel supply to the machinery space in accordance with **Par 10.** The master gas fuel valve required by **Par 7** should close automatically if the required air flow is not established and maintained by the exhaust ventilation system. The ventilation hood or casing should be installed or mounted to permit the ventilating air to sweep across the gas utilization unit and be exhausted at the top of the ventilation hood or casing.

5. The ventilation inlet and discharge for the required ventilation systems should be respectively from and to a safe location.

6. Each gas utilization unit should be provided with a set of three automatic valves. Two of these valves should be in series in the gas fuel pipe to the consuming equipment. The third valve should be in a pipe that vents, to a safe location in the open air, that portion of the gas fuel piping that is between the two valves in series. These valves should be so arranged that failure of the necessary forced draft, loss of flame on boiler burners, abnormal pressure in the gas fuel supply line, or failure of the valve control actuating medium will cause the two gas fuel valves which are in series to close automatically and cause the vent valve to open automatically. Alternatively, the function of one of the valves in series and of the valve in the vent line can be incorporated into one valve body so arranged that, when one of the above conditions occurs, flow to the gas utilization unit will be blocked and the vent opened. The three shut-off valves should be arranged for manual reset.

7. A master gas fuel valve that can be closed from within the machinery space should be provided within the cargo area. The valve should be arranged so as to close automatically if leakage of gas is detected, or loss of ventilation for the duct or casing or loss of pressurization of the double wall gas fuel piping occurs.

8. Gas fuel piping in machinery spaces should comply with **502.** to **505.** as far as found applicable. The piping should, as far as practicable, have welded joints. Those parts of the gas fuel piping, which are not enclosed in a ventilated pipe or duct according to **Par 1** and are on the open deck outside the cargo area should have full penetration butt-welded joints and should be fully radiographed.

9. Provision should be made for inerting and gas-freeing that portion of the gas fuel piping system located in the machinery space.

10. Gas detection systems provided in accordance with the requirements of **Pars 1** and **4** should comply with **1306. 2** and **1306. 4** through **1306. 8** as applicable; they should activate the alarm at 30 % of the lower flammable limit and shut down the master gas fuel valve referred to in **Par 7** before the gas concentration reaches 60 % of the lower flammable limit.

1604. Gas make-up plant and related storage tanks (IGC Code 16.4)

1. All equipment (heaters, compressors, filters, etc.) for making up the gas for its use as fuel, and the related storage tanks should be located in the cargo area in accordance with the requirement of **301. 5** (4). If the equipment is in an enclosed space, the space should be ventilated according to **1201.** and be equipped with a fixed fire-extinguishing system according to **1105.** and with a gas detection system according to **1306.,** as applicable.

2. The compressors should be capable of being remotely stopped from a position which is always and easily accessible, and also from the engine-room. In addition, the compressors should be capable of automatically stopping when the suction pressure reaches a certain value depending on the set pressure of the vacuum relief valves of the cargo tanks. The automatic shut-down device of the compressors should have a manual resetting. Volumetric compressors should be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves should be determined in such a way that, with the delivery valve kept closed, the maximum pressure does not exceed by more than 10 % the maximum working pressure, The requirements of **506. 1** (3) apply to these compressors.

3. If the heating medium for the gas fuel evaporator or heater is returned to spaces outside the cargo area it should first go through a degassing tank. The degassing tank should be located in the cargo area. Provisions should be made to detect and alarm the presence of gas in the tank. The vent outlet should be in a safe position and fitted with a flame screen.

4. Piping and pressure vessels in the gas fuel conditioning system should comply with **Sec 5.**

1605. Special requirements for main boilers (IGC Code 16.5)

1. Each boiler should have a separate uptake.

2. A system suitable to ensure the forced draught in the boilers should be provided. The particulars of such a system should be to the satisfaction of the Society.

3. Combustion chambers of boilers should be of suitable form such as not to present pockets where gas may accumulate.

4. The burner systems should be of dual type, suitable to burn either oil fuel or gas fuel alone or oil and gas fuel simultaneously. Only oil fuel should be used during manoeuvring and port operations unless automatic transfer from gas to oil burning is provided in which case the burning of a combination of oil and gas or gas alone may be permitted provided the system is demonstrated to the satisfaction of the Society. It should be possible to change over easily and quickly from gas fuel operation to oil fuel operation. Gas nozzles should be fitted in such a way that gas fuel is ignited by the flame of the oil fuel burner. A flame scanner should be installed and arranged to assure that gas flow to the burner is cut off unless satisfactory ignition has been established and maintained. On the pipe of each gas burner a manually operated shut-off valve should be fitted. An installation should be provided for purging the gas supply piping to the burners by means of inert gas or steam, after the extinguishing of these burners.

5. Alarm devices should be fitted in order to monitor a possible decrease in liquid fuel oil pressure or a possible failure of the related pumps.

6. Arrangements should be made that, in case of flame failure of all operating burners for gas or oil or for a combination thereof, the combustion chambers of the boilers are automatically purged before relighting. Arrangements should also be made to enable the boilers to be manually purged.

1606. Special requirements for gas-fired internal combustion engines and gas-fired turbines (IGC Code 16.6)

Special provisions for gas-fuelled internal combustion engines and for gas turbines will be considered by the Society in each case.

Section 17 Special Requirements

1701. General (IGC Code 17.1)

The provisions of this Section are applicable where reference is made in column "i" in the table of **Sec 19.** These are requirements additional to the general requirements of this Chapter.

1702. Materials of construction (IGC Code 17.2)

Materials which may be exposed to cargo during normal operations should be resistant to the corrosive action of the gases. In addition, the following materials of construction for cargo tanks, and associated pipelines, valves, fittings and other items of equipment should not be used for certain products as specified in column "i" in the table of **Sec 19**:
(1) mercury, copper and copper-bearing alloys, and zinc;
(2) copper, silver, mercury, magnesium and other acetylide-forming metals;
(3) aluminium and aluminium-bearing alloys;
(4) copper, copper alloys, zinc and galvanized steel;
(5) aluminium, copper and alloys of either;
(6) copper and copper-bearing alloys with greater than 1% copper.

1703. Independent tanks (IGC Code 17.3)

1. Products should be carried in independent tanks only.

2. Products should be carried in type C independent tanks and the provisions of **701. 3** apply. The design pressure of the cargo tank should take into account any padding pressure or vapour discharge unloading pressure.

1704. Refrigeration systems (IGC Code 17.4)

1. Only the indirect system described in **702. 4** (2) should be used.

2. For a ship engaged in the carriage of products which readily form dangerous peroxides, recondensed cargo should not be allowed to form stagnant pockets of uninhibited liquid. This may be achieved either by:

(1) using the indirect system described in **702. 4** (2) with the condenser inside the cargo tank; or
(2) using the direct system or combined system described in **702. 4** (1) and (3) respectively, or the indirect system described in **702. 4** (2) with the condenser outside the cargo tank, and designing the condensate system to avoid any places in which liquid could collect and be retained. Where this is impossible inhibited liquid should be added upstream of such a place.

3. If the ship is to carry consecutively products as specified in **Par 2** with a ballast passage between, all uninhibited liquid should be removed prior to the ballast voyage. If a second cargo is to be carried between such consecutive cargoes, the reliquefaction system should be thoroughly drained and purged before loading the second cargo. Purging should be carried out using either inert gas or vapour from the second cargo, if compatible. Practical steps should be taken to ensure that polymers or peroxides do not accumulate in the cargo system.

1705. Deck cargo piping (IGC Code 17.5)

One hundred per cent radiography of all butt-welded joints in cargo piping exceeding 75 mm in diameter is required.

1706. Exclusion of air from vapour spaces (IGC Code 17.6)

Air should be removed from the cargo tanks and associated piping before loading and then subsequently excluded by:
(1) introducing inert gas to maintain a positive pressure. Storage or production capacity of the inert gas should be sufficient to meet normal operating requirements and relief valve leakage. The oxygen content of inert gas should at no time be greater than 0.2 % by volume; or

(2) control of cargo temperatures such that a positive pressure is maintained at all times.

1707. Moisture control (IGC Code 17.7)

For gases which are non-flammable and may become corrosive or react dangerously with water, moisture control should be provided to ensure that cargo tanks are dry before loading and that during discharge, dry air or cargo vapour is introduced to prevent negative pressures. For the purposes of this paragraph, dry air is air which has a dew point of -45°C or below at atmospheric pressure.

1708. Inhibition (IGC Code 17.8)

Care should be taken to ensure that the cargo is sufficiently inhibited to prevent polymerization at all times during the voyage. Ships should be provided with a certificate from the manufacturer stating:

(1) Name and amount of inhibitor added;
(2) date inhibitor was added and the normally expected duration of its effectiveness;
(3) any temperature limitations affecting the inhibitor;
(4) the action to be taken should be length of the voyage exceed the effective lifetime of the inhibitors.

1709. Permanently installed toxic gas detectors (IGC Code 17.9)

1. Gas sampling lines should not be led into or through gas-safe spaces. Alarms referred to in **1306. 7** should be activated when the vapour concentration reaches the threshold limiting value.

2. The alternative of using portable equipment in accordance with **1306. 9** should not be permitted.

1710. Flame screens on vent outlets (IGC Code 17.10)

Cargo tank vent outlets should be provided with readily renewable and effective flame screens or safety heads of an approved type when carrying a cargo referenced to this Article. Due attention should be paid in the design of flame screens and vent heads to the possibility of the blockage of these devices by the freezing of cargo vapour or by icing up in adverse weather conditions. Ordinary protection screens should be fitted after removal of the flame screens.

1711. Maximum allowable quantity of cargo per tank (IGC Code 17.11)

When carrying a cargo referenced to this Article the quantity of the cargo should not exceed 3,000 m^3 in any one tank.

1712. Submerged electric cargo pumps (IGC Code 17.12)

The vapour space of cargo tanks equipped with submerged electric motor pumps should be inerted to a positive pressure prior to loading, during carriage and during unloading of flammable liquids.

1713. Ammonia (IGC Code 17.13)

1. Anhydrous ammonia may cause stress corrosion cracking in containment and process systems made of carbon-manganese steel or nickel steel. To minimize the risk of this occurring, measures detailed in **Pars 2** to **8** should be taken as appropriate.

2. Where carbon-manganese steel is used, cargo tanks, process pressure vessels and cargo piping should be made of fine-grained steel with a specified minimum yield strength not exceeding 355 N/mm^2 and with an actual yield strength not exceeding 440 N/mm^2. One of the following constructional or operational measures should also be taken:

(1) lower strength material with a specified minimum tensile strength not exceeding 410 N/mm^2 should be used; or
(2) cargo tanks, etc., should be post-weld stress relief heat treated; or
(3) carriage temperature should be maintained preferably at a temperature close to the product's boiling point of -33°C but in no case at a temperature above -20°C; or

(4) the ammonia should contain not less than 0.1 % w/w water.

3. If carbon-manganese steels with higher yield properties are used other than those specified in **Par 2,** the completed cargo tanks, piping, etc., should be given a post-weld stress relief heat treatment.

4. Process pressure vessels and piping of the condensate part of the refrigeration system should be given a post-weld stress relief heat treatment when made of materials mentioned in **Par 1.**

5. The tensile and yield properties of the welding consumables should exceed those of the tank or piping material by the smallest practical amount.

6. Nickel steel containing more than 5 % nickel and carbon-manganese steel not complying with the requirements of **Pars 2** and **3** are particularly susceptible to ammonia stress corrosion cracking and should not be used for containment and piping systems for the carriage of this product.

7. Nickel steel containing not more than 5 % nickel may be used provided the carriage temperature complies with the requirements specified in **2** (3).

8. In order to minimize the risk of ammonia stress corrosion cracking, it is advisable to keep the dissolved oxygen content below 2.5 ppm w/w. This can best be achieved by reducing the average oxygen content in the tanks prior to the introduction of liquid ammonia to less than the values given as a function of the carriage temperature T in the table below:

T (°C)	O_2 (%, v/v)
-30 and below	0.90
-20	0.50
-10	0.28
0	0.16
10	0.10
20	0.05
30	0.03

Oxygen percentages for intermediate temperatures may be obtained by direct interpolation.

1714. Chlorine (IGC Code 17.14)

1. Cargo containment system

(1) The capacity of each tank should not exceed 600 m^3 and the total capacity of all cargo tanks should not exceed 1,200 m^3.

(2) The tank design vapour pressure should not be less than 1.35 MPa (see also **701. 3** and **1703. 2**).

(3) Parts of tanks protruding above the upper deck should be provided with protection against thermal radiation taking into account total engulfment by fire.

(4) Each tank should be provided with two pressure relief valves. A bursting disc of appropriate material should be installed between the tank and the pressure relief valves. The rupture pressure of the bursting disc should be 0.1 MPa lower than the opening pressure of the pressure relief valve, which should be set at the design vapour pressure of the tank but not less than 1.35 MPa gauge. The space between the bursting disc and the relief valve should be connected through an excess flow valve to a pressure gauge and a gas detection system. Provision should be made to keep this space at or near the atmospheric pressure during normal operation.

(5) Outlets from pressure relief valves should be arranged in such a way as to minimize the hazards on board the ship as well as to the environment. Leakage from the relief valves should be led through the absorption plant to reduce the gas concentration as far as possible. The relief valve exhaust line should be arranged at the forward end of the ship to discharge outboard at deck level with an arrangement to select either port or starboard side, with a mechanical interlock to ensure that one line is always open.

(6) The Society and the port Administration may require that chlorine is carried in refrigerated state at a specified maximum pressure.

2. Cargo piping systems

(1) Cargo discharge should be performed by means of compressed chlorine vapour from shore, dry air or another acceptable gas or fully submerged pumps. The pressure in the vapour space of the tank during discharging should not exceed 1.05 MPa gauge. Cargo discharge compressors on board ships should not be accepted by the Society.
(2) The design pressure of the cargo piping system should be not less than 2.1 MPa gauge. The internal diameter of the cargo pipes should not exceed 100 mm. Only pipe bends should be accepted for compensation of pipeline thermal movement. The use of flanged joints should be restricted to a minimum, and when used the flanges should be of the welding neck type with tongue and groove.
(3) Relief valves of the cargo piping system should discharge to the absorption plant (see also **802. 16**).

3. Materials

(1) The cargo tanks and cargo piping systems should be made of steel suitable for the cargo and for a temperature of -40°C, even if a higher transport temperature is intended to be used.
(2) The tanks should be thermally stress-relieved. Mechanical stress relief should not be accepted as an equivalent.

4. Instrumentation-safety devices

(1) The ship should be provided with a chlorine absorbing plant with connections to the cargo piping system and the cargo tanks. The absorbing plant should be capable of neutralizing at least 2 % of the total cargo capacity at a reasonable absorption rate.
(2) During the gas-freeing of cargo tanks, vapours should not be discharged to the atmosphere.
(3) A gas detecting system should be provided capable of monitoring chlorine concentrations of at least 1 ppm by volume. Suction points should be located:
 (a) near the bottom of the hold spaces;
 (b) in the pipes from the safety relief valves;
 (c) at the outlet from the gas absorbing plant;
 (d) at the inlet to the ventilation systems for the accommodation, service and machinery spaces and control stations;
 (e) on deck at the forward end, in the middle and at the after end of the cargo area. (Only required to be used during cargo handling and gas-freeing operations).
 The gas detection system should be provided with an audible and visual alarm with a set point of 5 ppm.
(4) Each cargo tank should be fitted with a high pressure alarm giving an audible alarm at a pressure equal to 1.05 MPa gauge.

5. Personnel protection

In addition to the requirements given in **Sec 14** the following requirements should be met:

(1) The enclosed space required by **1404. 5** should be easily and quickly accessible from the open deck and from accommodation spaces and should be capable of being rapidly closed gastight. Access to this space from the deck and from the accommodation spaces should be by means of an air lock. The space should be so designed as to accommodate the entire crew of the ship and be provided with a source of uncontaminated air for a period of not less than 4 h. One of the decontamination showers required by **1404. 3** should be located near the air lock to the space.
(2) A compressor and the necessary equipment for filling the air bottles should be provided.
(3) One set of oxygen therapy equipment should be carried in the space referred to in (1).

6. Filling limits for cargo tanks

(1) The requirements of **1501. 4** (2) do not apply when it is intended to carry chlorine.
(2) The chlorine content of the gas in the vapour space of the cargo tank after loading should be greater than 80 % by volume.

1715. Diethyl ether and vinyl ethyl ether (IGC Code 17.15)

1. The cargo should be discharge only by deepwell pumps or by hydraulically operated submerged pumps. These pumps should be of a type designed to avoid liquid pressure against the shaft gland.

2. Inert gas displacement may be used for discharging cargo from type C independent tanks provided the cargo system is designed for the expected pressure.

1716. Ethylene oxide (IGC Code 17.16)

1. For the carriage of ethylene oxide the requirements of **1720.** apply, with the additions and modifications as given in this Article.

2. Deck tanks should not be used for the carriage of ethylene oxide.

3. Stainless steels types 416 and 442 as well as cast iron should not be used in ethylene oxide cargo containment and piping systems.

4. Before loading, tanks should be thoroughly and effectively cleaned to remove all traces of previous cargoes from tanks and associated pipework, except where the immediate prior cargo has been ethylene oxide, propylene oxide or mixtures of these products. Particular care should be taken in the case of ammonia in tanks made of steel other than stainless steel.

5. Ethylene oxide should be discharged only by deepwell pumps or inert gas displacement. The arrangement of pumps should comply with **1720. 5** (3).

6. Ethylene oxide should be carried refrigerated only and maintained at temperatures of less than 30°C.

7. Pressure relief valves should be set at a pressure of not less than 0.55 MPa gauge. The maximum set pressure should be specially approved by the Society.

8. The protective padding of nitrogen gas as required by **1720. 15** should be such that the nitrogen concentration in the vapour space of the cargo tank will at no time be less than 45 % by volume.

9. Before loading and at all times when the cargo tank contains ethylene oxide liquid or vapour, the cargo tank should be inerted with nitrogen.

10. The water spray system required by **1720. 17** and that required by **1103.** should operate automatically in a fire involving the cargo containment system.

11. A jettisoning arrangement should be provided to allow the emergency discharge of ethylene oxide in the event of uncontrollable self-reaction.

1717. Isopropylamine and monoethylamine (IGC Code 17.17)

Separate piping systems should be provided as defined in **106. 32.**

1718. Methyl acetylene-propadiene mixtures (IGC Code 17.18)

1. Methyl acetylene-propadiene mixtures should be suitable stabilized for transport. Additionally, upper limits of temperature and pressure during the refrigeration should be specified for the mixtures.

2. Examples of acceptable, stabilized compositions are:

(1) Composition 1
- (a) maximum methyl acetylene to propadiene molar ratio of **3** to **1**;
- (b) maximum combined concentration of methyl acetylene and propadiene of 65 mol per cent,
- (c) minimum combined concentration of propane, butane, and isobutane of 24 mol per cent, of which at least one third (on a molar basis) must be butanes and one third propane; and
- (d) maximum combined concentration of propylene and butadiene of 10 mol per cent.

(2) Composition 2
- (a) maximum methyl acetylene and propadiene combined concentration of 30 mol per cent;
- (b) maximum methyl acetylene concentration of 20 mol per cent;
- (c) maximum propadiene concentration of 20 mol per cent;
- (d) maximum propylene concentration of 45 mol per cent;
- (e) maximum butadiene and butylenes combined concentration of **2** mol per cent;
- (f) minimum saturated C_4 hydrocarbon concentration of **4** mol per cent; and
- (g) minimum propane concentration of 25 mol per cent.

3. Other compositions may be accepted provided the stability of the mixture is demonstrated to the satisfaction of the Society.

4. A ship carrying methyl acetylene-propadiene mixtures should preferably have an indirect refrigeration system as specified in **702. 4** (2). Alternatively, a ship not provided with indirect refrigeration may utilize direct vapour compression refrigeration subject to pressure and temperature limitations depending on the composition. For the example compositions given in **Par 2,** the following features should be provided:

(1) A vapour compressor that does not raise the temperature and pressure of the vapour above 60°C and 1.75 MPa gauge during its operation, and that does not allow vapour to stagnate in the compressor while it continues to run.

(2) Discharge piping from each compressor stage or each cylinder in the same stage of a reciprocating compressor should have:

(a) two temperature-actuated shutdown switches set to operate at 60°C or less;

(b) a pressure-actuated shutdown switch set to operate at 1.75 MPa gauge or less; and

(c) a safety relief valve set to relieve at 1.8 MPa gauge or less.

(3) The relief valve required by **Par 4** (2) (c) should vent to a mast meeting the requirements of **802. 9, 10, 13** and **14** and should not relieve into the compressor suction line.

(4) An alarm that sounds in the cargo control position and in the navigating bridge when a high pressure switch, or a high-temperature switch operates.

5. The piping system, including the cargo refrigeration system, for tanks to be loaded with methyl acetylene-propadiene mixtures should be either independent (as defined in **106. 20**) or separate (as defined in **106. 32**) from piping and refrigeration systems for other tanks. This segregation applies to all liquid and vapour vent lines and any other possible connections, such as common inert gas supply lines.

1719. Nitrogen (IGC Code 17.19)

Materials of construction and ancillary equipment such as insulation should be resistant to the effects of high oxygen concentrations caused by condensation and enrichment at the low temperatures attained in parts of the cargo system. Due consideration should be given to ventilation in such areas where condensation might occur to avoid the stratification of oxygen-enriched atmosphere.

1720. Propylene oxide and mixtures of ethylene oxide-propylene oxide with ethylene oxide content of not more than 30% by weight (IGC Code 17.20)

1. Products transported under the provisions of this Article should be acetylene-free.

2. (1) Unless cargo tanks are properly cleaned, these products should not be carried in tanks which have contained as one of the three previous cargoes any product known to catalyse polymerization, such as:

(a) anhydrous ammonia and ammonia solutions;

(b) amines and amine solutions;

(c) oxidizing substances (e.g. chlorine).

(2) Before loading, tanks should be thoroughly and effectively cleaned to remove all traces of previous cargoes from tanks and associated pipework, except where the immediate prior cargo has been propylene oxide or ethylene oxide-propylene oxide mixtures. Particular care should be taken in the case of ammonia in tanks made of steel other than stainless steel.

(3) In all cases, the effectiveness of cleaning procedures for tanks and associated pipework should be checked by suitable testing or inspection to ascertain that no traces of acidic or alkaline materials remain that might create a hazardous situation in the presence of these products.

(4) Tanks should be entered and inspected prior to each initial loading of these products to ensure freedom from contamination, heavy rust deposits and any visible structural defects. When cargo tanks are in continuous service for these products, such inspections should be performed at intervals of not more than 2 years.

(5) Tanks for the carriage of these products should be of steel or strainless steel construction.

(6) Tanks which have contained these products may be used for other cargoes after thorough cleaning of tanks and associated pipework systems by washing or purging.

3. (1) All valves, flanges, fittings and accessory equipment should be of a type suitable for use with these products and should be constructed of steel or stainless steel in accordance with recognized standards. Discs or disc faces, seats and other wearing parts of valves should be made of stainless steel containing not less than 11 % chromium.

(2) Gaskets should be constructed of materials which do not react with, dissolve in, or lower the autoignition temperature of these products and which are fire-resistant and possess adequate mechanical behaviour. The surface presented to the cargo should be polytetrafluorethylene (PTFE) or materials giving a similar degree of safety by their inertness. Spirally-wound stainless steel with a filler of PTFE or similar fluorinated polymer may be accepted by the Society.

(3) Insulation and packing if used should be of a material which does not react with, dissolve in, or lower the autoignition temperature of these products.

(4) The following materials are generally found unsatisfactory for gaskets, packing and similar uses in containment systems for these products and would require testing before being approved by the Society.

(a) Neoprene or natural rubber if it comes into contact with the products;
(b) Asbestos or binders used with asbestos;
(c) Materials containing oxides of magnesium, such as mineral wools.

4. Filling and discharge piping should extend to within 100 mm of the bottom of the tank or any sump.

5. (1) The products should be loaded and discharge in such a manner that venting of the tanks to atmosphere does not occur. If vapour return to shore is used during tank loading, the vapour return system connected to a containment system for the product should be independent of all other containment systems.

(2) During discharging operations, the pressure in the cargo tank should be maintained above 0.07 MPa gauge.

(3) The cargo should be discharged only by deepwell pumps, hydraulically operated submerged pumps, or inert gas displacement. Each cargo pump should be arranged to ensure that the product does not heat significantly if the discharge line from the pump is shut off or otherwise blocked.

6. Tanks carrying these products should be vented independently of tanks carrying other products. Facilities should be provided for sampling the tank contents without opening the tank to atmosphere.

7. Cargo hoses used for transfer of these products should be marked "FOR ALKYLENE OXIDE TRANSFER ONLY".

8. Hold spaces should be monitored for these products. Hold spaces surrounding type A and B independent tanks should also be inerted and monitored for oxygen. The oxygen content of these spaces should be maintained below 2 %. Portable sampling equipment is satisfactory.

9. Prior to disconnecting shore-lines, the pressure in liquid and vapour lines should be relieved through suitable valves installed at the loading header. Liquid and vapour from these lines should not be discharged to atmosphere.

10. Tanks should be designed for the maximum pressure expected to be encountered during loading, carriage or unloading of cargo.

11. Tanks for the carriage of propylene oxide with a design vapour pressure of less than 0.06 MPa and tanks for the carriage of ethylene oxide-propylene oxide mixtures with a design vapour pressure of less than 0.12 MPa should have a cooling system to maintain the cargo below the reference temperature. For reference temperature see **1501. 4** (1).

12. Pressure relief valve settings should not be less than 0.02 MPa gauge and for type C independent cargo tanks not greater than 0.7 MPa gauge for the carriage of propylene oxide and not greater than 0.53 MPa gauge for the carriage of ethylene oxide-propylene oxide mixtures.

13. (1) The piping system for tanks to be loaded with these products should be completely separate from piping systems for all other tanks, including empty tanks, and from all cargo compressors. If the piping system for the tanks to be loaded with these products is not independent as defined in **106. 20** the required piping separation should be accomplished by the removal of spool pieces, valves, or other pipe sections and the installation of blank flanges at these locations. The required separation applies to all liquid and vapour piping, liquid and vapour vent lines and any other possible connections such as common inert gas supply lines.

(2) The products should be transported only in accordance with cargo handling plans that have been approved by the Society. Each intended loading arrangement should be shown on a separate cargo handling plan. Cargo handling plans should show the entire cargo piping system and the locations for installation of blank flanges needed to meet the above piping separation requirements. A copy of each approved cargo handling plan should be kept on board the ship. The International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk should be endorsed to include reference to the approved cargo handling plans.

(3) Before each initial loading of these products and before every subsequent return to such services, certification verifying that the required piping separation has been achieved should be obtained from a responsible person acceptable to the port Administration and carried on board the ship. Each connection between a blank flange and pipeline flange should be fitted with a wire and seal by the responsible person to ensure that inadvertent removal of the blank flange is impossible.

14. The maximum allowable tank loading limits for each cargo tank should be indicated for each loading temperature which may be applied and for the applicable maximum reference temperature, on a list to be approved by the Society. A copy of the list should be permanently kept on board by the master.

15. The cargo should be carried under a suitable protective padding of nitrogen gas. An automatic nitrogen make-up system should be installed to prevent the tank pressure falling below 0.007 MPa gauge in the event of product temperature fall due to ambient conditions or malfunctioning of refrigeration system. Sufficient nitrogen should be available on board to satisfy the demand of the automatic pressure control. Nitrogen of commercially pure quality (99.9 % by valume) should be used for padding. A battery of nitrogen bottles connected to the cargo tanks through a pressure reduction valve satisfies the intention of the expression "automatic" in this context.

16. The cargo tank vapour space should be tested prior to and after loading to ensure that the oxygen content is 2 % by volume or less.

17. A water spray system of sufficient capacity should be provided to blanket effectively the area surrounding the loading manifold, the exposed deck piping associated with product handling and the tank domes. The arrangement of piping and nozzles should be such as to give a uniform distribution rate of 10 l/m^2 per minute. The water spray system should be capable of both local and remote manual operation and the arrangement should ensure that any spilled cargo is washed away. Remote manual operation should be arranged such that remote starting of pumps supplying water spray system and remote operation of any normally closed valves in the system can be carried out from a suitable location outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected. Additionally, a water hose with pressure to the nozzle, when ambient temperatures permit, should be connected ready for immediate use during loading and unloading operation.

1721. Vinyl chloride (IGC Code 17.21)

In cases where polymerization of vinyl chloride is prevented by addition of an inhibitor, **1708.** is applicable. In cases where no or insufficient inhibitor has been added, any inert gas used for the purposes of **1706.** should contain not more oxygen than 0.1 %. Before loading is started, inert gas samples from the tanks and piping should be analysed. When vinyl chloride is carried, a positive pressure should always be maintained in the tanks, also during ballast voyages between successive carriages.

Section 18 Operating Requirements

1801. Cargo information (IGC Code 18.1)

1. Information should be on board and available to all concerned, giving the necessary data for the safe carriage of cargo. Such information should include for each product carried:

(1) a full description of the physical and chemical properties necessary for the safe containment of the cargo;
(2) action to be taken in the event of spills or leaks;
(3) counter-measures against accidental personal contact;
(4) fire-fighting procedures and fire-fighting media;
(5) procedures for cargo transfer, gas-freeing, ballasting, tank cleaning and changing cargoes;
(6) special equipment needed for the safe handling of the particular cargo;
(7) minimum allowable inner hull steel temperatures; and
(8) emergency procedures.

2. Products required to be inhibited should be refused if the certificate required by **1708.** is not supplied.

3. A copy of this Chapter or national regulations incorporating the provisions of this Chapter should be on board every ship covered by this Chapter.

1802. Compatibility (IGC Code 18.2)

1. The master should ascertain that the quantity and characteristics of each product to be loaded are within the limits indicated in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and in the Loading and Stability Information booklet provided for in **202. 5** and that products are listed in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk as required under **Sec 3** of the Certificate.

2. Care should be taken to avoid dangerous chemical reactions if cargoes are mixed. This is of particular significance in respect of:

(1) tank cleaning procedures required between successive cargoes in the same tank; and
(2) simultaneous carriage of cargoes which react when mixed. This should be permitted only if the complete cargo systems including, but not limited to, cargo pipework, tanks, vent systems and refrigeration systems are separated as defined in **106. 32.**

1803. Personnel training (IGC Code 18.3)

1. Personnel involved in cargo operations should be adequately trained in handling procedures.

2. All personnel should be adequately trained in the use of protective equipment provided on board and have basic training in the procedures, appropriate to their duties, necessary under emergency conditions.

3. Officers should be trained in emergency procedures to deal with conditions of leakage, spillage or fire involving the cargo, and a sufficient number of them should be instructed and trained in essential first aid for cargoes carried.

1804. Entry into spaces (IGC Code 18.4)

1. Personnel should not enter cargo tanks, hold spaces, void spaces, cargo handling spaces or other enclosed spaces where gas may accumulate, unless:

(1) the gas content of the atmosphere in such space is determined by means of fixed or portable equipment to ensure oxygen sufficiency and the absence of toxic atmosphere; or
(2) personnel wear breathing apparatus and other necessary protective equipment and the entire operation is under the close supervision of a responsible officer.

2. Personnel entering any space designated as gas dangerous on a ship carrying flammable products should not introduce any potential source of ignition into the space unless it has been certified gas-free and is maintained in that condition.

3. (1) For internal insulation tanks, special fire precautions should be taken in the event of hot work carried out in the vicinity of the tanks. For this purpose, gas absorbing and deabsorbing characteristics of the insulation material should be taken into account.

(2) For internal insulation tanks, repairs should be carried out in accordance with the procedures provided for in **404. 7** (6).

1805. Carriage of cargo at low temperature (IGC Code 18.5)

1. When carrying cargoes at low temperatures:

(1) if provided, the heating arrangements associated with cargo containment systems should be operated in such a manner as to ensure that the temperature does not fall below that for which the materials of the hull structure is designed;
(2) loading should be carried out in such a manner as to ensure that unsatisfactory temperature gradients do not occur in any cargo tank, piping, or other ancillary equipment; and
(3) when cooling down tanks from temperatures at or near ambient, the cool-down procedure laid down for that particular tank, piping and ancillary equipment should be followed closely.

1806. Protective equipment (IGC Code 18.6)

Personnel should be made aware of the hazards associated with the cargo being handled and should be instructed to act with care and use the appropriate protective equipment as mentioned in **1401.** during cargo handling.

1807. Systems and controls (IGC Code 18.7)

Cargo emergency shutdown and alarm systems involved in cargo transfer should be tested and checked before cargo handling operations begin. Essential cargo handling controls should also be tested and checked prior to transfer operations.

1808. Cargo transfer operations (IGC Code 18.8)

1. Transfer operations including emergency procedures should be discussed between ship personnel and the persons responsible at the shore facility prior to commencement and communications maintained throughout the transfer operations.

2. The closing time of the valve referred to in **1303.1** (i.e. time from shutdown signal initiation to complete valve closure) should not be greater than:

$$\frac{3{,}600\,U}{LR} \quad \text{(sec)}$$

where:

U = ullage volume at operating signal level (m^3)

LR = maximum loading rate agreed between ship and shore facility (m^3/h).

The loading rate should be adjusted to limit surge pressure on valve closure to an acceptable level taking into account the loading hose or arm, the ship and the shore piping systems where relevent.

1809. Additional operating requirements (IGC Code 18.9)

Additional operating requirements will be found in the following paragraphs of this Chapter: **308. 4, 308.5, 701.1** (5), **802. 5, 802. 7, 904. 2, 1201.1, 1201.10, 1301.4, 1402. 5, 1402.6, 1403.1, 1501., 1502., 1602. 2, 1704. 2, 1706., 1707., 1712., 1713., 1714., 1715., 1716., 1717., 1718., 1720.**

Section 19 Summary of Minimum Requirements

EXPLANATORY NOTES

UN Number (column b)

The UN numbers as listed in the table of **Sec 19** are intended for information only.

Vapour detection required (column f)

F - Flammable vapour detection
T - Toxic vapour detection
O - Oxygen analyser
F+T- Flammable and toxic vapour detection

Gauging-types permitted (column g)

I - Indirect, or closed, as described in **1302. 2** (1) and (2)
C - Indirect, or closed, as described in **1302. 2** (1), (2) and (3)
R - Indirect, closed or restricted, as described in **1302. 2** (1), (2), (3) and (4).

Refrigerant gases

Non-toxic and non-flammable gases such as:
dichlorodifIuoromethane (1028)
dichloromonofluoromethane (1029)
dichlorotetrafIuoroethane (1958)
monochlorodifIuoromethane (1018)
monochlorotetrafluoroethane (1021)
monochlorotrifluoromethane (1022)

Unless otherwise specified, gas mixtures containing less than 5 % total acetylenes may be transported with no further requirements than those provided for the major components.

MFAG table No. (column h)

MFAG numbers are provided for information on the emergency procedures to be applied in the event of an incident with the products covered by the IGC Code. Where any of the products listed are carried at low temperature from which frostbite may occur MFAG No. 620 is also applicable.

a	b	c	d	e	f	g	h	i
Product name	UN number	Ship type	Independent tank type C required	Control of vapour space within cargo tanks	Vapour detection	Gauging	MFAG table No.	Special requirements
Acetaldehyde	1089	2 G/2 PG	-	Inert	F+T	C	300	**1404.3, 1404.4, 1704.1, 1706.1**
Ammonia, anhydrous	1005	2 G/2 PG	-	-	T	C	725	**1404.2, 1404.3, 1404.4, 1702.1, 1713.**
Butadiene	1010	2 G/2 PG	-	-	F+T	R	310	**1702.2, 1704.2, 1704.3, 1706., 1708.**
Butane	1011	2 G/2 PG	-	-	F	R	310	
Butane-propane mixtures	1011/ 1978	2 G/2 PG	-	-	F	R	310	
Butylenes	1012	2 G/2 PG	-	-	F	R	310	
Carbon dioxide	-	3 G	Yes	-	-	C	-	
Chlorine	1017	1 G	Yes	Dry	T	I	740	**1404., 1703.2, 1704.1, 1705., 1707., 1709., 1714.**
Diethyl ether*	1155	2G/2PG	-	Inert	F+T	C	330	**1404.2, 1404.3, 1702.6, 1703.1, 1706.1, 1710., 1711., 1715.**
Dimethylamine	1032	2 G/2 PG	-	-	F+T	C	320	**1404.2, 1404.3, 1404.4, 1702.1**
Dimethyl ether	-	2 G/2 PG	-	-	F+T	C	-	
Ethane	1961	2 G	-	-	F	R	310	
Ethyl chloride	1037	2 G/2 PG	-	-	F+T	R	340	
Ethylene	1038	2 G	-	-	F	R	310	
Ethylene oxide	1040	1 G	Yes	Inert	F+T	C	365	**1404.2, 1404.3, 1404.4, 1404.6, 1702.2, 1703.2, 1704.1, 1705., 1706.1, 1716.**
Ethyene oxide-propylene oxide mixtures with ethylene oxide content of not more than 30% by weight*	2983	2 G/2 PG	-	Inert	F+T	C	365	**1404.3, 1703.1, 1704.1, 1706.1, 1710., 1711., 1720.**
Isoprene*	1218	2 G/2 PG	-	-	F	R	310	**1404.3, 1708., 1710., 1712.**
Isopropylamine*	1221	2 G/2 PG	-	-	F+T	C	320	**1404.2, 1404.3, 1702.4, 1710., 1711., 1712., 1717.**

a	b	c	d	e	f	g	h	i
Product name	UN number	Ship type	Independent tank type C required	Control of vapour space within cargo tanks	Vapour detection	Gauging	MFAG table No.	Special requirements
Methane (LNG)	1972	2 G	-	-	F	C	620	
Methyl acetylene-propadiene mixtures	1060	2 G/2 PG	-	-	F	R	310	**1718.**
Methyl bromide	1062	1 G	Yes	-	F+T	C	345	**1404., 1702.3, 1703.2, 1704.1, 1705., 1709.**
Methyl chloride	1063	2 G/2 PG	-	-	F+T	C	340	**1702.3**
Monoethylamine*	1036	2 G/2 PG	-	-	F+T	C	320	**1404.2, 1404.3, 1404.4, 1702.1, 1703.1, 1710., 1711., 1712., 1717.**
Nitrogen	2040	3 G	-	-	O	C	620	**1719.**
Pentanes (all isomers)*	1265	2 G/2 PG	-	-	F	R	310	**1404.4, 1710., 1712.**
Pentene (all isomers)*	1265	2 G/2 PG	-	-	F	R	310	**1404.4, 1710., 1712.**
Propane	1978	2 G/2 PG	-	-	F	R	310	
Propylene	1077	2 G/2 PG	-	-	F	R	310	
Propylene oxide*	1280	2 G/2 PG	-	Inert	F+T	C	365	**1404.3, 1703.1, 1704.1, 1706.1, 1710., 1711., 1720.**
Refrigerant gases (see notes)	-	3 G	-	-	-	R	350	
Sulphur dioxide	1079	1 G	Yes	Dry	T	C	635	**1404., 1703.2, 1704.1, 1705., 1707., 1709.**
Vinyl chloride	1086	2 G/2 PG	-	-	F+T	C	340	**1404.2, 1404.3, 1702.2, 1702.3, 1703.1, 1706., 1721.**
Vinyl ethyl ether*	1302	2 G/2 PG	-	Inert	F+T	C	330	**1404.2, 1404.3, 1702.2, 1703.1, 1706.1, 1708., 1710., 1711., 1715.**
Vinylidene chloride*	1303	2 G/2 PG	-	Inert	F+T	R	340	**1404.2, 1404.3, 1702.5, 1706.1, 1708., 1710., 1711.**
* This cargo is covered also by the IBC Code.								

CHAPTER 6 SHIPS CARRYING DANGEROUS CHEMICALS IN BULK

Section 1 General

101. Application (IBC Code 1.1)

1. The requirements in this Chapter apply to ships constructed on or after 1 July 1986, unless expressly provided otherwise. The requirements are also to comply with the requirements of IMO Res. MSC. 4 (48), MSC. 176 (79) and its additional amendments. Ships constructed before 1 July 1986 are to comply with the requirements of IMO Res. A.212 (VII), MEPC. 144 (54) and its additional amendments.

2. The requirements in this Chapter apply to ships, including those of less than 500 gross tonnage, engaged in the carriage of bulk cargoes of dangerous chemicals or noxious liquid substances, other than petroleum or similar flammable products as follows:

(1) Products having significant fire hazards in excess of those of petroleum products and similar flammable products.
(2) Products having significant hazards in addition to or other than flammability.

3. Products that have been reviewed and determined not to present safety and pollution hazards to such an extent as to warrant the application of the Rules are found in **Sec 18.**

4. Liquids covered of this Chapter are those having a vapour pressure not exceeding 0.28 MPa absolute at a temperature of 37.8 ℃.

5. For the purpose of MARPOL 73/78, the requirements applies only to NLS tanker defined thereof, which are engaged in the carriage of Noxious Liquid Substances identified as such by an entry of X, Y or Z in column c of Sec 17.

6. For a product for carriage in bulk, but not listed in **Secs 17** or **18,** the Administration shall prescribe the preliminary suitable conditions for the carriage, having regard to the criteria for hazard evaluation of bulk chemicals. For the evaluation of the pollution hazard of such a product and assignment of its pollution category, the procedure specified in regulation 6.3 of Annex II of MARPOL 73/78 is to be followed.

7. The ship's hull, machinery and equipment not specified in this Chapter are generally to comply with the requirements in the relevant Chapters of these Rules.

8. The ships carrying flammable dangerous chemicals in bulk are also to be in compliance with the requirements in **Pt 7, Ch 1** and **Pt 8** unless otherwise required in this Chapter.

9. For ships to be classed for restricted service and ships not provided with propulsive machinery, the requirements may be modified as appropriate.

10. When it is intended to carry products covered by this Chapter and products covered by **Ch 5,** the ship shall comply with the requirements of both Chapters appropriate to the products carried, However, when a ship is designed and constructed for the carriage of the products listed exclusively in **Sec 17**, the requirements of this Chapter should take precedence.

102. Approval for plans

For classification survey during construction, the following plans and informations as may be necessary depending upon the products intended to be loaded, condition of cargo storage, construction of cargo containment system and other design conditions are to be submitted in triplicate before the work is commenced.

1. Plans and data for approval

(1) Manufacturing specifications for independent cargo tanks (including materials to be used, welding procedures and inspection and testing procedures for weld and cargo tanks).
(2) Details of cargo tank construction.
(3) Arrangements of cargo tank accessories (including details of fittings inside the tanks).
(4) Details of independent cargo tank supports, deck portions through which cargo tanks penetrate

and their sealing devices when provided.
(5) Plans showing arrangement and the methods of attachment of the insulation together with the working procedure concerned.
(6) When the cargoes are required to be cooled, the plans and informations in accordance with **Ch 5, 102. 1** (1), (6), (7), (8) and (16) are to be submitted depending upon the cargo storage plan and the type of cargo tank construction.
(7) Cargo pump construction plan including list of materials to be used and their specifications.
(8) Piping arrangement in cargo tank area.
(9) Cargo tank ventilation arrangement.
(10) Ventilation plan of cargo pump rooms, cofferdams, double bottoms and others.
(11) Diagram of monitoring and measurement system for cargo level, cargo temperature and others and the detail construction of their equipment.
(12) Control system for cargo temperature.
(13) Details of environmental control system such as inerting, padding, drying or ventilation including the piping diagram and the construction of their equipment.
(14) Instruments for cargo vapour detection.
(15) Electrical wiring plans and a table of electrical equipment used in dangerous spaces.
(16) Arrangement of earth connections for cargo tanks, pipe lines, machinery and equipment, only when flammable cargoes are intended to be loaded.
(17) Plans showing dangerous spaces.
(18) Fire extinguishing system.

2. Plans and data for reference

(1) Lists showing chemical and physical properties and other special properties of the all cargoes intended to be loaded. Loading plans of the dangerous chemicals coming within the scope of this Chapter and other chemicals to be loaded simultaneously with these dangerous chemicals.
(2) Guide of reactivity hazard defined by reactivity with other chemicals, water or the chemical itself including polymerization and, where deemed necessary, with the heating or cooling media. The chemicals not intended to be loaded simultaneously with the dangerous chemicals coming within the scope of this Chapter may be excluded from these guides.
(3) Data of reactivity hazard between intended cargoes and coating or lining in cargo tanks and of piping and equipment that may come into contact with cargo liquid or vapour.
(4) Data of suitability of corrosion-resistance materials for the cargoes having corrosive properties.
(5) Strength calculation of each cargo tanks and, where deemed necessary, thermal stress calculation.
(6) Capacity calculation of heating system as required cargoes to be heated.
(7) Plans and documents in accordance with **Ch 5, 102. 2** (1), (6), (8) and (10) depending upon the cargo storage plan and the type of cargo tank construction when the cargoes require to be cooled.
(8) Arrangements of access manholes stipulated in 304. in cargo tank area and the guide for access through these manholes.
(9) Operation manual stipulated in **Sec 16.**
(10) Calculation for ship survival capability stipulated in **Sec 2.**
(11) Equipment for personnel protection.

103. Equivalents

The construction, equipment, etc., which do not fall under the provisions of this Chapter but is considered to be equivalent to those required in this Chapter will be accepted by the Society.

104. National regulations

For the construction and equipment of the ship, attention is to be paid to the requirements of national regulations of the country in which the ship is registered and/or of the port which the ship intends to visit.

105. Hazards (IBC Code 1.2)

Hazards of products covered by this Chapter include as follows :

1. Fire hazard, defined by flashpoint, explosive/flammability limits/range and autoignition temperature of the chemical.

2. Health hazard, defined by:

(1) corrosive effects on the skin in the liquid state ; or
(2) acute toxic effect, taking into account values of :
LD_{50} (oral): a dose which is lethal to 50 % of the test subjects when administered orally;
LD_{50} (skin): a dose which is lethal to 50 % of the test subjects when administered to the skin;
LC_{50} (inhalation): the concentration which is lethal by inhalation to 50 % of the test subjects; or
(3) Other health effects such as carcinogenicity and sensitization.

3. Reactivity hazard, defined by reactivity:

(1) with water ;
(2) with air;
(3) with other products; or
(4) of the product itself (e.g. polymerization)

4. Marine pollution hazard, as defined :

(1) bioaccumulation ;
(2) lack of ready biodegradibility ;
(3) acute toxicity to aquatic organisms ;
(4) chronic toxity to acquatic organisms ;
(5) long term human health effect; and
(6) physical properties resulting in the product floating or sinking and so adversely affecting marine life.

106. Definitions (IBC Code 1.3)

The definitions of terms are to be as specified in the following and **Sec 4,** unless otherwise specified elsewhere.

1. "**Accommodation spaces**" are those spaces used for public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, games and hobbies rooms, barber shops, pantries containing no cooking appliances and similar spaces. "**Public spaces**" are those portions of the accommodation spaces which are used for halls, dining rooms, lounges and similar permanently enclosed spaces.

2. "**Administration**" means the Government of the State whose flag the ship is entitled to fly.

3. "**Anniversary date**" means the day and the month of each year, which will correspond to the date of expiry of the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk.

4. "**Boiling point**" is the temperature at which a product exhibits a vapour pressure equal to the atmospheric pressure.

5. "**Breadth (B)**" means the maximum breadth of the ship, measured amidships to the moulded line of the frame in a ship with a metal shell and to the outer surface of the hull in a ship with a shell of any other material. The breadth (B) should be measured in metres.

6. "**Cargo area**" is that part of the ship that contains cargo tanks, slop tanks, cargo pump rooms including pump rooms, cofferdams, ballast or void spaces adjacent to cargo tanks or slop tanks and also deck areas throughout the entire length and breadth of the part of the ship over the above-mentioned spaces. Where independent tanks are installed in hold spaces, cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forward hold space are excluded from the cargo area.

7. "**Cargo pump room**" is a space containing pumps and their accessories for the handling of products covered by this Chapter.

8. "**Cargo service spaces**" are spaces within the cargo area used for workshops, lockers and store-rooms of more than 2 m^2 in area, used for cargo handling equipment.

9. "**Cargo tank**" is the envelope designed to contain the cargo.

10. "**Chemical tanker**" is a cargo ship constructed or adapted and used for the carriage in bulk of any liquid product listed in **Sec 17.**

11. "**Cofferdam**" is the isolating space between two adjacent steel bulkheads or decks. This space may be a void space or a ballast space.

12. "**Control stations**" are those spaces in which ship's radio or main navigating equipment or the emergency source of power is located or where the fire-recording or fire-control equipment is centralized. This does not include special fire control equipment which can be most practically located in the cargo area.

13. "**Dangerous chemicals**" means any liquid chemicals designated as presenting a safety hazard, based on the safety criteria for assigning products to chapter 17.

14. "**Density**" is the ratio of the mass to the volume of a product, expressed in terms of kilograms per cubic meter. This applies to liquid, gases and vapours.

15 "**Explosive/flammability limits/range**" are the conditions defining the state of fuel-oxidant mixture at which application of an adequately strong external ignition source is only just capable of producing flammability in a given test apparatus.

16. "**Flash point**" is the temperature in degrees Celsius at which a product will give off enough flammable vapour to be ignited. Values given in this Chapter are "closed cup test" determined by an approved flash point apparatus.

17. "**Hold space**" is the space enclosed by the ship's structure in which an independent cargo tank is situated.

18. "**Independent**" means that a piping or venting system, for example, is in no way connected to another system and that there are no provisions available for the potential connection to other systems.

19. "**Length (**L**)**" means 96 % of the total length on a waterline at 85% of the least moulded depth measured from the top of the keel, or the length from the forside of the stem to the axis of the rudder stock on that waterline, if that be greater. In ships designed with a rake of keel, the waterline on which this length is measured should be parallel to the designed waterline. The length (L) should be measured in metres.

20. "**Machinery spaces of category A**" are those spaces and trunks to such spaces which contain:

(1) internal combustion machinery used for main propulsion; or
(2) internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW; or
(3) any oil-fired boiler or oil fuel unit, or any oil-fired equipment other than boilers, such as inert gas generators, incinerators, etc.

21. "**Machinery spaces**" are all machinery spaces of category A and all other spaces containing propelling machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces, and trunks to such spaces.

22. "**MARPOL 73/78**" means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, as amended.

23. "**Noxious liquid substance**" means any substance indicated in the pollution Category column of chapter 17 or 18 of the International Chemical Code, or the current MEPC.2/Circular or provisionally assessed under the provisions of regulation 6.3 of MARPOL Annex II as falling into category X, Y or Z.

24. "**Oil fuel unit**" is the equipment used for the preparation of oil fuel for delivery to an oil-fired boiler, or equipment used for the preparation for delivery of heated oil to an internal combustion engine, and includes any oil pressure pumps, filters and heaters dealing with oil al a pressure of more than 0.18 MPa gauge.

25. "**Organization**" is the International Maritime Organization (IMO).

26. "**Permeability**" of a space means the ratio of the volume within the space which is assumed to be occupied by water to the total volume of that space.

27 "**Port Administration**" means the appropriate authority of the country in the port of which the ship is loading or unloading.

28. ″**Products**″ is the collective term used to cover both Noxious Liquid Substances and Dangerous Chemicals

29. ″**Pump room**″ is a space, located in the cargo area, containing pumps and their accessories for the handling of ballast and oil fuel.

30. ″**Recognized standards**″ are applicable international or national standards acceptable to the Society or standards laid down and maintained by the Society which complies with the standards adopted by the organization.

31. ″**Recognized temperature**″ is the temperature at which the vapour pressure of the cargo corresponds to the set pressure of the pressure-relief valve.

32. ″**Separate**″ means that a cargo piping system or cargo vent system, for example, is not connected to another cargo piping or cargo vent system.

33. ″**Service spaces**″ are those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, store-rooms, workshops other than those forming part of the machinery spaces and similar spaces and trunks to such spaces.

34. ″ **SOLAS** ″ means the International Convention for the Safety of Life at Sea, 1974.

35. ″**Vapour pressure**″ is the equilibrium pressure of the saturate vapour above the liquid expressed in bars absolute at a specified temperature.

36. ″**Void space**″ is an enclosed space in the cargo area external to a cargo tank, other than a hold space, ballast space, oil fuel tank, cargo pump room, pump room, or any space in normal use by personnel.

Section 2 Ship Survival Capability and Location of Cargo Tanks

201. General (IBC Code 2.1)

1. Ships subject to this Chapter should survive the normal effects of flooding following assumed hull damage caused by some external force. In addition, to safeguard the ship and the environment, the cargo tanks of certain types of ships should be protected from penetration in the case of minor damage to the ship resulting, for example, from contact with a jetty or tug, and given a measure of protection from damage in the case of collision or stranding, by locating them at specified minimum distances inboard from the ship's shell plating. Both the damage to be assumed and the proximity of the cargo tanks to the ship's shell should be dependent upon the degree of hazard presented by the products to be carried.

2. Ships subject to this Chapter should be designed to one of the following standards:

(1) A "**type 1 ship**" is a chemical tanker intended to transport **Sec 17** products with very severe environmental and safety hazards which require maximum preventive measures to preclude an escape of such cargo.

(2) A "**type 2 ship**" is a chemical tanker intended to transport **Sec 17** products with appreciably severe environmental and safety hazards which require significant preventive measures to preclude an escape of such cargo.

(3) A "**type 3 ship**" is a chemical tanker intended to transport **Sec 17** products with sufficiently severe environmental and safety hazards which require a moderate degree of containment to increase survival capability in a damaged condition.

Thus a type 1 ship is a chemical tanker intended for the transportation of products considered to present the greatest overall hazard and type 2 and type 3 ships for products of progressively lesser hazards. Accordingly, a type 1 ship should survive the most severe standard of damage and its cargo tanks should be located at the maximum prescribed distance inboard from the shell plating.

3. The ship type required for individual products is indicated in column "e" in the table of **Sec 17.**

4. If a ship is intended to carry more than one product listed in **Sec 17,** the standard of damage should correspond to that product having the most stringent ship type requirement. The requirements for the location of individual cargo tanks, however, are those for ship types related to the respective products intended to be carried.

202. Freeboard and intact stability (IBC Code 2.2)

1. Ships subject to this Chapter may be assigned the minimum freeboard permitted by the International Convention on Load Lines in force. However, the draught associated with the assignment should not be greater than the maximum draught otherwise permitted by this Chapter.

2. The stability of the ship in all seagoing conditions should be to a standard which is acceptable to the Society.

3. When calculating the effect of free surfaces of consumable liquids for loading conditions it should be assumed that, for each type of liquid, at least one transverse pair or a single centre tank has a free surface and the tank or combination of tanks to be taken into account should be those where the effect of free surfaces is the greatest. The free surface effect in undamaged compartments should be calculated by a method acceptable to the Society.

4. Solid ballast should not normally be used in double bottom spaces in the cargo area. Where, however, because of stability considerations, the fitting of solid ballast in such spaces becomes unavoidable, then its disposition should be governed by the need to ensure that the impact loads resulting from bottom damage are not directly transmitted to the cargo tank structure.

5. The master of the ship should be supplied with a Loading and Stability Information booklet. This booklet should contain details of typical service and ballast conditions, provisions for evaluating other conditions of loading and a summary of the ship's survival capabilities. In addition, the booklet should contain sufficient information to enable the master to load and operate the ship in a safe and seaworthy manner.

203. Shipside discharges below the freeboard deck (IBC Code 2.3)

1. The provision and control of valves fitted to discharges led through the shell from spaces below the freeboard deck or from with in the superstructures and deckhouses on the freeboard deck fitted with weathertight doors should comply with the requirements of the relevant regulation of the International Convention on Load Lines in force, except that the choice of valves should be limited to:

(1) one automatic non-return valve with a positive means of closing from above the freeboard deck; or

(2) where the vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0.01 L, two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination under service conditions.

2. For the purpose of this Section "**summer load waterline**" and "**freeboard deck**", have the meanings as defined in the International Convention on Load Lines in force.

3. The automatic non-return valves referred to in **Par 1** (1) and (2) should be of a type acceptable to the Society and should be fully effective in preventing admission of water into the ship, taking into account the sinkage, trim and heel in survival requirements in **209.** and should comply with recognized standards.

204. Conditions of loading (IBC Code 2.4)

Damage survival capability should be investigated on the basis of loading information submitted to the Society for all anticipated conditions of loading and variations in draught and trim. Ballast conditions where the chemical tanker is not carrying products covered by this Chapter, or is carrying only residues for such products, need not be considered.

205. Damage assumptions (IBC Code 2.5)

1. The assumed maximum extent of damage should be:

(1) Side damage:
 (a) Longitudinal extent: 1/3 $L^{2/3}$ or 14.5 m, whichever is less
 (b) Transverse extent: B/5 or 11.5 m, whichever is less, measured inboard from the ship's side at right angles to the centreline at the level of the summer load line
 (c) Vertical extent: upwards without limit, from the moulded line of the bottom shell plating at centreline.

(2) Bottom damage:

	For 0.3 L from the forward perpendicular of the ship	Any other part of the ship
(a) Longitudinal extent:	1/3 $L^{2/3}$ or 14.5 m, whichever is less	1/3 $L^{2/3}$ or 5 m, whichever is less
(b) Transverse extent:	B/6 or 10 m, whichever is less	B/6 or 5 m, whichever is less
(c) Vertical extent:	B/15 or 2 m, whichever is less, measured from the moulded line of the bottom shell plating at centreline. (see **206. 2**)	B/15 or 2 m, whichever is less, measured from the moulded line of the bottom shell plating at centreline. (see **206. 2**)

2. Other damage:

If any damage of a lesser extent than the maximum damage specified in **Par 1** would result in a more severe condition, such damage should be considered.

206. Location of cargo tanks (IBC Code 2.6)

1. Cargo tanks should be located at the following distances inboard.

(1) Type 1 ships: from the side shell plating not less than the transverse extent of damage specified in **205. 1** (1) (b) and from the moulded line of the bottom shell plating at centreline not less than the vertical extent of damage specified in **205. 1** (2) (c) and nowhere less than 760 mm from the shell plating. This requirement does not apply to the tanks for diluted slops arising from tank washing.
(2) Type 2 ships: from the moulded line of the bottom shell plating at centreline not less than the vertical extent of damage specified in **205. 1** (2) (c) and nowhere less than 760 mm from the shell plating. This requirement does not apply to the tanks for diluted slops arising from tank washing.
(3) Type 3 ships: no requirement.

2. Except for type 1 ships, suction wells installed in cargo tanks may protrude into the vertical extent of bottom damage specified in **205. 1** (2) (c) provided that such wells are as small as practicable and the protrusion below the inner bottom plating does not exceed 25 % of the depth of the double bottom or 350 mm, whichever is less. Where there is no double bottom, the protrusion of the suction well of independent tanks below the upper limit of bottom damage should not exceed 350 mm. Suction wells installed in accordance with this paragraph may be ignored in determining the compartments affected by damage.

207. Flooding assumptions (IBC Code 2.7)

1. The requirements of **209.** should be confirmed by calculations which take into consideration the design characteristics of the ship; the arrangements, configuration and contents of the damaged compartments; the distribution, relative densities and the free surface effects of liquids; and the draught and trim for all conditions of loading.

2. The permeabilities of spaces assumed to be damaged should be as follows:

Spaces	Permeabilities
Appropriated to stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Voids	0.95
Intended for consumable liquids	0 to 0.95
Intended for other liquids	0 to 0.95

3. Wherever damage penetrates a tank containing liquids it should be assumed that the contents are completely lost from that compartment and replaced by salt water up to the level of the final plane of equilibrium.

4. Every watertight division within the maximum extent of damage defined in **205. 1** and considered to have sustained damage in positions given in **208. 1** should be assumed to be penetrated. Where damage less than the maximum is being considered in accordance with **205. 2,** only watertight divisions or combinations of watertight divisions within the envelope of such lesser damage should be assumed to be penetrated.

5. The ship should be so designed as to keep unsymmetrical flooding to the minimum consistent with efficient arrangements.

6. Equalization arrangements requiring mechanical aids such as valves or cross-levelling pipes, if fitted, should 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 **209.** and sufficient residual stability should be maintained during all stages where equalization is used. Spaces which are linked by ducts of large cross-sectional area may be considered to be common.

7. If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in **205.,** arrangements should be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

8. The buoyancy of any superstructure directly above the side damage should be disregarded. The unflooded parts of superstructures beyond the extent of damage, however, may be taken into consideration provided that:

(1) they are separated from the damaged space by watertight divisions and the requirements of **209. 3** in respect of these intact spaces are complied with; and

(2) openings in such divisions are capable of being closed by remotely operated sliding watertight doors and unprotected openings are not immersed within the minimum range of residual stability required in **209.;** however the immersion of any other openings capable of being closed weathertight may be permitted.

208. Standard of damage (IBC Code 2.8)

1. Ships should be capable of surviving the damage indicated in **205.** with the flooding assumptions in **207.** to the extent determined by the ship's type according to the following standards:

(1) A type 1 ship should be assumed to sustain damage anywhere in its length;

(2) A type 2 ship of more than 150 m in length should be assumed to sustain damage anywhere in its length;

(3) A type 2 ship of 150 m in length or less should be assumed to sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft;

(4) A type 3 ship of more than 225 m in length should be assumed to sustain damage anywhere in its length;

(5) A type 3 ship of 125 m in length or more but not exceeding 225 m in length should be assumed to sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft;

(6) A type 3 ship below 125 m in length should be assumed to sustain damage anywhere in its length except involving damage to the machinery space when located aft. However, the ability to survive the flooding of the machinery space should be considered by the Society.

2. In the case of small type 2 and type 3 ships which do not comply in all respects with the appropriate requirements of **Par 1** (3) and (6), special dispensation may only be considered by the Society provided that alternative measures can be taken which maintain the same degree of safety.

209. Survival requirements (IBC Code 2.9)

1. Ships subject to this Chapter should be capable of surviving the assumed damage specified in **205.** to the standard provided in **208.** in a condition of stable equilibrium and should satisfy the following criteria.

2. In any stage of flooding:

(1) the waterline, taking into account sinkage, heel and trim, should be below the lower edge of any opening through which progressive flooding or downflooding may take place. Such openings should include air pipes and openings which are closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated watertight sliding doors, and sidescuttles of the non-opening type;

(2) the maximum angle of heel due to unsymmetrical flooding should not exceed 25° except that this angle may be increased up to 30° if no deck immersion occurs;

(3) the residual stability during intermediate stages of flooding should be to the satisfaction of the Society. However, it should never be significantly less than that required by **Par 3.**

3. At final equilibrium after flooding:

(1) the righting lever curve should have a minimum range of 20° beyond the position of equilibrium in association with a maximum residual righting lever of at least 0.1 m within the 20° range; the area under the curve within this range should not be less than 0.0175 m · rad. Unprotected openings should not be immersed within this range unless the space concerned is assumed to be flooded. Within this range, the immersion of any of the openings listed in **Par 2** (1) and other openings capable of being closed weathertight may be permitted; and

(2) the emergency source of power should be capable of operating.

Section 3 Ship Arrangements

301. Cargo segregation (IBC Code 3.1)

1. Unless expressly provided otherwise, tanks containing cargo or residues of cargo subject to this Chapter should be segregated from accommodation, service and machinery spaces and from drinking water and stores for human consumption by means of a cofferdam, void space, cargo pump room, pump room, empty tank, oil fuel tank or other similar space.

2. Cargoes, residues of cargoes or mixtures containing cargoes which react in a hazardous manner with other cargoes, residues or mixtures, should:

(1) be segregated from such other cargoes by means of a cofferdam, void space, cargo pump room, pump room, empty tank, or tank containing a mutually compatible cargo;
(2) have separate pumping and piping systems which should not pass through other cargo tanks containing such cargoes, unless encased in a tunnel; and
(3) have separate tank venting systems.

3. Cargo piping should not pass through any accommodation, service or machinery space other than cargo pump rooms or pump rooms.

4. Cargoes subject to this Chapter should not be carried in either the fore or aft peak tank.

5. If cargo piping systems or cargo ventilation systems are to be separated. This separation may be achieved by the use of design or operational methods. Operational methods shall not be used within a cargo tank and shall consist of one of the following type:

(1) removing spool-pieces or valves and blanking the pipe ends.
(2) arrangement of two spectacle flanges in series, with provisions for detecting leakage into the pipe between the two spectacle flanges.

302. Accommodation, service and machinery spaces and control stations (IBC Code 3.2)

1. No accommodation or service spaces or control stations should be located within the cargo area except over a cargo pump room recess or pump room recess that complies with SOLAS regulations II-2/4.5.1 to 4.5.2.4 and no cargo or slop tank should be aft of the forward end of any accommodation.

2. In order to guard against the danger of hazardous vapours, due consideration should 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.

3. Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations should not face the cargo area. They should be located on the end bulkhead not facing the cargo area and/or on the outboard side of the superstructure or deck house at a distance of at least 4 % of the length (L) of the ship but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area. This distance, however, need not exceed 5 m. No doors should be permitted within the limits mentioned above, except that doors to those spaces not having access to accommodation and service spaces and control stations, such as cargo control stations and store-rooms may be fitted. Where such doors are fitted, the boundaries of the space should be insulated to "A-60" standard. Bolted plates for removal of machinery may be fitted within the limits specified above. Wheelhouse doors and wheel house windows may be located within the limits specified above so long as they are so designed that a rapid and efficient gas- and vapour-tightening of the wheelhouse can be ensured. Windows and sidescuttles facing the cargo area and on the sides of the super structures and deckhouses within the limits specified above should be of the fixed (non-opening) type. Such sidescuttles in the first tier on the main deck should be fitted with inside covers of steel or equivalent material.

303. Cargo pump rooms (IBC Code 3.3)

1. Cargo pump rooms should be so arranged as to ensure:

(1) unrestricted passage at all times from any ladder platform and from the floor; and
(2) unrestricted access to all valves necessary for cargo handling for a person wearing the required

personnel protective equipment.

2. Permanent arrangements should be made for hoisting an injured person with a rescue line while avoiding any projecting obstacles.

3. Guard railings should be installed on all ladders and platforms.

4. Normal access ladders should not be fitted vertical and should incorporate platforms at suitable intervals.

5. Means should be provided to deal with drainage and any possible leakage from cargo pumps and valves in cargo pump rooms. The bilge system serving the cargo pump room should be operable from outside the cargo pump room. One or more slop tanks for storage of contaminated bilge water or tank washings should be provided. A shore connection with a standard coupling or other facilities should be provided for transferring contaminated liquids to onshore reception facilities.

6. Pump discharge pressure gauges should be provided outside the cargo pump room.

7. Where machinery is driven by shafting passing through a bulkhead or deck, gastight seals with efficient lubrication or other means of ensuring the permanence of the gas seal should be fitted in way of the bulkhead or deck.

304. Access to spaces in the cargo area (IBC Code 3.4)

1. 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. Access 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.

2. For access 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.

3. For access through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening should be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

4. 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.

305. Bilge and ballast arrangements (IBC Code 3.5)

1. Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks should be independent of similar equipment serving cargo tanks and of cargo tanks themselves. Discharge arrangements for permanent ballast tanks sited immediately adjacent to cargo tanks should be outside machinery spaces and accommodation spaces. Filling arrangements may be in the machinery spaces provided that such arrangements ensure filling from tank deck level and non return valves are fitted.

2. Filling of ballast in cargo tanks may be arranged from deck level by pumps serving permanent ballast tanks, provided that the filling line has no permanent connection to cargo tanks or piping and that non-return valves are fitted.

3. Bilge pumping arrangements for cargo pump rooms, pump rooms, void spaces, slop tanks, double bottom tanks and similar spaces should be situated entirely within the cargo area except for void spaces, double bottom tanks and ballast tanks were such spaces are separated from tanks containing cargo or residues of cargo by a double bulkhead.

306. Pump and pipeline identification (IBC Code 3.6)

Provisions should be made for the distinctive marking of pumps, valves and pipelines to identify the service and tanks which they serve.

307. Bow or stern loading and unloading arrangements (IBC Code 3.7)

1. Cargo piping may be fitted to permit bow or stern loading and unloading. Portable arrangements should not be permitted.

2. Bow or stern loading and unloading lines should not be used for the transfer of products required to be carried in type 1 ships. Bow and stern loading and unloading lines should not be used for the transfer of cargoes emitting toxic vapours required to comply with **1512. 1,** unless specifically approved by the Society.

3. In addition to **501.,** the following provisions apply:

(1) The piping outside the cargo area should be fitted at least 760 mm inboard on the open deck. Such piping should be clearly identified and fitted with a shutoff valve at its connection to the cargo piping system within the cargo area. At this location, it should also be capable of being separated by means of a removable spool piece and blank flanges when not in use.
(2) The shore connection should be fitted with a shutoff valve and a blank flange.
(3) The piping should be full penetration butt-welded, and fully radiographed. Flange connections in the piping should only be permitted within the cargo area and at the shore connection.
(4) Spray shields should be provided at the connections specified in (1) as well as collecting trays of sufficient capacity with means for the disposal of drainage.
(5) The piping should be self-draining to the cargo area and preferably into a cargo tank. Alternative arrangements for draining the piping may be accepted by the Society.
(6) Arrangements should be made to allow such piping to be purged after use and maintained gas-safe when not in use. The vent pipes connected with the purge should be located in the cargo area. The relevant connections to the piping should be provided with a shutoff valve and blank flange.

4. Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations should not face the cargo shore connection location of bow or stern loading and unloading arrangements. They should 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 house 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 should 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 should be kept closed. Where, in the case of small ships, compliance with **302. 3** and this paragraph is not possible, the Society may approve relaxations from the above requirements.

5. Air pipes and other openings to enclosed spaces not listed in **307. 4** should be shielded from any spray which may come from a burst hose or connection.

6. Escape routes should not terminate within the coamings required by **307. 7** or within a distance of 3 m beyond the coamings.

7. Continuous coamings of suitable height should be fitted to keep any spills on deck and away from the accommodation and service areas.

8. Electrical equipment within the coamings required by **307. 7** or within a distance of 3 m beyond the coamings should be in accordance with the requirements of **Sec 10.**

9. Fire-fighting arrangements for the bow or stern loading and unloading areas should be in accordance with **1103. 16.**

10. Means of communication between the cargo control station and the cargo shore connection location should be provided and certified safe, if necessary. Provision should be made for the remote shutdown of cargo pumps from the cargo shoreconnection location.

Section 4 Cargo Containment

401. Definitions (IBC Code 4.1)

1. "**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 ship's hull.

2. "**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.

3. "**Gravity tank**" means a tank having a design pressure not greater than 0.07 MPa gauge at the top of the tank. A gravity tank may be independent or integral. A gravity tank should be constructed and tested according to recognized standards taking account of the temperature of carriage and relative density of the cargo.

4. "**Pressure tank**" means a tank having a design pressure greater than 0.07 MPa gauge. A pressure tank should be an independent tank and should be of a configuration permitting the application of pressure vessel design criteria according to recognized standards.

402. Tank type requirements for individual products (IBC Code 4.2)

Requirements for both installation and design of tank types for individual products are shown in column "f" in the table of **Sec 17.**

Section 5 Cargo Transfer

501. Piping scantlings (IBC Code 5.1)

1. Subject to the conditions stated in **Par 4** the wall thickness (t) of pipes should not be less than:

$$t = \frac{t_0 + b + c}{1 - \frac{a}{100}} \quad (\mathrm{mm})$$

where:

t_0 = theoretical thickness

$$t_0 = \frac{P \cdot D}{2K \cdot e + P} \quad (\mathrm{mm})$$

with

P = design pressure (MPa) referred to in **Par 2**

D = outside diameter (mm)

K = allowable stress($\mathrm{N/mm^2}$) referred to in **Par 5**

e = efficiency factor; equal to 1.0 for seamless pipes and for longitudinally or spirally welded pipes, delivered by manufacturers approved for making welded pipes, which are considered equivalent to seamless pipes wnen non-destructive testing on welds is carried out in accordance with recognized standards. In other cases, an efficiency factor of less than 1.0, in accordance with recognized standards, may be required depending on the manufacturing process.

b = allowance for bending (mm). The value of b should be chosen so that the calculated stress in the bend, due to internal pressure only, does not exceed the allowable stress. Where such justification is not given, b should be not less than:

$$b = \frac{D \cdot t_0}{2.5r} \quad (\mathrm{mm})$$

with

r = mean radius of the bend (mm).

c = corrosion allowance (mm). If corrosion or erosion is expected, the wall thickness of piping should be increased over that required by the other design requirements.

a = negative manufacturing tolerance for thickness (%).

2. The design pressure P in the formula for t_0 in **Par 1** is the maximum gauge pressure to which the system may be subjected in service, taking into account the highest set pressure on any relief valve on the system.

3. Piping and piping system components which are not protected by a relief valve, or which may be isolated from their relief valve, should be designed for at least the greatest of:

(1) for piping systems or components which may contain some liquid, the saturated vapour pressure at 45°C;

(2) the pressure setting of the associated pump discharge relief valve;

(3) the maximum possible total pressure head at the outlet of the associated pumps when a pump

discharge relief valve is not installed.

4. The design pressure should not be less than 1.0 MPa gauge except for open-ended lines where it should be not less than 0.5 MPa gauge.

5. For pipes, the allowable stress to be considered in the formula for to in **Par 1** is the lower of the following values:

R_m/A or R_e/B

where:

R_m = specified minimum tensile strength at ambient temperature (N/mm^2)

R_e = specified minimum yield stress at ambient temperature (N/mm^2). If the stress-strain curve does not show a defined yield stress, the 0.2 % proof stress applies.

A and B should have values of at least A = 2.7 and B = 1.8

6. (1) The minimum wall thickness should be in accordance with recognized standards.

(2) Where necessary for mechanical strength to prevent damage, collapse, excessive sag or buckling of pipes due to weight of pipes and content and to superimposed loads from supports, ship deflection or other causes, the wall thickness should be increased over that required by **Par 1** or, if this is impracticable or would cause excessive local stresses, these loads should be reduced, protected against or eliminated by other design methods.

(3) Flanges, valves and other fittings should be in accordance with recognized standards, taking into account the design pressure defined under **Par 2.**

(4) For flanges not complying with a standard the dimensions of flanges and associated bolts should be to the satisfaction of the Society.

502. Piping fabrication and joining details (IBC Code 5.2)

1. The requirements of this Article apply to piping inside and outside the cargo tanks. However, relaxations from these requirements may be accepted in accordance with recognized standards for open-ended piping and for piping inside cargo tanks except for cargo piping serving other cargo tanks.

2. Cargo piping should be joined by welding except:

(1) for approved connections to shutoff valves and expansion joints; and
(2) for other exceptional cases specifically approved by the Society.

3. The following direct connections of pipe lengths, without flanges may be considered:

(1) Butt-welded joints with complete penetration at the root may be used in all applications.
(2) Slip-on welded joints with sleeves and related welding having dimensions in accordance with recognized standards should only be used for pipes with an external diameter of 50 mm or less. This type of joint should not be used when crevice corrosion is expected to occur.
(3) Screwed connections in accordance with recognized standards should only be used for accessory lines and instrumentation lines with external diameters of 25 mm or less.

4. Expansion of piping should normally be allowed for by the provision of expansion loops or bends in the piping system.

(1) Bellows in accordance with recognized standards may be specially considered.
(2) Slip joints should not be used.

5. Welding, post-weld heat treatment and non-destructive testing should be performed in accordance with Recognized Standards.

503. Flange connections (IBC Code 5.3)

1. Flanges should be of the welded neck, slip-on or socket-welded type. However, socket-welded type flanges should not be used in nominal size above 50 mm.

2. Flanges should comply with recognized standards as to their type, manufacture and test.

504. Test requirements for piping (IBC Code 5.4)

1. The test requirements of this Article apply to piping inside and outside cargo tanks. However, relaxations from these requirements may be accepted in accordance with recognized standards for piping inside tanks and open-ended piping.

2. After assembly, each cargo piping system should be subject to a hydrostatic test to at least 1.5 times the design pressure. When piping systems or parts of systems are completely manufactured and equipped with all fittings, the hydrostatic test may be conducted prior to installation aboard the ship. Joints welded on board should be hydrostatically tested to at least 1.5 times the design pressure.

3. After assembly on board, each cargo piping system should be tested for leaks to a pressure depending on the method applied.

505. Piping arrangements (IBC Code 5.5)

1. Cargo piping should not be installed under deck between the outboard side of the cargo containment spaces and the skin of the ship unless clearances required for damage protection (see **206.**) are maintained; but such distances may be reduced where damage to the pipe would not cause release of cargo provided that the clearance required for inspection purposes is maintained.

2. Cargo piping, located below the main deck, may run from the tank it serves and penetrate tank bulkheads or boundaries common to longitudinally or transversally adjacent cargo tanks, ballast tanks, empty tanks, pump rooms or cargo pump rooms provided that inside the tank it serves it is fitted with a stop valve operable from the weather deck and provided cargo compatibility is assured in the event of piping failure. As an exception, where a cargo tank is adjacent to a cargo pump room, the stop valve operable from the weather deck may be situated on the tank bulkhead on the cargo pump room side, provided an additional valve is fitted between the bulkhead valve and the cargo pump. A totally enclosed hydraulically-operated valve located outside the cargo tank may, however, be accepted, provided that the valve is:

(1) designed to preclude the risk of leakage;
(2) fitted on the bulkhead of the cargo tank which it serves;
(3) suitably protected against mechanical damage;
(4) fitted at a distance from the shell, as required for damage protection; and
(5) operable from the weather deck.

3. In any cargo pump room where a pump serves more than one tank, a stop valve should be fitted in the line to each tank.

4. Cargo piping installed in pipe tunnels should also comply with the requirements of **Pars 1** and **2.** Pipe tunnels should satisfy all tank requirements for construction, location and ventilation and electrical hazard requirements. Cargo compatibility should be assured in the event of a piping failure. The tunnel should not have any other openings except to the weather deck and cargo pump room or pump room.

5. Cargo piping passing through bulkheads should be so arranged as to preclude excessive stresses at the bulkhead and should not utilize flanges bolted through the bulkhead.

506. Cargo transfer control systems (IBC Code 5.6)

1. For the purpose of adequately controlling the cargo, cargo transfer systems should be provided with:

(1) one stop valve capable of being manually operated on each tank filling and discharge line, located near the tank penetration; if an individual deepwell pump is used to discharge the contents of a cargo tank, a stop valve is not required on the discharge line of that tank;
(2) one stop valve at each cargo hose connection;
(3) remote shutdown devices for all cargo pumps and similar equipment.

2. The controls necessary during transfer or transport of cargoes covered by this Chapter other than in cargo pump rooms which have been dealt with elsewhere in this Chapter should not be located below the weather deck.

3. For certain products, additional cargo transfer control requirements are shown in column "o" in the table of **Sec 17.**

507. Ship's cargo hoses (IBC Code 5.7)

1. Liquid and vapour hoses used for cargo transfer should be compatible with the cargo and suitable for the cargo temperature.

2. Hoses subject to tank pressure or the discharge pressure of pumps should be designed for a bursting pressure not less than 5 times the maximum pressure the hose will be subjected to during cargo transfer.

3. For cargo hoses installed on board ships on or after 1 July 2002, each new type of cargo hose, complete with end-fittings, should be prototype-tested at a normal ambient temperature with 200 pressure cycles from zero to at least twice the specified maximum working pressure. After this cycle pressure test has been carried out, the prototype test should demonstrate a bursting pressure of at least 5 times its specified maximum working pressure at the extreme service temperature. Hoses used for prototype testing should not be used for cargo service. Thereafter, before being placed in service, each new length of cargo hose produced should be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure but not more than two fifths of its bursting pressure. The hose should be stencilled or otherwise marked with its specified maximum working pressure and, if used in other than ambient temperature services, its maximum and minimum service temperature as applicable. The specified maximum working pressure should not be less than 1.0 MPa gauge.

Section 6 Materials of Construction

601. General (IBC Code 6.1)

1. Structural materials used for tank construction, together with associated piping, pumps, valves, vents and their jointing materials, should be suitable at the temperature and pressure for the cargo to be carried in accordance with recognized standards. Steel is assumed to be the normal material of construction.

2. The shipyard is responsible for providing compatibility information to the ship operator and/or master. This must be done in a timely manner before delivery of the ship or on completion of a relevant modification of the material of construction.

3. Where applicable the following should be taken into account in selecting the material of construction:

(1) notch ductility at the operating temperature;
(2) corrosive effect of the cargo;
(3) possibility of hazardous reactions between the cargo and the material of construction; and
(4) suitability of linings.

4. The shipper of the cargo is responsible for providing compatibility information to the ship operator and/or master. This must be done in a timely manner before transportation of the product. The cargo shall be compatible with all materials of construction such that :

(1) no damages to the integrity of the materials of construction is incurred ; and/or
(2) no hazardous, or potentially hazardous reaction is created.

5. When a product is submitted to IMO for evaluation, and where compatibility of the product with materials referred to in paragraph 1 renders special requirements, the BLG Product Data Reporting form shall provide information on the required materials of construction. These requirements shall be reflected in Sec.15 and consequentially be referred to in column o of Sec 17. The reporting form shall also indicate if no special requirements are necessary. The products of the product is responsible for providing the correct information.

Section 7 Cargo Temperature Control

701. General (IBC Code 7.1)

1. When provided, any cargo heating or cooling systems should be constructed, fitted and tested to the satisfaction of the Society. Materials used in the construction of temperature control systems should be suitable for use with the product intended to be carried.

2. Heating or cooling media should be of a type approved for use with the specific cargo. Consideration should be given to the surface temperature of heating coils or ducts to avoid dangerous reactions from localized overheating or overcooling of cargo. (see also **1513. 6**)

3. Heating or cooling systems should be provided with valves to isolate the system for each tank and to allow manual regulation of flow.

4. In any heating or cooling system, means should be provided to ensure that, when in any condition other than empty, a higher pressure can be maintained within the system than the maximum pressure head that could be exerted by the cargo tank contents on the system.

5. Means should be provided for measuring the cargo temperature.

(1) The means for measuring the cargo temperature should be of restricted or closed type, respectively, when a restricted or closed gauging device is required for individual substances as shown in column "j" in the table of **Sec 17.**
(2) A restricted temperature-measuring device is subject to the definition for a restricted gauging device in **1301. 1** (2), e.g. a portable thermometer lowered inside a gauge tube of the restricted type.
(3) A closed temperature measuring device is subject to the definition for closed gauging device in **1301. 1** (3), e.g. a remote-reading thermometer of which the sensor is installed in the tank.
(4) When overheating or overcooling could result in a dangerous condition, an alarm system which monitors the cargo temperature should be provided. (See also operational requirements in **1606**.)

6. When products for which **1512., 1512. 1** or **3** are listed in column "o" in the table of **Sec 17** are being heated or cooled, the heating or cooling medium should operate in a circuit:

(1) which is independent of other ship's services, except for another cargo heating or cooling system, and which does not enter the machinery space; or
(2) which is external to the tank carrying toxic products; or
(3) Where the medium is sampled to check for the presence of cargo before it is recirculated to other services of the ship or into the machinery space. The sampling equipment should be located within the cargo area and be capable of detecting the presence of any toxic cargo being heated or cooled. Where this method is used, the coil return should be tested not only at the commencement of heating or cooling of a toxic product, but also on the first occasion the coil is used subsequent to having carried an unheated or uncooled toxic cargo.

702. Additional requirements (IBC Code 7.2)

For certain products, additional requirements contained in **Sec 15** are shown in column "o" in the table of **Sec 17.**

Section 8 Cargo Tank Venting and Gas-freeing Arrangements

801. Application (IBC Code 8.1)

1. Unless expressly provided otherwise, this section applies to ships constructed on or after 1 January 1994.

2. Ship constructed before 1 January 1994 shall comply with the requirements of Section 8 of the Rules which were in force prior to the said date.

3. Ships constructed on or after 1 July 1986 but before 1 January 1994 which fully comply with the requirements of the Rules at that time may be regarded as complying with the requirements of SOLAS regulation Il-2/4.5.3, 4.5.6, to 4.5.8, 4.5.10 and 11.6.

4. For ships to which this Chapter applies, the requirements of this Section shall apply in lieu of regulation II-2/59.1 and 59.2 of the 1974 SOLAS Convention, as amended.

5. Ships constructed on or after 1 July 1986, but before 1 July 2002 shall comply with the paragraph **803. 3**. However, the Society may approve relaxation of the requirements for ships of less than 500 gross tonnage which were constructed on or after 1 July 1986, but before 1 July 2002.

802. Cargo tank venting (IBC Code 8.2)

1. All cargo tanks should be provided with a venting system appropriate to the cargo being carried and these systems should be independent of the air pipes and venting systems of all other compartments of the ship. Tank venting systems should be designed so as to minimize the possibility of cargo vapour accumulating about the decks, entering accommodation, service and machinery spaces and control stations and in the case of flammable vapours entering or collecting in spaces or areas containing sources of ignition. Tank venting systems should be arranged to prevent entrance of water into the cargo tanks and at the same time, vent outlets should direct the vapour discharge upwards in the form of unimpeded jets.

2. The venting systems should be connected to the top of each cargo tank and as far as practicable the cargo vent lines should be self-draining back to the cargo tanks under all normal operational conditions of list and trim. Where it is necessary to drain venting systems above the level of any pressure/vacuum valve, capped or plugged drain cocks should be provided.

3. Provision should be made to ensure that the liquid head in any tank does not exceed the design head of the tank. Suitable high-level alarms, overflow control systems or spill valves, together with gauging and tank filling procedures may be accepted for this purpose. Where the means of limiting cargo tank overpressure includes an automatic closing valve, the valve should comply with the appropriate provisions of **1519.**

4. Tank venting systems should be designed and operated so as to ensure that neither pressure nor vacuum created in the cargo tanks during loading or unloading exceeds tank design parameters. The main factors to be considered in the sizing of a tank venting system are as follows:

(1) design loading and unloading rate;
(2) gas evolution during loading: this should be taken account of by multiplying the maximum loading rate by a factor of at least 1.25;
(3) density of the cargo vapour mixture;
(4) pressure loss in vent piping and across valves and fittings;
(5) pressure/vacuum settings of relief devices.

5. Tank vent piping connected to cargo tanks of corrosion-resistant material, or to tanks which are lined or coated to handle special cargoes as required by this Chapter, should be similarly lined or coated or constructed of corrosion-resistant material.

6. The master should be provided with the maximum permissible loading and unloading rates for each tank or group of tanks consistent with design of the venting systems.

803. Types of tank venting systems (IBC Code 8.3)

1. An open tank venting system is a system which offers no restriction except for friction losses to the free flow of cargo vapours to and from the cargo tanks during normal operations, An open venting system may consist of individual vents from each tank, or such individual vents may be combined into a common header or headers, with due regard to cargo segregation. In no case should shutoff valves be fitted either to the individual vents or to the header.

2. A controlled tank venting system is a system in which pressure and vacuum relief valves or pressure/vacuum valves are fitted to each tank to limit the pressure or vacuum in the tank. A controlled venting system may consist of individual vents from each tank or such individual vents on the pressure side only as may be combined into a common header or headers with due regard to cargo segregation. In no case should shutoff valves be fitted either above or below pressure or vacuum relief valves or pressure/vacuum valves. Provision may be made for bypassing a pressure or vacuum valve or pressure/vacuum valve under certain operating conditions provided that the requirement of **Par 6** is maintained and that there is suitable indication to show whether or not the valve is bypassed.

3. On ships constructed on or after 1 July 2002, controlled tank venting systems should consist of a primary and a secondary means of allowing full flow relief of vapour to prevent over-pressure or under-pressure in the event of failure of one means. Alternatively, the secondary means may consist of pressure sensors fitted in each tank with a monitoring system in the ship's cargo control room or position from which cargo operations are normally carried out. Such monitoring equipment should also provide an alarm facility which is activated by detection of over-pressure or under-pressure conditions within a tank.

4. The position of vent outlets of a controlled tank venting system should be arranged:

(1) at a height of not less than 6 m above the weather deck or above a raised walkway if fitted within 4 m of the raised walkway;
(2) at a distance of at least 10 m measured horizontally from the nearest air intake or opening to accommodation, service and machinery spaces and ignition sources.

5. The vent outlet height referred to in **4** (1) may be reduced to 3 m above the deck or a raised walkway, as applicable, provided that high velocity venting valves of a type approved by the Society, directing the vapour/air mixture upwards in an unimpeded jet with an exit velocity of at least 30 m/s, are fitted.

6. Controlled tank venting systems fitted to tanks to be used for cargoes having a flashpoint not exceeding 60°C (closed cup test) should be provided with devices to prevent the passage of flame into the cargo tanks. The design, testing and locating of the devices should comply with the requirements of the Society, which should contain at least the standards adopted by the Organization.

7. In designing venting systems and in the selection of devices to prevent the passage of flame for incorporation into the tank venting system, due attention should be paid to the possibility of the blockage of these systems and fittings by, for example, the freezing of cargo vapour, polymer build up, atmospheric dust or icing up in adverse weather conditions. In this context it should be noted that flame arresters and flame screens are more susceptible to blockage. Provisions should be made such that the system and fittings may be inspected, operationally checked, cleaned or renewed as applicable.

8. Reference in **Pars 1** and **2** to the use of shutoff valves in the venting lines should be interpreted to extend to all other means of stoppage, including spectacle blanks and blank flanges.

804. Venting requirements for individual products (IBC Code 8.4)

Venting requirements for individual products are shown in column "g", and additional requirements in column "o" in the table of **Sec 17.**

805. Cargo tank gas-freeing (IBC Code 8.5)

1. The arrangements for gas-freeing cargo tanks used for cargoes other than those for which open venting is permitted should be such as to minimize the hazards due to the dispersal of flammable or toxic vapours in the atmosphere and to flammable or toxic vapour mixtures in a cargo tank.

Accordingly, gas-freeing operations should be carried out such that vapour is initially discharged:

(1) through the vent outlets specified in **803. 3** and **803. 4;** or
(2) 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
(3) through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 20 m/s which are protected by suitable devices to prevent the passage of flame.
When the flammable vapour concentration at the outlets has been reduced to 30 % of the lower flammable limit and, in the case of a toxic product, the vapour concentration does not present a significant health hazard, gas-freeing may thereafter be continued at cargo tank deck level.

2. The outlets referred to in **1** (2) and **1** (3) may be fixed or portable pipes.

3. In designing a gas-freeing system in conformity with **Par 1,** particularly in order to achieve the required exit velocities of **1** (2) and **1** (3), due consideration should be given to the following:

(1) materials of construction of system;
(2) time to gas-free;
(3) flow characteristics of fans to be used;
(4) the pressure losses created by ducting, piping, cargo tank inlets and outlets;
(5) the pressure achievable in the fan driving medium (e.g. water or compressed air);
(6) the densities of the cargo vapour/air mixtures for the range of cargoes to be carried.

Section 9 Environmental Control

901. General (IBC Code 9.1)

1. Vapour spaces within cargo tanks and, in some cases, spaces surrounding cargo tanks may require to have specially controlled atmospheres.

2. There are four different types of control for cargo tanks, as follows:

(1) Inerting - by filling the cargo tank and associated piping systems and, where specified in **Sec 15,** the spaces surrounding the cargo tanks, with a gas or vapour which will not support combustion and which will not react with the cargo, and maintaining that condition.

(2) Padding- by filling the cargo tank and associated piping systems with a liquid, gas or vapour which separates the cargo from the air, and maintaining that condition.

(3) Drying - by filling the cargo tank and associated piping systems with moisture-free gas or vapour with a dewpoint of -40°C or below at atmospheric pressure, and maintaining that condition.

(4) Ventilation - forced or natural.

3. Where inerting or padding of cargo tanks is required:

(1) An adequate supply of inert gas for use in filling and discharging the cargo tanks should be carried or should be manufactured on board unless a shore supply is available. In addition, sufficient inert gas should be available on the ship to compensate for normal losses during transportation.

(2) The inert gas system on board the ship should be able to maintain a pressure of at least 0.007 MPa gauge within the containment system at all times. In addition, the inert gas system should not raise the cargo tank pressure to more than the tank's relief valve setting.

(3) Where padding is used, similar arrangements for supply of the padding medium should be made as required for inert gas in (1) and (2).

(4) Means should be provided for monitoring ullage spaces containing a gas blanket to ensure that the correct atmosphere is being maintained.

(5) Inerting or padding arrangements or both, where used with flammable cargoes, should be such as to minimize the creation of static electricity during the admission of the inerting medium.

4. Where drying is used and dry nitrogen is used as the medium, similar arrangements for supply of the drying agent should be made to those required in **Par 3.** Where agents are used as the drying medium on all air inlets to the tank, sufficient medium should be carried for the duration of the voyage, taking into consideration the diurnal temperature range and the expected humidity.

902. Environmental control requirements for individual products (IBC Code 9.2)

The required types of environmental control for certain products are shown in column "h" in the table of **Sec 17.**

Section 10 Electrical Installations

1001. General (IBC Code 10.1)

1. The provisions of this Section are applicable to ships carrying cargoes which are inherently, or due to their reaction with other substances, flammable or corrosive to the electrical equipment, and should be applied in conjunction with applicable electrical requirements of part D, chapter II-1 of the 1983 SOLAS amendments.

2. (1) Electrical installations shall be such as to minimize the risk of fire and explosion from flam mable products. Reference is made to the recommendation published the International Electrotechnical Commission, in particular to publication IEC 60079-1-1 : 2002

(2) Where the specific cargo is liable to damage the materials normally used in electrical apparatus, due consideration should be given to the particular characteristics of the materials chosen for conductors, insulation, metal parts, etc. As far as necessary, these components should be protected to prevent contact with gases or vapours liable to be encountered.

3. The Society should take appropriate steps to ensure uniformity in the implementation and the application of the provisions of this Section in respect of electrical installations.

4. Electrical equipment, cables and wiring shall not be installed in the hazardous locations unless it conforms with the standards not inferior to those acceptable to the recommendation published the International Electrotechnical Commission, in particular to publication IEC 60079-1-1 : 2002. However, for locations not covered by such standards, electrical equipment, cables and wiring which do not conform to the standards may be installed in hazardous locations based on a risk assessment to the satisfaction of the Society, to ensure that an equivalent level of safety is assured.

5. Where electrical equipment is installed in hazardous locations, as permitted in this Section, it should be to the satisfaction of the Society and certified by the relevent authorities recognized by the Society for operation in the flammable atmosphere concerned, as indicated in column "i" in the table of **Sec 17.**

6. For guidance, indication is given if the flashpoint of a substance is in excess of 60°C. In the case of heated cargo, carriage conditions might need to be established and the requirements for cargoes having a flashpoint not exceeding 60°C applied.

1002. Bonding (IBC Code 10.2)

Independent cargo tanks should be electrically bonded to the hull. All gasketed cargo pipe joints and hose connections should be electrically bonded.

1003. Electrical requirements for individual products (IBC Code 10.3)

Electrical requirements for individual products are shown in column "i" in the table of **Sec 17.**

Section 11 Fire Protection and Fire Extinction

1101. Application (IBC Code 11.1)

1. The requirements for tankers in chapter II-2 of the 1983 SOLAS amendments shall apply to ships covered by this Chapter, irrespective of tonnage, including ships of less than 500 tons gross tonnages, except that:

(1) regulations 4.5.5, 10.8 and 10.9 shall not apply;
(2) regulation 4.5.1.2 (i.e. the requirements for location of the main cargo control station) need not apply;
(3) regulation 10.2, 10.4 and 10.5 shall apply as they would apply to cargo ships of 2,000 tons gross tonnage and over;
(4) regulation of 10.5.6 shall apply to ships of 2,000 gross tonnage and over;
(5) the provisions of **1103.** shall apply in lieu of regulation 10.8; and
(6) the provisions of **1102.** shall apply in lieu of regulation 10.9.
(7) regulation 4.5.10 shall apply to ships of 500 gross tonnage and over, replacing "hydrocarbon gases" by "flammable vapours" in the regulation; and.
(8) regulations 13.3.4 and 13.4.3 shall apply to ships of 500 gross tonnage and over.

2. Notwithstanding the provisions of **Par 1,** ships engaged solely in the carriage of products which are non-flammable (entry NF in column "i" of the table of minimum requirements) need not comply with the requirements for tanker specified in SOLAS chapter II-2, provided that they comply with the requirements for cargo ships of that chapter, except that regulation 10.7 need not apply to such ships and **1102.** and **1103.** hereunder need not apply.

3. For ships engaged solely in the carriage of products with flashpoint above 60°C (entry "yes" in column "i" of the table of minimum requirements) the requirements of SOLAS chapter II-2 may apply as specified in regulation II-2/1.6.4 in lieu of the provisions of this Section.

4. Monitoring of the concentration of flammable vapour

In lieu of the provisions of SOLAS regulation II-2/1.6.7, the requirements of regulations II-2/4.5.10.1.1 and II-2/4.5.10.1.4 shall apply and a system for continuous monitoring of the concentration of flammable vapours shall be fitted on ships of 500 gross tonnage and over which were constructed before 1 January 2009 by the date of the first scheduled dry-docking after 1 January 2009, but not later than 1 January 2012. Sampling points or detector heads should be located in suitable positions in order that potentially dangerous leakages are readily detected. When the flammable vapour concentration reaches a pre-set level which shall not be higher than 10 % of the lower flammable limit, a continuous audible and visual alarm signal shall be automatically effected in the pump-room and cargo control room to alert personnel to the potential hazard. However, existing monitoring systems already fitted having a pre-set level not greater than 30 % of the lower flammable limit may be accepted. Notwithstanding the above provisions, the Administration may exempt ships not engaged on international voyages from those requirements.

1102. Cargo pump rooms (IBC Code 11.2)

1. The cargo pump room of any ship should be provided with a fixed carbon dioxide fire-extinguishing system as specified in regulation II-2/5.1 and .2 of the 1983 SOLAS amendments. A notice should be exhibited at the controls stating that the system is only to be used for fire-extinguishing and not for inerting purposes, due to the electrostatic ignition hazard. The alarms referred to in regulation II-2/5.1.6 of the 1983 SOLAS amendments should be safe for use in a flammable cargo vapour-air mixture. For the purpose of this requirements, an extinguishing system should be provided which would be suitable for machinery spaces. However, the amount of gas carried should be sufficient to provide a quantity of free gas equal to 45% of the gross volume of the cargo pump room in all cases; or

2. Cargo pump rooms of ships which are dedicated to the carriage of a restricted number of cargoes should be protected by an appropriate fire-extinguishing system approved by the Society.

3. A fire-extinguishing system consisting of either a fixed pressure water-spray system or a high-expansion foam system could be provided for a cargo pump room if cargoes will be carried which are not suited to extinguishment by carbon dioxide or equivalent media. The International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk should reflect this conditional requirement.

1103. Cargo area (IBC Code 11.3)

1. Every ship should be provided with a fixed deck foam system in accordance with the requirements of **Pars 2** to **12.**

2. Only one type of foam concentrate should be supplied, and it should be effective for the maximum possible number of cargoes intended to be carried. For other cargoes for which foam is not effective or is incompatible, additional arrangements to the satisfaction of the Society should be provided. Regular protein foam should not be used.

3. The arrangements for providing foam should be capable of delivering foam to the entire cargo tanks deck area as well as into any cargo tank, the deck of which is assumed to be ruptured.

4. The deck foam system should be capable of simple and rapid operation. The main control station for the system should be suitably located outside of the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fires in the areas protected.

5. The rate of supply of foam solution should be not less than the greatest of the following:

(1) 2 l/min per square metre of the cargo tanks deck area, where cargo tanks deck area means the maximum breadth of the ship times the total longitudinal extent of the cargo tank spaces;
(2) 20 l/min per square metre of the horizontal sectional area of the single tank having the largest such area;
(3) 10 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 1,250 l/min. For ships of less than 4,000 tonnes deadweight, the minimum capacity of the monitor should be to the satisfaction of the Society.

6. Sufficient foam concentrate should be supplied to ensure at least 30 min of foam generation when using the highest of the solution rates stipulated in **5** (1) to (3).

7. Foam from the fixed foam system should be supplied by means of monitors and foam applicators. At least 50 % of the foam rate required in **Par 5.** (1) or (2) should be delivered from each monitor. The capacity of any monitor should be at least 10 l/min of foam solution per square metre of deck area protected by that monitor, such area being entirely forward of the monitor. Such capacity should be not less than 1,250 l/min. For ships of less than 4,000 tonnes deadweight, the minimum capacity of the monitor should be to the satisfaction of the Society.

8. The distance from the monitor to the farthest extremity of the protected area forward of that monitor should be not more than 75 % of the monitor throw in still air conditions.

9. A monitor and hose connection for a foam applicator should be situated both port and starboard at the poop front or accommodation spaces facing the cargo area.

10. Applicators should be provided for flexibility of action during fire-fighting operations and to cover areas screened from the monitors. The capacity of any applicator should be not less than 400 l/min and the applicator throw in still air conditions should be not less than 15 m. The number of foam applicators provided should be not less than four. The number and disposition of foam main outlets should be such that foam from at least two applicators can be directed to any part of the cargo tanks deck area.

11. Valves should be provided in the foam main, and in the fire main where this is an integral part of the deck foam system, immediately forward of any monitor position to isolate damaged sections of those mains.

12. Operation of a deck foam system at its required output should permit the simultaneous use of the minimum required number of jets of water at the required pressure from the fire main.

13. Ships which are dedicated to the carriage of a restricted number of cargoes should be protected by alternative provisions to the satisfaction of the Society when they are just as effective for the products concerned as the deck foam system required for the generality of flammable cargoes.

14. Suitable portable fire-extinguishing equipment for the products to be carried should be provided and kept in good operating order.

15. Where flammable cargoes are to be carried all sources of ignition should be excluded from hazardous locations referred to in **1001. 4.**

16. Ships fitted with bow or stern loading and unloading arrangements should be provided with one additional foam monitor meeting the requirements of **Par 7** and one additional applicator meeting the requirements of **Par 10.** The additional monitor should be located to protect the bow or stern loading and unloading arrangements. The area of the cargo line forward or aft of the cargo area should be protected by the above-mentioned applicator.

1104. Special requirements (IBC Code 11.4)

Fire-extinguishing media determined to be effective for certain products are listed in column "l" in the table of **Sec 17.**

Section 12 Mechanical Ventilation in the Cargo Area

For ships to which this Chapter applies, the requirements of this Section replace the requirements of SOLAS regulation II-2/ 4.5.2.6 and 4.5.4. However, for products addressed under **1101. 2** and **1101. 3,** except acids and products for which **1517.** applies, SOLAS regulation II-2/4.5.2.6 and 4.5.4 may apply in lieu of the provisions of this Section.

1201. Spaces normally entered during cargo handling operations (IBC Code 12.1)

1. 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.

2. Provision should be made to ventilate such spaces prior to entering the compartment and operating the equipment and a warning notice requiring the use of such ventilation should be placed outside the compartment.

3. Mechanical ventilation inlets and outlets should be arranged to ensure sufficient air movement through the space to avoid the accumulation of toxic or flammable vapours or both (taking into account their vapour densities) and to ensure sufficient oxygen to provide a safe working environment, but in no case should the ventilation system have a capacity of less than 30 changes of air per hour based upon the total volume of the space. For certain products, increased ventilation rates for cargo pump rooms are prescribed in **1517.**

4. Ventilation systems should be permanent and should normally be of the extraction type. Extraction from above and below the floor plates should be possible. In rooms housing motors driving cargo pumps, the ventilation should be of the positive pressure type.

5. Ventilation exhaust ducts from spaces within the cargo area should discharge upwards in locations at least 10 m in the horizontal direction from ventilation intakes and openings to accommodation, service and machinery spaces and control stations and other spaces outside the cargo area.

6. Ventilation intakes should be so arranged as to minimize the possibility of recycling hazardous vapours from any ventilation discharge opening.

7. Ventilation ducts should not be led through accommodation, service and machinery spaces or other similar spaces.

8. Electric motors driving fans should be placed outside the ventilation ducts if the carriage of flammable products is intended. Ventilation fans and fan ducts, in way of fans only, for hazardous locations referred to in **Sec 10** should be of non sparking construction defined as:

(1) impellers or housing of nonmetallic construction, due regard being paid to the elimination of static electricity;
(2) impellers and housing of nonferrous materials;
(3) impellers and housing of austenitic stainless steel; and
(4) ferrous impellers and housing with not less than 13 mm design tip clearance.
Any combination of an aluminium or magnesium alloy fixed or rotating component and a ferrous fixed or rotating component, regardless of tip clearance, is considered a sparking hazard and should not be used in these places.

9. Sufficient spare parts should be carried for each type of fan on board, required by this Section.

10. Protection screens of not more than 13 mm square mesh should be fitted in outside openings of ventilation ducts.

1202. Pump rooms and other enclosed spaces normally entered (IBC Code 12.2)

Pump rooms and other enclosed spaces normally entered, which are not covered by **1201. 1,** should be fitted with mechanical ventilation systems, capable of being controlled from outside such spaces and complying with the requirements of **1201. 3,** except that the capacity should not be less than 20 changes of air per hour, based upon the total volume of the space. Provision should be made to ventilate such spaces prior to entering.

1203. Spaces not normally entered (IBC Code 12.3)

Double bottoms, cofferdams, duct keels, pipe tunnels, hold spaces and other spaces where cargo may accumulate, should be capable of being ventilated to ensure a safe environment when entry into the spaces is necessary. Where a permanent ventilation system is not provided for such spaces, approved means of portable mechanical ventilation should be provided. Where necessary owing to the arrangement of spaces, for instance hold spaces, essential ducting for such ventilation should be permanently installed. For permanent installations, the capacity of 8 air changes per hour should be provided and for portable systems the capacity of 16 air changes per hour. Fans or blowers should be clear of personnel access openings, and should comply with **1201. 8.**

Section 13 Instrumentation

1301. Gauging (IBC Code 13.1)

1. Cargo tanks should be fitted with one of the following types of gauging devices:

(1) Open device"which makes use of an opening in the tanks and may expose the gauger to the cargo or its vapour. An example of this is the ullage opening.

(2) Restricted device"which penetrates the tank and which, when in use, permits a small quantity of cargo vapour or liquid to be exposed to the atmosphere. When not in use, the device is completely closed. The design should ensure that no dangerous escape of tank contents (liquid or spray) can take place in opening the device.

(3) Closed device"which penetrates the tank, but which is part of a closed system and keeps tank contents from being released. Examples are the float-type systems, electronic probe, magnetic probe and protected sight glass. Alternatively an indirect device which does not penetrate the tank shell and which is independent of the tank may be used. Examples are weighing of cargo, pipe flow meter.

2. Gauging devices should be independent of the equipment required under **1519.**

3. Open gauging and restricted gauging should be allowed only where:

(1) open venting is allowed by this Chapter; or

(2) means are provided for relieving tank pressure before the gauge is operated.

4. Types of gauging for individual products are shown in column "j" in the table of **Sec 17.**

1302. Vapour detection (IBC Code 13.2)

1. Ships carrying toxic or flammable products or both should be equipped with at least two instruments designed and calibrated for testing for the specific vapours in question. If such instruments are not capable of testing for both toxic concentrations and flammable concentrations, then two separate sets of instruments should be provided.

2. Vapour detection instruments may be portable or fixed. If a fixed system is installed, at least one portable instrument should be provided.

3. When toxic vapour detection equipment is not available for some products which require such detection, as indicated in column "k" in the table of **Sec 17,** the Society may exempt the ship from the requirement, provided an appropriate entry is made on the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk. When granting such an exemption, the Society should recognize the necessity for additional breathing air supply and an entry should be made on the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk drawing attention to the provisions of **1402. 4** and **1604. 2** (2).

4. Vapour detection requirements for individual products are shown in column "k" in the table of **Sec 17.**

Section 14 Personnel Protection

1401. Protective equipment (IBC Code 14.1)

1. For the protection of crew members who are engaged in loading and discharging operations, the ship should have on board suitable protective equipment consisting of large aprons, special gloves with long sleeves, suitable footwear, coveralls of chemical-resistant material, and tight-fitting goggles or face shields or both. The protective clothing and equipment should cover all skin so that no part of the body is unprotected.

2. Work clothes and protective equipment should be kept in easily accessible places and in special lockers. Such equipment should not be kept within accommodation spaces, with the exception of new, unused equipment and equipment which has not been used since undergoing a thorough cleaning process. The Society may, however, approve storage rooms for such equipment within accommodation spaces if adequately segregated from living spaces such as cabins, passageways dining rooms, bathrooms, etc.

3. Protective equipment should be used in any operation which may entail danger to personnel.

1402. Safety equipment (IBC Code 14.2)

1. Ships carrying cargoes for which **1512., 1512. 1** or **3** is listed in column "o" in the table of **Sec 17** shall have on board sufficient but not less than three complete sets of safety equipment each permitting personnel to enter a gas-filled compartment and perform work there for at least 20 min. Such equipment shall be in addition to that required by SOLAS regulation II-2/10.10.

2. One complete set of safety equipment should consist of:

(1) one self-contained air-breathing apparatus (not using stored oxygen);
(2) protective clothing, boots, gloves and tightfitting goggles;
(3) fireproof lifeline with belt resistant to the cargoes carried; and
(4) explosion-proof lamp.

3. For the safety equipment required in **Par 1,** all ships should carry the following, either:

(1) one set of fully charged spare air bottles for each breathing apparatus;
(2) a special air compressor suitable for the supply of high-pressure air of the required purity.
(3) a charging manifold capable of dealing with sufficient spare breathing apparatus air bottles for the breathing apparatus; or
(4) fully charged spare air bottles with a total free air capacity of at least 6,000 l for each breathing apparatus on board in excess of the requirements of SOLAS regulation II-2/10.10.

4. A cargo pump room of ships carrying cargoes which are subject to the requirements of **1518.** or cargoes for which in column "k" in the table of **Sec 17** toxic vapour detection equipment is required but is not available should have either:

(1) a low-pressure line system with hose connections suitable for use with the breathing apparatus required by **Par 1.** This system should provide sufficient high-pressure air capacity to supply, through pressure reduction devices, enough low-pressure air to enable two men to work in a gas-dangerous space for at least 1 h without using the air bottles of the breathing apparatus. Means should be provided for recharging the fixed air bottles and breathing apparatus air bottles from a special air compressor suitable for the supply of high-pressure air of the required purity; or
(2) an equivalent quantity of spare bottled air in lieu of the low-pressure air line.

5. At least one set of safety equipment as required by **Par 2** should be kept in a suitable clearly marked locker in a readily accessible place near the cargo pump room. The other sets of safety equipment should also be kept in suitable, clearly marked, easily accessible, places.

6. The breathing apparatus should be inspected at least once a month by a responsible officer, and the inspection recorded in the ship's log-book. The equipment should be inspected and tested by an expert at least once a year.

1403. Emergency equipment (IBC Code 14.3)

1. Ships carrying cargoes for which "Yes" is indicated in column "n" of the Sec 17, shall be provided with suitable respiratory and eye protection sufficient for every person on board for emergency escape purposes, subject to the following:

(1) filter type respiratory protection is unacceptable;
(2) self-contained breathing apparatus shall have normally at least a duration of service of 15 min;
(3) emergency escape respiratory protection shall not be used for fire-fighting or cargo handling purposes and shall be marked to that effect.

2. The ships shall have on board medical first-aid equipment including oxygen resuscitation equipment and antidotes for cargoes carried, based on the guidelines developed by IMO.

3. A stretcher which is suitable for hoisting an injured person up from spaces such as the cargo pump room shall be placed in a readily accessible location.

4. Suitably marked decontamination showers and an eyewash shall be available on deck in convenient locations. The showers and eyewash shall be operable in all ambient conditions.

Section 15 Special Requirements

1501. General

The provisions of this Section are applicable where specific reference is made in column "o" in the table of **Sec 17**. These requirements are additional to the general requirements of this Chapter.

1502. Ammonium nitrate solution, 93 % or less (IBC Code 15.2)

1. The ammonium nitrate solution should contain at least 7 % by weight of water. The acidity (pH) of the cargo when diluted with ten parts of water to one part of cargo by weight should be between 5.0 and 7.0. The solution should not contain more than 10 ppm chloride ions, 10 ppm ferric ions, and should be free of other contaminants.

2. Tanks and equipment for ammonium nitrate solution should be independent of tanks and equipment containing other cargoes or combustible products. Equipment which may in service, or when defective, release combustible products into the cargo, e.g. lubricants, should not be used. Tanks should not be used for seawater ballast.

3. Except where expressly approved by the Society, ammonium nitrate solutions should not be transported in tanks which have previously contained other cargoes unless tanks and associated equipment have been cleaned to the satisfaction of the Society.

4. The temperature of the heat exchanging medium in the tank heating system should not exceed 160°C. The heating system should be provided with a control system to keep the cargo at a bulk mean temperature of 140°C. High-temperature alarms at 145°C and 150°C and a low-temperature alarm at 125°C should be provided. Where the temperature of the heat exchanging medium exceeds 160°C an alarm should also be given. Temperature alarms and controls should be located on the navigating bridge.

5. If the bulk mean cargo temperature reaches 145°C, a cargo sample should be diluted with ten parts of distilled or demineralized water to one part of cargo by weight and the acidity (pH) should be determined by means of a narrow range indicator paper or stick. Acidity (pH) measurements should then be taken every 24 h. If the acidity (pH) is found to be below 4.2, ammonia gas should be injected into the cargo until the acidity (pH) of 5.0 is reached.

6. A fixed installation should be provided to inject ammonia gas into the cargo. Controls for this system should be located on the navigating bridge. For this purpose, 300 kg of ammonia per 1,000 tonnes of ammonium nitrate solution should be available on board.

7. Cargo pumps should be of the centrifugal deepwell type or of the centrifugal type with water-flushed seals.

8. Vent piping should be fitted with approved weatherhoods to prevent clogging. Such weatherhoods should be accessible for inspection and cleaning.

9. Hot work on tanks, piping and equipment which have been in contact with ammonium nitrate solution should only be done after all traces of ammonium nitrate have been removed, inside as well as outside.

1503. Carbon disulphide (IBC Code 15.3)

Carbon disulphide may be carried either under water pad or under suitable inert gas pad as specified in the following paragraphs.

Carriage under water pad

1. Provision should be made to maintain a water pad in the cargo tank during loading, unloading and transit. In addition, an inert gas pad should be maintained in the ullage space during transit.

2. All openings should be in the top of the tank, above the deck.

3. Loading lines should terminate near the bottom of the tank.

4. A standard ullage opening should be provided for emergency sounding.

5. Cargo piping and vent lines should be independent of piping and vent lines used for other cargo.

6. Pumps may be used for discharging cargo, provided they are of the deepwell or hydraulically driven submersible types. The means of driving a deepwell pump should not present a source of ignition for carbon disulphide and should not employ equipment that may exceed a temperature of 80°C.

7. If a cargo discharge pump is used, it should be inserted through a cylindrical well extending from the tank top to a point near the tank bottom. A water pad should be formed in this well before attempting pump removal unless the tank has been certified as gas-free.

8. Water or inert gas displacement may be used for discharging cargo, provided the cargo system is designed for the expected pressure and temperature.

9. Safety relief valves should be of stainless steel construction.

10. Because of its low ignition temperature and close clearances required to arrest its flame propagation, only intrinsically safe system and circuits are permitted in the hazardous location described in **1002. 3.**

Carriage under suitable inert gas pad

11. Carbon disulphide should be carried in independent tanks with a design pressure of not less than 0.06 MPa gauge.

12. All openings should be located on the top of the tank, above the deck.

13. Gaskets used in the containment system should be of a material which does not react with, or dissolve in, carbon disulphide.

14. Threaded joints should not be permitted in the cargo containment system, including the vapour lines.

15. Prior to loading, the tank(s) should be inerted with suitable inert gas until the oxygen level is 2 % by volume or lower. Means should be provided to automatically maintain a positive pressure in the tank using suitable inert gas during loading, transport and discharge. The system should be able to maintain this positive pressure between 0.01 and 0.02 MPa gauge, and should be remotely monitored and fitted with over/underpressure alarms.

16. Hold spaces surrounding an independent tank carrying carbon disulphide should be inerted by a suitable inert gas until the oxygen level is 2 % or less. Means should be provided to monitor and maintain this condition throughout the voyage. Means should also be provided to sample these spaces for carbon disulphide vapour.

17. Carbon disulphide should be loaded, transported and discharged in such a manner that venting to the atmosphere does not occur. If carbon disulphide vapour is returned to shore during loading or to the ship during discharge, the vapour return system should be independent of all other containment systems.

18. Carbon disulphide should be discharged only by submerged deepwell pumps or by a suitable inert gas displacement. The submerged deepwell pumps should be operated in a way that prevents heat build-up in the pump. The pump should also be equipped with a temperature sensor in the pump housing with remote readout and alarm in the cargo control room. The alarm should be set at 80°C. The pump should also be fitted with an automatic shut-down device, if the tank pressure falls below atmospheric pressure during the discharge.

19. Air should not be allowed to enter the cargo tank, cargo pump or lines while carbon disulphide is contained in the system.

20. No other cargo handling, tank cleaning or deballasting should take place concurrent with loading or discharge of carbon disulphide.

21. A water spray system of sufficient capacity should be provided to blanket effectively the area surrounding the loading manifold, the exposed deck piping associated with product handling and the tank domes. The arrangement of piping and nozzles should be such as to give an uniform distribution rate of 10 $l/m^2/min$. Remote manual operation should be arranged such that remote starting of pumps supplying the water-spray system and remote operation of any normally closed valves in the system can be carried out from a suitable location outside the cargo area adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected.

The water-spray system should be capable of both local and remote manual operation, and the arrangement should ensure that any spilled cargo is washed away. Additionally, a water hose with pressure to the nozzle when atmospheric temperature permits, should be connected ready for immediate use during loading and unloading operations.

22. No cargo tanks should be more than 98 % liquid-full at the reference temperature (R).

23. The maximum volume (V_L) of cargo to be loaded in a tank should be:

$$V_L = 0.98\, V\rho_R/\rho_L$$

where:

V_L : volume of the tank

ρ_R : relative density of cargo at the reference temperature (R)

ρ_L : relative density of cargo at the loading temperature

R : reference temperature, i.e. the temperature at which the vapour pressure of the cargo corresponds to the set pressure of the pressure relief valve.

24. The maximum allowable tank filling limits for each cargo tank should be indicated for each loading temperature which may be applied, and for the applicable maximum reference temperature, on a list approved by the Administration. A copy of the list should be permanently kept on board by the master.

25. Zones on open deck, or semi-enclosed spaces on open deck within three metres of a tank outlet, gas or vapour outlet, cargo pipe flange or cargo valve of a tank certified to carry carbon disulphide, should comply with the electrical equipment requirements specified for carbon disulphide in column "i" in the table of **Sec 17.** Also, within the specified zone, no other heat sources, like steam piping with surface temperatures in excess of 80°C should be allowed.

26. Means should be provided to ullage and sample the cargo without opening the tank or disturbing the positive suitable inert gas blanket.

27. The product should be transported only in accordance with a cargo handling plan that has been approved by the Administration. Cargo handling plans should show the entire cargo piping system. A copy of the approved cargo handling plan should be available on board. The International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk should be endorsed to include reference to the approved cargo handling plan.

1504. Diethyl ether (IBC Code 15.4)

1. Unless inerted, natural ventilation should be provided for the voids around the cargo tanks while the vessel is under way. If a mechanical ventilation system is installed, all blowers should be of non-sparking construction. Mechanical ventilation equipment should not be located in the void spaces surrounding the cargo tanks.

2. Pressure relief valve settings should not be less than 0.02 MPa gauge for gravity tanks.

3. Inert gas displacement may be used for discharging cargo from pressure tanks provided the cargo system is designed for the expected pressure.

4. In view of the fire hazard, provision should be made to avoid any ignition source or heat generation or both in the cargo area.

5. Pumps may be used for discharging cargo, provided that they are of a type designed to avoid liquid pressure against the shaft gland or are of a hydraulically operated submerged type and are suitable for use with the cargo.

6. Provision should be made to maintain the inert gas pad in the cargo tank during loading, unloading and transit.

1505. Hydrogen peroxide solutions (IBC Code 15.5)

1. Hydrogen peroxide solutions over 60 % but not over 70 %

(1) Hydrogen peroxide solutions over 60 % but not over 70 % should be carried in dedicated ships only and no other cargoes should be carried.
(2) Cargo tanks and associated equipment should be either pure aluminium (99.5 %) or solid stainless steel (304 *L*, 316, 316 *L* or 316 *Ti*), and passivated in accordance with approved procedures. Aluminium should not be used for piping on deck. All nonmetallic materials of construction for the containment system should neither be attacked by hydrogen peroxide nor contribute to its decomposition.
(3) Pump rooms should not be used for cargo transfer operations.
(4) Cargo tanks should be separated by cofferdams from oil fuel tanks or any other space containing flammable or combustible materials.
(5) Tanks intended for the carriage of hydrogen peroxide should not be used for seawater ballast.
(6) Temperature sensors should be installed at the top and bottom of the tank. Remote temperature readouts and continuous monitoring should be located on the navigating bridge. If the temperature in the tanks rises above 35°C, visible and audible alarms should be activated on the navigating bridge.
(7) Fixed oxygen monitors (or gas sampling lines) should be provided in void spaces adjacent to tanks to detect leakage of the cargo into these spaces. Remote readouts, continuous monitoring (if gas-sampling lines are used, intermittent sampling is satisfactory) and visible and audible alarms similar to those for the temperature sensors should also be located on the navigating bridge. The visible and audible alarms should be activated if the oxygen concentration in these void spaces exceeds 30 % by volume. Two portable oxygen monitors should also be available as back-up systems.
(8) As a safeguard against uncontrolled decomposition, a cargo jettisoning system should be installed to discharge the cargo overboard. The cargo should be jettisoned if the temperature rise of the cargo exceeds a rate of 2°C per hour over a 5 h period or when the temperature in the tank exceeds 40°C.
(9) Cargo tank venting systems should have pressure/vacuum relief valves for normal controlled venting, and rupture discs or a similar device for emergency venting, should tank pressure rise rapidly as a result of uncontrolled decomposition. Rupture discs should be sized on the basis of tank design pressure, tank size and anticipated decomposition rate.
(10) A fixed water-spray system should be provided for diluting and washing away any concentrated hydrogen peroxide solution spilled on deck. The areas covered by the water-spray should include the manifold/hose connections and the tank tops of those tanks designated for carrying hydrogen peroxide solutions. The minimum application rate should satisfy the following criteria:
  (a) The product should be diluted from the original concentration to 35 % by weight within 5 min of the spill.
  (b) The rate and estimated size of the spill should be based upon maximum anticipated loading and discharge rates, the time required to stop flow of cargo in the vent of tank overfill or a piping/hose failure, and the time necessary to begin application of dilution water with actuation at the cargo control location or on the navigating bridge.
(11) Only those hydrogen peroxide solutions which have a maximum decomposition rate of 1 % per year at 25°C should be carried. Certification from the shipper that the product meets this standard should be presented to the master and kept on board. A technical representative of the manufacturer should be on board to monitor the transfer operations and have the capability tc test the stability of the peroxide. He should certify to the master that the cargo has been loaded in a stable condition.
(12) Protective clothing that is resistant to hydrogen peroxide solutions should be provided for each crew member involved in cargo transfer operations. Protective clothing should include nonflammable coveralls, suitable gloves, boots and eye protection.

2. Hydrogen peroxide solutions over 8 % but not over 60 % by weight

(1) The ship's shell plating should not form any boundaries of tanks containing this product.
(2) Hydrogen peroxide should be carried in tanks thoroughly and effectively cleaned of all traces of previous cargoes and their vapours or ballast. Procedures for inspection, cleaning, passivation and loading of tanks should be in accordance with MSC/Circ. 394. A certificate should be on

board the vessel indicating that the procedures in the circular have been followed. The passivation requirement may be waived by the Society for domestic shipments of short duration. Particular care in this respect is essential to ensure the safe carriage of hydrogen peroxide.
(a) When hydrogen peroxide is carried no other cargoes should be carried simultaneously.
(b) Tanks which have contained hydrogen peroxide may be used for other cargoes after cleaning in accordance with the procedures outlined in MSC/Circ. 394.
(c) Consideration in design should provide minimum internal tank structure, free draining, no entrapment and ease of visual inspection.

(3) Cargo tanks and associated equipment should be either pure aluminium (99.5 %) or solid stainless steel of types suitable for use with hydrogen peroxide (e.g. 304, 304 L, 316, 316 L, 316 Ti). Aluminium should not be used for piping on deck. All nonmetallic materials of construction for the containment system should neither be attacked by hydrogen peroxide nor contribute to its decomposition.
(4) Cargo tanks should be separated by a cofferdam from fuel oil tanks or any other space containing materials incompatible with hydrogen peroxide.
(5) Temperature sensors should be installed at the top and bottom of the tank. Remote temperature readouts and continuous monitoring should be located on the navigating bridge. If the temperature in the tank rises above 35°C, visible and audible alarms should activate on the navigating bridge.
(6) Fixed oxygen monitors (or gas-sampling lines) should be provided in void spaces adjacent to tanks to detect leakage of the cargo into these spaces. The enhancement of flammability by oxygen enrichments should be recognized. Remote readouts, continuous monitoring (if gas-sampling lines are used, intermittent sampling is satisfactory) and visible and audible alarms similar to those for the temperature sensors should also be located on the navigating bridge. The visible and audible alarms should activate if the oxygen concentration in these void spaces exceeds 30 % by volume. Two portable oxygen monitors should also be available as back-up systems.
(7) As a safeguard against uncontrolled decomposition, a cargo jettisoning system should be installed to discharge the cargo overboard. The cargo should be jettisoned if the temperature rise of the cargo exceeds a rate of 2°C per hour over a five-hour period or when the temperature in the tank exceeds 40°C.
(8) Cargo tank venting systems with filtration should have pressure/vacuum relief valves for normal controlled venting, and a device for emergency venting, should have for tank pressure rise rapidly as a result of an uncontrolled decomposition rate, as stipulated in (7). These venting systems should be designed in such a manner that there is no introduction of seawater into the cargo tank even under heavy sea conditions. Emergency venting should be sized on the basis of tank design pressure and tank size.
(9) A fixed water-spray system should be provided for diluting and washing away any concentrated solution spilled on deck. The areas covered by the water-spray should include the manifold/hose connections and the tank tops of those tanks designated for the carriage of hydrogen peroxide solutions. The minimum application rate should satisfy the following criteria:
(a) The product should be diluted from the original concentration to 35 % by weight within 5 minutes of the spill.
(b) The rate and estimated size of the spill should be based upon maximum anticipated loading and discharge rates, the time required to stop flow of the cargo in the event of tank overfill or a piping/hose failure, and the time necessary to begin application of dilution water with actuation at the cargo control location or on the navigating bridge.

(10) Only those hydrogen peroxide solutions which have a maximum decomposition rate of 1 % per year at 25°C should be carried. Certification from the shipper that the product meets this standard should be presented to the master and kept on board. A technical representative of the manufacturer should be on board to monitor the transfer operations and have the capability to test the stability of the hydrogen peroxide. He should certify to the master that the cargo has been loaded in a stable condition.
(11) Protective clothing that is resistant to hydrogen peroxide should be provided for each crew member involved in cargo transfer operations. Protective clothing should include coveralls that are nonflammable, suitable gloves, boots and eye protection.
(12) During transfer of hydrogen peroxide the related piping system should be separated from all other systems. Cargo hoses used for transfer of hydrogen peroxide should be marked "FOR HYDROGEN PEROXIDE TRANSFER ONLY".

3. Procedures for inspection, cleaning, passivation and loading of tanks for the carriage of hydrogen peroxide solutions 8-60%, which have contained other cargoes, or for the carriage of other cargoes after carriage of hydrogen peroxide.

(1) Tanks having contained cargoes other than hydrogen peroxide shall be inspected, cleaned and passivated before re-use for the transport of hydrogen peroxide solutions. The procedures for inspection and cleaning, as given in paragraphs (2) to (8) below, apply to both stainless steel and pure aluminium tanks (see paragraph 2.(2)). Procedures for passivation are given in paragraph (9) for stainless steel and (10) for aluminium. Unless otherwise specified, all steps apply to the tanks and to all associated equipment having been in contact with the other cargo.

(2) After unloading the previous cargo the tank shall be rendered safe and inspected for any residues, scale and rust.

(3) Tanks and associated equipment shall be washed with clean filtered water. The water to be used shall at least have the quality of potable water with a low chlorine content.

(4) Trace residues and vapours of the previous cargo shall be removed by steaming of tank and equipment.

(5) Tank and equipment are washed again with clean water (quality as above) and dried, using filtered, oil-free air.

(6) The atmosphere in the tank shall be sampled and investigated for the presence of organic vapours and oxygen concentration.

(7) The tank shall be checked again by visual inspection for residues of the previous cargo, scale and rust as well as for any smell of the previous cargo.

(8) If inspection or measurements indicate the presence of residues of the previous cargo or its vapours, actions described in paragraphs (3) to (5) shall be repeated.

(9) Tank and equipment made from stainless steel which have contained other cargoes than hydrogen peroxide or which have been under repair shall be cleaned and passivated, regardless of any previous passivation, according to the following procedure:

   (a) New welds and other repaired parts shall be cleaned and finished using stainless steel wire brush, chisel, sandpaper or buff. Rough surfaces shall be given a smooth finish. A final polishing is necessary.

   (b) Fatty and oily residues shall be removed by the use of appropriate organic solvents or detergent solutions in water. The use of chlorine-containing compounds shall be avoided as they can seriously interfere with passivation.

   (c) The residues of the degreasing agent shall be removed, followed by a washing with water.

   (d) In the next step, scale and rust shall be removed by the application of acid (e.g. a mixture of nitric and hydrofluoric acids), followed again by a washing with clean water.

   (e) All the metal surfaces which can come into contact with hydrogen peroxide shall be passivated by the application of nitric acid of a concentration between 10 and 35% by mass. The nitric acid must be free from heavy metals, other oxidizing agents or hydrogen fluoride. The passivation process shall continue for 8 to 24 h, depending upon the concentration of acid, the ambient temperature and other factors. During this time a continuous contact between the surfaces to be passivated and the nitric acid shall be ensured. In the case of large surfaces this may be achieved by recirculating the acid. Hydrogen gas may be evolved in the passivation process, leading to the presence of an explosive atmosphere in the tanks. Therefore, appropriate measures must be taken to avoid the build-up or the ignition of such an atmosphere.

   (f) After passivation the surfaces shall be thoroughly washed with clean filtered water. The washing process shall be repeated until the effluent water has the same pH value as the incoming water.

   (g) Surfaces treated according to the above steps may cause some decomposition when coming into contact with hydrogen peroxide for the first time. This decomposition will cease after a short time (usually within two or three days). Therefore an additional flushing with hydrogen peroxide for a period of at least two days is recommended.

   (h) Only degreasing agents and acid cleaning agents which have been recommended for this purpose by the manufacturer of the hydrogen peroxide shall be used in the process.

(10) Tanks and equipment made from aluminium and which have contained cargoes other than hydrogen peroxide, or which have been under repair, shall be cleaned and passivated. The following is an example of a recommended procedure:

   (a) The tank shall be washed with a solution of a sulphonated detergent in hot water, followed

by a washing with water.
(b) The surface shall then be treated for 15 to 20 min with a solution of sodium hydroxide of a concentration of 7% by mass or treated for a longer period with a less concentrated solution (e.g. for 12 h with 0.4 to 0.5% sodium hydroxide). To prevent excessive corrosion at the bottom of the tank when treating with more concentrated solutions of sodium hydroxide, water shall be added continuously to dilute the sodium hydroxide solution which collects there.
(c) The tank shall be thoroughly washed with clean, filtered water. As soon as possible after washing, the surface shall be passivated by the application of nitric acid of a concentration between 30 and 35% by mass. The passivation process shall continue for 16 to 24 h. During this time a continuous contact between the surfaces to be passivated and the nitric acid shall be ensured.
(d) After passivation the surfaces shall be thoroughly washed with clean, filtered water. The washing process shall be repeated until the effluent water has the same pH value as the incoming water.
(e) A visual inspection shall be made to ensure that all surfaces have been treated. It is recommended that an additional flushing is carried out for a minimum of 24 h with dilute hydrogen peroxide solution of a concentration approximately 3% by mass.

(11) The concentration and stability of the hydrogen peroxide solution to be loaded shall be determined.
(12) The hydrogen peroxide is loaded under intermittent visual supervision of the interior of the tank from an appropriate opening.
(13) If substantial bubbling is observed which does not disappear within 15 min after the completion of loading, the contents of the tank shall be unloaded and disposed of in an environmentally safe manner. The tank and equipment shall then be repassivated as described above.
(14) The concentration and stability of the hydrogen peroxide solution shall be determined again. If the same values are obtained within the limits of error as in paragraph (10), the tank is considered to be properly passivated and the cargo ready for shipment.
(15) Actions described in paragraphs (2) to (8) shall be carried out under the supervision of the master or shipper. Actions described in paragraphs (9) to (15) shall be carried out under the on-site supervision and responsibility of a representative of the hydrogen peroxide manufacturer or under supervision and responsibility of another person familiar with the safety-relevant properties of hydrogen peroxide.
(16) The following procedure shall be applied when tanks having contained hydrogen peroxide solution are to be used for other products (unless otherwise specified, all steps apply to the tanks and to all associated equipment having been in contact with hydrogen peroxide):
(a) Hydrogen peroxide cargo residue shall be drained as completely as possible from tanks and equipment.
(b) Tanks and equipment shall be rinsed with clean water, and subsequently thoroughly washed with clean water.
(c) The interior of the tank shall be dried and inspected for any residues. Steps (a) to (c) in (16), shall be carried out under the supervision of the master or the shipper. Step (c) in paragraph (16) shall be carried out by a person familiar with the safety-relevant properties of the chemical to be transported and of hydrogen peroxide.

SPECIAL CAUTIONS :
(1) Hydrogen peroxide decomposition may enrich the atmosphere with oxygen and appropriate precautions shall be observed.
(2) Hydrogen gas may be evolved in the passivation processes described in paragraphs (9)(e), (10)(b) and (10)(d), leading to the presence of an explosive atmosphere in the tank. Therefore, appropriate measures must be taken to avoid the build-up or the ignition of such an atmosphere.

1506. Motor fuel anti-knock compounds (containing lead alkyls) (IBC Code 15.6)

1. Tanks used for these cargoes should not be used for the transportation of any other cargo except those commodities to be used in the manufacturer of motor fuel anti-knock compounds containing lead alkyls.

2. If a cargo pump room is located on deck level according to **1518.**, the ventilation arrangements should be in compliance with **1517.**

3. Entry into cargo tanks used for the transportation of these cargoes is not permitted unless approved by the Society.

4. Air analysis should be made for lead content to determine if the atmosphere is satisfactory prior to allowing personnel to enter the cargo pump room or void spaces surrounding the cargo tank.

1507. Phosphorus, yellow or white (IBC Code 15.7)

1. Phosphorus should, at all times, be loaded, carried and discharged under a water pad of 760 mm minimum depth. During discharge operations, arrangements should be made to ensure that water occupies the volume of phosphorus discharged. Any water discharged from a phosphorus tank should be returned only to a shore installation.

2. Tanks should be designed and tested to a minimum equivalent water head of 2.4 m above the top of the tank, under designed loading conditions, taking into account the depth, relative density and method of loading and discharge of the phosphorus.

3. Tanks should be so designed as to minimize the interfacial area between the liquid phosphorus and its water pad.

4. A minimum ullage space of 1 % should be maintained above the water pad. The ullage space should be filled with inert gas or naturally ventilated by two cowled standpipes terminating at different heights but at least 6 m above the deck and at least 2 m above the pump house top.

5. All openings should be at the top of cargo tanks, and fittings and joints attached thereto should be of materials resistant to phosphorus pentoxide.

6. Phosphorus should be loaded at a temperature not exceeding 60°C.

7. Tank heating arrangements should be external to tank and have a suitable method of temperature control to ensure that the temperature of the phosphorus does not exceed 60°C. A high-temperature alarm should be fitted.

8. A water drench system acceptable to the Society should be installed in all void spaces surrounding the tanks. The system should operate automaticatly in the event of an escape of phosphorus.

9. Void spaces referred to in **Par 8** should be provided with effective means of mechanical ventilation which should be capable of being sealed off quickly in an emergency.

10. Loading and discharge of phosphorus should be governed by a central system on the ship which, in addition to incorporating high-level alarms, should ensure that no overflow of tanks is possible and that such operations can be stopped quickly in an emergency from either ship or shore.

11. During cargo transfer, a water hose on deck should be connected to a water supply and kept flowing throughout the operation so that any spillage of phosphorus may be washed down with water immediately.

12. Ship-to-shore loading and discharge connections should be of a type approved by the Society.

1508. Propylene oxide and mixtures of ethylene oxide/propylene oxide with an ethylene oxide content of not more than 30 % by weight (IBC Code 15.8)

1. Products transported under the provisions of this Article should be acetylene-free.

2. Unless cargo tanks are properly cleaned, these products should not be carried in tanks which have contained as one of the three previous cargoes any products known to catalyse polymerization, such as:

(1) mineral acids (e.g. sulphuric, hydrochloric, nitric);
(2) carboxylic acids and anhydrides (e.g. formic, acetic);
(3) halogenated carboxylic acids (e.g. chloracetic);
(4) sulphonic acids (e.g. benzene sulphonic);
(5) caustic alkalis (e.g. sodium hydroxide, potassium hydroxide);
(6) ammonia and ammonia solutions;
(7) amines and amine solutions;

(8) oxidizing substances.

3. Before loading, tanks should be thoroughly and effectively cleaned, to remove all traces of previous cargoes from tanks and associated pipework, except where the immediately prior cargo has been propylene oxide or ethylene oxide/propylene oxide mixtures. Particular care should be taken in the case of ammonia in tanks made of steel other than stainless steel.

4. In all cases, the effectiveness of cleaning procedures for tanks and associated pipework should be checked by suitable testing or inspection to ascertain that no traces of acidic or alkaline materials remain that might create a hazardous situation in the presence of these products.

5. Tanks should be entered and inspected prior to each initial loading of these products to ensure freedom from contamination, heavy rust deposits and visible structural defects. When cargo tanks are in continuous service for these products, such inspections should be performed at intervals of not more than 2 years.

6. Tanks for the carriage of these products should be of steel or stainless steel construction.

7. Tanks for the carriage of these products may be used for other cargoes after thorough cleaning of tanks and associated pipework systems by washing or purging.

8. All valves, flanges, fittings and accessory equipment should be of a type suitable for use with the products and should be constructed of steel or stainless steel in accordance with recognized standards. Discs or disc faces, seats and other wearing parts of valves should be made of stainless steel containing not less than 11 % chromium.

9. Gaskets should be constructed of materials which do not react with, dissolve in, or lower the autoignition temperature of these products and which are fire-resistant and possess adequate mechanical behaviour. The surface presented to the cargo should be polytetrafluoroethylene (PTFE), or materials giving a similar degree of safety by their inertness. Spirally wound stainless steel with a filler of PTFE or similar fluorinated polymer may be accepted.

10. Insulation and packing, if used, should be of a material which does not react with, dissolve in, or lower the autoignition temperature of these products.

11. The following materials and generally found unsatisfactory for gaskets, packing and similar uses in containment systems for these products and would require testing before being approved by the Society:

(1) Neoprene or nature rubber, if it comes into contact with the products.
(2) Asbestos, or binders used with asbestos.
(3) Materials containing oxides of magnesium, such as mineral wools.

12. Threaded joints should not be permitted in the cargo liquid and vapour lines.

13. Filling and discharge piping should extend to within 100 mm of the bottom of the tank or any sump pit.

14. The containment system for a tank containing these products should have a valved vapour return connection.

15. The products should be loaded and discharged in such a manner that venting of the tanks to atmosphere does not occur. If vapour return to shore is used during tank loading, the vapour return system connected to a containment system for the product should be independent of all other containment systems.

16. During discharge operations, the pressure in the cargo tank should be maintained above 0.007 MPa gauge.

17. Tanks carrying these products should be vented independently of tanks carrying other products. Facilities should be provided for sampling the tank contents without opening the tank to atmosphere.

18. The cargo should be discharged only by deepwell pumps, hydraulically operated submerged pumps, or inert gas displacement. Each cargo pump should be arranged to ensure that the product does not heat significantly if the discharge line from the pump is shut off or otherwise blocked.

19. Cargo hoses used for transfer of these products should be marked **"FOR ALKYLENE OXIDE TRANSFER ONLY".**

20. Cargo tanks, void spaces and other enclosed spaces, adjacent to an integral gravity cargo tank carrying propylene oxide, should either contain a compatible cargo (those cargoes specified in **Par 2** are examples of substances considered incompatible) or be inerted by injection of a suitable inert gas. Any hold space in which an independent cargo tank is located should be inerted. Such inerted spaces and tanks should be monitored for these products and oxygen. Portable sampling equipment is satisfactory. The oxygen content of these spaces should be maintained below 2 %.

21. In no case should air be allowed to enter the cargo pump or piping system while these products are contained within the system.

22. Prior to disconnecting shore-lines, the pressure in liquid and vapour lines should be relieved through suitable valves installed at the loading header. Liquid and vapour from these lines should not be discharged to atmosphere.

23. Propylene oxide may be carried in pressure tanks or in independent or integral gravity tanks. Ethylene oxide/propylene oxide mixtures should be carried in independent gravity tanks or pressure tanks. Tanks should be designed for the maximum pressure expected to be encountered during loading, conveying and discharging cargo.

24. Tanks for the carriage of propylene oxide with a design pressure less than 0.06 MPa gauge and tanks for the carriage of ethylene oxide/propylene oxide mixtures with a design pressure less than 0.12 MPa gauge should have a cooling system to maintain the cargo below the reference temperature.

25. The refrigeration requirement for tanks with a design pressure less than 0.06 MPa gauge may be waived by the Society for ships operating in restricted areas or on voyages of restricted duration, and account may be taken in such cases of any insulation of the tanks. The area and times of year for which such carriage would be permitted should be included in the conditions of carriage on the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk.

26. Any cooling system should maintain the liquid temperature below the boiling temperature at the containment pressure. At least two complete cooling plants automatically regulated by variations within the tanks should be provided. Each cooling plant should be complete with the necessary auxiliaries for proper operation. The control system should also be capable of being manually operated. An alarm should be provided to indicate malfunctioning of the temperature controls. The capacity of each cooling system should be sufficient to maintain the temperature of the liquid cargo below the reference temperature of the system.

27. An alternative arrangement may consist of three cooling plants, any two of which should be sufficient to maintain the liquid temperatures below the reference temperature.

28. Cooling media which are separated from the products by a single wall only should be nonreactive with the products.

29. Cooling systems requiring compression of the products should not be used.

30. Pressure relief valve settings should not be less than 0.02 MPa gauge and for pressure tanks not greater than 0.7 MPa gauge for the carriage of propylene oxide and not greater than 0.53 MPa gauge for the carriage of propylene oxide/ethylene oxide mixtures.

31. The piping system for tanks to be loaded with these products should be separated from piping systems for all other tanks, including empty tanks. If the piping system for the tanks to be loaded is not independent, the required piping separation should be accomplished by the removal of spool pieces, valves, or other pipe sections, and the installation of blank flanges at these locations. The required separation applies to all liquid and vapour piping, liquid and vapour vent lines and any other possible connections, such as common inert gas supply lines.

32. These products may be transported only in accordance with cargo handling plans that have been approved by the Society. Each intended loading arrangement should be shown on a separate cargo handling plan. Cargo handling plans should show the entire cargo piping system and the locations for installation of blank flanges needed to meet the above piping separation requirements. A copy of each approved cargo handling plan should be maintained on board the ship. The International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk should be endorsed to include reference to the approved cargo handling plans.

33. Before each initial loading of these products and before every subsequent return to such service, certification verifying that the required piping separation has been achieved should be obtained from a responsible person acceptable to the port Administration and carried on board the ship. Each connection between a blank flange and a pipeline flange should be fitted with a wire and seal by the responsible person to ensure that inadvertent removal of the blank flange is impossible.

34. (1) No cargo tanks should be more than 98 % liquid-full at the reference temperature.

(2) The maximum volume (V_L) of cargo to be loaded in a tank should be:

$$V_L = 0.98\,V\frac{\rho_R}{\rho_L}$$

where

V = volume of the tank

ρ_R = relative density of cargo at the reference temperature.

ρ_L = relative density of cargo at the loading temperature and pressure.

(3) The maximum allowable tank filling limits for each cargo tank should be indicated for each loading temperature which may be applied, and for the applicable maximum reference temperature, on a list to be approved by the Society. A copy of the list should be permanently kept on board by the master.

35. The cargo should be carried under a suitable protective padding of nitrogen gas. An automatic nitrogen make-up system should be installed to prevent the tank pressure falling below 0.07 MPa gauge in the event of product temperature fall due to ambient conditions or maloperation of refrigeration systems. Sufficient nitrogen should be available on board to satisfy the demand of the automatic pressure control. Nitrogen of commercially pure quality (99.9 % by volume) should be used for padding. A battery of nitrogen bottles connected to the cargo tanks through a pressure reduction valve satisfies the intention of the expression "automatic" in this context.

36. The cargo tank vapour space should be tested prior to and after loading to ensure that the oxygen content is 2 % by volume or less.

37. A water-spray system of sufficient capacity should be provided to blanket effectively the area surrounding the loading manifold, the exposed deck piping associated with product handling and the tank domes. The arrangement of piping and nozzles should be such as to give a uniform distribution rate of 10 l/min per square metre. Remote manual operation should be arranged such that remote starting of pumps supplying the water- spray system and remote operation of any normally closed valves in the system can be carried out from a suitable location outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected. The water-spray system should be capable of both local and remote manual operation and the arrangement should ensure that any spilled cargo is washed away. Additionally, a water hose with pressure to the nozzle, when atmospheric temperatures permit, should be connected ready for immediate use during loading and unloading operations.

38. A remotely operated, controlled closing-rate, shutoff valve should be provided at each cargo hose connection used during cargo transfer.

1509. Sodium chlorate solution, 50 % or less (IBC Code 15.9)

1. Tanks and associated equipment which have contained this product may be used for other cargoes after thorough cleaning by washing or purging.

2. In the event of spillage of this product, all spilled liquid should be thoroughly washed away without delay. To minimize fire risk, spillage should not be allowed to dry out.

1510. Sulphur, Molten (IBC Code 15.10)

1. Cargo tank ventilation should be provided to maintain the concentration of hydrogen sulphide below one half of its lower explosive limit throughout the cargo tank vapour space for all conditions of carriage, i.e. below 1.85 % by volume.

2. Where mechanical ventilation systems are used for maintaining low gas concentrations in cargo tanks, an alarm system should be provided to give warning if the system fails.

3. Ventilation systems should be so designed and arranged as to preclude depositing of sulphur within the system.

4. Openings to void spaces adjacent to cargo tanks should be so designed and fitted as to prevent the entry of water, sulphur or cargo vapour.

5. Connections should be provided to permit sampling and analysing of vapour in void spaces.

6. Cargo temperature controls should be provided to ensure that the temperature of the sulphur does not exceed 155°C.

7. Sulphur (molten) has a flashpoint above 60°C : however, electrical equipment shall be certificated safe for gases evolved.

1511. Acids (IBC Code 15.11)

1. The ship's shell plating should not form any boundaries of tanks containing mineral acids.

2. Proposals for lining steel tanks and related piping systems with corrosion-resistant materials may be considered by the Society. The elasticity of the lining should not be less than that of the supporting boundary plating.

3. Unless constructed wholly of corrosion-resistant materials or fitted with an approved lining, the plating thickness should take into account the corrosivity of the cargo.

4. Flanges of the loading and discharge manifold connections should be provided with shields, which may be portable, to guard against the danger of the cargo being sprayed; and in addition, drip trays should also be provided to guard against leakage on to the deck.

5. Because of the danger of evolution of hydrogen when these substances are being carried, the electrical arrangements should comply with **1001.4.** The certified safe type equipment should be suitable for use in hydrogen-air mixtures. Other sources of ignition should not be permitted in such spaces.

6. Substances subjected to the requirements of this Article should be segregated from oil fuel tanks, in addition to the segregation requirements in **301. 1.**

7. Provision should be made for suitable apparatus to detect leakage of cargo into adjacent spaces.

8. The cargo pump room bilge pumping and drainage arrangements should be of corrosion-resistant materials.

1512. Toxic products (IBC Code 15.12)

1. Exhaust openings of tank vent systems should be located:

(1) at a height of $B/3$ or 6 m, whichever is greater, above the weather deck or, in the case of a deck tank, the access gangway;
(2) not less than 6 m above the fore-and-aft gangway, if fitted within 6 m of the gangway; and
(3) 15 m from any opening or air intake to any accommodation and service spaces;
(4) the vent height may be reduced to 3 m above the deck or fore-and-aft gangway, as applicable, provided high-velocity vent valves of a type approved by the Society, directing the vapour-air mixture upwards in an unimpeded jet with an exit velocity of at least 30 m/s, are fitted.

2. Tank venting systems should be provided with a connection for a vapour return line to the shore installation.

3. Products should:

(1) not be stowed adjacent to oil fuel tanks;
(2) have separate piping systems; and
(3) have tank vent systems separate from tanks containing nontoxic products. (see also **307. 2**)

4. Cargo tank relief valve settings should be a minimum of 0.02 MPa gauge.

1513. Cargoes protected by additives (IBC Code 15.13)

1. Certain cargoes with a reference in column "o" in the table of **Sec 17** by the nature of their chemical make-up, tend, under certain conditions of temperature, exposure to air or contact with a catalyst, to undergo polymerization, decomposition, oxidation or other chemical changes. Mitigation of this tendency is carried out by introducing small amounts of chemical additives into the liquid cargo or by controlling the cargo tank environment.

2. Ships carrying these cargoes should be so designed as to eliminate from the cargo tanks and cargo handling system any material of construction or contaminants which could act as a catalyst or destroy the inhibitor.

3. Care should be taken to ensure that these cargoes are sufficiently protected to prevent deleterious chemical change at all times during the voyage. Ships carrying such cargoes should be provided with a certificate of protection from the manufacturer and kept during the voyage specifying:

(1) the name and amount of additive present;
(2) whether the additive is oxygen dependent;
(3) date additive was put in the product and duration of effectiveness;
(4) any temperature limitations qualifying the additives" effective lifetime; and
(5) the action to be taken should the length of voyage exceed the effective lifetime of the additives.

4. Ships using the exclusion of air as the method of preventing oxidation of the cargo should comply with **901. 3.**

5. A product containing an oxygen dependent additive should be carried without inertion (in tanks of a size not greater than 3,000 m^3). Such cargoes should not be carried in a tank requiring inertion under the requirements of **SOLAS** chapter II-2.

6. Venting systems should be of a design that eliminates blockage from polymer build-up. Venting equipment should be of a type that can be checked periodically for adequacy of operation.

7. Crystallization or solidification of cargoes normally carried in the molten state can lead to depletion of inhibitor in parts of the tank contents. Subsequent remelting can thus yield pockets of uninhibited, liquid with the accompanying risk of dangerous polymerization. To prevent this, care should be taken to ensure that at no time are such cargoes allowed to crystallize or solidify, either wholly or partially, in any part of the tank. Any required heating arrangements should be such as to ensure that in no part of the tank does cargo become overheated to such an extent that any dangerous polymerization can be initiated. If the temperature from steam coils would induce overheating, an indirect low-temperature heating system should be used.

1514. Cargoes with a vapour pressure greater than 0.1013 MPa absolute at 37.8°C (IBC Code 15.14)

1. For a cargo referenced in column "o" in the table of **Sec 17** to this Article, a mechanical refrigeration system should be provided unless the cargo system is designed to withstand the vapour pressure of the cargo at 45°C. Where the cargo system is designed to withstand the vapour pressure of the cargo at 45°C, and no refrigeration system is provided, a notation should be made in the conditions of carriage on the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk to indicate the required relief valve setting for the tanks.

2. A mechanical refrigeration system should maintain the liquid temperature below the boiling temperature at the cargo tank design pressure.

3. When ships operate in restricted areas and at restricted times of the year, or on voyages of limited duration, the Society involved may agree to waive requirements for a refrigeration system. A notation of any such agreement, listing geographic area restrictions and times of the year, or voyage duration limitations, should be included in the conditions of carriage on the International Certificate for the Carriage of Dangerous Chemicals in Bulk.

4. Connections should be provided for returning expelled gases to shore during loading.

5. Each tank should be provided with a pressure gauge which indicates the pressure in the vapour space above the cargo.

6. Where the cargo needs to be cooled, thermometers should be provided at the top and bottom of each tank.

7. (1) No cargo tanks should be more than 98 % liquid-full at the reference temperature (R).

(2) The maximum volume (V_L) of cargo to be loaded in a tank should be:

$$V_L = 0.98\,V\frac{\rho_R}{\rho_L}$$

where

V = volume of the tank

ρ_R = relative density of cargo at the reference temperature (R)

ρ_L = relative density of cargo at the loading temperature

R = reference temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valve.

(3) The maximum allowable tank filling limits for each cargo tank should be indicated for each loading temperature which may be applied, and for the applicable maximum reference temperature, on a list approved by the Society. A copy of the list should be permanently kept on board by the master.

1515. Cargoes with low ignition temperature and wide flammability range (IBC Code 15.15)

Deleted.

1516. Cargo contamination (IBC Code 15.16)

1. Where column "o" in the table of **Sec 17** refers to this Article, water should not be allowed to contaminate this cargo. In addition, the following provisions apply:

(1) Air inlets to pressure/vacuum relief valves of tanks containing the cargo should be situated at least 2 m above the weather deck.

(2) Water or steam should not be used as the heat transfer media in a cargo temperature control system required by **Sec 7.**

(3) The cargo should not be carried in cargo tanks adjacent to permanent ballast or water tanks unless the tanks are empty and dry.

(4) The cargo should not be carried in tanks adjacent to slop tanks or cargo tanks containing ballast or slops or other cargoes containing water which may react in a dangerous manner. Pumps, pipes or vent lines serving such tanks should beseparate from similar equipment serving tanks containing the cargo. Pipelines from slop tanks or ballast lines should not pass through tanks containing the cargo unless encased in a tunnel.

1517. Increased ventilation requirements (IBC Code 15.17)

For certain products, the ventilation system as described in **1201.3** should have a minimum capacity of at least 45 changes of air per hour based upon the total volume of space. The ventilation system exhaust ducts should discharge at least 10 m away from openings into accommodation spaces, work areas or other similar spaces, and intakes to ventilation systems, and at least 4 *m* above the tank deck.

1518. Special cargo pump room requirements (IBC Code 15.18)

For certain products, the cargo pump room should be located on the deck level or cargo pumps should be located in the cargo tank. The Society may give special consideration to cargo pump rooms below deck.

1519. Overflow control (IBC Code 15.19)

1. The provisions of this Article are applicable where specific reference is made in column "o" in the table of **Sec 17,** and are in addition to the requirements for gauging devices.

2. In the event of a power failure on any system essential for safe loading, an alarm should be given to the operators concerned.

3. Loading operations should be terminated at once in the event of any system essential for safe loading becoming inoperative.

4. Level alarms should be capable of being tested prior to loading.

5. The high-level alarm system required under **Par 6** should be independent of the overflow control system required by **Par 7** and should be independent of the equipment required by **1301.**

6. Cargo tanks should be fitted with a visual and audible high-level alarm which complies with **Pars 1** to **5** and which indicates when the liquid level in the cargo tank approaches the normal full condition.

7. A tank overflow control system required by this Article should:

(1) come into operation when the normal tank loading procedures fail to stop the tank liquid level exceeding the normal full condition;
(2) give a visual and audible tank overflow alarm to the ship's operator; and
(3) provide an agreed signal for sequential shutdown of onshore pumps or valves or both and of the ship's valves. The signal, as well as the pump and valve shutdown, may be dependent on operator's intervention. The use of shipboard automatic closing valves should be permitted only when specific approval has been obtained from the Society and the port Administrations concerned.

8. The loading rate (LR) of the tank should not exceed:

$$LR = \frac{3{,}600U}{t} \quad (\mathrm{m^3/h})$$

where

U = ullage volume ($\mathrm{m^3}$) at operating signal level;

t = time (s) needed from the initiating signal to fully stopping the cargo flow into the tank, being the sum of times needed for each step in sequential operations such as operator's responses to signals, stopping pumps and closing valves; and should also take into account the pipeline system design pressure.

1520. Alkyl(C_7-C_9) nitrates, all isomers (IBC Code 15.20)

1. The carriage temperature of the cargo should be maintained below 100°C to prevent the occurrence of a self-sustaining, exothermic decomposition reaction.

2. The cargo may not be carried in independent pressure vessels permanently affixed to the vessel's deck unless:

(1) the tanks are sufficiently insulated from fire; and

(2) the vessel has a water deluge system for the tanks such that the cargo temperature is maintained below 100°C and the temperature rise in the tanks does not exceed 1.5°C/hour for a fire of 650°C (1200°F).

1521. Temperature sensors (IBC Code 15.21)

Temperature sensors should be used to monitor the cargo pump temperature to detect overheating due to pump failures.

Section 16 Operational Requirements

1601. Maximum allowable quantity of cargo per tank (IBC Code 16.1)

1. The quantity of a cargo required to be carried in a type 1 ship should not exceed 1,250 m^3 in any one tank.

2. The quantity of a cargo required to be carried in a type 2 ship should not exceed 3,000 m^3 in any one tank.

3. Tanks carrying liquids at ambient temperatures should be so loaded as to avoid the tank becoming liquid-full during the voyage, having due regard to the highest temperature which the cargo may reach.

1602. Cargo information (IBC Code 16.2)

1. A copy of this Chapter, or national regulations incorporating the provisions of this Chapter, should be on board every ship covered by this Chapter.

2. Any cargo offered for bulk shipment shall be indicated in the shipping documents by the product name, under which it is listed in Sec 17 or 18 or the latest edition of MEPC.2/Circ. or under which it has been provisionally assessed. Where the cargo is a mixture, an analysis indicating the dangerous components contributing significantly to the total hazard of the product shall be provided, or a complete analysis if this is available. Such an analysis shall be certified by the manufacturer or by an independent expert acceptable to the Society.

3. Information should be on board, and available to all concerned, giving the necessary data for the safe carriage of the cargo. Such information should include a cargo stowage plan to be kept in an accessible place, indicating all cargo on board, including each dangerous chemical carried:

(1) a full description of the physical and chemical properties, including reactivity necessary for the safe containment of the cargo;
(2) action to be taken in the event of spills or leaks;
(3) countermeasures against accidental personal contact;
(4) fire-fighting procedures and fire-fighting media;
(5) procedures for cargo transfer, tank cleaning, gas-freeing and ballasting;
(6) for those cargoes required to be stabilized or inhibited in accordance with **1501., 1505. 1** (11) or **1513. 3,** the cargo should be refused if the certificate required by these paragraphs is not supplied.

4. If sufficient information necessary for the safe transportation of the cargo is not available, the cargo should be refused.

5. Cargoes which evolve highly toxic imperceptible vapours should not be transported unless perceptible additives are introduced into the cargo.

6. Where column "o" in the table of **Sec 17** refers to this paragraph, the cargo's viscosity at 20°C shall be specified on a shipping document and if the cargo's viscosity exceeds 50mPa·s at 20°C, the temperature at which the cargo has a viscosity of 50mPa·s shall be specified in the shipping document.

7. Where column "o" in the table of **Sec 17** refers to this paragraph, the cargo's melting point shall be indicated in the shipping document.

1603. Personnel training (IBC Code 16.3)

1. All personnel should be adequately trained in the use of protective equipment and have basic training in the procedures appropriate to their duties, necessary under emergency conditions.

2. Personnel involved in cargo operations should be adequately trained in handling procedures.

3. Officers shall be trained in emergency procedures to deal with conditions of leakage, spillage or fire involving the cargo, based on the guidelines developed by IMO, and a sufficient number of them shall be instructed and trained in essential first aid for cargoes carried, based on the guidelines developed by the IMO. Refer to the Medical First Aid Guide for use in Accident involving Dangerous Goods (MFAG), which provides advice on the treatment of casualties in accordance with the symptoms exhibited as well as equipment and antidotes that may be appropriate for treating the casulity and to the relevant provisions of the STCW Code, part A and B.

1604. Opening of and entry into cargo tanks (IBC Code 16.4)

1. During handling and carriage of cargoes producing flammable or toxic vapours, or both, or when ballasting after the discharge of such cargo, or when loading or unloading cargo, cargo tank lids should always be kept closed. With any hazardous cargo, cargo tank lids, ullage and sighting ports and tank washing access covers should be open only when necessary.

2. Personnel should not enter cargo tanks, void spaces around such tanks, cargo handling spaces or other enclosed spaces unless:

(1) the compartment is free of toxic vapours and not deficient in oxygen; or
(2) personnel wear breathing apparatus and other necessary protective equipment, and the entire operation is under the close supervision of a responsible officer.

3. Personnel should not enter such spaces when the only hazard is of a purely flammable nature, except under the close supervision of a responsible officer.

1605. Stowage of cargo samples (IBC Code 16.5)

1. Samples which have to be kept on board should be stowed in a designated space situated in the cargo area or, exceptionally, elsewhere, subject to the approval of the Society.

2. The stowage space should be:

(1) cell-divided in order to avoid shifting of the bottles at sea;
(2) made of material fully resistant to the different liquids intended to be stowed; and
(3) equipped with adequate ventilation arrangements.

3. Samples which react with each other dangerously should not be stowed close to each other.

4. Samples should not be retained on board longer than necessary.

1606. Cargoes not to be exposed to excessive heat (IBC Code 16.6)

1. Where the possibility exists of a dangerous reaction of a cargo such as polymerization, decomposition, thermal instability or evolution of gas, resulting from local overheating of the cargo in either the tank or associated pipelines, such cargo should be loaded and carried adequately segregated from other products whose temperature is sufficiently high to initiate a reaction of such cargo (see **701. 5**(4)).

2. Heating coils in tanks carrying this product should be blanked off or secured by equivalent means.

3. Heat-sensitive products should not be carried in deck tanks which are not insulated.

4. In order to avoid elevated temperatures, this cargo should not be carried in deck tanks.

Section 17 Summary of Minimum Requirements

1. The list of the products applied to this Section shall refer to the summary of minimum requirements in chapter 17 of the IBC Code, as amended, which shall be in accordance with the guidances specified separatedly.
2. Mixtures of noxious liquid substances presenting pollution hazards only and which are provisionally assessed under regulation 6.3 of MARPOL Annex II, may be carried under the requirements of this Chapter applicable to the appropriate position of the entry in this Section for noxious liquids, not otherwise specified (n.o.s).

Section 18 List of Chemicals to which this Chapter does not apply

1. This Section applies to products, which have been reviewed for their safety and pollution hazards and determined not to present hazards to such an extent as to warrant application of the Code.

2. Although the products listed in this Section fall outside the scope of this Chapter, the attention of the Society is drawn to the fact that some safety precautions may be needed for their safe transportation. Accordingly, the Society should prescribe appropriate safety requirements.

3. Some liquid substances are identified as falling into pollution category Z and, therefore, subject to certain operational requirements of Annex II of MARPOL 73/78.

4. Liquid mixtures which are assessed or provisionally under regulation 6.3 of MARPOL Annex II as falling into pollution category Z or OS, and which do not present safety hazards, may be carried under the appropriate entry in this Section for "Noxious or Non-Noxious liquid Substances, not otherwise specified (n.o.s)".

5. The list of the products applied to this Section shall refer to the products in chapter 18 of the IBC Code as amended. The explanatory notes of the products are of the following.

(1) Product name : The product names shall be used in the shipping document for any cargo offered for bulk shipments. Any additional name may be included in brackets after the product name. In some cases, the product name are not identical with the names given in previous issues of the Code.

(2) Pollution category : The letter Z means the pollution category assigned to each product under Annex II of MARPOL 73/78. OS means the product was evaluated and found to fall outside the categories X, Y, or Z.

6. The list of products shall be in accordance with the guidances specified separatedly.

Section 19 Index of Products Carried in Bulk

The index of products shall be in accordance with the guidances specified separatedly.

Section 20 Transport of Liquid Chemical Wastes

2001. General (IBC Code 20.1)

1. Maritime transport of liquid chemical wastes could present a threat to human health and to the environment.

2. Liquid chemical wastes should, therefore, be transported in accordance with relevant international conventions and recommendations and, in particular, where it concerns maritime transport in bulk, with the requirements of this Chapter.

2002. Definitions (IBC Code 20.2)

For the purpose of this Section:

(1) "**Liquid chemical wastes**" are substances, solutions or mixtures, offered for shipment, containing or contaminated with one or more constituents which are subject to the requirements of this Chapter and for which no direct use is envisaged but which are carried for dumping, incineration or other methods of disposal other than at sea.

(2) "**Transboundary movement**" means maritime transport of wastes from an area under the national jurisdiction of one country to or through an area under the national jurisdiction of another country, or to or through an area not under the national jurisdiction of any country, provided at least two countries are concerned by the movement.

2003. Applicability (IBC Code 20.3)

1. The requirements of this Section are applicable to the transboundary movement of liquid chemical wastes in bulk by seagoing ships and should be considered in conjunction with all other requirements of this Chapter.

2. The requirements of this Section do not apply to:

(1) wastes derived from shipboard operations which are covered by the requirements of MARPOL 73/78;

(2) substances, solutions or mixtures containing or contaminated with radioactive materials which are subject to the applicable requirements for radioactive materials.

2004. Permitted shipments (IBC Code 20.4)

Transboundary movement of wastes is permitted to commence only when:

(1) notification has been sent by the competent authority of the country of origin, or by the generator or exporter through the channel of the competent authority of the country of origin, to the country of final destination; and

(2) the competent authority of the country of origin, having received the written consent of the country of final destination stating that the wastes will be safely incinerated or treated by other methods of disposal, has given authorization to the movement.

2005. Documentation (IBC Code 20.5)

In addition to the documentation specified in **1602.**, ships engaged in transboundary movement of liquid chemical wastes transported in bulk should carry on board a waste movement document issued by the competent authority of the country of origin.

2006. Classification of liquid chemical wastes (IBC Code 20.6)

For the purpose of the protection of the marine environment all liquid chemical wastes transported in bulk should be treated as Category A noxious liquid substances, irrespective of the actual evaluated category.

2007. Carriage and handling of liquid chemical wastes (IBC Code 20.7)

Liquid chemical wastes are to be carried in ships and cargo tanks in accordance with the minimum requirements for liquid chemical wastes specified in **Sec 17**, unless there are clear grounds indicating that the hazards of the wastes would warrant:

(1) carriage in accordance with the ship type 1 requirements; or
(2) any additional requirements of this Chapter applicable to the substance or, in case of a mixture, its constituent presenting the predominant hazard.

Section 21 Criteria for assigning carriage requirements for products subject to the IBC Code

This Criteria is to be in accordance with the guidances specified separately.⚓

2012

Guidance Relating to the Rules for the Classification of Steel Ships

Part 7
Ships of Special Service

Chapter 5 Ships Carrying Liquefied Gases in Bulk
Chapter 6 Ships Carrying Dangerous Chemicals in Bulk

GA-07B-E

KOREAN REGISTER OF SHIPPING

APPLICATION OF THE GUIDANCE

This "Guidance relating to the Rules for Classification of Steel Ships" (hereafter called as the Guidance) is prepared with the intent of giving guidelines as to the treatment of the various provisions for items required the unified interpretations and items not specified in details in the Rules, and the requirements specified in the Guidance are to be applied, in principle, in addition to the various provisions in the Rules.
As to any technical modifications which can be regarded as equivalent to any requirements in the Guidance, their flexible application will be properly considered.

APPLICATION OF PART 7 "SHIPS OF SPECIAL SERVICE(CH 5, 6)"

1. Unless expressly specified otherwise, the requirements in the Guidance apply to ships for which contracts for construction are signed on or after 1 July 2012.
2. The amendments to the Guidance for 2011 edition and their effective date are as follows;

Effective Date 1 January 2012

CHAPTER 5 SHIPS CARRYING LIQUEFIED GASES IN BULK

Section 5 Process Pressure Vessels and Liquid, Vapour and Pressure Piping Systems

- 503. 1 has been amended.

CHAPTER 6 SHIPS CARRYING DANGEROUS CHEMICALS IN BULK

Section 15 Special Requirements

- 1511. 1 has been amended.

Effective Date 1 July 2012

CHAPTER 5 SHIPS CARRYING LIQUEFIED GASES IN BULK

Section 8 Cargo Tank Vent System

- 801. (2) has been amended.

Section 9 Environmental Control

- Fig 7.5.36 of 904. has been amended.

CONTENTS

CHAPTER 5 SHIPS CARRYING LIQUEFIED GASES IN BULK

Section 1 General

101. Application

In application to 101. of the Rules, requirements for ships not having the international certificate of fitness for the carriage of liquefied gases in bulk shall be complied with Annex 7A-1 of this guidance.

106. Definitions

1. Cargo area

Cargo area extended by the requirements in **303. 1** (2) of the Rules is, for example, as shown in **Fig 7.5.1** of the Guidance.

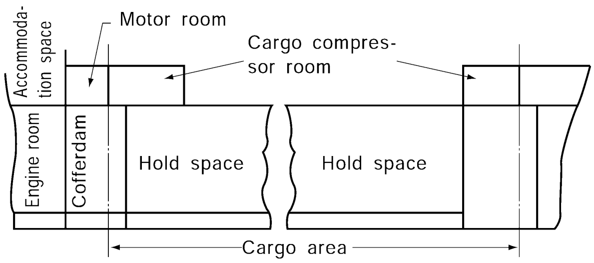
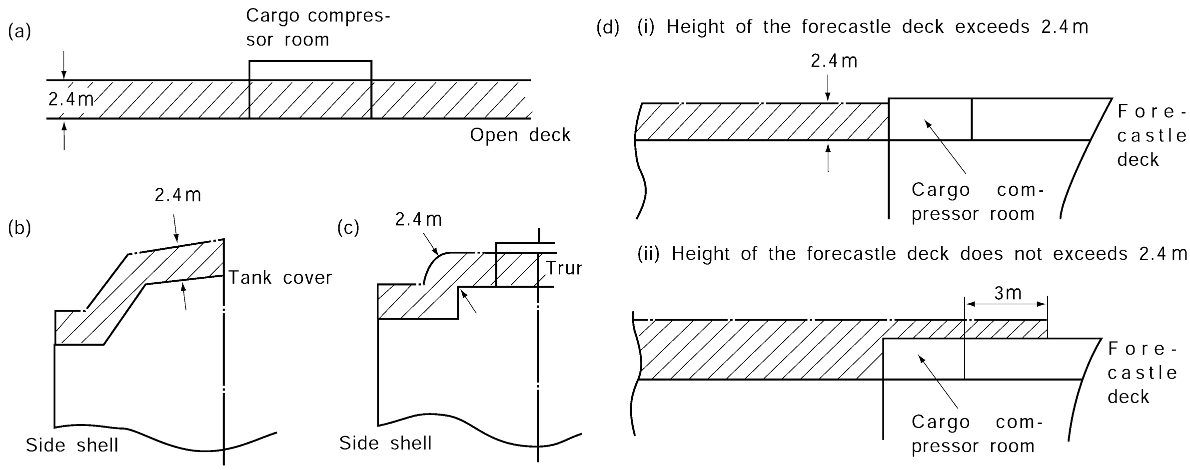


Fig. 7.5.1

2. Gas-dangerous space

(1) The "approved manner to ensure that its atmosphere is at all times maintained in a gas-safe condition" referred to in **106. 17** (1) of the Rules means to ensure that there are no openings which are directly led to the compartments specified in **106. 17** (2) through (12) of the Rules, or to protect by air locks specified in **306.** of the Rules.
(2) The "3 m of any cargo tank outlet, gas or vapour outlet, cargo pipe flange or cargo valve or of entrances and ventilation openings to cargo pump rooms and cargo compressor rooms" referred to in **106. 17** (7) of the Rules is to be measured as a sphere above outlets and openings, and as a cylinder below.
(3) The "area on the open deck up to a height of 2.4 m above the weather deck" referred to in **106. 17** (8) of the Rules is, for example, as shown in (a) through (d) of **Fig 7.5.2** of the Guidance.
(4) The "direct opening into" referred to in **106. 17** (12) of the Rules includes those openings such as hatches normally used for access which are closed by doors, covers, etc. Bolted plates for removal of machinery need not be regarded as direct openings where another means for access are provided.



Note:
A space in the cargo compressor room is to consider the gas-dangerous space in accordance with the requirements in **106. 17**(6) of the Rules.

Fig 7.5.2

3. Hold space

"Hold spaces" in the requirements in **106. 19** of the Rules includes the peripheral compartments of cargo tanks in the case of integral tanks. (See **Fig 7.5.3** of the Guidance)

4. Independent

The "provisions available for the potential connection to other systems" referred to in **106. 20** of the Rules include the blank flanges.

5. Interbarrier space

"Inter-barrier space" referred to in **106. 22** of the Rules means the peripheral compartments of the cargo tanks in the case of integral tanks. (See **Fig 7.5.3** of the Guidance)

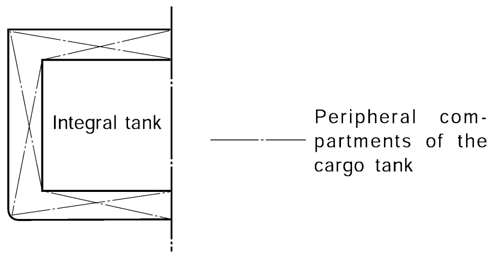


Fig 7.5.3

Section 2 Ship Survival Capability and Location of Cargo Tanks

202. Freeboard and intact stability

1. Solid ballast

In applying the requirements in **202. 4** of the Rules, the solid ballast is to comply with the following requirements.

(1) In case where solid ballast is arranged under unavoidable reasons to ensure stability of the ship, the distance between such solid ballast and the cargo tank is to be not less than 760 mm at any point.

(2) The solid ballast is to be of concrete blocks and similar materials which can be fitted securely to the hull structure of the ship. No solid ballast consisting of scrap iron in bulk, etc. is accepted.

2. Stability information

The items relating to the survival capability of the ship to be entered in the stability information specified in **202. 5** of the Rules are to include, at least, the following (1) through (5) :

(1) Data relating to loading and distribution of cargo and ballast necessary to ensure compliance with damage survival requirements.

(2) Data relating to the ship's survival capabilities.

(3) Plan showing the damage control procedures (describing the locations of fittings necessary for the damage control such as closing appliances and valves, and list of instructions for their controls)

(4) Data relating to the effects of free surface or liquid heeling moments of cargo tanks at all stages of filling.

(5) Example calculations and standard blank forms to facilitate calculations (which are useful for verifying compliance with the survival requirements in an intact condition of the ship).

203. Shipside discharges below the freeboard deck

1. In applying the requirements in **203. 1** of the Rules, the following requirements (1) to (3) are to be complied with :

(1) The scupper pipes within the superstructure are to be in accordance with the requirements in **Pt 5, Ch 6, 302. 1** of the Guidance.

(2) The inboard side open ends of scupper pipes are to be in accordance with the requirements in **Pt 5, Ch 6, 302. 2** (1) (A) of the Guidance.

(3) The direct overboard discharge pipes of top side tanks are to be in accordance with the requirements in **Pt 5, Ch 6, 302. 2** (1) (B) of the Guidance.

2. The requirements of **203. 1** of the Rules don't apply to the overboard discharge pipes from the superstructure and deckhouse located on or above the second deck on freeboard deck.

204. Conditions of loading

To ensure the compliance with the survival requirements in **209.** of the Rules for "all anticipated conditions of loading and variations in draught and trim" specified in **204.** of the Rules at least one or combination of the following (1) to (3) are to be taken for the draught up to the summer water load line :

(1) Carry out damage stability calculations for all anticipated conditions of loading.

(2) Provide manual or calculating machine capable of carrying out the required damage stability calculations. When calculating machine is provided, suitable means of redundancy is to be provided for possible failure of the machine.

(3) Provide diagrams permitting to verify compliance with the survival requirements on the basis of the data in intact condition of the ship(e.g. KG values).

205. Damage assumptions

1. Other damages

For the purpose of the requirements in **205. 2** (2) of the Rules, the transverse bulkheads assumed to remain intact in the requirements in **208. 1** (4) to (6) of the Rules may also be assumed that they remain free from local damages.

206. Location of cargo tanks

1. For the purpose of the requirements in **206. 1** of the Rules, cargo tanks are to be arranged where distances to the primary barrier are to be satisfied with the Rule requirements in case the distances between cargo tanks are fixed.

2. For the purpose of the requirements in **206. 3** of the Rules, the suction wells are not to be installed less than 760 mm from the shell plating.

207. Flooding assumptions

1. General

(1) Conditions that are anticipated to cause more severe results are to be selected of all anticipated conditions of loading, and consideration is to be given to the following (A) through (H) in making calculation according to **207. 1** of the Rules.
   (A) Tanks in way of the assumed damage filled with liquid at increments of about 25 % between empty and the maximum weight of liquid, or liquids, intended to be carried in the particular tanks under consideration.
   (B) The distribution of liquids in the adjacent tanks concerned which will give the most severe result, taking trim into account.
   (C) A number of draughts over the operating range, up to and including the tropical freeboard mark. The fresh water free boards need not be considered.
   (D) The effect of damage involving the machinery space and adjacent tanks containing liquids over a number of draughts as in (C) above.
   (E) The ship in either the departure or the arrival condition, whichever will give the most severe result.
   (F) The ship without trim and a sufficient number of trims covering the operating range, in order to permit interpolation.
   (G) Where the assumed damage causes the ship to trim by the stern, condition having the largest allowable trim by the stern, consistent with operational requirements.
   (H) Where the assumed damage causes the ship to trim by the bow, condition having the largest allowable trim by the bow, consistent with operational requirements.

(2) The free surface effects of intact cargo tanks in the damage stability calculation are to be computed for the actual angle of heel caused by assumed damage and for each angle of heel within the stability limit.

(3) In calculating the effect of free surface of consumable liquids, it is to be assumed that, for each type of liquid, at least one transverse pair or a single centre line tank has maximum free surface, and the tank or combination of tanks to be taken into account are to be those where the effect of free surfaces is the greatest ; in each tank the centre of gravity of the contents is to be taken at the centre of volume of the tank. The remaining tanks are to be assumed either completely empty or completely filled, and the distribution of consumable liquids among these tanks is to be such as to obtain the greatest possible height above the keel for the centre of gravity.

(4) In calculating free surface effects given in the preceding (3), the requirements are to be complied with preceding (2).

2. Permeability

For the purpose of the requirements in **207. 2** of the Rules, the Society may approve a lesser permeability in consideration of volume of the insulations etc. provided within the compartment.

3. Damage of transverse bulkhead

In applying the requirements for damage of transverse bulkhead specified in **207. 4** of the Rules, the extent of damage when the transverse bulkhead is stepped or recessed, are for example, as shown in **Fig 7.5.4** of the Guidance.

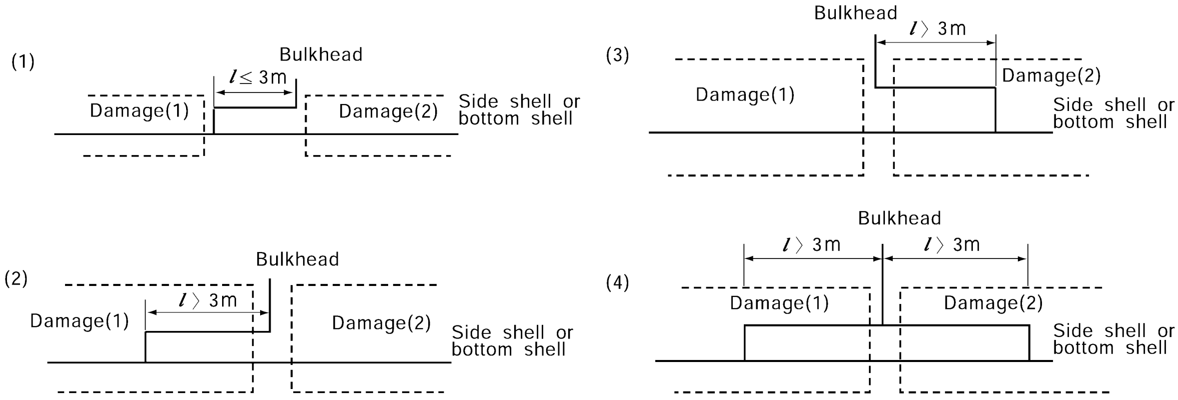


Fig 7.5.4

4. Equalization arrangements

(1) The equalization arrangements specified in **207. 6** of the Rules are to be made operable from a readily accessible place in the damaged condition before using the equalization arrangement.

(2) The righting arm curve of the ship without using the equalization arrangement referred to in the preceding (1) is to be determined in accordance with the requirements in **207. 3** of the Rules, but calculation in this case is to be made assuming that the cross-levelling pipe is closed or this equalization arrangement is not effectively functioning.

(3) The cross sectional area of the cross-levelling pipe used for the equalization arrangement referred to in the preceding (1) is to satisfy the value obtained from the following equation :

$$A \geq 7.5\frac{V}{\sqrt{H}} \quad (\mathrm{cm}^2)$$

where:

A : cross sectional area of cross-levelling pipe (cm^2)

V : estimated flooding volume in flooded compartment (cm^3)

H : height from the draught line before flooding to the centre line of pipe (m)

(4) "ducts of large cross-sectional area" referred to in **207. 6** of the Rules are to satisfy both of the following equations :

$$A \geq 150\frac{V}{\sqrt{H}} \quad (\mathrm{cm}^2), \qquad A \geq 2Sh \quad (\mathrm{cm}^2)$$

where:

V : value obtained by the preceding (3)

H : height obtained by the preceding (3) to the centre of duct

S : frame distance (cm). However, in case of longitudinal framing system, S may be obtained from the following equation but not to be less than 61 cm :

$$S = 45 + 0.2L_f \quad (\mathrm{cm})$$

h : B/15 (cm)

5. Progressive flooding

The "arrangements should be such that progressive flooding cannot thereby extend" referred to in the requirements in **207. 7** of the Rules may be such as a stop valve operable from the exposed deck and accommodation space, etc. provided outside the extent of damage. In this case, any part of operating systems is to effectively function for assumed damage.

6. Buoyancy of superstructure

(1) For the purpose of **207. 8** of the Rules, the longitudinal extent of damage to superstructures above a machinery space located aft is to be the same as the longitudinal extent of the side damage to the machinery space specified **208. 1** of the Rules. (See **Fig 7.5.5** of the Guidance)

(2) The sliding watertight doors specified in **207. 8** (2) of the Rules are to be remotely operable from a readily accessible place in case of damage. Further, the openings of weathertight accepted within the minimum range of residual stability are to be capable of being securely closed at final equilibrium.

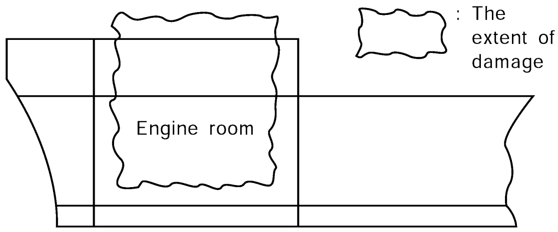


Fig. 7.5.5

208. Standard of damage

1. General

(1) For the purpose of the standard of damage specified in **208. 1** of the Rules, damage assumed to have sustained within 0.3 L_f or there about from the stern are to be in accordance with the following requirements (A) and (B) :

(A) For bottom damage for 0.3 L_f from the forward perpendicular and above (according to **205. 1** (2) of the Rules), such damage may not be considered beyond the point of 0.3 L_f from the forward perpendicular.

(B) For cases of bottom damage which is applied to damage sustained in areas after the point of 0.3 L_f from the forward perpendicular (according to **205. 1** (2) of the Rules), such damage is to be considered up to the point corresponding to 0.3 L_f - 5.0 m from the forward perpendicular.

(2) For a type 3G ship less than 125 m in length(L_f) specified in **208. 1** (6) of the Rules, the ability to survive the flooding of machinery space is to be in accordance with the following (A) and (B):

(A) The ability to survive the flooding of machinery space is to be in accordance with the requirements **209. 1** (1) and (2) of the Rules.

(B) Where L_f is 70 m or more and less than 125 m, the areas under the curve at least within 20° range beyond the position of equilibrium are to be 0.0175 m · rad or more at final equilibrium after flooding.

(C) Where L_f is less than 70 m, the areas under curve are to be 0.0088 m · rad or more.

(3) In case the bulkhead in machinery space is watertight structure at the flooding of machinery space referred to in the preceding (2), around machinery space areas of superstructures located aft may be considered the spare buoyancy. In this case the doors located at bulkhead of machinery space are to be sliding watertight doors remotely operated from superstructure deck.

2. Standard of damage for small ships

Small ships specified in **208. 2** of the Rules are ships less than 70 m of L_f. Special dispensations except type 1G ships may be in accordance with the following (1) through (4) :

(1) The extent of damage and the standard of damage are to be complied with the requirements **205.** and **208. 1** of the Rules respectively.

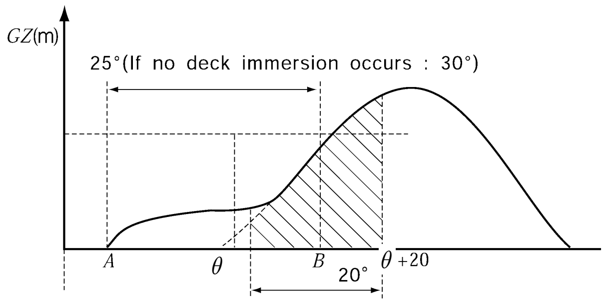
(2) It is to be in accordance with the requirements **209. 1** (1) and (2) of the Rules.
(3) The areas under the righting lever curve within 20° range beyond the position of equilibrium are to be 0.0175 m · rad or more at final equilibrium after flooding.
(4) The maximum values of residual righting lever is not limited.

209. Survival requirements

1. Survival requirements

(1) For the purpose of the requirements of **209. 1** (1) of the Rules, openings specified in the following (A) and (B) may be regarded as watertight flash deck openings.
(A) Openings protected by tank covers with strength equivalent to deck plating.
(B) Openings for cargo containment systems on the weather decks sealed with effectively packing of non-combustible material complied with the requirements in **Pt 8, Ch 1, 103.** (1) of the Rules or equivalent and of sufficient strength.
(C) Sounding pipe with closing head
(2) For the purpose of **209. 2** (1) of the Rules, openings capable of being closed weathertight whose immersion are accepted within the required range of residual stability are to be closed securely at final equilibrium after flooding. However, the requirement may not apply to float type air pipes with automatic closing systems in water.

2. For the purpose of **209. 2** (1) of the Rules, the righting lever curve may be considered to satisfy the requirements within the range of residual stability between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs) further through 20° from any arbitrary angle of heel within the residual stability range. (See **Fig 7.5.6** of the Guidance)



θ : any angle commencing between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs).

Fig 7.5.6

Section 3 Ship Arrangements

301. Segregation of the cargo area

1. Segregation of the hold space

(1) "Forward of machinery spaces of category A" referred to in **301. 1** of the Rules means to be located forward of the forward bulkhead (including the stepped or recessed portions) in machinery spaces of category A. (See **Fig 7.5.7** of the Guidance)

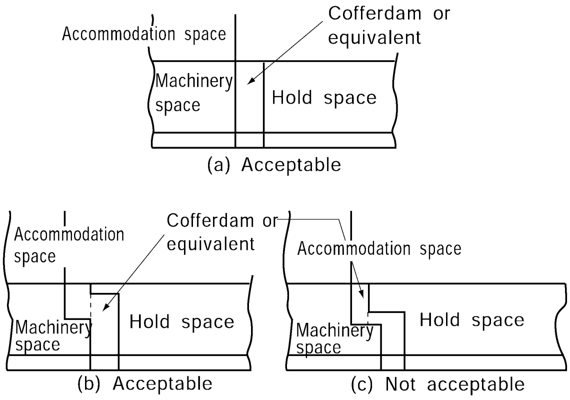


Fig. 7.5.7

(2) Where machinery spaces of category A are located forward of hold spaces, which "deemed necessary by the Society for the safety or navigation of the ship" specified in the requirements in **301.1** of the Rules, the following requirements (A) and (B) are to be complied with. Further, the Society may give additional requirements when deemed necessary. :
   (A) The requirements for fire protection and fire extinguishing for the machinery spaces of category A specified in **Pt 8** of the Rules are to be complied with.
   (B) The requirements for periodically unmanned machinery spaces specified in **Pt 6, Ch 2** of the Rules and **Pt 8, Ch 2** of the Guidance are to be complied with.

(3) Hold spaces are neither to be located forward of the collision bulkhead nor aftward of the aft peak bulkhead.

2. Segregation of the hold space in case of a cargo containment system not requiring secondary barrier

(1) "If there is no source of ignition or fire hazard" referred to in the requirements in **301. 2** of the Rules means those compartments such as ballast tanks, fresh water tanks, cofferdams, fuel oil tanks, cargo service spaces where there is no source of ignition and is not normally entered by persons, cargo pump rooms and cargo compressor rooms, etc.

(2) The packing used for bolted watertight manholes fitted on the boundaries of ballast tanks, cofferdams, fuel oil tanks from among the compartments referred to the preceding (1) may not be of non-combustible material.

3. Segregation of the hold space in case of a cargo containment system requiring secondary barrier

"If there is no source of ignition or fire hazard" referred to in the requirements in **301. 3** of the Rules means the compartments specified in **301. 2** (1) above.

4. Segregation of cargo piping

(1) For the purpose of the requirements in **301. 5** (1) of the Rules, combinations of a screw-down check valve and a check valve or of a spectacle flange and a stop valve are to be provided at the inter-connections of cargo or cargo vapour lines and inert gas lines necessary for the operation. (See **Fig 7.5.8** of the Guidance)

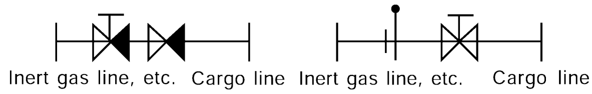


Fig. 7.5.8

(2) The screw-down check valve specified in the preceding (1) may be replaced with a combination of check valve and stop valve. Further, the spectacle flange may be replaced with a spool piece.

(3) "Vertical trunk-way" referred to in the requirements in **301. 5** (3) of the Rules is to comply with the following requirements (A) through (G) :

(A) The access opening in the vertical trunk-way is to comply with the requirements in **305. 3** of the Rules.

(B) The bilge discharge system in the vertical trunk-way is to comply with the requirements in **307. 1** (2) and **2** of the Rules.

(C) Pressure relief system complying with the requirements in **802. 2** of the Rules is to be provided.

(D) Inerting system complying with the requirements in **902. 2** of the Rules is to be provided.

(E) The electrical installations within the vertical trunk-way are to comply with the requirements in **1002. 3** (1) of the Rules.

(F) Ventilation system complying with the requirements in **1202.** of the Rules is to be provided.

(G) Gas detecting system complying with the requirements in **1306. 7** of the Rules is to be provided.

5. Emergency cargo jettisoning piping system

For the purpose of the requirements in **301. 6** of the Rules, the emergency cargo jettisoning piping system is to comply with the requirements in **308. 3** and **7** of the Rules. The Society may give additional requirements according to details of arrangement.

6. Openings for cargo containment system

"Arrangements for sealing the weather decks in way of openings for cargo containments systems" referred to in **301. 7** of the Rules means the arrangements complying with the requirements in **Pt 4, Ch 2, 102.** and 103. of the Rules.

302. Accommodation, service and machinery spaces and control stations

1. Segregation of hold spaces requiring a secondary barrier

"To be so located as to avoid the entry of gas from the hold space to such spaces through a single failure of a deck or bulkhead" referred to in **302. 1** of the Rules means that boundaries of the compartment are so arranged as not to make linear contact or point contact with hold spaces. (See **Fig 7.5.9** of the Guidance)

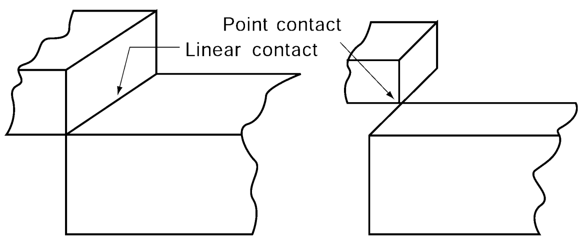


Fig. 7.5.9

2. Location of air intakes and openings in to accommodation spaces, etc.

Compliance with the requirements in **302. 4, 308. 4, 802. 10** and **1201. 6** of the Rules would also ensure compliance with the requirement in **302. 2** of the Rules. Air outlets are subject to the same requirements as air inlets and air intakes.

3. Arrangements of entrances, air inlets and openings

(1) Windows and side-scuttles "so designed that a rapid and efficient gas and vapour tightening of the wheelhouse can be ensured" referred to in **302. 4** of the Rules means those fitted with packing and clamping devices. These window and side scuttles are subject to hose tests or other suitable tests acceptable to the Society to verify their gas-tightness.
(2) In case where clear view screens are provided in wheelhouse within the restricted area specified in **302. 4** of the Rules, additional clamping devices are to be provided to the clear view screen or alternative arrangement of closing the window to make it gastight when the screen is not in rotating motion is to be made.
(3) The requirements in **302. 4** of the Rules may not apply to ships dedicated to the carriage of cargo which require neither F nor T in column f of **Table in Ch 5, Sec 19** of the Rules.

4. Closing devices of air intakes and openings

(1) For the purpose of the requirements in **302. 6** of the Rules, closing devices for air intakes and openings are to have suitable gas-tightness where steel made fire protection flaps without gaskets are not accepted.
(2) For the purpose of the requirements in **302. 6** of the Rules, the closing devices in ships intended to carry toxic products which require T in column f of the Table in **Ch 5, Sec 19** of the Rules, the following requirements (A) through (D) are to be complied with :
(A) The requirements in the preceding (1) are to be complied with.
(B) The compartments required to have closing means operable from inside are to be as follows :
(a) radio rooms and navigating rooms
(b) mess rooms and galleys
(c) cabins, lavatories, hospitals, etc.
(C) Internal closing required in (B) above is not required for such compartments not normally manned as listed below.
(a) deck store rooms
(b) forecastle store rooms
(c) engine room casings and steering gear compartments
(d) workshops
(e) cargo control rooms located within the cargo area
(D) When internal closing is required, this is to include both ventilation intakes and outlets.

303. Cargo pump rooms and cargo compressor rooms

1. Location

(1) For the purpose of the requirements in **303. 1** of the Rules, where cargo pump rooms and compressor rooms are permitted to be fitted at the after end of the after-most hold space or at the forward, the arrangements are, for example, as shown in **Fig 7.5.10** of the Guidance.

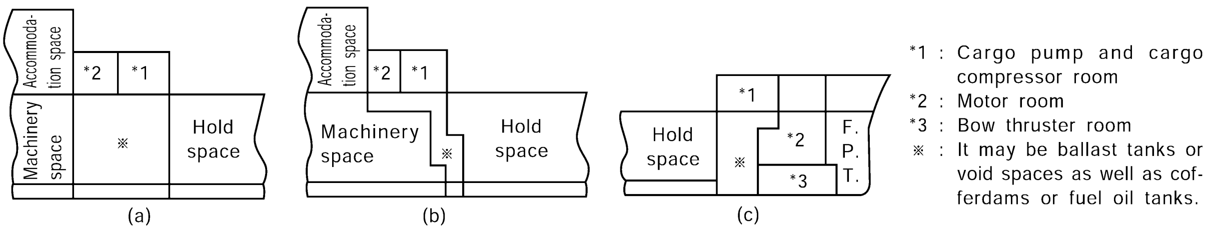


Fig. 7.5.10

(2) For the purpose of the requirements in **303. 1** (1) of the Rules, the arrangement that cargo pump rooms and cargo compressor rooms are located below the exposed deck is not accepted.
(3) The compartments within the cargo area extended according to the requirements in **303. 1** (2) of the Rules may not be regarded as gas-dangerous space as far as the following requirements (A) and (B) are complied with (See **Fig 7.5.11** of the Guidance). However, consideration is to be given to the requirements in **303. 1** (3) of the Rules.

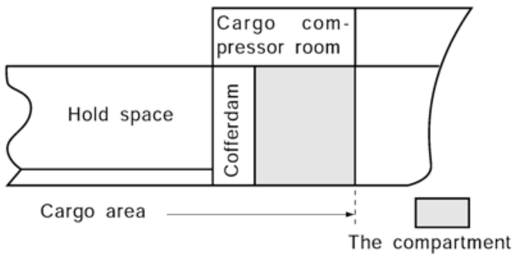


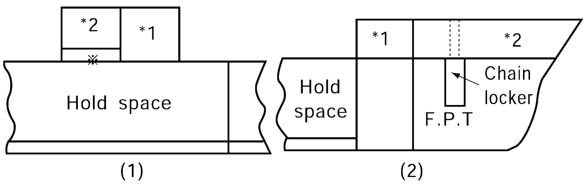
Fig. 7.5.11

(A) The access holes and air vents to the compartment are to have no openings to gas-dangerous space.
(B) The compartment is not to fall under any compartments specified in **106. 17** (1) and (2) of the Rules.

(4) The requirements in **303. 1** (3) of the Rules are also to apply to cases where cargo area is not extended according to the requirements in **303. 1** (2) of the Rules.

2. Gastight seal of shaft

(1) Shaft seals such as those manually feeding grease periodically are not considered as the "other means of ensuring the permanence of the gas seal" referred to in **303. 2** of the Rules.
(2) The shaft seals required in **303. 2** of the Rules are to be provided outside cargo pump rooms and cargo compressor rooms.
(3) The arrangement of motor rooms housing electric motors driving cargo pumps and cargo compressors referred to in **303. 2** of the Rules is to be as, for example, shown in **Fig 7.5.12** (1) of the Guidance. If the arrangement can not be complied with the above requirement in case of such as a small ship, it may be as, for example, shown in **Fig 7.5.12** (2) of the Guidance, where the openings of compartments such as chain lockers considered as the source of ignition are provided in the motor rooms, however, the openings are to be closed by steel watertight covers fitted with warning signs stating that "The openings are to be always kept closed. If opened, the motor room is to be sufficiently ventilated."
(4) The motor rooms referred to in the preceding (3) are to be arranged in gas-safe spaces.



*1 : Cargo pump and cargo compressor room
*2 : Motor room
※ : Cofferdam it is to be needed for the hold space having secondary barrier.

Fig. 7.5.12

3. Access and discharge of drainage

Drain plugs provided on the casing walls of the compartment for draining onto the exposed deck may be accepted, as the "Suitable arrangements...... to deal with drainage" referred to in **303. 3** of the Rules.

304. Cargo control rooms

1. Location

The boundaries where "A-60" class insulation is required according to the requirements in **304. 1** (2) of the Rules are to be as, for example, shown in **Fig 7.5.13** of the Guidance. The ceilings and floors of the cargo control room, asterisked in the drawing, are also to be applied with "A-60" class insulation.

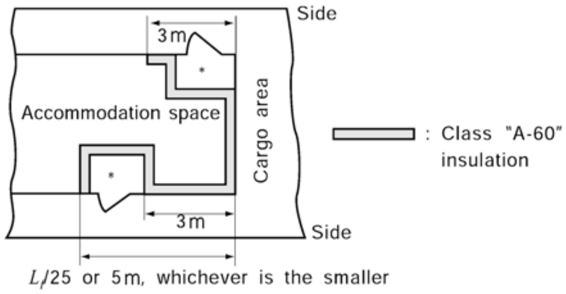


Fig 7.5.13

2. Source of ignition

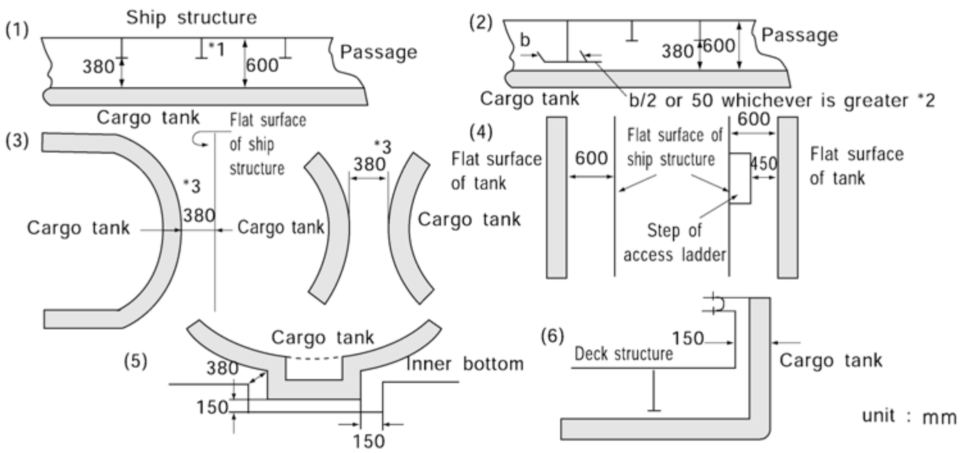
For the purpose of the requirements in **304. 3** of the Rules, the electrical installations in the cargo control room are to comply with the requirements in **1002.** of the Rules depending on the location of the room. The cargo control room is to be provided with mechanical ventilation complying with the requirements in **1201.** of the Rules.

305. Access to spaces in the cargo area

1. The minimum clearance for inspection required in the requirement of **305. 1** and **2** of the Rules are to be as shown in **Fig 7.5.14** of the Guidance.

2. Access for inspection of insulation

According to the requirements in **305. 2** of the Rules, neither visual inspection may be required on one side of the insulation in hold spaces of membrane tanks and semi-membrane tanks nor apply the requirements in **305. 3** of the Rules.



(Note)

1. *1 : This distance between the surface to be inspected and the surface to which structural elements are fitted may t at least 450*mm* in case of a curved tank surface (e.g. in case of type C independent tank).
2. *2 : Where the Surveyor does not require to pass between the surface to be inspected and any part of the structure.
3. *3 : Where the Surveyor does not require to pass between that curved surface and another surface, a smaller distanc than 380*mm* may be accepted taking into account the curved surface.
4. If necessary for inspection, fixed or portable staging is to be installed. This staging is not to impair the distances required in (1) to (4) of the picture.
5. If fixed or portable ventilation ducting has to be fitted in compliance with **1202.** of the Rules, such ducting is not to impair the distances required above (1) to (4) of the picture.

Fig 7.5.14 Cargo Tank Clearances for Inspection

3. The details of minimum opening size required in **305. 3** (1) (B) and (C) of the Rules are to be as shown in **Fig 7.5.15** of the Guidance.

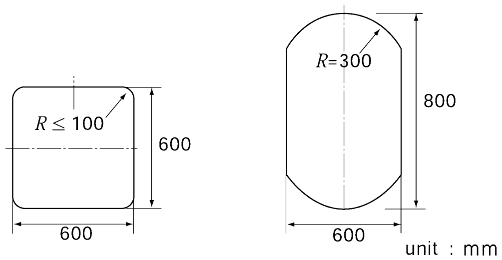


Fig 7.5.15 Minimum Opening Size

4. Access to spaces in the hold spaces, etc.

(1) In applying the requirements in **305. 3** (1) (B) of the Rules, type C independent tanks may have the access holes from exposed spaces with a diameter not less than 600 mm.
(2) In case where those tanks can not be provided with the access holes specified in the preceding (1) due to strength reasons in ships with L_f not more than 70 m, they may be replaced with circular holes with a diameter not less than 500 mm or oval holes with equivalent open area. However, they are to be sufficient to allow entry by a personnel wearing protective clothing and to allow unconscious personnel to be removed from the space.
(3) In case where direct or indirect access from open weather deck without access to gas-safe space, the requirements of **305. 3** (1) (B) and (C) of the Rules may not apply to spaces separated from hold spaces described in **106. 17** (4) (B) of the Rules.
(4) Access hole from weather deck specified in the preceding (3) may be opened at gas-dangerous space. In this case, it is to be applied the requirements for gas-dangerous space except the requirements of **305. 3** (1) (B) and (C) of the Rules.
(5) In applying the requirements in **305. 3** (3) of the Rules, access hole from the weather deck is to comply with the requirements in the preceding (4).

5. Access to gas-safe spaces

"Open weather deck" referred to in the requirements of **305. 4** of the Rules means the exposed part of the uppermost continuous deck within the cargo area.

306. Air-locks

1. Location of gastight doors

For the purpose of the requirements in **306. 1** of the Rules, the steel doors for air-lock are to be verified for their gas-tightness by hose tests or other means considered appropriate by the Society, as necessary.

2. Maintenance of overpressure in the protected space

For the purpose of the requirements in **306. 4** of the Rules, maintenance of overpressure in spaces protected by air-locks is to be by the differential pressure sensing devices provided within the compartment, but alternatively, either of the following method (1) or (2) may be employed :

(1) 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 :
(A) monitoring of current or power in the electrical supply to the ventilation motors ; or
(B) air low sensors in the ventilation ducts.
(2) In spaces where the ventilation rate is less than 30 air changes per hour and where one of the means specified in the preceding (1) is fitted, in addition, the arrangements are to be made to de-energize electrical equipment which is not of the certified safe type, if more than one air-lock door is moved from the closed position.

3. Ventilation

(1) For the purpose of the requirements in **306. 5** of the Rules, the ventilating fans for air-lock space and their air intakes are to be provided in the gas-safe space. However, in this case, the ventilating fans may not comply with the requirements in **1201.** of the Rules. Protection screens of not more than 13 mm×13 mm square mesh are to be fitted in outside openings of ventilation ducts.

(2) For the purpose of the requirements in **306. 5** of the Rules, verification of maintenance of pressure in spaces protected by air-locks is to be by, for example, monitoring of current in electrical supply to the ventilation motors, air flow sensors in the ventilation ducts or differential pressure sensing devices. The standard ventilation rate in the air-lock space is 8 air changes per hour.

307. Bilge, ballast and fuel oil arrangements

1. Drainage arrangements of hold spaces

(1) For the purpose of the requirements in **307. 1** (1) of the Rules, the drainage arrangements of hold spaces are to be of bilge pumps and bilge pipings provided with in the cargo area complying with the requirements in **Pt 5, Ch 6, Sec 4** of the Rules, or to be of bilge suction system by eductors. In the case of bilge eductors, those capacity and arrangement are to comply with the requirements in **Pt 5, Ch 6** of the Guidance and the total capacity of the eductor is not to be less than 40 m^3/hr.
(2) Where eductors are provided in accordance with the preceding (1), root valves are to be provided in driving water lines at the aft end of the cargo area, and the branch lines of the driving water line are to be fitted with screw-down check valves.
(3) For the purpose of the requirements in **307. 1** (1) of the Rules, the means to detect gas leakage in hold spaces, when the hold spaces are not inerted, may be commonly used for sounding pipes specified in **Pt 5, Ch 6, 203.** of the Rules. In case where the sounding pipes are provided together with gas leakage detecter, an automatic closing head is to be fitted at the each of upper end of the sounding pipes. When hold spaces are inerted, the requirements in (4) are to be complied with.
(4) For the purpose of the requirements in **307. 1** (2) of the Rules, the drainage arrangements of hold spaces are to comply with the requirements in the preceding (1) and (2). The means of detecting gas leakage in hold spaces is to be of the level alarm system of closed type complying with the requirements in **1302. 2** (3) of the Rules.
(5) Cofferdam and void spaces are also to comply with this Article.

2. Drainage system of interbarrier spaces

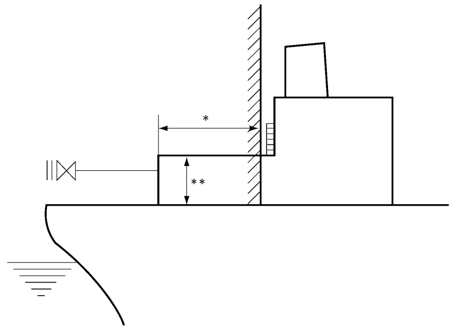
For the purpose of the requirements in **307. 2** of the Rules, the drainage arrangements for dealing with any leakage into the hold or insulation spaces are to comply with the following requirements (1) through (4) :

(1) Even in the case of a partial secondary barrier which is designed on condition that the total volume of leaked cargo would evaporate, the drainage arrangements are to be provided.
(2) In case where a complete secondary barrier is provided and estimation of leakage of liquid cargo is not carried out, the capacity of the drainage arrangements is to comply with the requirements in **Pt 5, Ch 6, Sec 4** of the Rules.
(3) The drainage arrangements to deal with the leaked cargo may commonly serve as those required in **307. 1** (2) of the Rules.
(4) The piping system of the drainage arrangements of leaked cargo is to comply with the requirements in **Sec 5** of the Rules. The water-driven eductor is not accepted as such arrangement.

308. Bow or stern loading and unloading arrangements

1. Arrangements of air inlets and openings

For the purpose of the requirements in **308. 4** of the Rules, the arrangements of air intakes and openings to accommodation spaces are, for example, not to be provided within the shadowed range in **Fig 7.5.16** of the Guidance.



* : $0.04L_f$ or 3m, whichever is the greater, but need not exceed 5m.
** : To be of the standard height of superstructure prescribed in the 1966 International Load Line Convention or more.

Fig 7.5.16

Section 4 Cargo Containment

402. Definitions

1. Integral tanks

In case where the design vapour pressure is made higher than 0.025 MPa in accordance with the requirements in **402. 1** (2) of the Rules, special consideration is to be given to stress concentration for the welding and detailed construction of cargo tanks.

2. Membrane tanks

In case where the design vapour pressure is made higher than 0.025 MPa in accordance with the provision to the requirements in **402. 2** (2) of the Rules, this vapour pressure is to be taken into account when model test specified in **404. 2** (2) of the Rules is conducted. In this case, special consideration is to be given to stress concentration for the welding and construction details of the adjacent hull structure.

3. "Recognized standards" of the requirements in **402. 4** (2) of the Rules means normally the requirements in **Pt 3, Ch 15** of the Rules.

4. In applying the requirements of **402. 4** (4) of the Rules, if the carriage of products (it is only applicable to products having a relative density exceeding 1.0) not covered by the requirements in **Pt 7, Ch 5** of the Rules is intended, the following requirements (1) and (2) are to be complied with :

(1) The double amplitude of the primary membrane stress $\triangle\sigma_m$ created by the maximum dynamic pressure differential $\triangle P$ is not to exceed the allowable double amplitude of the dynamic membrane stress $\triangle\sigma_A$ as specified in **402. 4** (4) of the Rules, ie: $\triangle\sigma_m \leq \triangle\sigma_A$.

(2) The dynamic pressure differential $\triangle P$ is to be calculated as follows:

$$\triangle P = P(a_{\beta 1}Z_{\beta 1} - a_{\beta 2}Z_{\beta 2})/1.02\times 10^5 \quad (\mathrm{MPa})$$

where P, a_β, Z_β are as defined in **403. 2** (2) of the Rules, see also **Fig 7.5.17** of the Guidance. $a_{\beta 1}$ and $Z_{\beta 1}$ are the a_β- and Z_β- values giving the maximum liquid pressure hgdmax as defined in **403. 2** of the Rules. $a_{\beta 2}$ and $Z_{\beta 2}$ are the ab and Z_β values giving the minimum liquid pressure hgdmin.

In order to evaluate the maximum pressure differential $\triangle P$, pressure differentials is to be evaluated over the full range of the acceleration ellipse as shown in **Fig 7.5.17** of the Guidance.

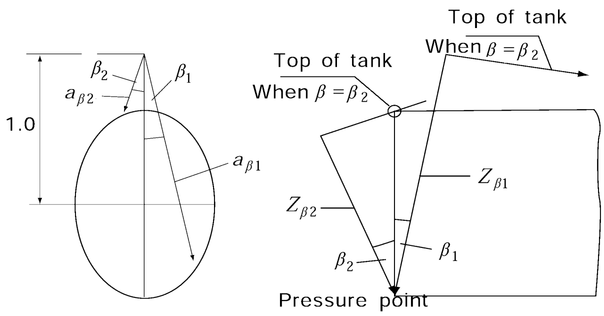


Fig 7.5.17 Acceleration Ellipse and Evaluation of Pressure Differentials

5. Design vapour pressure

For the purpose of the requirements in **402. 6** (2) of the Rules, when a design vapour pressure either higher or lower than 45°C is employed, the ambient temperature is to be of the highest atmospheric temperature of the sea area which is the permanent trade area of the ship obtained from the weather data covering a long period.

6. Design temperature

"Provision to the satisfaction of the Society" referred to in the requirements in **402. 7** of the Rules means the cargo temperature/pressure control systems and temperature indication system complying with the requirements in **Sec 7** and **Sec 13** of the Rules.

403. Design loads

1. General

(1) For the purpose of the requirements in **403. 1** (2) of the Rules, in the case of type B and C independent tanks, their stress levels under the pressure tests are to be confirmed that they are within the stress range specified in the **410. 10** (2) and (3) of the Rules.
(2) The cargo tanks other than those indicated in the preceding (1) are to be verified in strength undergoing the enough analysis required for each tank type in considering the internal pressure distribution at the time of the pressure test. However, when the detailed analysis is carried out, the preceding (1) may apply.
(3) For the purpose of the requirements in **403. 1** (4) of the Rules, the added mass due to hull damage or flooding may not be considered.

2. Internal pressure

(1) As the "Equivalent calculation procedures" referred to in the requirements in **403. 2** (1) of the Rules, the following (A) to (B) may be based upon :
(A) In the case of square tanks, the water head at arbitrary point j on the tank plate is to be obtained from the following equations :

$$h_j = h_{j \cdot st} + h_{j \cdot dyn} \quad \text{(MPa)}$$

$$h_{j \cdot st} = \frac{P_0 + \rho \cdot z_j}{1.02 \times 10^5} \quad \text{(MPa)}$$

$$h_{j \cdot dyn} = \frac{\rho \sqrt{(x_j \cdot a_x)^2 + (y_j \cdot a_y)^2 + (z_j \cdot a_z)^2}}{1.02 \times 10^5} \quad \text{(MPa)}$$

P_0 and ρ : as specified in **403. 2** of the Rules.
a_x, a_y and a_z : as specified in **Fig 7.5.18** of the Guidance and in **403. 2** of the Rules.
x_j, y_j and z_j (m) : as specified in **Fig 7.5.18** of the Guidance.

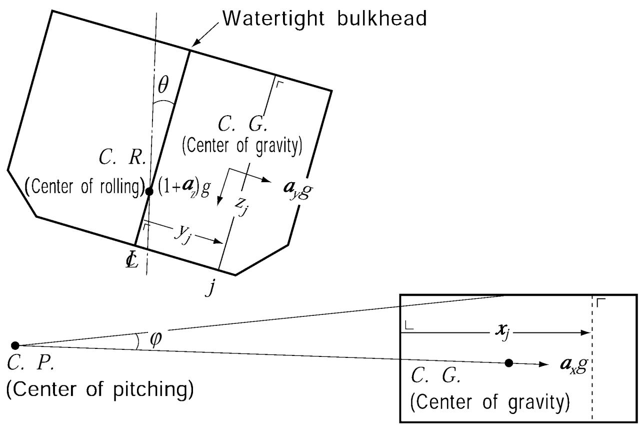


Fig. 7.5.18

(B) In the case of spherical tanks, pressure $P(\phi, \theta)$, at arbitrary point on the tank plate is to be obtained from the following equations :
(a) $P(\phi,\theta) = P(\phi,\theta)_{st} + P(\phi,\theta)_{dyn}$ ·· (MPa)

$$P(\phi,\theta)_{st} = P_0 + \rho \cdot R \cdot (1-\cos\theta)/(1.02\times10^5) \quad \text{(MPa)}$$

$$P(\phi,\theta)_{dyn} = \sqrt{P_1^2 + P_2^2 + P_3^2} \quad \text{(MPa)}$$

$$P_1 = \rho \cdot R(\sqrt{1+a_x^2} - a_x \cdot \sin\phi \cdot \cos\theta - 1)/(1.02\times10^5) \quad \text{(MPa)}$$

$$P_2 = \rho \cdot R(\sqrt{1+a_y^2} - a_y \cdot \sin\phi \cdot \cos\theta - 1)/(1.02\times10^5) \quad \text{(MPa)}$$

$$P_3 = \rho \cdot R \cdot a_z(1-\cos\theta)/(1.02\times10^5) \quad \text{(MPa)}$$

where ;

P_0, ρ, a_x, a_y and a_z : as specified in the preceding (A)

R : inner radius of sphere (m)

ϕ, θ : as specified in **Fig 7.5.19** of the Guidance.

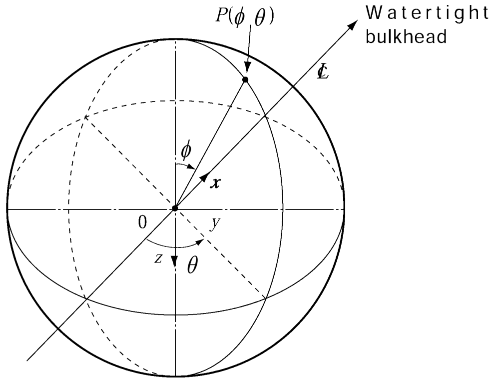


Fig. 7.5.19

(b) Notwithstanding the value specified in the preceding (a), the value of P is not to be less than the following value :

$$P(\phi,\theta)_{\min} = P_0 + \rho \cdot R(1+a_z) \cdot (1-\cos\phi)/(1.02\times10^5) \quad \text{(MPa)}$$

where;

P_0, ρ, R and a_z : as specified in the preceding (A).

(C) In the case of cylindrical tank arranged horizontally along the longitudinal direction of the ship, pressure $P(x_j, \phi)$ at an arbitrary point on the tank plate is to be obtained from the following equation :

(a) $P(x_j,\phi)_{st} = P_0 + \rho R(1-\cos\phi)/(1.02\times10^5)\ (1.02\times10^5)$ (MPa)

$$P(x_j,\phi)_{dyn} = \sqrt{P_1^2 + P_2^2 + P_3^2} \quad \text{(MPa)}$$

$$P_1 = \rho \cdot x_j \cdot a_x/(1.02\times10^7) \quad \text{(MPa)}$$

$$P_2 = \rho \cdot R(\sqrt{1+a_y^2} - a_y \sin\phi - 1)/(1.02\times10^5) \quad \text{(MPa)}$$

$$P_3 = \rho \cdot R \cdot a_z(1-\cos\phi)/(1.02\times10^5) \quad \text{(MPa)}$$

$$P(x_j,\phi)_{\min} = P_0 + \rho \cdot R(1+a_z)(1-\cos\phi)/(1.02\times10^5) \quad \text{(MPa)}$$

where;

P_0, ρ, a_x, a_y and a_z : as specified in the preceding (B)

R : inner radius of cylinder (m)

ϕ, x_j : as specified in **Fig 7.5.20** of the Guidance.

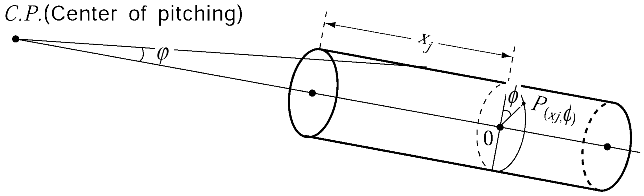


Fig. 7.5.20

(b) Notwithstanding the value specified in the preceding (a), the value of P is not to be less than the following value :

$$P(x_j, \phi)_{\min} = P_0 + \rho \cdot R(1+a_z)(1-\cos\phi)/(1.02\times 10^5) \cdots \ (\mathrm{MPa})$$

(2) For the purpose of the requirements in **403. 4** (3) of the Rules, the stress due to fatigue load may be generally determined by using the cumulative probability curve as shown in **Fig 7.5.21.**

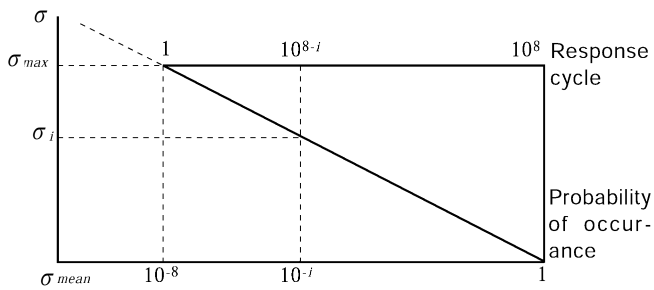


Fig. 7.5.21

(3) When the fatigue strength analysis specified in the requirements in **404. 5** of the Rules is carried out using the frequency distribution of cyclic stress shown in the preceding (2), the number of representative stress(σ_i) is to be eight, and σ_i and its number of repetition n_i may be obtained from the following equation :

$$\sigma_i = \frac{17-2 \cdot i}{16}\sigma_{\max}$$
$$n_i = 0.9\times 10^i$$

where :

i = 1, 2, ..., 8

σ_{max} : stress induced by the predicted maximum dynamic load (half amplitude)

(4) For the purpose of **403. 4** (4) of the Rules, the fatigue load used in the calculation of propagation speed of fatigue cracks is, as a rule, to be the predicted maximum load value that can occur at the most severe period in the trade area specified. In case where analysis is made by using the load frequency distribution given in **Fig 7.5.4** of the Rules, the number of representative stress(σ_i) is to be set at five and si and its number of repetition n_i may be obtained from the following equations :

$$\sigma_i = \frac{5.5-i}{5.3}\sigma_{max}$$
$$n_i = 1.8\times 10^i$$

where :

i = 1, 2, . . ., 5

σ_{max} : stress created by the predicted maximum load

(5) The "ships for restricted service" referred to in **403. 4** (5) of the Rules means those ships with notations "Coasting Service" or "Smooth Water Service" affixed. In this case, the dynamic load may be determined by the results of calculation of ship motions carried out on the basis of the data on sea and weather conditions at the navigating area which are considered appropriately by the Society.

3. Sloshing loads

(1) For the purpose of the requirements in **403. 5** of the Rules, sloshing loads are to be determined in such a way that assessments are made by model experiment for each type of cargo tanks. For cargo tanks where partial filling is intended, data concerning the resonant period of the hull and natural period of the liquids are to be available on board the ship for avoiding the danger of resonance.

(2) Notwithstanding the requirements in the preceding (1), in the type C independent tank in ships with L_f not exceeding 90 m, consideration for structural strength of cargo tanks due to sloshing loads may not be necessary. For tanks partial filling is intended, however, sufficient consideration is to be taken for the installation of equipment in cargo tanks such as cargo piping and cargo pump, against impact loads due to sloshing.

4. Thermal loads

(1) For the purpose of the requirements in **403. 6** (1) of the Rules, arrangements for cooling down are to be provided so as not to cause excessive stress on the tank structures. Further, where cargo with temperature lower than 0°C but not lower than -55°C is carried, such installations for cooling down are also to be provided.

(2) The arrangements shown in the preceding (1) are to be such that safety in cooling down using the arrangements has been proved by records of cargo tanks of similar design or cooling down operation is performed at a rate not exceeding the safe temperature reduction curve which has been proved by thermal stress analysis.

(3) The installations shown in the preceding (1) are to be also capable of performing cooling down at time when excessive thermal loads may be anticipated due to splashing of the residual cargo liquid in ballast passage of the ship under heavy weather as well as at time of cargo loading.

(4) For the purpose of the requirements in **403. 6** (2) of the Rules, no thermal stress analysis may be required for cargo tanks with design temperature of -10°C or upward, in general. In cargo tanks with design temperature at -55°C or below, the structural strength is to be verified through thermal stress analysis by taking into account the vertical temperature distribution at time of cooling down and partial cargo loading, and when necessary, the temperature distribution in the direction of the plate thickness of plating of full loaded tanks.

(5) For tanks other than those specified in the preceding (4), the Society may request thermal stress analysis of the cargo tank by taking into account the constraining condition of the cargo tank by tank supporting structure in case where the tank supporting system is special, and thermal analysis in consideration of the effect of materials with different coefficients of thermal expansion in case where such materials are used.

(6) In the cases referred to in the preceding (4) and (5) where the type of tank supporting system is special, the Society may request thermal analysis on the tank supporting structure itself.

404. Structural analysis

1. Membrane tanks

(1) For the purpose of the requirements in **404. 2** (1) of the Rules, in the assessments of plastic deformations and fatigue of the membrane and thermal insulation materials, all static and dynamic stresses and thermal stress specified in **403.** of the Rules are to be taken into account.

(2) In the assessments referred to in the preceding (1), verification is to be made through fatigue tests on a model combining the elements of the tank, secondary barrier, insulation structure and tank supporting structure considering the dimensional effects on real tank and the effects of dispersions in materials and fabrication accuracy as an integral part of the test specified in **404. 2** (2) of the Rules.

(3) Tests specified in the requirements in **404. 2** (2) of the Rules, are to be conducted on a model in combination of the primary barrier, insulation structure and secondary barrier. Test object and testing procedure are to be determined for each type of tank in each case.

(4) The assessments of collapse of the membrane referred to in the requirements of **404. 2** (4) of the Rules are to be made in accordance with the following requirements (A) to (C) :

(A) For overpressure and negative pressure in the interbarrier space, collapse test is to be conducted on a prototype model of the membrane to verify its ultimate strength.

(B) For sloshing loads, impact load experiment is to be carried out on a prototype model of the membrane to verify its strength when the Society considers necessary.

(C) For vibrations, the natural frequency of the membrane is to be determined whereby it is to be verified that the membrane does not undergo resonance with the vibrations excited by propeller and main engine.

(5) For the purpose of the requirements in **404. 2** (5) of the Rules, the hull structure adjacent to membrane tanks is to comply with the requirements in **Pt 3, Ch 15** of the Rules and, in addition, the stress in the hull structure is to be restricted in consideration of the structural strength of membrane tanks, if necessary. The allowable stresses of the membrane, membrane supporting structures and insulation materials are to be determined in each case according to the mechanical properties of materials, records of construction, product specifications and levels of product quality control practice.

2. Semi-membrane tanks

(1) For the purpose of the requirements in **404. 3** of the Rules, stress analysis is to be carried out on the structural members of cargo tanks in consideration of the loads specified in the requirements in **403.** of the Rules. In this case, the requirements in **405. 1** (4) of the Rules apply correspondingly to the allowable stress.

(2) For stress analysis referred to in the preceding (1), the Society may request model test to verify the accuracy in such stress analysis or stress measurements at time of pressure test of cargo tanks when the Society deems necessary.

3. Type A independent tanks

(1) For the purpose of the requirements in **404. 4** (1) of the Rules, the corrosion allowance may be reduced or may not be required in accordance with the requirements in **405. 2** of the Rules. In structures where the membrane or axial force due to internal pressure can not be neglected, the calculation equation specified in **Pt 3, Ch 15** of the Rules may be used after suitable modification.

(2) In case where no corrosion allowance specified in **405. 2** of the Rules is required in accordance with the preceding (1), stiffeners may have section modulus more than 1/1.2 of one required in **Pt 3, Ch 15, Sec 2** of the Rules.

(3) For the purpose of the requirements in **404. 4** (2) of the Rules, the following (A) to (C) are to be considered for loads and ship deflections.

(A) Ship deflections due to longitudinal bending moment in waves and longitudinal still water bending moment.

(B) Ship deflections due to horizontal bending moment in waves and twisting moment, when necessary due to type of supporting structures.

(C) Internal pressure specified in **403. 2** of the Rules.

4. Type B independent tanks

In applying the requirements in **404. 5** of the Rules, the following requirements (1) through (10) are to be complied with :

(1) The cargo tank structure is to be analyzed by three dimensional frame structural analysis method or finite element method. The model for the analysis is to include concerned hull structures and support construction considering ship deflections and local deflections of hull due to vertical, horizontal and twisting moments.

(2) The strength members of cargo tanks are to be computed in details by the finite element method. In case where compatible results can be obtained, however, the frame structural analysis method may be used in replacement therewith.

(3) In the preceding (1) and (2), dynamic loads necessary for the calculation of interactions between the hull and cargo tanks specified in **404. 5** (2) of the Rules are, as a rule, to be determined by long-term distribution in accordance with the requirements in **403. 4** and **404. 5** (3) of the

Rules where the most probable largest load in terms of the probability of occurrence as deemed appropriate by the Society is to be used. The dynamic stress(σ_{dyn}) due to such loads are to be evaluated for their phase difference according to the requirements in **405. 1** (9) of the Rules, and the total stress including dynamic stress is to be the sum of such dynamic stress and static stress(σ_{st}). However, the load within cargo tanks may be considered as the internal pressure specified in the requirements in **403. 2** (2) of the Rules by using the value of long-term distribution of acceleration computed by direct calculation according to the requirements in **403. 4** and **404. 5** (3) of the Rules.

(4) The scantlings of cargo tank plates and stiffeners fitted to tank plates are to the satisfaction of the Society in consideration of the stress distribution and the mode of stress.

(5) In case where bulkheads are provided in cargo tanks, the scantlings of bulkhead plates and stiffeners fitted to the bulkhead plates are to the satisfaction of the Society.

(6) The strength members in cargo tanks are to be subjected to fatigue strength analysis for both the base metal and welded joints of high stress regions and stress concentration regions. S-N curves are to be plotted by experiment by the taking into account the following (A) through (F) :

(A) Shape and size of test specimen
(B) Stress concentration and notch sensitivity
(C) Mode of stress
(D) Mean stress
(E) Welding conditions
(F) Ambient temperature

In the experiment, the number of test specimen is to be determined statistically and S-N curves are to be plotted against non-destruction probability P = 50 %.

(7) Relative to the design standards for the secondary barrier, the crack propagation analysis specified in the requirements in **404. 5** (1) of the Rules is to be carried out to verify that the assumed initial cracks would not reach the critical crack length in a period. The rate of cargo leakage is to be computed on the basis of the crack length obtained by this analysis.

(8) It is to be verified that the cargo tank plates and associated structural members have sufficient strength against compressive buckling, tripping buckling of stiffeners, shearing buckling, and bending buckling of tripping brackets.

(9) The cargo tank plates and stiffeners are to have such scantlings as not to be caused harmful effects by resonance with the vibrations of exciting sources. The natural frequencies of the cargo tanks and stiffeners used in the above assessment are to be the minimum values in a state in contact with cargo liquid.

(10) The accuracy in stress analysis is to be verified by model tank test or pressure measurements taken at time of pressure tests on a real ship in accordance with the requirements in **410. 13** of the Rules.

5. Type C independent tanks

(1) For the purpose of the requirements in **404. 6** of the Rules, for the scantlings, shapes and reinforcements of openings of cargo tanks against internal pressure in cargo tanks, the requirements for Class 1 pressure vessels in **Pt 5, Ch 5** of the Rules apply.

(2) The "standard acceptable to the Society" referred to in the requirements in **404. 6** (2) of the Rules means such standards as KS, ASME, etc. P_4 among design external pressure P_0 is to be the value computed by applying the requirements in **Pt 3, Ch 10, Sec 2, Ch 16, Sec 2** and **Ch 17, Sec 2** of the Rules corresponding to the location of the tanks.

405. Allowable stresses and corrosion allowances

1. Allowable stresses

(1) The "classical analysis procedures" referred to in the requirements in **405. 1** (3) of the Rules means the beam theory where the type of stress to be assessed is the combined stress of bending stress and axial stress.

(2) For the purpose of the requirements in **405. 1** (3) of the Rules, the allowable stress for the equivalent stress σc when detailed stress calculations are made on primary members is to be as given in **Table 7.5.1** of the Guidance.

Table 7.5.1 Allowable Stresses for the Primary Equivalent Stress

Ferrite steels	Austenitic steels	Aluminium alloys
0.79 R_e	0.84 R_e	0.79 R_e
0.53 R_m	0.42 R_m	0.42 R_m
(Note) For each member, the smaller of the above values is to be used with R_e and R_m as specified in **405. 1** (7) of the Rules		

(3) For the purpose of the requirements in **405. 1** (5) of the Rules, the allowable stress for the primary stress of the prismatic Type B independent tanks is to be in accordance with the requirements in **405. 1** (4) of the Rules.

(4) For the purpose of the requirements in **405. 1** (7) of the Rules, the values of R_e and R_m when the strength of welds is less than that of the parent metal as in the case of 9 % nickel steel are to be of the required values of mechanical properties of the weld metal. For welded joints of aluminium alloys R5083-O and R5083/5183 and 9 % nickel steel, the values of R_e and R_m may be modified in consideration of the increase in the yield stress and tensile stress at low temperature after taking into account the welding procedure employed.

(5) Permissible stresses in way of supports of type C independent tanks made of carbon manganese steel.

(A) For the purpose of the requirements in **405. 1** of the Rules, the following criterion for the allowable stresses in way of supports of type C independent tanks made of carbon manganese steel may be used:

$$\sigma_e = \sqrt{(\sigma_n + \sigma_b)^2 + 3\tau^2} \le \sigma_a$$

where:

σ_e : equivalent stress($\mathrm{N/mm^2}$)

σ_n : nominal stress in the circumferential direction of the stiffening ring ($\mathrm{N/mm^2}$)

σ_b : bending stress in the circumferential direction of the stiffening ring ($\mathrm{N/mm^2}$)

τ : shear stress in the stiffening ring ($\mathrm{N/mm^2}$)

σ_a : allowable stress ($\mathrm{N/mm^2}$), to be taken as the smaller of the values:

0.57 R_m or 0.85 R_e

R_m and R_e as defined in **405. 1** (7) of the Rules

Equivalent stress values Re is to be calculated over the full extent of the stiffening ring by a procedure acceptable to this Society, for a sufficient number of load cases as defined in **406. 2** and **3** of the Rules.

(B) The following assumptions are to be made for the stiffening rings:

(a) The stiffening ring is to be considered as a circumferential beam formed by web, face plate, if any, and associated shell plating.
The effective width of the associated plating should be taken as:

(i) For cylindrical shells:
an effective width (mm) not greater than 0.78 $\sqrt{rt}$ on each side of the web.
A double plate, if any, may be included within that distance.
where:
r = mean radius of the cylindrical shell (mm)
t = shell thickness (mm)

(ii) For longitudinal bulkheads (in the case of lobe tanks):
the effective width (mm) is to be determined according to established standards.
A value of 20 tb on each side of the web may be taken as a guidance value.
where:
t_b = bulkhead thickness (mm)

(b) The stiffening ring is to be loaded with circumferential forces, on each side of the ring, due to the shear stress, determined by the bi-dimensional shear flow theory from the shear force of the tank.

(C) The following factors are to be taken into account:

(a) Elasticity of support material (intermediate layer of wood or similar material)

(b) Change in contact surface between tank and support, and of the relevant reactions, due to:

- thermal shrinkage of tank
- elastic deformations of tank and support material

The final distribution of the reaction forces at the supports is not to show any tensile forces.

(D) The buckling strength of the stiffening rings is to be examined.

2. Corrosion allowances

(1) The corrosion allowance "where there is no environmental control around the cargo tank, such as inerting" referred to in the requirements in **405. 2** (1) of the Rules, in the case of steel, is to be 1 mm. Except for tanks carrying cargoes containing considerable amounts of impurities or corrosive substances such as chlorine and sulfur dioxide, no corrosion allowance may be required for aluminum alloys and stainless steel.

(2) For the purpose of the requirements in **405. 2** (2) of the Rules, no corrosion allowance may be required for the internal surface of pressure vessels including the Type C independent tank except for the case where corrosive substances are to be loaded. For the exterior surface where there is no environmental control around the cargo tank such as inerting or where there is no protection by suitable insulation materials having the approved vapour barrier, the corrosion allowance for steel is to be the smaller of 1 mm or 1/6 of the required thickness excluding the corrosion allowance.

(3) In case where no corrosion allowance is considered for cargo tanks protected by insulation according to the requirements in **405. 2** (2) of the Rules, the gastightness of the vapour barrier of insulation structure is to have been verified. This gastightness is to be verified in the test of insulation specified in the requirements in **409. 7** of the Rules.

406. Supports

1. General

In spaces between the refrigerated tanks and supports, suitable insulation materials are to be provided so that hull structure might not be cooled excessively through the supporting structures according to the requirement of **408. 1** of the Rules.

2. Provision against the rotational effect

(1) The analysis of supporting structures against the load conditions specified in **406. 2** and **3** of the Rules is to be done while giving considerations to the following conditions (A) and (B) :

(A) A condition where static load by the weight of cargo tank containing the cargo at a static heel angle of 30° and the static sea water pressure without dynamic pressure due to waves is imposed.

(B) A condition where load by the weight of cargo tank containing the cargo with the acceleration caused by ship motions specified in the requirements in **406. 3** of the Rules and the dynamic seawater pressure due to waves are imposed. Such dynamic sea water pressure due to waves may be determined by the requirements in **Pt 7, Ch 3, 103.** of the Rules.

(2) The results of analysis for the conditions indicated in the preceding (1) are not to exceed the allowable stress determined in consideration of the requirements in **405. 1** of the Rules depending on type of cargo tanks. Further, sufficient safety factor against the critical buckling stress is to be considered.

407. Secondary barrier

1. Hull structure acting as a secondary barrier

(1) For the purpose of requirements in **407. 2** (2) of the Rules, thermal stress analysis is to be carried out for the calculation condition in case of cargo leakage specified in the requirements in **409. 1** of the Rules.
(2) The combined stress of the maximum membrane stress or the maximum bending stress obtained in the analysis of the preceding (1) and the static stress created by the static load specified in the requirements in **403.** of the Rules is not to exceed 90 % of the yield stress of the material.
(3) In the ship designed under the same design temperature and loading conditions of similar ships where it is verified that the thermal stress is sufficiently small, the Society may accept omission of the analysis referred to in the preceding (1).

2. Tank type and secondary barrier

The conditions for approving partial secondary barrier for the semi-membrane tanks specified in Note 2 of **Table 7.5.2** of the Rules are to be in accordance with the following (1) through (6) :

(1) Detailed stress analysis is to be carried out. Wave loads as the design load are to be assumed in details according to the requirements in **403. 4** of the Rules. The results of stress analysis are to be verified for the accuracy by measuring the stresses at time of pressure tests on a real ship or model test.
(2) The results of stress analysis under the requirements in the preceding (1) are not to exceed the allowable stress specified in the requirements in **405. 1** (4) of the Rules.
(3) The requirements in **404. 4** (6), (7) and (9) of the Guidance are to be complied with.
(4) Cargo tanks are to be subjected to buckling analysis depending on their structural type whereby it is to be verified that they have sufficient strength against buckling.
(5) Repair procedures for cargo tanks are to be established. On the fatigue strength and crack propagation analysis in case such repair procedures have been applied, assessments are to be carried out by applying the requirements in **404. 4** (6) and (7) of the Guidance correspondingly.
(6) The hull structure adjacent to cargo tanks is to be subjected to strength analysis compatible with the case of cargo tanks. In addition to carrying out detailed stress analysis by the method of which accuracy has been verified by stress measurements, etc., it is to be verified that the strength is sufficient through the fatigue strength analysis and crack propagation analysis done by applying the requirements in **404. 5** of the Rules correspondingly.

3. Standards of secondary barrier

(1) For the purpose of the requirements in **407. 4** of the Rule, the secondary barriers of nonmetal material are to conform to the following requirements (A) to (C) :
  (A) Compatibility with the cargo is to have been verified, and to have necessary mechanical properties at the cargo temperature under the atmospheric pressure.
  (B) A model test may be required to prove that the secondary barrier has effective performance when the Society deems it necessary.
  (C) For welded joints, welding procedure tests and production test are to be conducted. The test plans for the above are to have been approved by the Society beforehand.
(2) For the purpose of the requirements in **407. 4** (1) of the Rules, no special analysis of the complete secondary barrier for verifying that "it is capable of containing any envisaged leakage of liquid cargo for a period of 15 days" may be carried out except for cases where the Society deems it specially necessary.

4. Extent of secondary barrier

(1) For the purpose of the requirements in **407. 5** of the Rules, the extent of the secondary barrier is, at least, to cover the surface of leaked liquid cargo corresponding to a static heel angle of 30°.
(2) The "surface of leaked liquid cargo" referred to in the preceding (1) means a surface of fully leakage of fully loaded cargo for the complete secondary barrier, and of liquid cargo determined in accordance with the requirements in **407. 6** of the Rules for the partial secondary barriers.
(3) For spaces outside the extent of the secondary barriers specified in the preceding (1), the hull structures are to be protected against splashes of leaked cargo by the spray shields specified in the requirements in **407. 6** (2) of the Rules, or the extent of the secondary barrier is to be suitably extended.

5. Partial secondary barrier

(1) For the purpose of the requirements in **407. 6** of the Rules, the protection of the inner bottom plating at the lower part of cargo tanks is to conform to the following requirements (A) and (B) :

(A) According to the requirements in **407. 2** of the Rules, the inner bottom plating is to act as the secondary barrier.

(B) In case where a drip tray is provided as a secondary barrier for example as shown in **Fig 7.5.22** of the Guidance with consideration so as not to allow the leaked liquid cargo to overflow from the secondary barrier, no protection may be required. However, where no such consideration is taken, the inner bottom plating is to be protected by insulation materials.

(2) The spray shield specified in the requirements in **407. 6** (2) of the Rules is to have been verified by test that it has satisfactory performance to act as the shield.

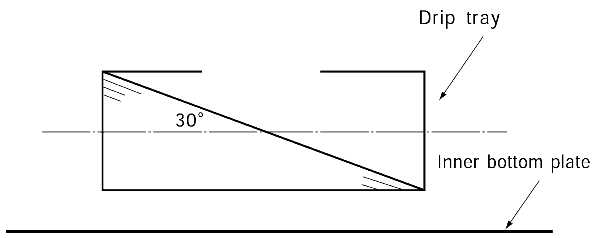


Fig. 7.5.22 Drip Tray to Protect the Inner Bottom Plate

6. Periodical survey of secondary barrier

(1) For the purpose of the requirements in **407. 7** of the Rules, the test procedure where visual inspection of the secondary barrier is not possible is to be in accordance with the following requirements (A) to (C) :

(A) The inspection method of the secondary barrier and its criteria relating to the performance to act as the secondary barrier are to be verified for their effectiveness through model test.

(B) The secondary barrier is to be verified by model test for the required performance. This model test is to be capable of verifying that the secondary barrier can maintain the necessary performance throughout the life of the ship.

(C) When sufficient data to prove the effectiveness and reliability relative to the preceding (A) and (B) are submitted to the satisfaction of the Society, this model test may be omitted.

408. Insulation

1. Protection of hull structure for low temperature products

For the purpose of the requirements in **408. 1, 2** and **3** of the Rules, the calculation conditions in computing the temperature of hull structures are to be in accordance with the following (A) through (D) :

(A) The loading condition of the ship for the calculation is to be full loaded condition.

(B) At the upright cargo leakage is to be considered for the calculation in accordance with the following (a) through (d). However, no leakage may be considered for integral tanks and type C independent tanks.

(a) It is to be assumed that the failure of all cargo tanks located between transverse watertight bulkheads are caused. However, in case where the cross section of the ship is divided into more than one compartments by longitudinal bulkheads of the ship, it is to be assumed that the failure of all cargo tanks within each such compartment is caused.

(b) It is to be assumed that the locations of the failure of the cargo tank cover all conceivable ones.

(c) It is to be assumed that only the liquid cargo leaks out where the cargo tank, supports and hull remain intact without involving any deflections or fracture.

(d) For cargo tanks where the complete secondary barrier is required according to the requirements in **407. 3** of the Rules, it is to be assumed that the leakage of liquid cargo occurs instantaneously and the levels of residual liquid cargo in damaged cargo tank and the leaked liquid level in the hold space reach the same level instantaneously.

(C) The boundary conditions of the calculation mode1 are to be in accordance with the following requirements (a) through (k) :

(a) The temperature of the compartment adjacent to hold spaces is to be determined by heat transmission calculation. The atmosphere of the compartment which is adjacent to the compartment contiguous to hold space may be taken as a still air at 0°C. In the case of machinery space, it may be assumed as a still air at 5°C.

(b) It is to be assumed that there is no radiation of sun beam.

(c) The atmospheric air and sea water are to be assumed as still atmospheric air at 5°C and still sea water at 0°C respectively.

(d) The structures in hold space such as insulation materials and supports are to be assumed that they do not absorb liquid cargo.

(e) In compartments where gases exist other than in hold spaces, it is to be assumed that they are in natural convection.

(f) It is to be assumed that the gas and liquid within the same compartment are at the same temperature.

(g) At time of damage to the cargo tank, the gaseous phase in the cargo tank and that in hold spaces are to be assumed to have a pressure equals to the atmospheric pressure.

(h) It is to be assumed that there is no transfer of gases within the insulation materials.

(i) It is to be assumed that there is no influence of moisture.

(j) The temperature of the secondary barrier in a state of leakage is to be assumed to be the same as the cargo temperature at the atmospheric pressure, whereas the temperature of the intact cargo tank is the design temperature. The ship is to be assumed to stay upright.

(k) It is to be assumed that there is no influence of paints.

(D) The calculation conditions in heat transmission calculation are to be in accordance with the following requirements (a) through (i) :

(a) Temperature distribution and heat transmission are to be dealt with as the phenomena in a steady state. No transient condition may be considered.

(b) Sea water is to be assumed to have a density of 1,025 kg/m^3 and a coagulation point of 2.5°C with physical properties compatible with those of fresh water for other items.

(c) The liquid cargo is to be assumed to have uniform temperature distribution.

(d) The heat transfer coefficients at various boundaries can be computed by using the numeral values given in **Table 7.5.2** of the Guidance, but calculation may be carried out by using empirical equations given in the heat transfer engineering data which has been made public. In this case, heat transfer due to radiation is also to be taken into account.

Table 7.5.2 The Heat Transfer Coefficient at Various Boundaries

Boundaries	Heat transfer coefficients ($W/m^2 \cdot °C$)
Still gas ← → Hull or liquid	5.8
Still sea water ← → Hull	116.3
Cargo vapour ← → Hull contacted to air	11.6

(e) The substance for which temperature distribution is investigated is to be assumed to be of homogeneous one without directivity.

(f) Frames may be dealt with as fins.

(g) In case where hold spaces located forward and afterward the hold space under study are in the same conditions, they may be treated as a two dimensional problem.

(h) The cooling effect by the latent heat of evaporation of the liquid cargo may not be taken into account.

(i) The temperature of structural members is to be represented by the temperature at their half thickness, and for individual members, the following requirements (i) through (iv) are to be complied with :

(i) The temperature of those frames fitted to plates is to be assumed to be the same as the temperature of the plates, but when the temperature distribution of the frame in the direction of depth is known, the area mean of the temperature distribution may be taken.

(ii) The temperature of web frames supporting frames or plates is to be the temperature at their half depth for webs, and the temperature of face plates for these.
(iii) The temperature of members connecting the inner shell and outer shell, e.g., brackets and girders is to be of the mean of the temperature of the inner shell and that of the outer shell.
(iv) The temperature of brackets is to be the temperature at their centroid.

409. Materials

1. Hull material not forming secondary barrier

(1) For the purpose of the requirements in **409. 4** of the Rules, brackets, panel breakers on such as girders, tripping brackets and docking brackets provided to prevent buckling of structural members may be excluded from the application of the requirements.
(2) Notwithstanding the requirements in the preceding (1), for longitudinal strength members and stiffeners in deep tanks and watertight bulkheads among those shown above the requirements apply.

2. Insulation materials

(1) For the purpose of the requirements in **409. 5** of the Rules, insulation materials of independent tanks and integral tanks are to be free from generating harmful defects that degrade the insulation performance even under such conditions of service that can actually take place in insulation structure including forced deflection and thermal expansion and contraction.
(2) The performance referred to in the preceding (1) is to be verified in the insulation procedure test specified in 5 below as necessary.

3. Protection of insulation

For the purpose of the requirements in **409. 6** of the Rules, insulation materials are to be protected in accordance with the following requirements (1) to (3) :

(1) For insulation materials installed in hold spaces and tank covers, no fire protections and protections for mechanical damage may be provided except for cases where such are specially necessary. However, these insulation materials are to be applied with coating or subjected to surface treatment with aluminium foil, etc.
(2) Insulation materials provided at exposed areas are to be protected by galvanized iron sheets or to be of the non-combustible insulation materials specified in the requirements in **Pt 8, Ch 1, 104.** (1) of the Rules applied with moisture-resistant coating. In case where the Society deems necessary, provision of steel covering may be requested as a protection against mechanical damage.
(3) The coating materials to be applied on the surface of insulation materials are to comply with the requirements in **Pt 8, Ch 1, 308. 2** of the Rules or equivalent.

4. Properties of insulation materials

(1) For the purpose of the requirements in **409. 7** of the Rules, the properties of insulation materials are, in general, to be verified by the tests given in **Table 7.5.3** of the Guidance.
(2) In addition to complying with the requirements in the preceding (1), property verification test may be requested by the Society depending on the insulation system.
(3) If the material, which has been approved according to the Guidance given by the Society, satisfies the performance requirements and such performance is considered to serve the purpose, the tests referred to in the preceding (1) may be omitted.
(4) For insulation materials to which the requirements in the preceding (1) to (3) do not apply, the following requirements (A) and (B) are to be complied with :
   (A) For insulation materials used for supports of independent tanks, the requirements given in the column of membrane tank and semi-membrane tank in **Table 7.5.3** of the Guidance apply.
   (B) For insulation materials provided in cargo tanks to which no provision of insulation is required according to the requirements in **408.** of the Rules, data on the necessary properties of those specified in **409. 7** (1) of the Rules depending on the insulation system is to be submitted to the Society.
(5) The test method for the properties specified in **409. 7** (1) of the Rules is to be **Table 7.5.4** of the Guidance or to the satisfaction of the Society.

5. Quality control of insulation materials

"The satisfaction of the Society" referred to in the requirements in **409. 8** of the Rules means as shown in the following (1) and (2):

(1) The insulation materials are to be approved in accordance with the Guidance. In the above, tests and inspection are to be conducted according to the procedures on the manufacture, storage, handling and product quality control established by the manufacturer.

(2) The inspection for insulation work is to include the following items of tests and inspections (A) to (C):

(A) Insulation procedure test
For insulation system and insulation procedure without previous records, tests are to be conducted in accordance with the test plan approved by the Society. The test may be conducted at the manufacturer of insulation materials or shipyard as necessary.

(B) Insulation production test
In accordance with the test plan approved by the Society in advance, tests are to be conducted to verify the work control, working environment control and product quality control during insulation procedure.

(C) Completion inspection
After the insulation work is completed, inspection is to be conducted for dimensions, shape, appearance, etc. in accordance with the procedures already approved by the Society, and in addition, the insulation performance is also to be verified in the test specified in **410. 14** of the Rules.

Table 7.5.3 Properties of Insulation Material for Cargo Tank Types

No.	Ensuring items		Integral tank	Membrane/ semi-membrane tank[3]	Type A/B independent tank	Type C independent tank	Internal insulation tank[4]	Note
1	Compatibility with the cargo			○[1]	○[1]		○	
2	Solubility in the cargo			○[1]	○[1]		○	
3	Absorption of the cargo		□	○[1]	○[1]		○	
4	Shrinkage			○[1]	○[1]	○	○	
5	Aging		□	○	○[1]	□	○	
6	Closed cell content		△	△	△	△	△	applied only to closed cell material
7	Density		○	○	○	○	○	
8	Mechanical properties	Bending strength	○	○	○	○	○	
		Compress. strength		○			○	
		Tensile strength	○	○	○	○	○	
		Shearing strength	○	○	○[2]	○[2]	○	
9	Thermal expansion		□	○			○	
10	Abrasion			○	△[1]		○	
11	Cohesion		□	△		□	△	applied to cohered material
12	Thermal conductibility		○	○	○	○	○	
13	Resistance to vabration		△	△	△[1]		△	refer to **409. 9** of the Rules
14	Resistance to fire and flame spread		○	○	○	○	○	

Remarks
○ : Items to be verified through verification test for properties.
△ : Items to be verified through verification test where deemed necessary depending on the insulation material.
□ : Items for which preparation of data on the properties is desirable.

Notes :
1) Necessary when the insulation material acts as spray shield specified in the requirements in **407. 6** (2) of the Rules. In other cases, data on the properties is to be prepared.
2) Not generally required for cargo tanks where the design temperature exceeds -10°C.
3) It is necessary to verify the fatigue strength characteristics in accordance with the requirements in **402. 2** and **404. 3** of the Rules.
4) It is necessary to verify the fatigue strength characteristics in accordance with the requirements in **404. 7** and **409. 7** (2) of the Rule.

Table 7.5.4 Test Items for Insulation Materials

Test items	Test methods
1. Compatibility with the cargo	Tensile, compress., shearing, bending test after dipping in the cargo
2. Solubility in the cargo	Changes in thesize and weight of test specimen before and after dipping in the cargo
3. Absorption of the cargo	Comparison of weight of test specimen or test of water absorbing properties before and after dipping in the cargo
4. Shrinkage	ASTM D2126
5. Aging	ASTM D756 (Comparison of thermal conductivity before and after aging)
6. Closed cell content	ASTM D2856
7. Density	ASTM D1622
8. Mechanical properties	Bending (ASTM C203, D790) Compress.(ASTM D1621) Tensile (ASTM D1623) Shearing (ASTM C273)
9. Thermal expansion	ASTM D696
10. Abrasion	-
11. Cohesion	-
12. Thermal conductibility	KS L9016, ASTM C518
13. Resistance to vibration	-
14. Resistance to fire and flame spread	DIN4102

410. Construction and testing

1. Independent tanks

(1) For the purpose of the requirements in **410. 1** (1) of the Rules, the fillet weld of the full penetration type approved for joints between cargo tank plates and dome are, at least, to conform to the following requirements (A) or (B) depending on cargo tank type :

(A) In the case of Type A independent tank, non-destructive testing procedure is to be established.

(B) In the case of Type B and Type C independent tank, records of production are to be kept and fatigue strength is to be ensured by fatigue strength analysis and non- destructive testing procedures established for the proposed construction.

(2) The "dome-to-shell connections" referred to in the requirements in **410. 1** (1) of the Rules are applicable to tanks with MARVS is 0.07 MPa or below, and the connections mean ordinary cargo pipes or other penetrations of equivalent size sufficiently small when compared with the size of dome.

(3) In welding of the penetrations referred to in the preceding (2) full penetration type welding may not be required, but are to have proper grooves. In this case, all the weld lines for penetrations of pipes with outside diameter exceeding 100 mm, and the partial weld lines for those with outside diameter of 100mm or below, are to be subjected to non-destructive test as appropriate.

(4) The "specifically approved by the Society" referred to in the requirements in **410. 1** (2) (A) of the Rules means the case of tanks where MARVS is 1.0 MPa or below and the design temperature is higher than -10°C satisfying both of the following requirements (A) and (B). However, this is to be limited to areas where non-destructive test is possible.

(A) Pressure vessels where removal of backing strip is operationally difficult and which are not used in an atmosphere liable to generating stress corrosion cracks.

(B) There is no excessive stress concentration.

(5) As a case "specially approved by the Society" referred to in the requirements in **410. 1** (2) (b)

of the Rules, full penetration welding may not be required for small nozzle diameters for use in measurement, inspection or similar other application being fitted to the cargo tank with MARVS of not more than 1.0 MPa and the design temperature is not less than -10°C. In this case, welding is to comply with the requirements in KS B 6231.

2. Membrane tanks

(1) For the purpose of the requirements in **410. 3** of the Rules, quality assurance procedure, welding control, design details, quality control of materials, construction method, inspection and standards of production testing of components for membrane tanks are to be developed during the prototype test specified in **404. 2** of the Rules or another prototype test separately conducted for development of production procedure, and their effectiveness is to be verified. The relevant data is to be noted in the construction procedure manual for cargo tanks including the insulation construction of membrane tanks.
(2) The construction procedure manual referred to in the preceding (1) is to be approved by the Society after being verified through prototype test.

3. Integral tanks

For the purpose of the requirements in **410. 6** of the Rules, the hydraulic test of integral tanks is to conform to the requirements in **Pt 3, Ch 1, 209.** of the Rules. However, for tanks whose design MARVS exceeds 0.025 *MPa* or specific gravity of the cargo exceeds 0.6, the test may be such as to conform to the requirements specified in **410. 10** (1) of the Rules correspondingly.

4. Hull structure adjacent to membrane or semi-membrane tanks

(1) The "hydrostatically or hydropneumatically tested in accordance with recognized standards" referred to in the requirements in **410. 7** of the Rules means the hydraulic test according to the requirements in **Pt 3, Ch 1, 209.** of the Rules. In this case, hydraulic pressure may be applied from hull structures such as ballast tanks and cofferdams.
(2) The leakage test for the "other hold structure supporting the membrane" referred to in the requirements in **410. 7** of the Rules is to be in accordance with the testing procedure applicable to general hull structures as specified in **Pt 3, Ch 1, 209.** of the Rules.

5. Type C independent tanks

(1) For the purpose of the requirements in **410. 9** (1) of the Rules, the allowable dimensional deviations for the manufacture and fabrication are to conform to the requirements in **Pt 5, Ch 5, 402. 5** of the Rules, and in addition to the requirements in KS B 6231.
(2) For the purpose of the requirements in **410. 9** (2) (B) of the Rules, the ultrasonic testing is to be conducted in the following cases (A) and (B) :
  (A) In case where defect detection by radiographic testing fails and ultrasonic testing is considered additionally necessary.
  (B) In case where ultrasonic testing is considered necessary for the quality control of essential structural members.
(3) For the purpose of the requirements in **410. 9** (2) of the Rules, testing procedure and acceptance criteria for the non-destructive tests are to be in accordance with the requirements in **603. 6** (1) of the Guidance.

6. Hydrostatic or hydropneumatic test for independent tank

(1) For the purpose of the requirements in **410. 10** (1) and (2) of the Rules, the hydrostatic or hydropneumatic test of cargo tanks is to be conducted by simulating the actual load conditions (static load + dynamic load) in accordance with the following requirements (A) and (B) :
  (A) Test of cargo tanks
  Hydrostatic-hydropneumatic test is to simulate the static pressure of cargo, acceleration by ship motions and internal pressure including the vapour pressure by water head and pneumatic pressure. (See **Fig 7.5.23, 7.5.24** and **7.5.25** of the Guidance)
  (B) Load test of supporting structures
  Hydraulic test is to simulate the cargo weight and the load created by the acceleration due to ship motions solely by the weight of water. (See **Fig 7.5.26** of the Guidance)
(2) All tests specified in the preceding (1) (A) and (B) may be conducted individually.

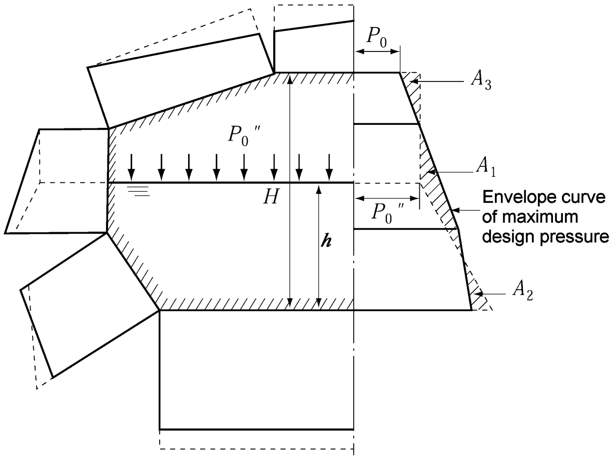


Fig 7.5.23 Simulating the Internal Pressure Distribution of Rectangular Tank

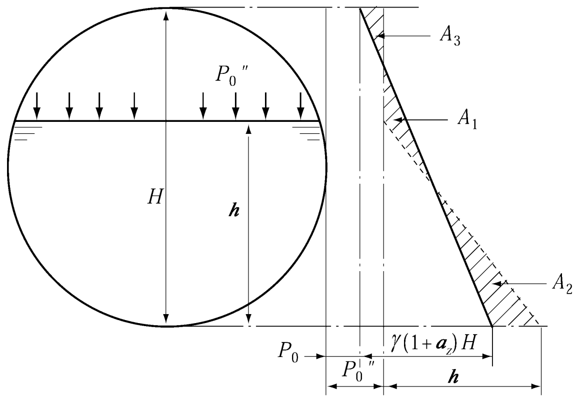


Fig 7.5.24 Simulating the Internal Pressure Distribution of Spherical Tank

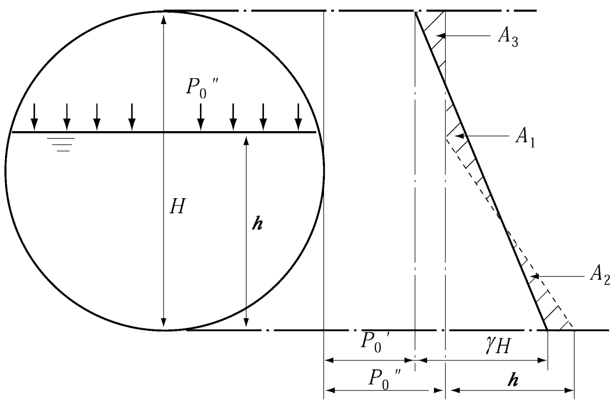


Fig 7.5.25 Simulating the Internal Pressure Distribution at Pressure Discharge

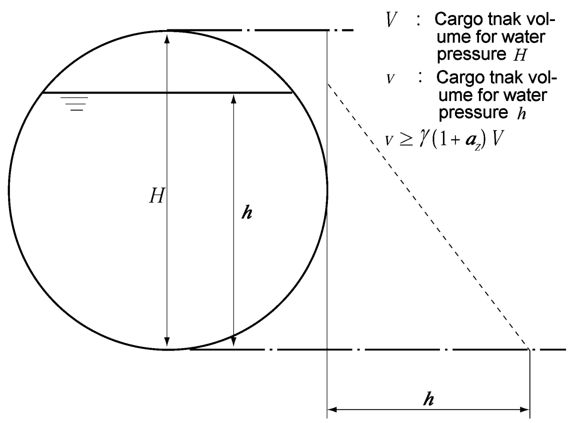


Fig 7.5.26 Simulating the Loading Condition of Support Structure

* Explanatory notes on symbols in **Fig 7.5.23** to **7.5.26** of the Guidance

- ------ : maximum loading condition which is predicted to actually encounter
- ··· : pressure testing condition simulating as far as practicable (P_0'' and h are to be chosen so that $P_0'' > P_0$ or $P_0'' > P_0'$ and $A_2 + A_3 > A_1$ as far as practicable)
- H : depth of tank
- h : water head
- γ : specific gravity of cargo
- a_z : maximum vertical acceleration (non-dimensional)
- P_0 : design vapour pressure at ordinary passage
- P_0' : design vapour pressure during pressurized unloading in port
- P_0'' : air pressure

(3) In the case of the cargo tank of supports which can be regarded as those of the same type manufactured at the same manufacturing plant, implementation of the second and subsequent tests of cargo tanks and supports specified in the preceding (1) (B) may be omitted when deemed acceptable by the Society.

(4) The "pressure vessels other than simple cylindrical and spherical pressure vessels" referred to in the requirements in **410. 10** (3) (A) of the Rules means those cylindrical or spherical pressure vessels with supporting structures of well proved records. In tanks of special shape having supporting structures likely to cause excessive bending stress or bicylindrical shape tanks, the stress

levels are to be verified by strain measurement through prototype test.

(5) "Where necessary" referred to in the requirements in **410. 10** (3) (D) of the Rules means a case in which the shipbuilding berth or hull structure can not withstand the hydrostatic load when cargo tanks are filled with water to the tank top level and another case in which a large load exceeding the design load is imposed on the structural members of the tank or adjacent structures by conducting the hydrostatic test.

(6) For the purpose of the requirements in **410. 10** (3) (F) of the Rules, the leakage test is to be of the airtightness test conducted at a pressure of MARVS or more of the pressure vessel.

7. Tightness test for cargo tanks

For the purpose of the requirements in **410. 11** of the Rules, in case where leakage of cargo tanks can not be inspected in the hydraulic test or hydrostatic-hydropneumatic test according to the requirements in **410. 10** of the Rules, the tightness test of cargo tanks is to be conducted separately. This test is to be of the airtightness test conducted at a pressure of MARVS or more of the cargo tank.

8. Stress measurements instrumentation of type B independent tanks

For the purpose of the requirements in **410. 13** of the Rules, in case where stress measurements of the cargo tank previously built which can be regarded as the tank of the same design manufactured at the same shipyard had resulted in good agreement with design stress levels, provision of instrumentation of independent tanks stress levels for tanks subsequently built may be omitted.

9. Gas-trial and cargo full loading test (related to 505. 4 of the Rules)

(1) In accordance with the requirements in **410. 14** and **505. 4** of the Rules the following tests (A) and (B) are to be conducted in the attendance of the Surveyor to verify the performance of the cargo containment installations and cargo handling equipment :

(A) Gas-trial

On items given in **Table 7.5.5** of the Guidance, tests are to be conducted to verify the performance of the cargo containment system cargo handling equipment and instrumentation using a suitable quantity of the cargo after the completion of all the construction work. However, for cargo tanks with a design temperature of 0°C or more, omission of this test may be accepted if substitution is made by the operating test with the substituting medium to verify the requirements given in **Table 7.5.5** of the Guidance except for the case where the tank is of the first cargo tank manufactured by the manufacturer of cargo tanks.

(B) Cargo full loading test

On items given in **Table 7.5.6** of the Guidance, tests are to be conducted after completion of all the construction work to verify that the cargo containment installations, cargo handling equipment and instrumentation satisfy the design conditions under the fully loaded condition of cargo. However, for this test, the attendance of the Surveyor may be omitted for ships whose cargo containment and cargo transfer installations can be regarded as of the same specification of those which have previously been built and tested at the same shipyard.

(2) The kinds of real liquid cargo and gas used in the gas-trial and cargo full loading test specified in the preceding (1) are to be such that reproduction of the most severe conditions of those design conditions of the cargo containment system, the transfer installations, the reliquefaction system, etc. and consideration is to be given to the following requirements (A) and (B) :

(A) The verification relative to design temperatures is to be made by reproducing the condition that the cargo on the basis of which design temperature has been determined is cooled down as close to the design temperature as practicable.

(B) For design conditions basing on the corrosivity or extreme toxicity, omission of verification through the use of these cargoes in gas-trial may be accepted in case where experimental data and information to prove the compliance of the construction and equipment including structural materials have been submitted to the Society.

(3) The quantities of the real cargo and vapour used in the gas-trial and cargo full loading test referred to in the preceding (1) are to be sufficient to conducting the tests specified in (1) above.

(4) The cargo full loading test to capacity specified in the preceding (1)(B) may be conducted simultaneously with the gas-trial indicated in the preceding (1)(A).

(5) The survey items "at loading operation" specified in **Table 7.5.6** of the Guidance in the preceding (1)(B) may be substituted by the test items which were carried out during on board test and gas trial, and the survey items on "Condition of cargo tanks and other cargo containment

systems after full loading" may be confirmed when the inspection for "discharging operation" is carried out.

Table 7.5.5 Test Items at the Gas Trial

Test item	◎ : Attendance of the Surveyor ○ : Submittion of the record	Inspection equipme	Survey item
1. Drying test	○	· Inert gas generator	· Dew point · Change of dryness in cargo tanks and hold spaces
2. Inerting test	○	· Inert gas generator	· Operation of the inert gas generator · Measuring of atmosphere in cargo tanks
3. Inert gas purge test using cargo vapour	○	· Cargo vapourizer · Compressor	· Change of O_2/temperature of cargo vapour in cargo tanks · Quantity of cargo vapour (or liquid) supply · Capacity of the vapourizer · Capacity of the compressor
4. Cool-down test	◎/○	· Spray pump · Compressor · Cargo piping · Temperature indicators forcargo tank · Spray piping	· Temperature curve of cargo tanks[1)] · Inspection of hold spaces/condition of insulation of tanks (after cool-down) · Cooling condition of spray piping·Cooling condition of cargo piping · Capacity of spray pump · Cargo consumption · Capacity of compressor (property of return gas) · Temperature/pressure in cargo tank · Shrinkage of cargo tank[2)]
5. Loading test of cargo liquid	◎/○	· Compressor · Cargo piping related for loading · level gauge/temperature indicator	· Temperature/pressure level in cargo tanks · Temperature/pressure in hold spaces · Temperature/pressure of cargo liquid/gas at manifolds · Service condition of cargo piping
6. Operation test of cargo pump	◎/○	· All cargo pumps	· Discharge pressure/current of cargo pumps · Liquid level/pressure in cargo tanks · Stripping
7. Operation test of pressure/temperature control system	◎/○	· Depend on the type of controls	· Depend on the type of controls

Notes :
1) The Society may approve omission in consideration of the quality control status and manufacturing records of insulation materials.
2) To be verified only in case of independent tanks.

Table 7.5.6 Survey Items of Full Load Test

	Survey items
1. At loading operation	· Continuous loading rate · Actual operation of level, temperature, pressure indicator, etc. · Actual operation of alarm system[1)] · Actual operation of overflow control system[1)]
2. Condition of cargo tanks and other cargo containment systems after full loading	· Cargo tanks and supports · Hull adjacent to cargo tanks (cold spot) · Insulation capacity of cargo tanks and supports · Atmosphere in hold spaces
3. During voyage	· Insulation capacity of cargo tanks and supports · Cold spot on the construction adjacent to cargo tanks · Capacity of pressure/temperature indicator
4. At discharging operation	· Discharging rate · Other operation of discharging · Submitting/survey of related records without attendance for **3** above.
Note : 1) In case where implementation is difficult, the verification of operation may be made by suitable other method.	

10. Cold spot inspection

(1) The cold spot inspection of cargo tanks specified in **410. 16** of the Rules is to be carried out during the cargo full loading test to capacity specified in **410. 9** (1) for the membrane tank, semi-membrane tank, internal insulation tank, and when necessary, independent tank.

(2) The cold spot inspection of cargo tanks specified in the preceding (1) may be confirmed when the inspection for discharging operation is carried out.

11 Examination before and after the first loaded voyage (Only if the LNG Vessels)

In accordance with the requirements in 410. 14 & 16 of the Rules, it is preferred that Gas Trial and Cargo Loading Tests are finished at the shipyard, but either or both of these may be postponed until after entering into a voyage and the survey requirements are as follows

(1) First Loading (Considered to be full loading) :
- (A) Priority to be given to latter stages of loading (approximately last 6 hours).
- (B) Review cargo logs and alarm reports.
- (C) 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.
- (D) Examination of on-deck cargo piping systems including expansion and supporting arrangements.
- (E) Witness topping off process for cargo tanks including high level alarms activated during normal loading.
- (F) Advise master to carry out cold spot examination of the hull and external insulation during transit voyage to unloading port.

(2) First Unloading :
- (A) Priority to be given to the commencement of unloading (approximately first 4 - 6 hours).

(B) Witness emergency shutdown system testing prior to commencement of unloading.
(C) Review cargo logs and alarm reports.
(D) 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.

(E) Examination of on-deck cargo piping systems including expansion and supporting arrangements.
(F) Obtain written statement from the Master that the cold spot examination was carried out during the transit voyage found satisfactory. Where possible, the surveyor should examine selected spaces.

12. Inspection of Secondary Barrier

With respect to the requirement of **410. 12**, it is to be verified that secondary barriers keep a specific level of tightness required in the system design in accordance with an appropriated procedures. For cargo containment system with glued secondary barriers, a tightness test are to be carried out in accordance with approved system designers' procedure before and after initial cool down and related values obtained in the test are to be recorded for the use as reference for periodical surveys. If significant differences in the results before and after cool down for each tank or between tanks or if other anomalies are observed, an investigation is to be carried out and additional testing such as differential pressure, thermographic or acoustic emissions testing is to be carried out as necessary. For containment systems with welded metallic secondary barriers, a tightness test after initial cool down is not required.

411. Stress relieving for type C independent tanks

1. Stress relieving by post-weld heat treatment

For the purpose of the requirements in **411. 1** of the Rules, the stress relieving is to be in accordance with the following requirements (1) to (3) :

(1) The post-weld heat treatment is to comply with the requirements in **Pt 5, Ch 5, 403.** of the Rules.
(2) For 9 % nickel steel, 5 % nickel steel and aluminium alloy 5083-O, post-weld heat treatment may, in general, be omitted.
(3) For cargo tanks made of carbon steel and carbon manganese steel with the design temperature of -10°C or more, the requirements in **Pt 5, Ch 5, 403.** of the Rules may be based upon except for cargo tanks anticipated to carry chlorine, ammonia and toxic cargoes.

Section 5 Process Pressure Vessels and Liquid, Vapour and Pressure Piping Systems

501. General

1. Process pressure vessels

(1) For the purpose of the requirements in **501. 2** of the Rules, "process pressure vessels" means the pressure vessels used for cargo operation, cooling, processing of boil-off gases and temporarily containing the cargo inside where heat exchangers are included. They, however, do not include those pressure vessels for refrigerant without containing cargo and parts of cargo pumps, compressors and valves subjected to internal pressure.

(2) Of those process pressure vessels referred to in the preceding (1), for the process pressure vessels that are not used for cargo storage, only the requirements in **404. 6** (1) and (2), **405. 1** (6) and **2, 409. 3, 410. 1, 2, 9, 10** (3), **11** and **18** and **411. 1** of the Rules apply.

502. Cargo and process piping

1. General

(1) For the purpose of the requirements in **502. 1** (1) of the Rules, "product and process piping" means the piping used for cargo operation, cooling, heating, processing and disposing of boil-off gases having a possibility of coming to contact with the cargo. The refrigerant piping which does not directly come to contact with the cargo is not included.

(2) For product and process piping referred to in the preceding (1), in addition to the requirements in **502.** to **505.** of the Rules and, the requirements **Pt 5, Ch 6** of the Rules apply where considered as necessary by the Society.

(3) For the purpose of the requirements in **502. 1** (3) of the Rules, for piping with design temperature lower than 5°C, the following requirements (A) to (C) are to be complied with to protect the hull structure.

(A) The branches of the piping are to be insulated for thermally separating them from the hull structure. However, in case where the materials of hull structures comply with the requirements given in **Table 7.5.7** of the Rules against the temperature obtained by heat transmission calculation in consideration of the design temperature of the piping, these requirements may be dispensed with.

(B) As a means of protection for hull structures against cargo leakage from the piping, drain pans or equivalent manufactured from the materials specified in **Table 7.5.5** and **Table 7.5.6** of the Guidance having sufficient capacity are to be arranged according to the design temperature of the piping at all locations where liquid leakage is likely.

(C) Drain pans or equivalent indicated in the preceding (B) are to be provided below all flange joints of liquid piping with design temperature not exceeding 55°C located outside the cargo tanks. However, in case where the arrangement is made in such a way that the hull structures do not reach dangerous temperature even in case of leakage from flanges, these requirements may be dispensed with.

(4) The materials of drain pans referred to in the preceding (3) (B) and (C) may be made such that they comply with the requirements of Korean Industrial Standards or recognized standards and are suitable for the design temperature of the piping system.

(5) For the purpose of the requirements in **502. 1** (4) of the Rules, the electrical bonding is to conform to the requirements of **Pt 6, Ch 1, 104.** of the Rules. In case where the gasketed flange joint are used, the flange bolts only are not considered as an earthing, and the connections and earthing are to be provided with earthing conductors. Also, in case where electrical bondings are necessary for cargo tanks and secondary barriers, such bondings are to be provided at readily accessible places.

(6) The "suitable means" referred to in the requirements in **502. 1** (5) of the Rules means the residual liquid discharging piping led to cargo tank, liquid cargo line or other drain tank.

(7) "All pipelines or components which may be isolated in a liquid full condition" referred to in the requirements in **502. 1** (6) of the Rules means, for example, those pipelines given in the following (A) and (B) :

(A) Pipeline between two adjacent stop valves.

(B) Pipeline between stop valve and compressor or pump likely to be liquid full. However, where the relief valve mounted on the compressor or pump is in effective condition, this requirement may be dispensed with.

(8) For the pipeline indicated in the preceding (7), a relief valve is to be provided irrespective of its design pressure. This relief valve is to be of approved one in accordance with the special requirements given by the Society.

(9) The "means to detect and dispose of any liquid cargo which may flow into the vent system" referred to in the requirements in **502. 1** (7) of the Rules means the fol1owing (A) and (B) (See **Fig 7.5.27** of the Guidance) :

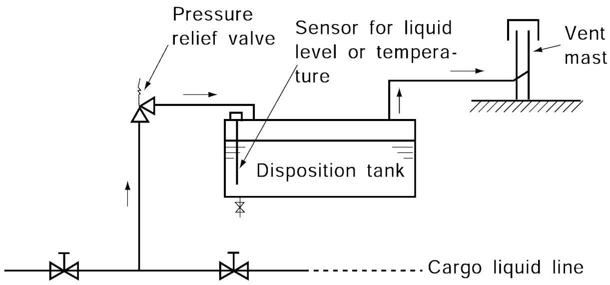


Fig 7.5.27 Example Means to Detect and Dispose of Any Liquid Cargo Which may Flow into the Vent System

(A) As a means to dispose of the liquid cargo, a tank with a capacity larger than those determined in the following (a) to (c) is to be provided. The material of the disposition tank is to be of equivalent to the liquid cargo piping or higher grade, and in the case of pressurized cargo tanks, consideration is to be given to the temperature drop due to expansion and evaporation.

(a) By assuming possible state of liquid full condition that may actually take place, the quantity of liquid cargo to be covered is to be determined.

(b) Due to heat input from the fire, the quantity of expansion for the quantity of liquid indicated in (a) above to rise from the initial temperature (normally, the minimum design temperature of the pipeline) to the temperature of vapour saturation at the set pressure of the relief valve is to be obtained and on the basis of which the quantity of the liquid to the disposition tank is to be determined.

(c) By giving consideration to the back pressure of the vent pipeline, the liquid phase quantity in the disposition tank of the inflow quantity obtained in the preceding (b) is to be computed to obtain the capacity.

(B) As a means for detecting liquid cargo, a high level alarm sensor or low temperature alarm sensor in case of low temperature cargo tanks, and a high level alarm sensor in case of pressure cargo tanks, are to be provided in the disposition tank and to issue alarm when the sensor functions.

2. Scantlings based on internal pressure

For the purpose of the requirements in **502. 2** of the Rules, the following requirements are to be complied with :

(1) The joint efficiency of electric-resistance welded pipes where non-destructive testing for full length of weld lines is not conducted is to be 0.85.

(2) For methane, propane, butane, butadiene and propylene cargoes, the corrosion allowance is to be 0.3 mm for carbon-manganese steel and 0 mm for stainless steel and aluminium alloys. Where effective corrosion control are taken for the interior of carbon-manganese steel pipes, the corrosion allowance may be 0.15 mm.

(3) In addition to the preceding (2), for carbon-manganese steel pipes arranged on open deck without any effective external corrosion control means, 1.2 mm is to be added to the required corrosion allowance.

(4) The negative manufacturing dimensional deviation in pipe thickness is, except for expressly provided otherwise, to be in accordance with the requirements in **Pt 2, Ch 1, 401. 7, 402. 7** and **404. 7** of the Rules.

3. Design pressure

(1) For the purpose of the requirements in **502. 3** (2) of the Rules, where design vapour temperature higher or lower than 45°C is employed, the requirements in **402. 6** (1) of the Rules apply.
(2) The "relief valve on a pipeline system" referred to in the requirements in **502. 3** (2) (F) of the Rules means the one which is approved in accordance with the special requirements given by the Society.

4. Permissible stress

(1) The "minimum wall thickness to be in accordance with recognized standards" referred to in the requirements in **502. 4** (2) of the Rules means the value corresponding to Schedule 40 of KS SPPS for carbon-manganese steel, and the value corresponding to Schedule 10 *S* for stainless steel. However, for steel pipes provided with effective corrosion control or those not arranged under corrosive environment, the value may be reduced to the extent acceptable to the Society with a limitation of 1 mm. Further, the value for pipes in cargo tanks and pipes having open ends may also be reduced to the extent acceptable to the Society.
(2) The cases where increase in pipe size is required according to the requirements in **502. 4** (3) of the Rules are the cases in which such becomes necessary on the basis of the results of stress analysis specified in the requirements in **502. 5** of the Rules, and in which suitable supports and means to absorb structural expansion and contraction can not be arranged due to convenience of on-deck piping, etc.
(3) As a presumption for the condition indicated in the preceding (2), the supports for piping are to be so arranged as to prevent exertion of the own weight of the pipe on valves or other fittings and to prevent generation of excessive vibration.
(4) For the purpose of the requirements in **502. 4** (4) of the Rules, fittings are to comply with the following requirements (A) and (B) :
(A) Valves, flanges and other fittings are to comply with the requirements of KS, ANSI or equivalent for their type and size, and the requirements in **Pt 5, Ch 6, 104.** of the Rules for flanges.
(B) The design pressure of bellows type expansion joints to be used in vapour piping may be taken 0.2 MPa for those provided on pipelines with open ends, and 0.5 MPa for those provided on other pipelines.

5. Stress analysis

(1) For the purpose of the requirements in **502. 5** of the Rules, the calculation conditions and allowable stress in the stress analysis are to be in accordance with the following requirements (A) through (E) as standard :
(A) As temperature condition, a state uniformly cooled down to the design temperature is to be considered. As the reference temperature (thermal stress = 0), 15°C is to be regarded as standard.
(B) Loading conditions are to be in accordance with the following requirements (a) through (d) :
(a) As internal pressure, the design pressure specified in the requirements in **502. 3** of the Rules is to be considered.
(b) The own weight of pipelines, when can not be neglected, is to be considered including its acceleration.
(c) As forced displacement, the forced strains corresponding to allowable sagging moment and hogging moment for the hull are to be considered.
(d) As thermal load, one which can be determined according to the condition indicated in the preceding (A) is to be considered.
(C) Support conditions are to be as deemed appropriate by the Society depending on the construction, arrangement and materials of the pipe supports.
(D) Allowable stresses are to be as deemed appropriate by the Society depending on the calculation method and materials of pipelines.
(E) Insulation materials are to be considered to give no contribution at all to the strength of the pipeline.
(2) According to the requirements in **502. 5** of the Rules, stress analysis may be required for pipings with the design temperature higher than -110°C where the following (A) to (C) are relevant :

(A) Where suitable supports or means to absorb structural expansion and contraction can not be arranged due to convenience of on-deck piping arrangement.
(B) Where new supporting method or new means to absorb expansion and contraction are used.
(C) Other cases where the Society deems necessary.

6. Materials

(1) For the purpose of the requirements in **502. 6** (1) of the Rules, the materials of pipings, valves and fittings are to comply with the relevant requirements in **Sec 6** of the Rules, and at the same time, to conform to the relevant requirements in **Pt 2, Ch 1** of the Rules. However, for materials used in pipings as specified in the following (A) through (D), those conforming to KS or other standards as deemed appropriate by the Society may be used where they comply with the requirements in Sec 6 of the Rules considering the temperature.
(A) Pipes, valves and pipe fittings used for cargo piping and process piping with the design pressure not exceeding 1.0 MPa and design temperature of 0°C or more.
(B) Valves and pipe fittings used for cargo piping and process piping with the design pressure not exceeding 3.0 MPa and design temperature of 0°C or more and nominal diameter less than 100 *A*.
(C) Pipes, valves and pipe fittings used for accessory piping or instrumentation piping with diameter not exceeding 25 mm irrespective of the design pressure and design temperature.
(2) Notwithstanding the requirements in the preceding (1), the piping having open ends not coming to contact with the liquid cargo led from the pressure relieving valves of cargo tanks and cargo piping or process piping with the design temperature of -55°C or higher may not be made of the steel for low temperature services specified in **Table 7.5.6** of the Rules. Further, its material may be such as to comply with KS or other standards as deemed appropriate by the Society.
(3) For the purpose of the requirements in **502. 6** (2) of the Rules, the insulation applied on the short pipes with a melting point lower than 925°C fitted to the cargo tank, except for the minimum range of area necessary for inspection and maintenance of pipe flanges, is to be protected according to the requirements specified in **409. 3** (2) of the Guidance. Further, the insulation materials for cargo piping and other piping are to conform to the requirements in **409. 4** (4) (B) of the Guidance.

503. Tests of piping components and pumps prior to installation on board

1. Requirements of type tests

(1) For the purpose of the requirements in **503. 1** (1) of the Rules, those valves which are relevant to the following (A) or (B) are to be approved in accordance with the requirements in the Guidance.
(A) All valves used for the cargo and process piping with the design temperature lower than -55°C.
(B) Those valves used for accessory piping or instrumentation piping of the design temperature lower than -55°C with an outside diameter exceeding 25 mm and normally come to contact with the cargo.
(2) For the purpose of the requirements in **503. 1** (2) of the Rules, all bellows type expansion joints provided on all cargo piping including the cargo liquid/vapour piping provided both inside and outside the tanks, and vent piping with open ends are to be of the approved ones in accordance with the special requirements given by the Society.
(3) In applying **503. 1** (3) (B) (b) of the Rules, the capacity tests are to be in compliance with the followings :
(A) For submerged pumps, the capacity test is to be carried out with the design medium or with a medium below the minimum working temperature.
(B) For deep well pumps, the capacity test may be carried out with water.

504. Piping fabrication and joining details

1. Application

According to the requirements in **504. 1** of the Rules, the requirements specified in **504. 2** to 6 of the Rules may be modified in accordance with the following (1) and (3) :

(1) For pipes provided inside the cargo tanks with open end excluding pump discharging pipings,

the following requirements (A) to (C) apply :
(A) Butt welded joints with backing strips, sleeve joints and screw joints may be used in all cases.
(B) Slip-on and socket welded joints may be used in all cases.
(C) Non-destructive testing for butt welded joints may be omitted.
(2) For pipes with open ends provided outside the cargo tanks are to conform to the requirements specified in the preceding (1) (A) and (B), and in addition, the non-destructive testing for butt welded joints may be reduced to 10% sampling.

2. Connection of pipes without flanges

The "screwed couplings" referred to in the requirements in **504. 2** (3) of the Rules are to conform to the requirements of KS B 0222 or equivalent.

3. Flange connection

For the purpose of the requirements in **504. 3** (2) of the Rules, type and size of flange connections are to comply with the **Pt 5, Ch 6, Fig 5.6.1** of the Rules for the welded neck, slip-on and socket welded type as following requirements (1) to (3) :

The others except welding connection are to comply with the requirements of KS, ANSI or other standards as deemed appropriate by the Society for their type and size.

(1) Welded neck type : Type A in **Pt 5, Ch 6, Fig 5.6.1** of the Rules
(2) Slip-on welded type : Type B1 in **Pt 5, Ch 6, Fig 5.6.1** of the Rules
(3) Socket welded type : Type B2, B3 in **Pt 5, Ch 6, Fig 5.6.1** of the Rules

4. Welding, post-weld heat treatment and non-destructive testing

(1) For the purpose of the requirements in **504. 6** (2) of the Rules, the post-weld heat treatment of pipes with thickness less than 10 mm may be omitted except for those required in the requirements in **Pt 5, Ch 6, 105. 5** of the Rules.
(2) For the purpose of the requirements in **504. 6** (3) of the Rules, the radiographic testing method and the judgement for acceptance are to conform to the requirements in **Pt 5, Ch 6, 1204.** of the Rules.
(3) The "other non-destructive tests" referred to in **504. 6** (3) (B) of the Rules means the ultrasonic testing, and depending on use of pipes, magnetic particle testing or liquid penetrant testing, and the testing procedures are to conform to the requirements in KS D 0250, KS D 0213, KS B 0816.

505. Testing of piping on board

1. Application

For the purpose of the requirements in **505. 1** of the Rules, for pipes within the cargo tank and pipes with open ends, the hydraulic test and leak test specified in the requirements in **505. 2** and **3** of the Rules may be omitted. However, the hydraulic test specified in the requirements in **505. 2** of the Rules is to be conducted for pipes without open ends and discharging pipes provided inside the cargo tanks.

2. Leak test

For the purpose of the requirements in **505. 3** of the Rules, the leak test of pipelines is to be conducted at a pressure of 90 % of the design pressure of the pipings, The test pressure may be modified, when test is conducted with a liquid of high leak detecting ability.

3. Test under operating condition

For the purpose of the requirements in **505. 4** of the Rules, the test is to be conducted according to the requirements in **410. 9** of the Guidance.

506. Cargo system valve requirements

1. Stop valves fitted to the cargo tank

(1) For the purpose of the requirements in **506. 1** (1) and (2) of the Rules, no expansion joints are

to be provided between the cargo tank and stop valves fitted to the cargo tank. "To be capable of local manual operation and provide full closure" referred to in the requirements means that the stop valve is fitted with manual operated closing means.

(2) For the purpose of the requirements in **506. 1** (2) of the Rules, the duplicated provisions of manual stop valve and emergency shutdown valve may be made in such a way as shown in **Fig 7.5.28** of the Guidance.

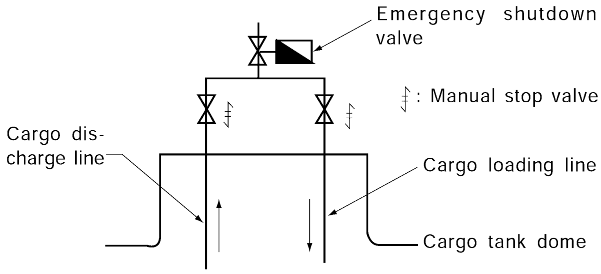


Fig. 7.5.28 Duplicate Provisions of Stop Valve and Emergency Shutdown Valve

2. Cargo hose connection

(1) The "connections not used in transfer operations" referred to in the requirements in **506. 3** of the Rules means those not used for cargo operation, for example, hose connection used for gas free operation. In this case, stop valve and blind flange are to be provided at the connection.

(2) For the purpose of the requirements in **506. 3** of the Rules, the connection between the cargo hose connection and shore line is to be electrically bonded.

3. Emergency shutdown valves

The emergency shutdown valves specified in **506. 4** of the Rules are to be in accordance with the following requirements (1) to (5) :

(1) In case where there is no cargo control room and no remote control of cargo operation is carried out, one of the remote control locations of the emergency shutdown valves is to be in the wheelhouse.

(2) The "fail-closed type" referred to in the requirement of the Rules is, for example, one of given in the following (A) and (B) :

(A) The type in which the hydraulic or pneumatic pressure is solely used in valve opening motion, and the valve closing motion including the case of fail-closure is effected by spring or weight.

(B) Where valve diameter is so large that both opening and closing motions of the valve are hydraulically or pneumatically effected, the operating oil or air in the fail-closure operation is to be supplied from a specially provided accumulator and the system setup is to comply with the following requirements (a) to (c) :

(a) The valve operating cylinder may be used for both ordinary motion and fail-closure motion, but the hydraulic or pneumatic line from the special accumulator for fail-closure operation to the valve operating cylinder is not to serve commonly with those for ordinary valve operation. Further, no stop valve is to be provided on the hydraulic or pneumatic line for fail-closure.

(b) The capacity of a special accumulator for fail-closure operation is to be sufficient to operate, at least, twice all the emergency shutdown valves. However, when a special accumulator is connected to the emergency shutdown valves of the same type provided on both sides of the ship, it may be made in such a way that the emergency shutdown valves on one side is operated twice.

(c) Alarm is to be given in the event of loss of hydraulic or pneumatic pressure for ordinary valve motion and activation of fail-closure operation.

(3) To "be capable of local manual closing operation" referred to in the requirements of the Rules means the one which can be directly manually closed, and in addition those shutdown by manual release of hydraulic pressure or pneumatic pressure or shutdown by manual pump.

(4) To "fully close under all service conditions within 30 s of actuation" referred to in the requirements of the Rules means that the emergency shutdown valve assumes the completely closed within 30 s from the issuance of closing signals of the valve. This provision may not apply to

the manual emergency shutdown valves given in the preceding (3).

(5) No stop valve is to be provided on the hydraulic or pneumatic line for closing the emergency shutdown valve.

507. Ship's cargo hoses

1. General

For the purpose of the requirements in **507.** of the Rules, the cargo hoses carried by the ship are to be one of given in the following (1) to (3) :

(1) Accepted ones by either preliminary survey in accordance with Ship Safety Act or inspection in accordance with the requirements of type approval

(2) Accepted ones by an inspection organization recognized by the Society

(3) Approved ones in accordance with the requirements of the Guidance

508. Cargo transfer methods

1. Cargo transfer installations

(1) For the purpose of the requirements in **508. 1** of the Rules, when the cargo transfer methods are of the submerged pumps or by deep well pumps, standby cargo pump or the cargo transfer installations according to the requirements in **508. 2** of the Rules are to be provided.

(2) The standby cargo pump referred to in the preceding (1) may be such as to conform to the following requirements :

(A) Where two sets or more cargo pumps are provided in one cargo tank, the provision of standby cargo pump may be omitted even when both of them are normally subjected to simultaneous operation. Where cargo tank of such a construction that it is separated by a bulkhead and connecting holes or bulkhead valve with remote control are not provided, each such tank separated by the bulkhead is to be regarded as one cargo tank.

(B) The stripping pump may be regarded as a standby cargo pump.

(C) The eductor may be regarded as a standby cargo pump. In this case, however, care is to be taken so that even when cargoes of different kinds are carried simultaneously, the driving fluid is available at all times.

(3) The cargo pumps specified in the requirements in **508. 1** of the Rules are to be approved in accordance with the requirements of the Guidance.

2. Cargo transfer by gas pressurization

(1) The "gas pressurization" referred to in the requirements in **508. 2** of the Rules means, for example, to pressurize the cargo tank with cargo vapour pressurized by cargo compressor or cargo heater.

(2) The compressor referred to in the preceding (1) is to be approved in accordance with the Guidance.

Section 6 Materials of Construction

601. General

1. Mechanical properties

For the purpose of the requirements in **601. 5** of the Rules, the required values of tensile strength, yield stress and elongation of a material are to be in accordance with the requirements in **Pt 2, Ch 1** of the Rules applicable to the material.

2. Alternative materials

When the design temperature of a material falls under the higher temperature range than the specified one for the material in **Table 7.5.5** and **Table 7.5.6** of the Rules, the impact test temperature given in **Table 7.5.3** to **Table 7.5.6** of the Rules correspondingly to the design temperature may be used instead of the impact test temperature depending on the material. For example, in the case of 2.25 % nickel steel pipes used at the design temperature of -45°C, the impact test temperature may be -50°C, while in the case of 3.5 % nickel steel plates used at the design temperature of -61°C, the impact test temperature may be -70°C.

3. Properties after post-weld heat treatment

For the purpose of the requirements in **601. 8** of the Rules, when post-weld heat treatment is carried out, the properties of the base material are to be in accordance with the requirements given in **Table 7.5.3** to **Table 7.5.6** of the Rules in the heat treated condition or equivalent condition whether such post-weld heat treatment is regarded in **411.** or **504. 6** (2) of the Rules or not. The welds properties at welding procedure qualification tests and production weld tests specified in the requirements in **603.** of the Rules are to satisfy the requirements in **603. 4** and **6** of the Rules in the heat treated condition.

602. Material requirements

(1) For the purpose of the requirements in **Table 7.5.3** of the Rules, the following requirements are to be complied with :
  (A) The use of the longitudinally or spirally welded pipes given in the Note (1) of the Table is to be in accordance with the relevant requirements in **Pt 2, Ch 1, Sec 4** of the Rules.
  (B) Fittings of type C independent tanks and process pressure vessels with the design pressure not exceeding 3.0MPa and design temperature of 0°C or more and nominal diameter less than 100A given in Note (1) may comply with the requirements of KS or other standards as deemed appropriate by the Society.
  (C) The controlled rolling as a substitution for normalizing given in Note (2) may be of the temperature controlled rolling or Thermo-Mechanical Controlled Processing (TMCP). Also, the controlled rolling as a substitution for tempering and quenching may be of TMCP.
(2) The controlled rolling as a substitution for normalizing or tempering and quenching given in Note (4) of **Table 7.5.4** of the Rules may be of TMCP.
(3) For the purpose of the requirements in **Table 7.5.5** of the Rules, the following requirements are to be complied with :
  (A) For the purpose of the requirements in Note (2) of the Table, aluminium alloy of 5083, austenitic stainless steel, 36 % nickel steel and 9 % nickel steel may be used at the design temperature up to 196°C.
  (B) For the purpose of the requirements in Note (4) of the Table, the chemical composition limit of a material, if the material specified in **Pt 2** of the Rules, is to be in accordance with the relevant requirements in **Pt 2, Ch 1** of the Rules.
  (C) For the purpose of the requirements in Note (7) of the Table, the omission of the impact test given in Note (7) of the Table may generally be accepted for the austenitic steel of the type referred to in the Table.
(4) For the purpose of the requirements in **Table 7.5.6** of the Rules, the following requirements are to be complied with :
  (A) The use of vertically or spirally welded pipes given in Note (1) of the Table is to be in accordance with the requirements in the preceding (1) (A).
  (B) The requirements for forgings and castings given in Note (2) of the Table are to be in ac-

cordance with the relevant requirements in **Pt 2, Ch 1** of the Rules if specified.
(C) For the design temperature given in Note (3) of the Table lower than -165°C, the provision in the preceding (3) (A) are to apply.
(D) The chemical composition limit given in Note (5) of the Table is to be in accordance with the requirements in the preceding (3) (B).
(E) The omission of the impact test given in Note (8) of this Table are to be in accordance with the requirements in the preceding (3) (C).

603. Welding and non-destructive testing

1. General

(1) The requirements in **603.** of the Rules apply to independent tanks, semi-membrane tanks, process pressure vessels, integral tanks and piping. The requirements on membrane tanks, are to the satisfaction of the Society depending on the structural type of the tank.
(2) For the purpose of the requirements in **603. 6** of the Rules, the following requirements (A) and (B) are to be complied with.
(A) The impact test may generally be omitted for austenitic stainless steels of types given in **Table 7.5.5** and **Table 7.5.6** of the Rules.
(B) The impact test may generally be omitted for aluminum alloys of 5083 and welding material of 5183.

2. Welding procedure qualification tests of cargo tanks and process pressure vessels

For the purpose of the requirements in **603. 3** (2) of the Rules the following requirements are to be complied with :
(1) Longitudinal bend tests which are required in lieu of transverse bend tests in the case where the base material and weld metal have different strength level specified in **603. 3** (2) (B) of the Rules, such as 9 % nickel steel, are to be in accordance with the requirements in **Pt 2, Ch 2, 402.** of the Rules.
(2) For the purpose of the requirements in **603. 3** (2) (D) of the Rules, for type C independent tanks and process pressure vessels, macroscopic and microscopic examinations and hardness tests are to be carried out according to the requirements of the Rules. For other independent tanks, integral tank and semi-membrane tanks, macroscopic examinations are to be carried out according to the requirements in **Pt 2, Ch 2, Sec 4** of the Rules.

3. Test requirements

(1) For the purpose of the requirements in **603. 4** of the Rules, the welding procedure qualification test are also to comply with the relevant requirements in **Pt 2, Ch 2, Sec 4.** and **Pt 5, Ch 5, Sec 4** of the Rules.
(2) For the purpose of the requirements in **603. 4** (1) of the Rules, the transverse tensile strength of weld metal which has lower tensile strength than that of the parent metal, e.g. in the case of 9 % nickel steel, is to comply with the requirements in **Pt 2, Ch 2, 402. 5** of the Rules.
(3) For the purpose of the requirements in **603. 4** (2) of the Rules, bend tests are also to comply with the requirements in **Pt 2, Ch 2, 402. 6** of the Rules. In case where the base metal is of RLP9 specified in **Pt 2, Ch 1** of the Rules, bend tests may be omitted.
(4) For the purpose of the requirements in **603. 4** (3) of the Rules, the test temperature of impact tests may be determined in accordance with the requirements in **601. 2** of the Guidance.

4. Welding procedure qualification tests for piping

For the purpose of the requirements in **603. 5** of the Rules, welding procedure qualification tests for pipes are also to be in accordance with the relevant requirements in **Pt 2, Ch 1** and **Pt 2, Ch 2, Sec 4** of the Rules.

5. Production weld tests

(1) For the purpose of the requirements in **603. 6** of the Rules, production weld tests are also to be in accordance with the relevant requirements in **Pt 2, Ch 2, Sec 3** of the Rules and **Pt 5, Ch 5, 405.** of the Rules.
(2) For the purpose of the requirements in **603. 6** (1) of the Rules, the number of test specimens for production weld tests of secondary barriers may be reduced to the extent as deemed appropriate by the Society considering the experience of same welding procedures in past, workman-

ship and quality control. In general, intervals of production weld tests for secondary barriers may be approximately 200 mm of butt weld joints and the tests are to be representative of each welding position.

(3) For the purpose of the requirements in **603. 6** (4) of the Rules, number of test specimens for the production weld tests for integral tanks may be reduced to the same level as in the case of secondary barrier given in the preceding (2). Production weld tests for membrane tanks are left to the discretion of the Society depending on the construction system of the tank.

6. Non-destructive testing

(1) For the purpose of the requirements in **603. 7** (1) of the Rules, the following requirements are to be complied with.

(A) For the non-destructive tests specified in the requirements in **603. 7** (1) (B) of the Rules for the remaining welds of tank plates of type A and B independent tanks and semi-membrane tanks other than butt welds, fillet welds of highly stressed parts of main structural members of cargo tanks are to be examined magnetic particle or dye penetrant tests given in the following (B). Butt welds of highly stressed parts of main structural members such as face plates of girders are to be subjected to radiographic test given in the following (B).

(B) The following requirements (a) through (d) are to apply as the testing procedures and acceptance criteria for the non-destructive tests referred to in the requirements in **603. 7** (1) (C) of the Rules :

(a) For radiographic tests, the test may be in accordance with the requirements in KS B 0845, ISO 2437, ISO 2504 and ISO/R1027 where the acceptance criteria are to be KS Grade 2 or higher. In the case of KS Grade 3, acceptance is left to the discretion of the Society in consideration of the importancy of the structural members and nature of defects, etc.

(b) For ultrasonic tests, the requirements in KS D 0250 apply correspondingly.

(c) For magnetic particle test, the requirements in KS D 0213 apply correspondingly.

(d) For dye penetrant tests, the requirements in KS B 0816 apply correspondingly.

(C) Where ultrasonic tests are performed as a substitution for radio-graphic tests according to the requirements in **603. 7** (1) (C) of the Rules, at least 10 % of the whole testing objects are to be subjected to radiographic tests.

(2) For the purpose of the requirements in **603. 7** (3) of the Rules, the welding inspection procedures and acceptance criteria for integral tanks are to comply with the requirements in **603. 7** (1) (A) of the Rules correspondingly. The procedures and criteria for membrane tanks are to be to the satisfaction of the Society, depending on the structural type of the tanks.

(3) For the purpose of the requirements in **603. 7** (6) of the Rules, the radio-graphic tests of secondary barriers where the hull structure acts as the secondary barrier are to be performed for the double bottom tank top platings and bulkhead platings in accordance with the requirements for shell platings of ordinary ships specified in **Pt 2, Ch 2, 309.** of the Rules.

Section 7 Cargo Pressure/Temperature Control

701. General

1. Means of control

The "system allowing the product to warm up and increase in pressure" referred to in the requirements in **701. 1** (3) of the Rules means the pressurized cargo tanks which are, in general, accepted for ships with limited area of service. The ambient design temperature and period of voyage as the design conditions of the system are to be to the satisfaction of the Society in consideration of the sea and weather conditions of the service area, and where necessary, possible extension of voyage for sheltering from heavy weather.

2. Design requirement of the systems

(1) For the purpose of the requirements in **701. 2** of the Rules, the cooling system is to comply with the following requirements (A) to (C) :
  (A) For the refrigerating plant, the following requirements (a) and (b) are to be complied with :
    (a) In the case of indirect system, the relevant requirements in **Pt 9, Ch 1** of the Rules are to be complied with.
    (b) In the case of the direct system, the following requirements (i) through (vii) are to be complied with :
      (i) The construction of compressors is to be such that causes only a small amount of gas leakage and without sparks.
      (ii) A relief valve or overpressure preventing device is to be provided on the discharge from the compressor. However, when overpressure is unlikely, this requirement may be dispensed with. The vent pipe of the relief valve of the compressor is to be led to the vent system specified in the requirements in **802. 9** of the Rules.
      (iii) A pressure gauge is to be provided on the discharge side of the compressor.
      (iv) Means to avoid the entry of cargo liquid into the compressor are to be provided.
      (v) The requirements in **Pt 9, Ch 1, 401.** and **404. 1** of the Rules apply correspondingly.
      (vi) The temperature of the cooling sea water used in the calculation of capacity of the refrigeration plant is to be the ambient sea water temperature specified in **701. 2** of the Rules.
      (vii) The compressors and heat exchangers are to be approved in accordance with the requirements of the Guidance.
  (B) For pressure vessels and pipings, the requirements in **501. 2** and **502.** of the Rules and **501. 1** and **502. 1** (1) of the Guidance are to be complied with.
  (C) For pressure relief valves, level gauges and other fittings, the relevant requirements in **Secs 5, 8** and **13** of the Rules apply correspondingly as necessary.
(2) The increments/decrements of design ambient temperature specified in the requirements in **701. 2** of the Rules are to be in accordance with **402. 3** of the Guidance.
(3) The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

3. Design requirement for dangerous cargoes

The "certain highly dangerous cargoes specified in **Sec 17**" referred to in **701. 3** of the Rules means the cargoes to which **1703. 2** of the Rules applies as required in column h in Table of **Sec 19** of the Rules.

702. Refrigeration systems

1. Stand-by unit and heat exchanger

For the purpose of the requirements in **702. 1** of the Rules, the stand-by unit of the refrigeration system and stand-by heat exchangers are to comply with the following requirements :

(1) The stand-by refrigeration system referred to in the requirements of the Rules does not include heat exchanger.
(2) Where the whole necessary capacity is shared by multiple sets of units, the capacity of the stand-by unit may be made in such a way that it compensates the capacity of one unit having

the largest capacity among others.

(3) Where the refrigeration plants are all driven by electric motors, electrical supply to the motors is to be fed from two or more generators.

(4) The piping of the stand-by heat exchangers may, for example, be made as given in **Fig 7.5.29** of the Guidance. In this case, the total capacity of the heat exchangers including stand-by unit is to be 125 % or more of the maximum requirement.

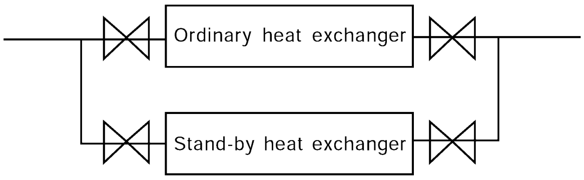


Fig. 7.5.29 The Example Piping of the Stand-by Heat Exchanger

2. Requirement for carrying simultaneously cargoes or chemical reaction

The "cargoes which may react chemically in a dangerous manner" referred to in **702. 2** (1) of the Rules means those cargoes in combination as given in **Table 7.5.7** of the Guidance. For other cargoes not given in this Table, except for those given in the notes of the Table, decision is to be taken in each case upon investigating the physical properties.

Table 7.5.7 Cargoes Which may React Chemically in a Dangerous Manner

Group No.	Groups	Product name								
6	Ammonia	Ammonia, anhydrous	6							
7	Aliphatic amines	Dimenthylamine Monoethylamine		7						
16	Alkylene oxides	Propylene oxide	*H*	*H*	16					
19	Aldehydes	Acetaldehyde	*H*	*H*		19				
30	Olefines	Butadiene Ethylene Propylene Butylene Methyl acetylene -propadiene alxtures					30			
31	Paraffins	Butane Ethane Methane (LNG) Propane						31		
35	Vinyl halides	Vinyl chloride							35	
36	Halogenated hydrocarbons	Ethyl chloride Methyl bromide Methyl chloride								36

Notes:
1. [H] in Table denotes possibility of dangerous reaction whereas blank column signifies no possibility of such reaction.
2. In general, chlorine and ethylene oxide are to be individually refrigerated or not carried together with other cargo.
3. Nitrogen has no danger of reacting with other cargo.

3. Cooling water

(1) "Any other essential service" referred to in the requirements in **702. 3** of the Rules means water supply to equipment necessary for propulsion, discharge of bilges, ballasting/deballasting and fire services specified in **Pt 5, Ch 1, 102. 1** of the Guidance. The service for the water spray system specified in the requirements in **1103.** of the Rules is to be included therein.
(2) In case where the stand-by cooling pump is used for service common to that given in the preceding (1), the capacity of this pump is not to be less than the total capacity of the maximum cooling requirement and the necessary capacity for the particular service.

4. Type of refrigeration system

The "certain cargoes specified in **Sec 17**" referred to in the requirements in **702. 4** (1) and (3) of the Rules means those cargoes to which the application of the provisions of **1704. 1** of the Rules is required in column h in Table of **Sec 19** of the Rules.

5. Heat Exchange

For the purpose of the requirements in **702. 5** of the Rules, the compressors for the refrigerant and other equipment that directly handle the refrigerant are, as a rule, to be installed within the cargo area. However, in case where proper means of detecting the leakage of the cargo into the refrigerant and shutting-off the inflow of the leaked cargo to the spaces outside the cargo area after the detection of leakage is established depending on the possibility of cargo leakage into the refrigerant pipes within the heat exchangers, this requirement may be dispensed with.

Section 8 Cargo Tank Vent System

801. General

For the purpose of the requirements in **801.** of the Rules, the pressure relief system of hold spaces is to be in accordance with the following requirements :

(1) In hold spaces not regarded as the interbarrier space and in case where environmental control within the space is required in accordance with the provisions in **902.** and **903.** of the Rules, one or more pressure relief systems of sufficient capacity are to be provided. The set pressure of those pressure relief systems is to be so set as not to exceed the design pressure of the cargo containment system and hull construction under the condition of dry air sealing, inerting or voyaging. The location of the vent discharge outlet to which the exhaust from the pressure relief systems is to be in accordance with the requirements in **Pt 5, Ch 6, 201. 5** of the Rules, and in addition, consideration is to be given so as not to cause the inert gas to accumulate on deck.

(2) The pressure relief system of hold spaces regarded as the interbarrier space or part thereof is to conform to the requirements in **802. 1** of the Guidance.

(3) The evaluation of the adequacy of type C independent tank vent system is to be in accordance with requirements in IMO Res. A. 829(19).

802. Pressure relief systems

1. Pressure relief system for interbarrier spaces

(1) The "pressure relief devices to the satisfaction of the Society" referred to in the requirements in **802. 2** of the Rules means pressure relief valves, rupture discs or equivalent. Two or more of them in combination are to be provided in each space to be covered.

(2) When only pressure relief valves are provided as the pressure relief devices given in the preceding (1), the following requirements (A) and (B) are to be complied with :

(A) In case where the cargo tank is of the type A independent tank, semi-membrane tank provided with complete secondary barrier, membrane tank or integral tank, the following requirements (a) and (b) are to be complied with :

(a) The capacity of the pressure relief system is to be sufficient to relieve the greater of the maximum supply capacity of the inerting system and dry air supply system or the estimated volume of cargo evaporation in an event of failure of the cargo tank.

(b) Pressure relief valves are to be in accordance with the requirements in **802. 3** of the Guidance.

(B) In case where the cargo tank is of the type B independent tank or semi-membrane tank provided with partial secondary barrier, the following requirements (a) and (b) are to be complied with :

(a) The capacity of pressure relief device is to be in accordance with the preceding (A) (a).

(b) Pressure relief valves may not be such as being approved in accordance with the requirements in **802. 3** of the Guidance. However, they are to be equivalent to those complying with the requirements for PV valves in **Pt 7, Ch 1, 1004. 1** of the Guidance.

(3) When, as a pressure relief device referred to in the preceding (1), pressure relief valve and rupture disc are provided in combination, they are to conform to the following requirements (A) to (C) for the cargo tank types indicated in the preceding (2) (A) :

(A) The capacity of the pressure relief valve is to be sufficient to relieve the maximum supply capacity of the inerting system.

(B) Pressure relief valves are to be in accordance with the requirements in the preceding (2) (B) (b).

(C) The capacity of rupture disc is to be sufficient to relieve the volume of cargo evaporation in an event of failure of the cargo tank, and the construction is to be as deemed appropriate by the Society.

(4) The relieving capacity of pressure relief devices for interbarrier spaces is to be determined as followings :

(A) The combined relieving capacity 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 :

$$Q_{sa} = 3.4 A_c \frac{\rho}{\rho_v} \sqrt{h} \quad (\mathrm{m^3/s})$$

where:

Q_{sa} : minimum required discharge rate of air at standard conditions of 273K and 0.1013 MPa

A_c : design crack opening area ($\mathrm{m^2}$), $\pi\delta\, l/4$

δ : maximum crack opening width (m), 0.2 t

t : thickness of tank bottom plating (m)

l : design crack length equal to the diagonal of the largest plate panel of the tank bottom (m), see **Fig 7.5.30** of the Guidance

h : maximum liquid height above tank bottom plus 10·MARVS (m)

ρ : density of product liquid phase at the set pressure of the interbarrier space relief device ($\mathrm{kg/m^3}$)

ρ_v : density of product vapour phase at the set pressure of the interbarrier space relief device and a temperature of 273 K ($\mathrm{kg/m^3}$)

(B) The relieving capacity of pressure relief devices of interbarrier spaces surrounding type B independent cargo tanks may be determined on the basis of the preceding (A). However, the leakage rate is to be determined in accordance with **407. 6** (1) of the Rules.

(C) The relieving capacity of pressure relief devices of interbarrier spaces of membrane and semi-membrane tanks is to be evaluated on the basis of specific membrane or semi-membrane tank design.

(D) The relieving capacity of pressure relief devices of 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 paragraph are emergency devices for protecting the hull structure from being unduly overstressed in case of a pressure rise in the interbarrier space due to primary barrier failure. Therefore, such devices need not comply with the requirements in **802. 9** and **802. 10** of the Rules.

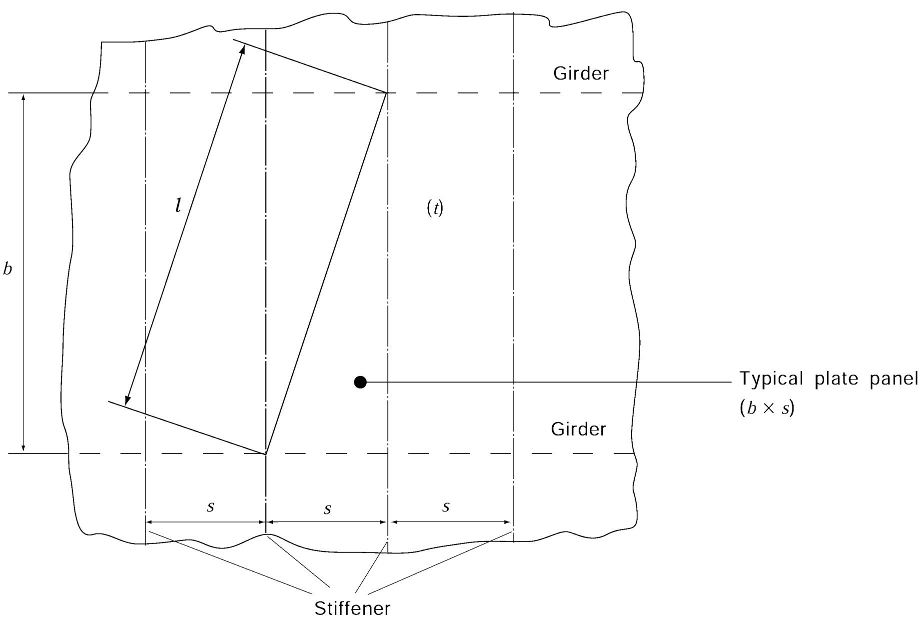


Fig. 7.5.30 The Example Size of Tank Bottom Plate

2. Arrangement of pressure relief valves

For the purpose of the requirements in **802. 4** of the Rules, for the cargo tank with the design temperature lower than 0°C, it is to be verified through temperature distribution calculation, etc. that the valve would not freeze or it is provided with anti-freezing construction. In ships where the requirements in **Pt 3, Ch 20** of the Rules apply or ships regularly navigate through the sea of cold zone, the pressure relief valves are to have satisfactory proved function under freezing condition or to be provided with heating system to prevent functional inability due to freezing.

3. Capacity of pressure relief valves

For the purpose of the requirements in **802. 5** of the Rules, pressure relief valves to be provided in cargo tanks, cargo piping and interbarrier spaces, as necessary, are to be approved in accordance with the Guidance for Approval of Manufacturing Process and Type Approval, etc.

4. Changing of set pressure of relief valves

The means as "necessary for isolating the valves not in use from the cargo tank" referred to in **802. 6** of the Rules means, for example, the arrangement as shown in **Fig 7.5.31** of the Guidance.

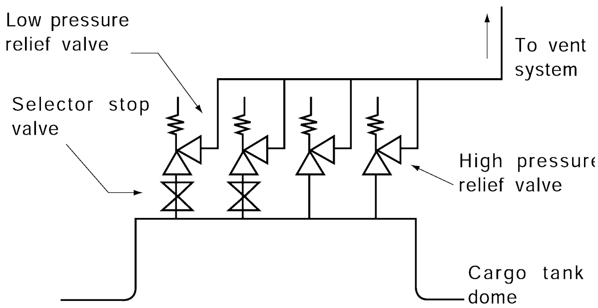
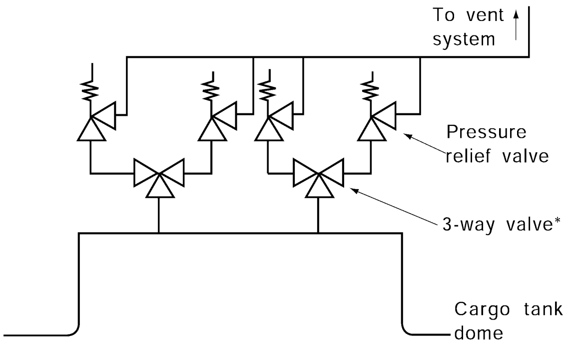


Fig. 7.5.31

5. Stop valves between tanks and pressure relief valves

(1) For the purpose of the requirements in **802. 8** of the Rules, no stop valve is to be provided in the vent piping on the downstream of the pressure relief valve.
(2) The "suitable arrangements" referred to in the requirements in **802. 8** (1) of the Rules means, for example, the arrangement as shown in **Fig 7.5.31** of the Guidance, the arrangement through transfer of the 3-way valve as shown in **Fig 7.5.32** of the Guidance or by stop valve of inter-locking type.
(3) The "suitably maintained spare valve" referred to in the requirements in **802. 8** (3) of the Rules means, for example, valves of the same type and capacity of valve ① and valve ② in the arrangement as shown in **Fig 7.5.33** of the Guidance. In this case, if valve ① and valve ② are of the completely same type and capacity, only one set of such spare may be accepted.



* : 3-way valve in which the direction of opening is indicated where means are provided to prevent any intermediate valve position

Fig. 7.5.32

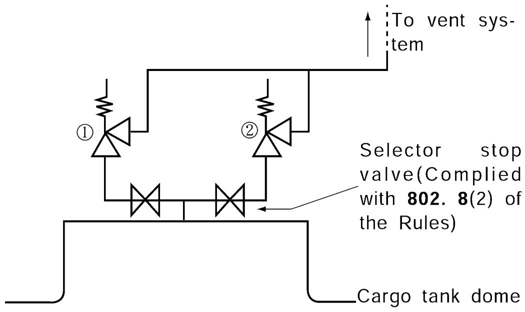


Fig. 7.5.33

6. Venting system

(1) To "be so constructed that the discharge of gas will be directed upwards and so arranged as to minimize the possibility of water or snow entering the vent system" referred to in the requirements in **802. 9** of the Rules means for example, as shown in **Fig 7.5.34** of the Guidance.
(2) For the purpose of the requirements in **802. 9** of the Rules, the height of the vent discharge outlet is to be measured from the exposed deck at the place where the vent mast is provided.

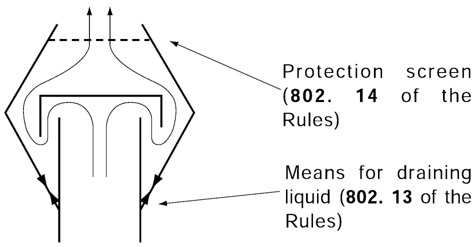


Fig. 7.5.34 Example of Construction of Vent Discharge Outlet

7. Arrangement of vent exits

For the purpose of the requirements in **802. 10** of the Rules, the distance to the vent discharge outlet is to be measured horizontally.

8. Arrangement of all other cargo vent exits

For the purpose of the requirements in **802. 11** of the Rules, the arrangements of other vent discharge outlet are to be in accordance with following requirements (1) to (3) :

(1) Vent discharge outlets from the gas fuel piping specified in **1603. 6** of the Rules are to be in accordance with the requirements in **802. 9** and **10** of the Rules.
(2) Vent discharge outlets shown in the following (A) and (B) are to be arranged at a horizontal distance not less than 10 m from the nearest air intakes, discharge outlets or opening to accommodation spaces, service spaces and control stations, or other gas-safe spaces.
   (A) Vent discharge outlet of the discharge gas from gas detecting system specified in the requirements in **1306. 5** (2) of the Rules.
   (B) Discharge outlet specified in the requirements in **1603. 5** of the Rules
(3) Vent discharge outlets from pressure relief valves or rupture discs of interbarrier spaces are to be installed in gas dangerous zones.

9. Pressure relief system for carrying incompatible cargoes simultaneously

The "separate pressure relief system" referred to in the requirements in **802. 12** of the Rules means the independent vent system including an independently provided pressure relief valve. In this case, no specific requirement is provided on the distance between vent discharge outlets.

10. Means for draining of vent piping system

For the purpose of the requirements in **802. 13** of the Rules, drain plugs or drain cocks are to be provided at places, such as vent post bottoms and bend parts of vent pipes, where drains are likely to accumulate.

11. Protection screens on vent outlets

The "protection screens" referred to in the requirements in **802. 14** of the Rules means wire gauze of 13 mm × 13 mm mesh or below with suitable strength against falling objects.

12. The "special guidelines" referred to in **802. 18** of the Rules means **Annex 7A-2.**

803. Additional pressure relieving system for liquid level control

1. Requirement of additional pressure relieving systems

The words "to prevent the tank from becoming liquid full" contained in **803. 1** of the Rules have the meaning that 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 the requirements in **1501. 3** of the Rules.

804. Vacuum protection systems

1. Fitting of vacuum protection systems

(1) For the purpose of the requirements in **804. 2** (1) of the Rules, the means to stop all suction of the cargo liquid or cargo vapour may be by shutting off valves or stopping the equipment provided that they are automatically operated.

(2) For the purpose of the requirements in **804. 2** (2) of the Rules, the vacuum relief valve is to conform to the requirements in **802. 5** of the Rules and to be approved in accordance with the Guidance. However, means as specified in the requirements in **804. 2** (1) or (3) of the Rules are to be provided, and where vacuum relief valve adjusted to function at a pressure lower than such means is provided as an additional device, the requirements may be dispensed with for this vacuum relief valve as an additional means.

2. Requirement of vacuum protection systems

For the purpose of the requirements in **804. 3** of the Rules, vacuum relief valves are to be in accordance with the following requirements (1) and (2) :

(1) Only for cases where vacuum relief valves adjusted to a set pressure lower than the operating pressure of the device specified in the requirements in **804. 2** (1) or (3) of the Rules, are provided for additional means of the devices, it may be accepted to admit the air to be introduced into the tank even in case of flammable cargoes except for the cases specified in the relevant requirements in **Sec 17** of the Rules.

(2) The air suction opening for the vacuum relief valve as an additional device indicated in the preceding (1) may be made in such a way that the requirements in **802. 9** and **10** of the Rules do not apply. However, the requirements in **Pt 5, Ch 6, 201. 5** of the Rules are to be complied with, and the construction of the suction opening is, for example, to be as shown in **Fig 7.5.34** of the Guidance.

805. Size of valves

1. Size of valves

For the purpose of the requirements in **805. 2** of the Rules, the fire exposure factor is to be in accordance with the following requirements (1) through (4) :

(1) The insulation materials used at exposed spaces when F = 0.5 are to conform to the requirements in **409. 3** (2) of the Guidance.

(2) In the case of integral tanks, F = 0.1.

(3) The fire exposure factor of the tank which partially protrudes beyond the tank cover having the

fire integrity equivalent to the deck and deck structure is to be of such a value as obtained by proportional distribution of cargo tank surface areas above and below the deck or tank cover.

(4) In case where hold spaces filled with dry air is accepted for semi-membrane tanks provided with partial secondary barriers in accordance with the requirements in **902. 2** (2) of the Rules, $F = 0.2$.

Section 9 Environmental Control

901. Environmental control within cargo tanks and cargo piping systems

1. Gas-free and purge systems of cargo tanks

For the purpose of the requirements in **901. 1** of the Rules, the design and arrangement of gas-freeing and purging piping systems of cargo tanks are to be in accordance with the following requirements (1) and (2) :

(1) For installation of piping and fixing of pipe fittings in cargo tanks, sufficient consideration is to be taken for possible transient temperature differential.
(2) The effectiveness of replacement of cargo tank atmosphere is to be verified at time of gas trial given in **410. 9** of the Guidance.

2. Monitoring of purging and gas-freeing

For the purpose of the requirements in **901. 2** of the Rules, the arrangement of gas sampling points in cargo tanks is to be determined according to the cargo properties, cargo tank construction and capacity and the abilities of gas-freeing and purging systems, and where appropriate, the adequacy of the arrangement of gas sampling points is to be verified by the performance test. The locations of gas sampling points are, as standard, to be at the upper, middle and lower space of the cargo tank.

3. Inerting of cargo tanks

For the purpose of the requirements in **901. 3** of the Rules, for cargo tanks carrying petroleum products, etc. the requirements in this Chapter apply, and in addition, the requirements specified in **Pt 8, Ch 1, 401. 2** of the Rules are to be complied with.

902. Environmental control within the hold spaces (cargo containment systems other than type C independent tanks)

1. Environmental control, requiring full secondary barriers

(1) For the purpose of the requirements in **902. 1** of the Rules, even in cases where full secondary barrier is not required according to the requirements in **407. 3** of the Rules, if flammable gases are carried in type A independent tank, integral tank, membrane tank and semi-membrane tank, the requirements in **902. 1** of the Rules apply correspondingly.
(2) The "suitable dry inert gas" referred to in the requirements in **902. 1** of the Rules means the inert gas of which dew point is controlled in accordance with **904. 1** (4) of the Guidance. Further, the "normal consumption for at least 30 days" referred to in the requirements in **902. 1** of the Rules is to be given consideration for the effects of atmospheric pressure and temperature variations during the passage and additional consumption by gas detection, etc.

2. Environmental control, requiring partial secondary barriers

(1) For the purpose of the requirements in **902. 2** of the Rules, even in cases where the provision of partial secondary barriers is not required according to the requirements in **407. 3** of the Rules, when flammable gases are carried by type B independent tank, the requirements in **902. 2** of the Rules apply.
(2) The "suitable dry inert gas" and the "normal consumption for at least 30 days" referred to in the requirements in **902. 2** (1) of the Rules are to be as specified in 1 (2) above.
(3) In cases where dry air is introduced into the interbarrier spaces and hold spaces, at least the following requirements (A) to (C) are to be complied with :
   (A) Dew point of dry air is to be controlled according to **904. 1** (4) of the Guidance.
   (B) On the supply piping of dry air, one stop valve is to be provided at the inlet into the space which is filled with dry air, and two non-return valves are to be provided within the cargo area side near the forward or aft end of the cargo area. However, one of the two non-return valves may be substituted by 3-in one set as **Fig 7.5.35** of the Guidance.

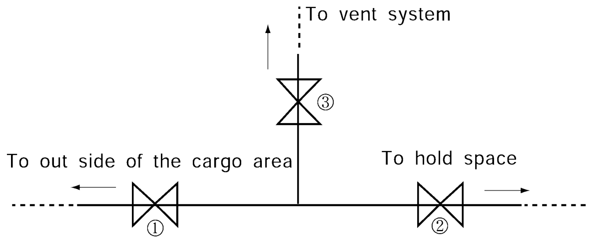


Fig. 7.5.35

(C) Instrumentation is to be provided in accordance with the following requirements (a) to (c) :
- (a) At the outlet of the dry air supply system, pressure gauge and thermometer are to be provided.
- (b) One or more dew point meters as deemed appropriate by the Society are to be provided. However, in case where only one dew point meter is provided, a spare cell unit is to be provided.
- (c) At the outlet of the dry air supply system, interbarrier spaces and hold spaces, connections for dew point meter are to be provided.

3. Environmental control for non-flammable gases

(1) The "suitable dry air or inert atmosphere" referred to in the requirements in **902. 3** of the Rules means a state in which spaces are filled with the air with controlled dew point or inert gas according to the requirements in **904. 1** (4) of the Guidance. This inert gas system may not conform to the requirements in 904. and 905. of the Rules, but is to be provided with a storage system or generating system capable of making up a consumption for at least 30 days.
(2) In case where dry air is introduced according to the preceding (1), the requirements in **902. 2** (3) of the Guidance are to be complied with.

4. Environmental control for doble hull and double bottom spaces

Ventilation, inerting and gas measurements for double hull and double bottom spaces are to comply with the requirements in **Ch 1, 1009.** to **1011.** of the Rules.

903. Environmental control of spaces surrounding type C independent tanks

1. Environmental control of spaces surrounding type C independent tanks

For the purpose of the requirements in **903.** of the Rules, the environmental control of the compartment is to be in accordance with **902. 3** (1) and (2) of the Guidance.

904. Inerting

1. Properties of inert-gas and its supply

For the purpose of the requirements in **904. 1** of the Rules, the following requirements (1) through (4) are to be complied with :

(1) For the inert gas supply piping, evaporator and heater, if necessary, are to be provided so that the compartment supplied with inert gas can be maintained at proper temperature and pressure and further, thermometer and pressure gauges are to be provided for monitoring.
(2) Where the inert gas is stored in inert gas bottles, the following requirements (A) through (D) are to be complied with :
(A) The inert gas bottles and piping are to be dealt with according to the following requirements (a) to (c) :
- (a) The material of the piping may be according to the requirements of the standard as deemed appropriate by the Society.
- (b) The gas bottle may be according to the requirements of the National Standards notwith-

standing the requirements in **Pt 5, Ch 5, Sec 3** of the Rules.
(c) The hydraulic tests for pipes, valves and pipe fittings may be omitted.
(B) The location of installation of the bottles is to be as given in the following (a) and (b) :
(a) The inert gas bottles are, as a rule, to be located in the storage room within the cargo area.
(b) The storage room of inert gas bottles is to be well ventilated so as not to allow leaked gas accumulate the room and be capable of being accessed from the exposed deck.
(C) The inert gas bottles are to be so arranged to be safe against ship motions and vibrations, and are to be stored upright as far as practicable.
(D) The piping system, after assembly of board, is to be subjected to airtightness test at a pressure 1.25 times the maximum working pressure or more, and free flow test at a suitable pressure.
(3) Where the permanent storage tank installed on deck is used as the inert gas storage container, the requirements for the design, tests and inspection of the tank and the piping are to be in accordance with the relevant requirements specified for process pressure vessels and piping systems in **Sec 4** and **Sec 5** of the Rules. However, consideration may be given as appropriate depending on their service conditions.
(4) The dew point of dry inert gas is, in general, not exceed the minimum design temperature of the exposed surface of the insulation material of the cargo tank into the hold space and hul1 structural members of the space being inerted in normal condition.

2. Storage of inert gas at low temperature

For the purpose of the requirements in **904. 3** of the Rules, the thermal isolation between the hull structure and the storage tank, and where necessary, the inert gas supply piping is to be in accordance with **502. 1** (3) of the Guidance.

3. Prevention of the back flow of cargo vapour

For the purpose of the requirements in **904. 4** of the Rules, the arrangement to prevent the back flow of cargo vapour from entering the inert gas system is to be in accordance with **301. 4** (1) of the Guidance. (See **Fig 7.5.36** of the Guidance)

4. Isolation of spaces being inerted

(1) For the purpose of the requirements in **904. 5** of the Rules, the isolation of the spaces being inerted such as cargo tanks, cargo piping system, process pressure vessels and their piping system from the inert gas system are to be in accordance with the preceding **Par 3.**
(2) The isolation of the spaces being isolated other than those indicated in the preceding (1) is to be in accordance with the following requirements (A) and (B) :
(A) The isolation of the interbarrier spaces, hold spaces where the cargo vapour does not exist in normal condition and the outer side of double wall gas fuel piping specified in the requirements in **1603. 1** (1) of the Rules may be by a stop valve.
(B) The isolation of the compartments where cargo vapours are likely to exist in normal condition is to be by the combination of screw-down check valve, stop valve, automatic or control valve, and non-return valve. (See **Fig 7.5.36** of the Guidance)

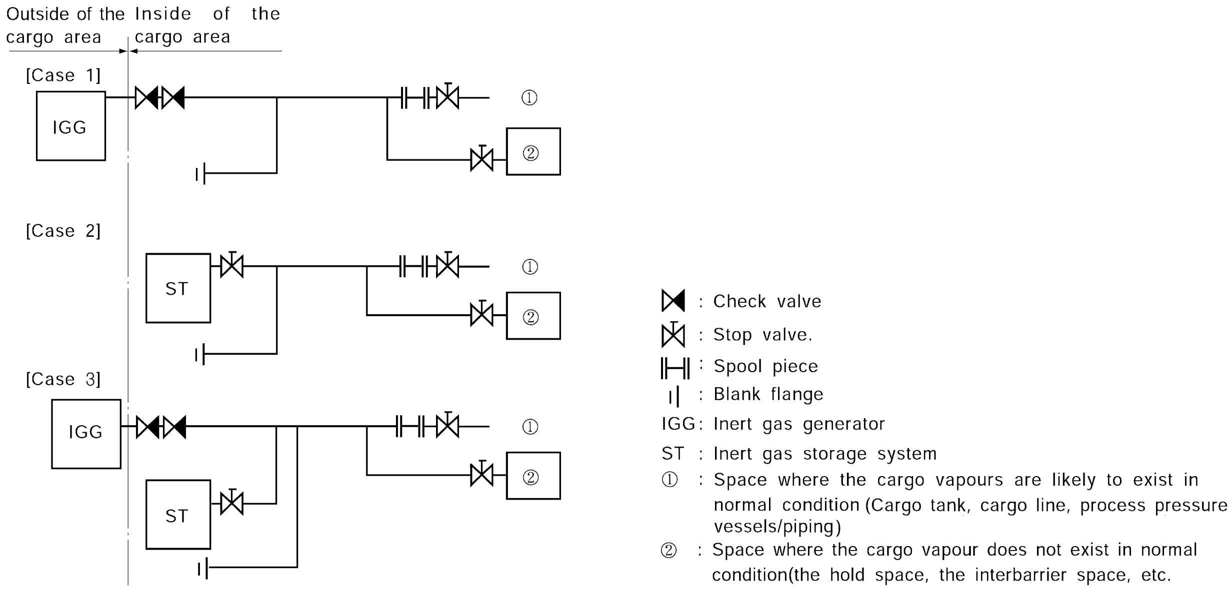


Fig 7.5.36

905. Inert gas production on board

1. Inert gas production equipment

(1) For the purpose of the requirements in **905. 1** of the Rules, the combustion type inerting systems are to be in accordance with the relevant requirements of **Pt 8, Annex 8-5** of the Guidance and the following requirements (A) to (C).

(A) Inerting gas production equipment is to be provided with sufficient amount of suitable fuel oil.

(B) Where two sets or more inerting gas production equipments are provided, the stop valve is to be installed on the supply outlets of each equipment.

(C) Where the volumetric blower is provided in inerting gas production equipment, the pressure relief valves are to be installed on discharge outlets of blowers to prevent generating the over pressure.

(2) In addition to the preceding (1), nitrogen generating system is to be complied with the relevant requirements in **Pt 8, Annex 8-5** of the Guidance.

(3) The components of inerting gas production equipment given in the preceding (1) and (2) are to be approved by the Society.

Section 10 Electrical Installations

1001. General

1. Certified safe type equipment

(1) The words "satisfaction of the Society" referred to in **1001. 5** of the Rules mean the explosion protected electrical equipment required by **Pt 6, Ch 1, Sec 9** of the Rules and having the performance classified by Gases and Vapours Group and Temperature Class according to **Table 7.5.8** of the Guidance by the type of vapour or equivalent.

(2) The words "approved one as the certified safe type" mean that type tested as the explosion-protected electrical equipment in accordance with the requirements in **Pt 6, Ch 1, 109. 3** and **4** of the Rules and/or equipment recognized that there is no fear of serving as a source of ignition structurally.

Table 7.5.8 Gases and Vapours Groups and Temperature Class

Product name	UN number	Gases and vapours groups	Temperature class
Acetic aldehyde	1089	II A	T4
Ammonia, anhydrous	1005	II A	T1
Butadiene	1010	II B	T2
Butane	1011	II A	T2
Butane－propane mixtures	1011/1978	II A	T2
Butylenes	1012	※	※
Chlorine	1017	－	－
Diethyl ether	1155	II B	T4
Dimethylamine	1032	II A	T2
Ethane	1961	II A	T1
Ethyl chloride	1037	II A	T1
Ethylene	1038	II B	T2
Ethylene oxide	1040	II B	T2
Ethylene oxide－propylene oxide mixtures with ethylene oxide content of not more than 30 % by weight	2983	※	※
Isoprene	1218	II B	T3
Isopropylamine	1221	II A	T2
Methane (LNG)	1972	II A	T1
Methyl acetylene-propadiene mixtrues	1060	※	※
Methyl bromide	1062	※	※
Methyl chloride	1063	II A	T1
Monoethylamine	1036	II A	T2
Nitrogen	2040	－	－
Propane	1978	II A	T1
Propylene	1077	II A	T2
Propylene oxide	1280	II B	T2
Refrigerant gases (see notes)	－	－	－
Sulphur dioxide	1079	－	－
Vinyl chloride	1086	II A	T3
Vinyl ethyl ether	1302	II B	T3
Vinylidene chloride	1303	II A	T2

Notes:
1. Temperature classes and gases and vapours groups are as defined in IEC 60079.
2. 「—」 indicates that the product is non-flammable, and * is to be to satisfaction of the Societ

Section 11 Fire Protection and Fire Extinction

1101. Fire safety requirements

1. Exclusion of ignition source

For the purpose of the requirements in **1101. 2** of the Rules, in the gas-dangerous zones or areas specified in the requirements in **106. 17** of the Rules, for ships carrying flammable substances, electrical equipment, windlasses, openings of chain lockers which are regarded as sources of ignition are not to be provided except for those approved under the relevant requirements in **Sec 10** of the Rules.

1102. Fire water main equipment

1. Fire pump and fire main

For the purpose of the requirements in **1102. 1** of the Rules, the minimum pressure at fire hydrant of the fire main is to be not less than 0.5 MPa gauge irrespective whether the fire pump and water main as used as part of water spray system or not.

2. Nozzles

For the purpose of the requirements in **1102. 4** of the Rules, all nozzles provided for fire-fighting are to be in accordance with the relevant requirements of **Pt 8, Ch 3** of the Rules.

3. Remote control

In case of applying the requirements in **1102. 5** of the Rules, at least one of fire pumps is to be capable of starting by remote control, and all valves provided between the fire pump and fire main are to be capable of being opened by remote control from the navigation bridge or other control stations outside the cargo area.

1103. Water spray system

1. Area to be covered

(1) For the purpose of the requirements in **1103. 1** (1) of the Rules, the area to be covered at the exposed tank dome is to include the areas where stop valves for cargo tanks and emergency shutdown valves specified in the requirements in **506. 1** of the Rules are fitted.
(2) For the purpose of the requirements **1103. 1** (3) of the Rules, the area of the manifold is to include the areas where emergency shutdown valves specified in the requirements in **506. 3** of the Rules are fitted. Further, the "control valve" referred to in the requirements in **1103. 1** (3) of the Rules is to include stop valves for the transfer of cargo line to and from vapour line.
(3) The "high fire risk items" referred to in the requirements in **1103. 1** (4) of the Rules are not to include the hydraulic machinery and electric motors. Further, the "boundaries .... all facing the cargo area" referred to in the requirements in **1103. 1** (4) of the Rules are not to include the ceiling of the compartment to be covered.

2. Arrangement and capacity

For the purpose of the requirements in **1103. 2** of the Rules, the following requirements (1) to (2) are to be complied with :

(1) The nozzles for protecting vertical surfaces are to be arranged per every two tiers for the end walls of the accommodation spaces, as standard.
(2) The intermediate valves fitted with the fire main are to be provided at the connections between the branch line and spray main for example, as shown in **Fig 7.5.37** of the Guidance.

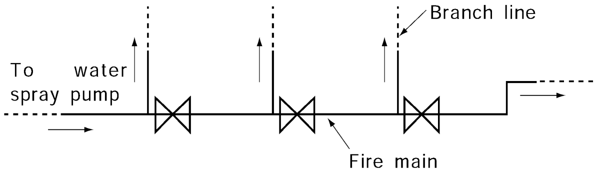


Fig. 7.5.37

3. Use for other services

For the purpose of the requirements in **1103. 4** of the Rules, the ballast pump and bilge pump may be used commonly for the water spray system.

1104. Dry chemical powder fire-extinguishing systems

1. General

The "satisfactory to the Society" referred to in the requirements in **1104. 1** of the Rules means that the requirements in **507. 1** of the Guidance are complied with.

2. Component of the systems

For the purpose of the requirements in **1104. 2** of the Rules, dry chemical powder fire-extinguishing systems are to conform to the requirements in **1104. 2** to **6** of the Rules, and in addition they are to be approved in accordance with the Guidance.

3. Monitors and hand hose lines

For the purpose of the requirements in **1104. 3** of the Rules, the manifold areas may be protected by only one monitor provided that it can be so fixed to protect the manifold area used for cargo operation even if there are manifolds on both sides of the ship.

4. Capacity of dry chemical powder

For the purpose of the requirements in **1104. 6** of the Rules, when the areas to be covered are located higher than the installed positions of monitors and manual hose reels, the Society may request increase in the capacity of these monitors and manual hose reels depending on their arrangement.

1105. Cargo compressor and pump rooms

1. Fixed fire-extinguishing installation for cargo compressor and pump rooms

For the purpose of the requirements in **1105. 1** of the Rules, the fixed gas fire-extinguishing systems for cargo compressor and pump rooms are to be in accordance with the requirements following (1) through (6). Independent inert gas system is to be provided, if the fire-extinguishing medium is not compatible with inerting.

(1) The fixed gas fire-extinguishing system is to conform to the relevant requirements in **Pt 8, Ch 3** of the Rules correspondingly.
(2) In the case of carbon dioxide or halogenated hydro-carbon fire-extinguishing systems, the requirements in **Ch 6, 1102. 1** of the Rules are to be complied with.
(3) In the case of the nitrogen gas fire-extinguishing system, the volume of nitrogen gas is to be not less than that multiply following values by total volume of the relevant spaces and also to be in accordance with national requirements.

$$\frac{21 - O_2}{21} \times 1.2$$

where :

O_2 : limit volume of carbon (Vol%)

(4) The storage containers and pipings for nitrogen gas fire-extinguishing system are to be such that nitrogen gas equal to 85 % of the volume of preceding (3) can be discharged into the space within 2 minutes.

(5) The boundaries of cargo compressor and pump rooms in relation to the requirements in **1105.** of the Rules is to remain in a state corresponding to "A-0" class fire integrity including doors, etc. of the boundaries. Packing provided for doors is, as a rule, to be of non-combustible material defined in the relevant requirements in **Pt 8, Ch 1** of the Rules. However, in case where special consideration is taken for structural details in way of openings, materials and quantity of the packing, the packing need not be of non-combustible one.

(6) Notwithstanding the requirements in the preceding (5), when steel blind covers are provided for the windows fitted on the boundary of the compartment and the exposed area, these windows may not be "A-0" class. Further, at the boundary to electric motor room, no windows are to be provided unless they correspond to "A-0" class.

Section 12 Mechanical Ventilation in the Cargo Area

1201. Spaces required to be entered during normal cargo handling operations

1. Ventilation exhaust ducts from gas-dangerous spaces

For the purpose of the requirements in **1201. 6** of the Rules, the construction of ventilation exhaust ducts is, for example, to be as shown in **Fig 7.5.38** of the Guidance.

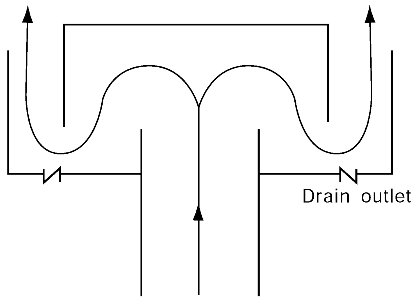


Fig. 7.5.38

2. Arrangement of ventilation intakes

For the purpose of the requirements in **1201. 7** of the Rules, ventilation intakes are, at least, to be located in the gas-safe areas.

3. Construction of ventilation fans

For the purpose of the requirements in **1201. 9** of the Rules, the following requirements (1) and (2) are to be complied with :

(1) Ventilation fans are to be approved in accordance with the Guidance.
(2) The ventilation fans for motor rooms where electric motors to drive cargo compressors and cargo pumps are installed are to conform to the requirements in **1201. 9** of the Rules, and in addition, to the following requirements (A) and (B) :
  (A) To have a ventilation capacity of not less then 30 air changes of the total volume of the motor room per hour.
  (B) Electric motors driving ventilation fans are to conform to the relevant requirements in **Ch 5, Sec 10** of the Rules depending on the location of motors, and in addition, to the requirements for exterior-mounted type specified in **Pt 8, Ch 1, 312. 2** of the Guidance when motors are installed in exposed spaces.

4. Spare parts

"Spare parts" means one spare impeller for each type of fan.

5. Protection screens of ventilation duct openings

The Protection screens are to be in accordance with **802. 11** of the Guidance.

1202. Spaces not normally entered

1. Ventilation of hold spaces

(1) Natural ventilation alone is not acceptable.

Section 13 Instrumentation (Gauging, Gas Detection)

1301. General

1. Centralization of controls equipments and indicators

For the purpose of the requirements in **1301. 3** of the Rules, in case where control equipment and indicators are unable to be centralized in the cargo control room or other suitable places, they are to be provided in the wheelhouse.

2. Calibration and test of measuring instruments

For the purpose of the requirements in **1301. 4** of the Rules, tests and inspections of measuring instruments are to be in accordance with the following requirements (1) to (3) :

(1) Tests and inspections of measuring instruments during manufacture of each are to conform to the following requirements (A) to (C) :
  (A) Gas detection equipment are to be in accordance with the requirements in the Guidance.
  (B) Level gauges are to be in accordance with the requirements in the Guidance for Approval of Manufacturing Process and Type Approval, Etc.
  (C) Pressure gauges and temperature indicating devices are to be in accordance with the requirements of the standards recognized by the Society or are to be manufactured under effective quality control system and to be ensured for their reliability.

(2) After installation on board the ship, the instrument is to be subjected to operation test to verify that it has the specified performance. This test is not necessarily conducted with the actual cargo, but for gas detection equipment, suitable test gases are to be used in the test.

(3) For retests and testing procedures of instrumentation after installation on board the ship, at least the following items are to be noted in the Operation Manual specified in the requirements in **1801. 1** of the Rules :
  (A) Check method and testing procedure before use
  (B) Check method and testing procedure during use
  (C) Periodical check method and intervals specified by the manufacturer
  (D) Service life of equipment (excluding those permanent system components)
  (E) Periodical inspection procedure specified in the requirements in **Pt 1, Ch 2, 204.** (4) of the Rules
  (F) Other precautions

1302. Level indicators for cargo tanks

1. General

For the purpose of the requirements **1302. 1** of the Rules, the following requirements (1) and (2) are to be complied with :

(1) The performance and construction of level gauges are to be approved according to the Guidance for Approval of Manufacturing Process and Type Approval, Etc.

(2) The effectiveness and number of units of level gauges are to be in accordance with the following requirements (A) and (B) :
  (A) Where only one level gauge is fitted, it is to be arranged so that any necessary maintenance can be carried out while the cargo tank is in service.
  (B) For example, in case where gauging of levels is limited at high level and low level, such level is considered effective on condition that cargo is loaded within such range.

2. Type of level indicators

For the purpose of the requirements in **1302. 2** of the Rules, in case where the prospective cargoes are plural and the type of level gauges required in column g in Table of **Sec 19** of the Rules is also plural where two or more level gauges are provided for each requirement (in the case shown in **1** (2) (A) above, may be one), they may be multiplicate. However, for the type of level gauge for less severe requirements, warning sign stating that the level gauge is not to be used for other cargoes than the specified cargoes is to be posted.

3. Sighting ports

For the purpose of the requirements in **1302. 3** of the Rules, the construction and liquid-tight and gas-tight performance of the sighting ports are to be equivalent to the tank top plating and suitable protection steel covers are to be provided. For the purpose of the requirements in **1302. 1** of the Rules, the sighting ports are not to be regarded as level gauges required.

4. Tubular glass gauge

Tubular glass gauges are to conform to the requirements in **1302. 4** of the Rules, and in addition, to the requirements in **Pt 5, Ch 5, 129.** of the Rules.

1303. Overflow control

1. General

For the purpose of the requirements in **1303. 1** of the Rules, the following requirements are to be complied with :

(1) High level alarm systems are to be in accordance with **Pt 7, Ch 1, 1004. 5** of the Guidance.
(2) The sensor for automatic closing of the loading valve for overflow control may be combined with those of level gauges required in **1302. 1** of the Rules.

2. Omission of automatic shutoff

The "maximum possible pressure during the loading operation" referred to in the requirements in **1303. 2** (2) of the Rules is to be considered as the maximum pressure generated by the discharge pressure of shore-based transfer pump and cargo vapour pressure.

3. Level alarms with electrical circuits

To "be capable of being tested prior to loading" referred to in the requirements in **1303. 3** of the Rules means to be capable of verifying by test (for example, by buzzer test) that all alarm circuits are in normal working condition when verification through actual operation is impossible. However, a special attention is to be paid to those that can not be always monitored the breaking down of the circuit.

1304. Pressure gauges

1. Pressure gauges and alarms of cargo tanks

(1) The low pressure alarm provided on the navigation bridge under the requirements in **1304. 1** of the Rules, when the provision of vacuum relief valve is required by the provision in **804. 2** of the Rules, is to be capable of issuing alarm at a suitable differential pressure between inside and outside of cargo tank, which is lower than the maximum design external pressure of the cargo tank.
(2) The alarm system specified in the requirements in **1304. 1** of the Rules is to issue visible and audible alarms.

1305. Temperature indicating devices

1. General

The "lowest temperature for which the cargo tank has been approved by the Society" referred to in the requirements in **1305. 1** of the Rules means the lowest design temperature indicated together with the classification characters in the Register Book.

2. Temperature indicating devices of hull structure when a cargo is carried at a temperature lower than −55°C

The word, "where applicable" referred to in the requirements in **1305. 2** of the Rules means the case where provision is made for heating the structural hull members as specified in the requirements in **408. 4** of the Rules. At four points, at least, on double bottom tank top platings, the temperature sensors are to be provided.

3. Temperature indicating devices of cargo tanks when a cargo is carried at a temperature lower than −55°C

For the purpose of the requirements in **1305. 3** of the Rules, the temperature indicating devices for cases of carrying the cargo at a temperature lower than -55°C are to be in accordance with the following requirements :

(1) In order to verify the cooling down or loading procedures according to the requirements in **403. 4** (1) of the Guidance, temperature indicating devices required in the provisions in **1305. 3** (1) of the Rules are to be provided.

(2) The temperature sensors provided for verifying the cooling down procedure specified in the requirements in **1305. 3** (2) of the Rules are to be arranged under considering the arrangement of spray nozzles and construction of cargo containment system. For the other cargo tanks which can be regarded as having the same construction and arrangements as the cargo tanks provided with above sensors, the temperature indicating devices specified in the requirements in preceding (1) and **1305. 1** of the Rules may only be provided.

1306. Gas detection requirements

1. General

The "equipment acceptable to the Society" referred to in the requirements in **1306. 1** of the Rules may be followed as given in **507. 1** (1) to (3) of the Guidance.

2. Positions of fixed sampling heads

For the purpose of the requirements in **1306. 2** of the Rules, the positions of fixed sampling heads are to be arranged where cargo vapours are liable to accumulate by taking into account the geometrical configurations of the compartment to be covered, construction and arrangement of the space within the compartment. In this case, the sampling heads are, as a rule, to be provided at least at two locations for each such compartment.

3. Location of gas detection equipment

The "safe location" referred to in the requirements in **1306. 5** (2) of the Rules means the location specified in **802. 8** (2) of the Guidance when the sampled gas is of the dangerous ones. In case where the sampled gas is not dangerous, it may be returned to the place of sampling.

4. Gas detection equipment for toxic products

For the purpose of the requirements in **1306. 9** of the Rules, the use of portable gas detecting equipment is to be in accordance with the following requirements :

(1) At least two sets of portable gas detecting equipments are to be provided on board.

(2) In the case of the cargo expressed in "$F+T$" in column f in Table of **Sec 19** of the Rules, the fixed type flammable gas detecting device specified in the requirements in **1306. 11** of the Rules is to be provided additionally.

(3) In case where the equipments are composed of consumables such as detecting tubes, suitable spare parts such as detecting tubes are to be provided on board in addition to the equipments specified in the preceding (1) by taking into account the shipboard work and the frequency of carriage of the cargo. In the case of the detecting tube type, detecting tubes are to be provided for each kind of loadings cargos as above requirement, but two suction pumps for each type of the portable detection equipments may be enough.

5. Gas detection for cargo containment systems other than independent tanks

For the purpose of the requirements in **1306. 11** of the Rules, the gas detection equipment for hold spaces and interbarrier spaces of cargo tanks other than independent tanks are to be in accordance with the following requirements :

(1) In the case of integral tanks, the requirements in **1306. 11** of the Rules do not apply. However, the requirements in **1306. 7** (5) of the Rules apply to the hold space of this cargo containment system.

(2) The available measuring range of gas detector is to be ordinarily made under the graduation where the lower explosive limit is taken as 100% but the range may be changeable to measure gas concentration between 0 % and 100 % in volumetric percent if necessary.

6. Gas detection for toxic gases

For the purpose of the requirements in **1306. 12** of the Rules, the gas sampling pipes of hold spaces and inter-barrier spaces dealing with toxic gas in case of portable gas detection equipment are to have openings at the upper part or lower part of the compartment in consideration of the cargo vapour density and automatic closing pipe heads are to be fitted at their top ends. In case where the sounding pipes specified in the requirements in **Pt 5, Ch 6, 203.** of the Rules can be used for the purpose in consideration of the cargo vapour density and the set pressure of the relief valve of the compartment, they may be used commonly therewith.

7. Instruments for measurement of oxygen levels

The "suitable instrument for the measurement of oxygen levels" referred to in the requirements in **1306. 14** of the Rules means the one as given in **507. 1** of the Guidance in a corresponding manner.

Section 15 Filling Limits for Cargo Tanks

1501. General

1. Filling limit higher than 98 %

For the purpose of the requirements in **1501. 3** of the Rules, the loading limits are to be in accordance with the following requirements :

(1) The "filling limit (FL)" means the maximum liquid volume in a cargo tank relative to the accepted tank volume when the liquid cargo has reached the reference temperature specified in the requirements in **1501. 4** of the Rules. In this case, the total volume of the cargo tank may include the volume of tank dome provided that either of the following conditions is satisfied :

(A) In applying the requirements in **403. 2** (2) of the Rules, consideration is given to the tank dome for determining Z_β.

(B) Tank dome is to be in accordance with **403. 2** (2) of the Guidance.

(2) In case where the following conditions (A) and (B) are satisfied, the filling limit may be a value exceeding 98% within the limit not exceeding 99.5 % :

(A) The maximum allowable filling limit results from the following formula :

$$\frac{V_{FL}}{V} \times 100 \ (\%)$$

where

V_{FL} : cargo tank volume to liquid level corresponding to the filling limit (m^3)

V : accepted total tank volume (m^3)

(B) Under conditions specified in **802. 17** of the Rules, the suction funnels of the pressure relief valves are to remain well above the sloped liquid level for the expanded volume determined by following formula :

$$V_{FL} \times \frac{100+\alpha_t}{100} \ (\mathrm{m}^3)$$

where:

α_t : the value as given by the following formula :

$$\alpha_t = \sqrt{\alpha_1^2+\alpha_2^2+\alpha_3^2} \ (\%)$$

α_1 : relative increase in liquid volume due to the tolerance of level gauges as given by the following formula : $\alpha_1 = \frac{dV}{dh}\left(\frac{h \times \Delta Z}{V}\right) \ (\%)$

where:

dV/dh : variation of tank volume per metre filling height at the filling height h (m^3/m)

h : filling height (m) at the filling limit FL to be investigated (FL > 98 %)

$\triangle Z$: maximum total tolerance of level gauges (%)

V : as specified in the preceding (A)

α_2 : relative increase in liquid volume due to the tolerance of temperature gauges as given by the following formula :

$$\alpha_2 = 100 \times \left\{ 1 - \left(\frac{T_C - T_L - \Delta T}{T_C - T_L} \right)^{0.26} \right\} (\%)$$

where:

T_C : critical temperature of the product (K)

T_L : highest loading temperature of the product (K)

$\triangle T$: maximum tolerance of temperature gauges (K)

α_3 : relative increase in liquid volume due to the difference between loading temperature and the temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valves taking into account the accuracy of the cargo tank calibration as given by the following formula :

$$\alpha_3 = \left(\frac{\rho_L}{\rho_R} - 1 \right) \times \Delta a \quad (\%)$$

where:

ρ_L and ρ_R : cargo densities as defined in **1501. 2** of the Rules

$\triangle a$: accuracy of cargo tank calibration (%)

2. Reference temperature

The "cargo tank becoming liquid full" referred to in the requirements in **1501. 4** (2) of the Rules is to be construed as given in **803. 1** of the Guidance in a corresponding manner.

Section 16 Use of Cargo as Fuel

1605. Special requirements for main boilers

1. The "on the pipe of each gas burner a manually operated shut-off valve should be fitted" referred to the requirements in **1605. 4** of the Rules is to be in accordance with **Fig 7.5.39** of the Guidance.

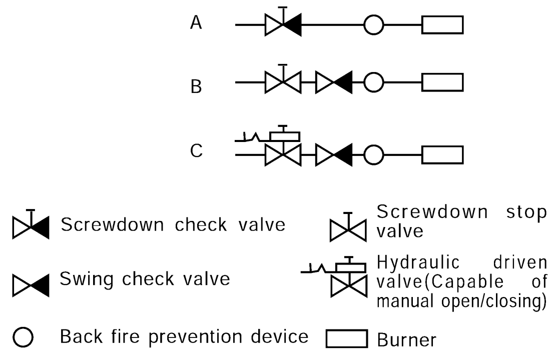


Fig. 7.5.39 Example for Arrangement of Manually Operated Shutoff Valve

Section 17 Special Requirements

1720. Propylene oxide and mixtures of ethylene oxide-propylene oxide with ethylene oxide (content of not more than 30 % by weight)

1. Valves, flanges and fittings

For the purpose of the requirements in **1720. 3** (3) of the Rules, the materials for insulation and packing with neoprene, natural rubber, asbestos and binders used with asbestos are not to be used. The materials containing oxides of magnesium, also are not to be used.

2. Padding of nitrogen gas

For the purpose of the requirements in **1720. 15** of the Rules, the nitrogen gas generator of membrane type capable of ensuring a purity not less than 99% in volume may be used.

Section 18 Operating Requirements

1801. Cargo information

1. General

In the cargo information specified in the requirements in **1801. 1** of the Rules, at least, the following items (1) through (11) are to be included, and the detailed contents are to be guided by the requirements in **Ch 18** of the IGC Codes with the contents as specified in **Sec 18** of the Rules. These detailed contents may be covered under separate booklets, but in such a case, it is to be expressly shown in the specific operation manual that reference is to be made to separate booklet.

(1) Cargo information
   (A) A full description of the physical and chemical properties necessary for the safe containment of the cargo
   (B) Action to be taken in the event of spills or leaks
   (C) Counter-measures against accidental personal contact
   (D) Fire-fighting procedures and fire-fighting media
   (E) Procedures for cargo transfer, gas-freeing, ballasting, deballasting, environmental control within the hold spaces and interbarrier spaces, tank cleaning and changing cargoes
   (F) Special equipment needed for the safe handling of the particular cargo
   (G) Minimum allowable inner hull steel temperatures
   (H) Emergency procedures
   (I) Action to be taken for inhibition
(2) Cargo stowage information
   (A) Hull strength and strength of cargo containment system
   (B) Stability (intact and damage)
(3) Personal training
   (A) Emergency measures
   (B) Assignment of work duty (cargo handling, fire-fighting, etc.)
   (C) Use of protective clothings and first-aiding
(4) Access to gas-dangerous spaces
   (A) Entering after gas-free or entering wearing protective clothings under the supervision of the duty officer
   (B) Exclusion of source of ignition
   (C) Special measures in the case of internal insulation tanks
(5) Carriage of low temperature cargoes
   (A) Use of heating arrangement
   (B) Procedures of cooling down
(6) Handling of protective equipment and their storage areas
(7) Cargo transfer system and control
   (A) Tests and inspection of control
   (B) Tests and inspection of alarms and emergency shutdown system
(8) Cargo transfer operation
   (A) Discussion between ship personnel and the persons responsible at the shore facility at time of cargo discharge
   (B) Emergency procedures
   (C) Cargo stowage plan
(9) Cargo handling operation
(10) Information on national rules and regulations
(11) The provisions in each Chapter of the IGC Code prescribing the working restrictions which are also specified in the following requirements of **Ch 5** of the Rules :
   106. 32, 308. 1 (1), **308. 3** (3), **308. 4, 308. 5, 410. 14, 701. 1** (5), **802. 5, 802. 7, 901. 3, 902., 904. 2, 1201. 10, 1202., 1301. 4, 1303. 1, 1306. 6, 1306. 9, 1402. 4, 1402. 5, 1402. 6, 1501., 1502., 1603., 1704. 2, 1704. 3, 1706., 1707., 1708., 1710., 1711., 1712., 1713., 1714., 1715., 1716., 1717., 1718. and 1720.**

Section 19 Summary of Minimum Requirements

The requirements for the construction and equipment of the ship when the cargo recognized to have equivalent danger of the liquefied gas or other cargo indicated in **Sec 19** of the Rules is carried are to be determined according to the physical properties (vapour pressure, liquid density, latent heat of evaporation, etc.) of the cargo as far as the basic design of the construction and equipment are concerned unless otherwise required by the Administration. Further, each item of the minimum requirements and special requirements of **Sec 19** of the Rules are to be determined individually. ⚓

CHAPTER 6 SHIPS CARRYING DANGEROUS CHEMICALS IN BULK

Section 1 General

101. General

1. Application

(1) Where the products specified in Table of **Sec 17** of the Rules are added to the cargo carried in bulk to maintain the properties of the cargo, the requirements in **Ch 6** of the Rules may not apply to such additive cargoes. However, in consideration of the properties and quantity of such additive cargoes, additional requirements for tank vent system, electrical installations, instrumentation, safety equipment, etc. may be applied.
(2) Where the mixed products not reacting with each other such as polymer, etc. are carried, all requirements for the product separated each other are to apply.

106. Definitions

1. Definitions

(1) For the purpose of **Ch 6** of the Rules and the Guidance, the term "adjacent" means all cases of facial contact, linear contact and point contact unless otherwise specified.
(2) The term "cargo area" referred to in **106. 5** of the Rules excludes the fuel oil tanks adjacent to the cargo tanks or slop tanks of the arrangement as given in **Fig 7.6.1** of the Guidance. However, the requirements specified in **Ch 6, 304.** of the Rules apply.
(3) The piping system "separated" from each other as referred to in **106. 24** of the Rules mean either of the following :
  (A) Piping system completely independent from each other.
  (B) The piping system that come through with the tank carrying other cargo, but can be separated by the means as exemplified in [Acceptable] in **Fig 7.6.2** of the Guidance when cargoes likely to cause dangerous reaction with each other are carried may be regarded as those completely independent from each other. In case where separation can be achieved by this method, operational precautions are to be noted in the Operation Manual.

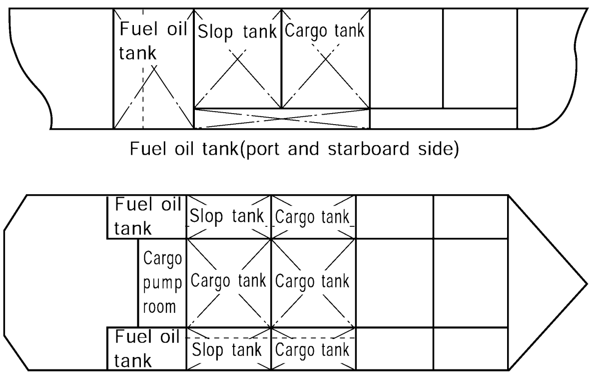


Fig. 7.6.1

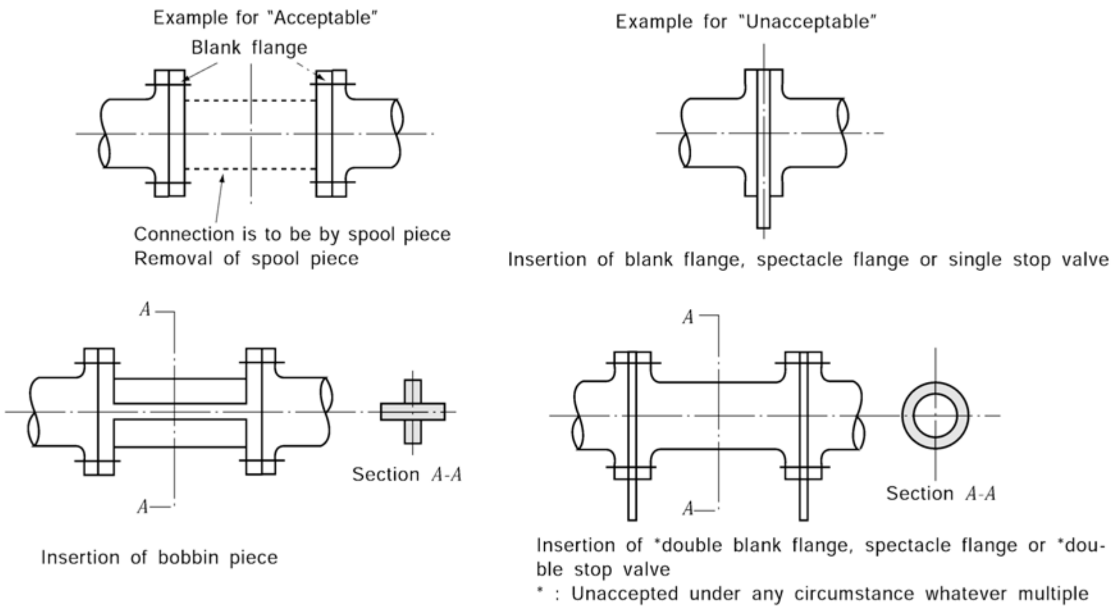

Example for "Acceptable"
Blank flange
Connection is to be by spool piece
Removal of spool piece
Example for "Unacceptable"
Insertion of blank flange, spectacle flange or single stop valve
A
A
Section A-A
Insertion of bobbin piece
A
A
Section A-A
Insertion of *double blank flange, spectacle flange or *double stop valve
* : Unaccepted under any circumstance whatever multiple

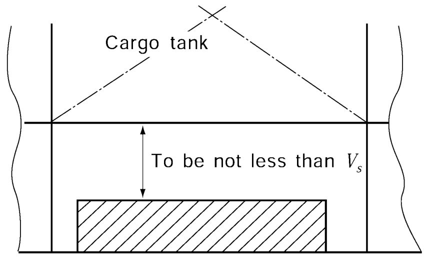
Fig. 7.6.2

Section 2 Ship Survival Capability and Location of Cargo Tanks

202. Freeboard and intact stability

1. Solid ballast

Where the requirements for the initial stability are not satisfied, use of solid ballast may be approved. When solid ballast is provided directly below the tank, the distance between the top of solid ballast and cargo tank bottom is to be not less than the vertical extent of damage(V_s) as given **Fig 7.6.3** of the Guidance.



Shaded section : Solid ballast
V_s: Vertical extent of damage given in **205.** of the Rules

Fig. 7.6.3

203. Shipside discharges below the freeboard deck

1. For the purpose of the requirements in **203. 1** of the Rules, the following requirements (1) and (2) are to be complied with.

(1) The scupper pipes within the superstructure are to be in accordance with the requirements in **Pt 5, Ch 6, 302. 1** of the Guidance.

(2) The inboard open ends of scupper pipes are to be in accordance with the requirements in **Pt 5, Ch 6, 302. 2** (1) (A) of the Guidance.

2. The requirements of **203. 1** of the Rules do not apply to the overboard discharges led through the shell from the superstructure and deckhouse located on or above the second deck on freeboard deck.

3. The scupper pipe in hazardous area is not to pass through the safety area or engine room.

205. Damage assumption

1. Assumed maximum extent of damage

For the purpose of the standard of damage specified in **205. 1** (2) of the Rules, damage assumed to have sustained within 0.3 L_f from the forward perpendicular of the ship are to be in accordance with the following requirements (1) and (2) :

(1) For bottom damage for 0.3 L_f from the forward perpendicular and forward (according to **205. 1** (2) of the Rules), such damage may not be considered beyond the point of 0.3 L_f from the forward perpendicular.

(2) For cases of bottom damage which is applied to damage sustained in areas after the point of 0.3 L_f from the forward perpendicular (according to **205. 1** (2) of the Rules), such damage is to be considered up to the point corresponding to 0.3 L_f - 5.0 m from the forward perpendicular.

206. Location of cargo tanks

1. Location of cargo tanks

Notwithstanding the requirements for the location of cargo tanks in **206.** of the Rules, cargo pump room bilges or tank washings may be thrown into any cargo tanks.

2. Suction well installed in cargo tanks

It is desirable that the area of suction well is not larger than the area necessary for the installation of cargo pumps, suction pipes, valves, heating coils, etc. added with the area necessary for sufficient suction, cleaning and maintenance.

207. Flooding assumptions

1. Equalization arrangements

The "cross-levelling pipes" specified in **207. 6** of the Rules are to comply with the following requirements :

(1) Use of this equalization arrangement is to be accepted only for obtaining the GZ area of 0.0175 m·rad for the righting lever of 0.1 m and the range between the state of equilibrium and 20°. Without the use of this equalization arrangement, the requirements for heel angle and positive stability range are to be satisfied. (See **Fig 7.6.4** of the Guidance)

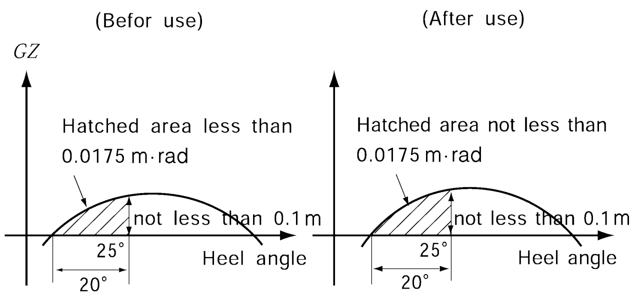


Fig 7.6.4

(2) When righting lever curves before use of this equalization arrangements are determined, the following assumptions are to be made :
   (A) The cargo or consumable liquid in the damaged space has completely spilled out.
   (B) The damaged space is filled with sea water to the water level outside the ship.
   (C) The cross-levelling pipes are closed.

(3) The time required for horizontal adjustment is to be not more than 15 minutes.

(4) The cross sectional area A of piping used for horizontal adjustment is to be as follows :

$$A \geq 7.5\,V/\sqrt{H} \quad (\mathrm{cm}^2)$$

where:

V : Quantity of water expected to enter the flooded space (m^3)

H : Height from the draught line before flooding to the centre line of the pipe (m)

(5) It is not desirable to connect spaces on both sides of the ship with a large diameter duct to ensure the same rate of flooding as this aggravates the heeling moment of the ship in turning motion.

2. Buoyancy of superstructure

(1) In the case of the side damage where the machinery space is regarded as one-space flooding in **207. 8** of the Rules, damage extent applicable to spaces other than the machinery space is applied to poop. With this reason, therefore, the space within poop surrounding the machinery space and enveloped by watertight bulkheads can not be treated as a reserve buoyancy unless watertight bulkheads are arranged as given in **Fig 7.6.5** of the Guidance. However, in case where such treatment is accepted under the special requirements for small ships in accordance with **208. 2** of the Rules as a special relaxation by the Society, the above requirements may not be applied. Where the engine room bulkhead is knuckled, the space between the foremost end and the aftermost end is to be taken as the damaged space of the superstructure as given in **Fig 7.6.6** of the Guidance.

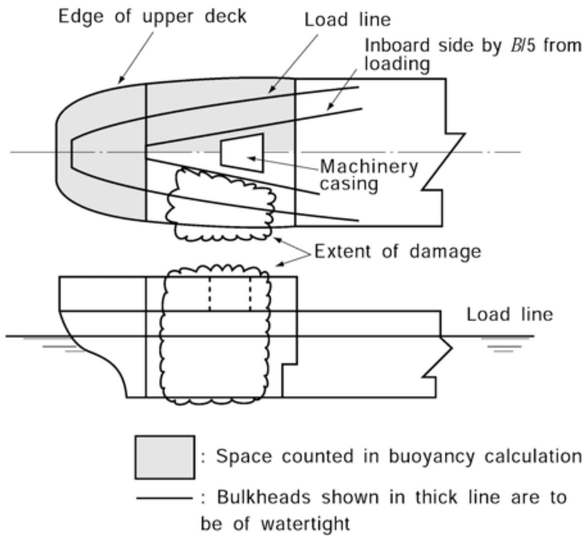


Fig 7.6.5

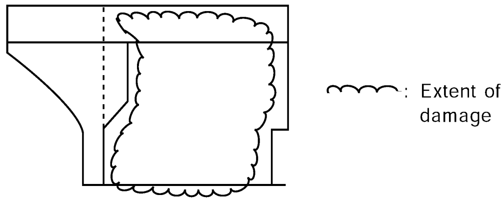


Fig 7.6.6

(2) In **207. 8** (2) of the Rules, the remotely operated sliding watertight doors are to be capable of being controlled from a safe and readily accessible place. Weathertight openings submerge in water under the minimum range of residual stability are to be capable of closing securely in a state of equilibrium.

208. Standard of damage

1. Assumed extent of damage

(1) In **208. 1** (3) and (5) of the Rules, the treatment of the stairway cases located forward or aft end bulkheads of the machinery space is to be in accordance with **Fig 7.6.7** of the Guidance.

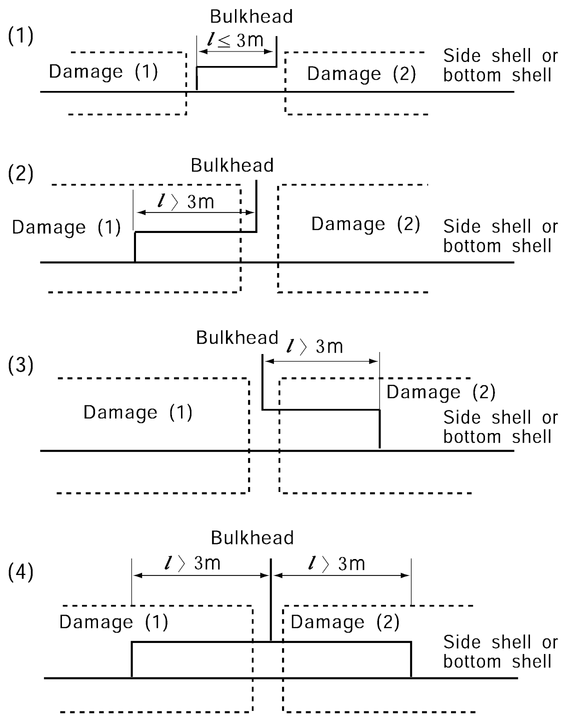


Fig 7.6.7

(2) In **208. 1** (6) of the Rules, the expression "should be considered by the Society" means that the survival requirements specified in 209. of the Rules under a condition of flooding only in the machinery space are satisfied, or the following requirements are satisfied (See **Fig 7.6.8** of the Guidance) :

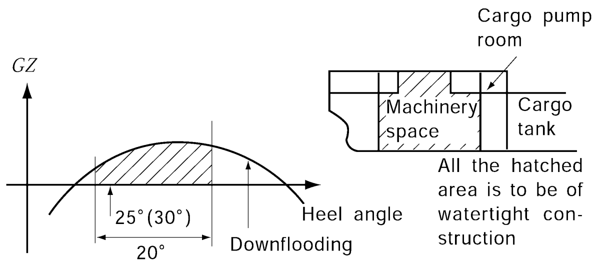


Fig. 7.6.8

(A) The area with positive sign of the righting lever curve within the range from an arbitrary point between the final state of equilibrium after flooding and 25° (or 30° when the deck side line is not submerged) to 20° is to be :

(a) $70\,m \le L_f < 125\,\mathrm{m}$: 0.0175 $\mathrm{m \cdot rad}$ or more.

(b) $L_f < 70\,\mathrm{m}$: 0.0088 $\mathrm{m \cdot rad}$ or more

(B) The position of down flooding is to be in accordance with **209. 3** (1) of the Rules.

(C) The angle of heel is to be in accordance with **209. 2** (2) of the Rules. Where the machinery casing is of the watertight construction, the space in poop surrounding the machinery space may be treated as a reserve buoyancy. When a door is provided, it is to be of the watertight sliding door remotely operated from the poop deck.

2. Alternative measures

The "special dispensations" in **208. 2** of the Rules are to be in accordance with the following. (See **Fig 7.6.9** of the Guidance)

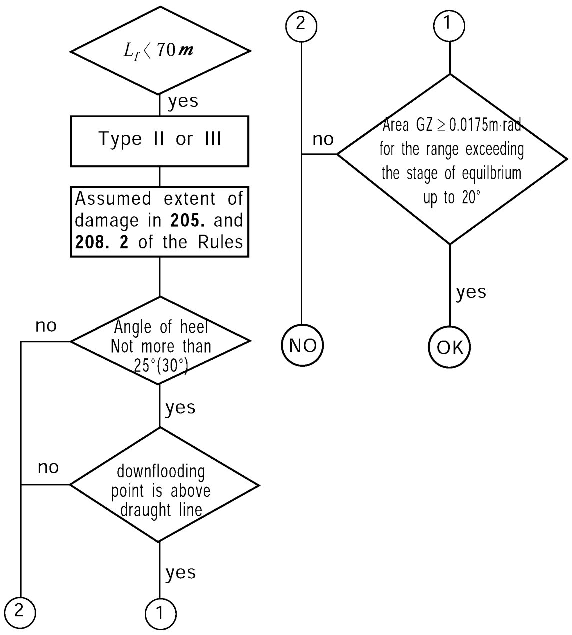


Fig. 7.6.9

(1) No dispensations are to be accepted for Type I ships.

(2) Small ships mean as those whose $L_f < 70\,\mathrm{m}$.

(3) Except for the case of flooding of machinery space of Type III ships(**208. 1** (6) of the Rules), it is to be in accordance with the following :

(A) Assumed extent of damage is to be in accordance with **205., 208. 1** (3) and (6) of the

Rules.

(B) Down flooding point and angle of heel are to be in accordance with **209. 2** and **3** of the Rules.

(C) The area with positive sign of the righting lever curve within the range from an arbitrary point between the final stage of equilibrium after flooding and 25° (or 30° when the deck side line is not submerged) to 20° is to be 0.0175 m.rad or more.

(D) The maximum value of GZ is not specified.

209. Survival requirements

1. Stability criteria at any stage of flooding

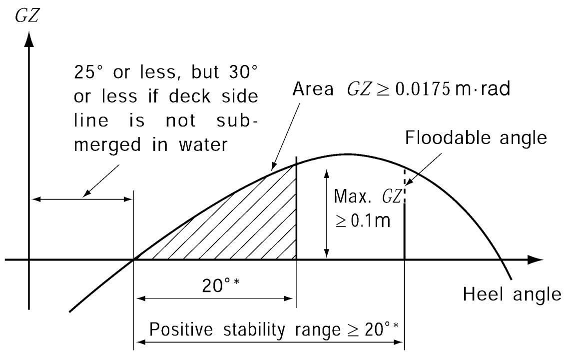
The words "to the satisfaction of the Society" in **209. 2** (3) of the Rules mean as follows :

In ordinary cases, the final stage of flooding is considered most severe, but the most severe condition may be encountered during intermediate stages of flooding involving replacement of sea water in the damaged space. In this connection, stability during such intermediate stages of flooding are to be considered when specifically requested by the Society.

2. Stability criteria at final equilibrium after flooding

(1) In **209. 3** of the Rules, floodable weathertight openings within the minimum stability range (20°) are to be capable of being securely closed at the final stage of equilibrium after flooding. Where safe access thereto is impracticable due to submersion of deck or large angle of heel, such weathertight openings may not be accepted. However, air pipes of float type, etc. having self-closing mechanism in case of submersion in water may be accepted.

(2) The survival requirements at the final stage of equilibrium after flooding are to be in accordance with **Fig 7.6.10** of the Guidance.



Note * : The initial point of calculation of the stability range at an angle of heel of 20° may be taken arbitrarily at any intermediate point between the angle of heel at the final stage of equilibrium and the maximum angle of heel.

Fig 7.6.10

Section 3 Ship Arrangements

301. Cargo segregation

1. Segregation of tank containing cargo or residues of cargo

For cargo tanks and slop tanks, neither linear contacts nor point contacts with accommodation spaces, service spaces, machinery space, etc. are to be accepted. Further, no segregation of spaces in contact by means of slanting plates is to be accepted.

2. Segregation of cargoes which react with other cargoes

Where cargoes which react with other cargoes in a hazardous manner are loaded simultaneously, the ship arrangement as given in **Fig 7.6.11** of the Guidance is not to be accepted. Only in the requirements for segregation of cargoes which react with each other, the linear contacts and point contacts as given in **Fig 7.6.12** of the Guidance may be accepted. Where the cargo pipes are of common pipes, they are not to pass through cargo tanks carrying cargoes which react with each other in a hazardous manner except for the cases where pipe arrangement is provided a tunnel or made as given in **Fig 7.6.13** of the Guidance.

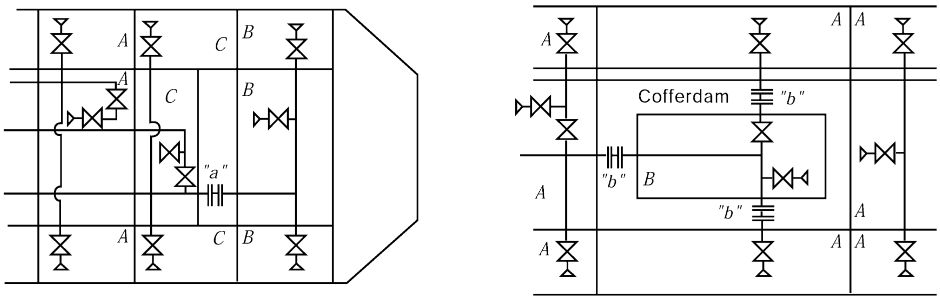
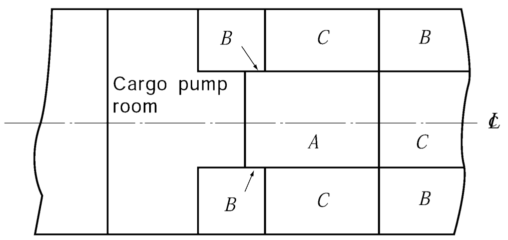
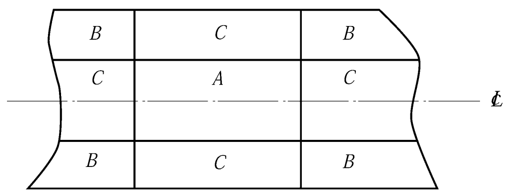


Fig. 7.6.13



A and *B* react with each other in a hazardous manner. (Arrowhead of *B* indicates facial contacts.)
A and *C*, and *B* and *C* do not react with each other in a hazardous manner.

Fig. 7.6.11



A and *B* react with each other in a hazardous manner.
A and *C*, and *B* and *C* do not react with each other in a hazardous manner.

Fig. 7.6.12

Notes :

1. "a" and "b" are to be separated within cofferdam or void spaces in the method specified in 301.5 of the Rules. No separation in thanks is to be accepted.
2. A and B are cargoes which react with each other in a hazardous manner.
3. A and C, and B and C are safe cargoes which do not react with each other in a hazardous manner. In this case, however, cargo operation of cargo B by connecting the spool pieces of "a" and "b: after discharging cargo A is unacceptable, and therefore provisions of independent cargo pumps may be required for cargo operation on tanks segregated under the method given above.

3. Cargo piping

Cargo piping is not to pass through the spaces specified in **301. 3** of the Rules and, in addition, spaces such as fuel oil tanks, fresh water tanks and control stations.

302. Accommodation, service and machinery spaces and control stations

1. Arrangements

When segregated by a gastight deck and well ventilated, such a space is not electrically hazardous space, and in this case, arrangement of accommodation spaces, service spaces or control stations above fuel oil tanks adjacent to cargo tanks in the poop as given in Fig **7.6.14** of the Guidance may be accepted. Paint lockers, regardless of their use, should not be located above the cargo area.

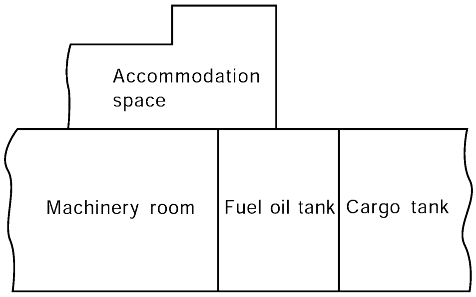


Fig 7.6.14

2. Location of air intakes and openings

The locations of air intakes and openings are to comply with the requirements in **302. 3, 307. 4, 803. 2, 1201. 5** and **1512.** of the Rules.

3. Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations

(1) For exhaust air outlets of the mechanical ventilation system of accommodation, service and machinery spaces and exhaust air outlets specified in **302. 2, 307. 4, 803. 3** and **1512. 1** of the Rules the requirements in this Chapter also apply.

(2) Spaces where doors can be provided are to be restricted to lockers containing cargo gears and safety equipment, cargo control room and decontamination shower room. As given in **Fig 7.6.15** of the Guidance, these spaces are not provided with passageways led to accommodation spaces and service spaces and control station, and the casings, floors and ceilings adjacent to the accommodation spaces are to be insulated to "A-60" standard.

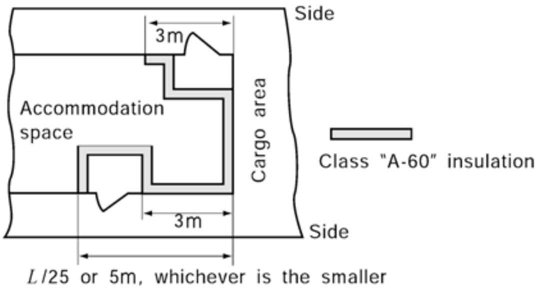


Fig 7.6.15

(3) The gastight wheelhouse doors and windows are to be fitted with packing and dog bolts. These windows, doors and clear view screens are to be hose-tested at a pressure of 0.2MPa. To ensure gastightness of the clear view screen, an additional window fitted with dog bolts or other means of gastight capable of tightening the window pane when the screen is not rotating are to be provided.

(4) For ships carrying dangerous chemicals in bulk, irrespective of the kind of cargo, coaming is to be provided at the forward end of the deckhouse to prevent the ingress of the cargo overflown on the deck into the deckhouse including the accommodation and service spaces and control stations as given in **Fig 7.6.16** of the Guidance. The height of coaming is to be 300 mm from the deck, 50 mm above the upper edge of the sheer strake or 50 mm above the upper face of the deck longitudinals, whichever is the greatest.

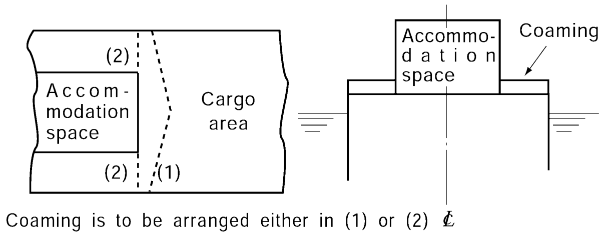


Fig. 7.6.16

303. Cargo pump rooms

1. Arrangement of cargo pump rooms

Where cargo pump rooms are normally manned, or in case where cargo pump rooms are specially large, an additional escape trunk is to be provided. In this case, it is desirable that two escape routes led to the weather deck are available.

2. Permanent arrangement for hoisting an injured person

The permanent arrangement for hoisting an injured person from cargo pump room is to be in accordance with the following requirements :

(1) To be capable of being one-man-operated from the weather deck.
(2) To be capable of lifting an injured person up to the place on the weather deck.
(3) To be capable of lifting a weight of not less than 255 kg.

3. Access ladders

The angle of normal access ladders provided in cargo pump room to a horizontal plane is to be not more than 60°.

4. Means for discharging cargoes and bilges

(1) For pumps and valves dealing with cargoes likely to cause corrosions of structural members or contamination with other bilges within the cargo pump room due to leakage of corrosive cargoes, interactive cargoes or water prohibitive cargoes, proper bilge processing systems are to be provided according to degree of hazard. For instance, as the bilge processing systems for pumps dealing with interactive cargoes, provisions of independent bilge processing systems may be considered. In case where interactive cargoes are handled in the same cargo pump room, simultaneous cargo operations are to be avoided whereby the next cargo operation is to be carried out after complete bilge processing for the first cargo.

(2) Slop tanks specified in **303. 5** of the Rules are to comply with the following requirements (A) through (D) :

(A) In case of using the tank both as cargo tank and slop tank, the same requirements applicable to cargo tanks apply.

(B) Where no cargo is carried and only bilges or tank washings are contained, no requirements for ship type (only concerning the cargo tank arrangement) apply, notwithstanding kind of cargoes contained in bilges or tank washings. However, for the minimum requirements other than ship type, the following (a), (b) and (c) are to be complied with :

(a) For ventilation system, electrical installation and instrumentation, the severest of the requirements applicable to the cargoes contained in the slops is to apply.
(b) For tank environmental control and its special requirements, all the requirements for all cargoes contained in the slops are to be satisfied.
(c) For tank type, the requirements for the cargo contained in the slops are to be satisfied.

(C) For tank washings of tanks that carried the dangerous cargoes subjected to **1512.** of the Rules, slop tanks containing bilges of the cargo pump room used for the cargo operation of these cargoes and pipes serving them, the requirements of **1512.** of the Rules apply without exceptions.

(D) In case where two or more cargoes which react in a hazardous manner are carried, the tank washings and bilges containing these cargoes are not to be contained in the same slop tank. Therefore, slop tanks equal in number to that of cargoes which react in a hazardous manner carried at the same time are to be provided. In this case, when cargo tanks are used as slop tanks, these cargo tanks are to be provided with the pumps and pipelines to serve as the slop tanks.

(E) For ships carried the oil subjected to MARPOL 73/78 Annex 1, the capacity of slop tanks is to be complied with MARPOL 73/78 Annex 1.

5. Cargo pump discharge pressure gauges

"Cargo pumps" specified in **303. 6** of the Rules are the cargo pumps, tank cleaning pumps, bilge pumps, etc. used for handling cargoes and liquids containing cargoes in general.

6. Gas tightness of shafting passing through bulkhead or deck

The shaft seals of a type for periodical feeding of grease are not acceptable. Only continuous gas-tight sealing type is acceptable. These shaft seals are to be provided outside the cargo pump room. (See **Fig 7.6.17** of the Guidance)

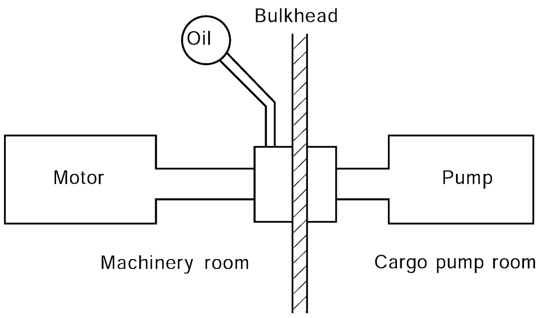


Fig. 7.6.17

304. Access to spaces in the cargo are

1. General

(1) Spaces having direct openings to hold spaces containing independent tanks are to be to the requirements in **304.** of the Rules irrespective of the definition of the cargo area. Fuel oil tanks which have face contacts, linear contacts or point contacts with cargo tanks and those arranged directly below cargo pump room are not included in the cargo area, but subject to the following requirements.

(A) Fuel oil tank adjacent to cargo tank or in linear or point contact therewith. (See **Fig 7.6.18** of the Guidance) Access holes are to be to the requirements in this Paragraph, and access is to be from the cargo area.

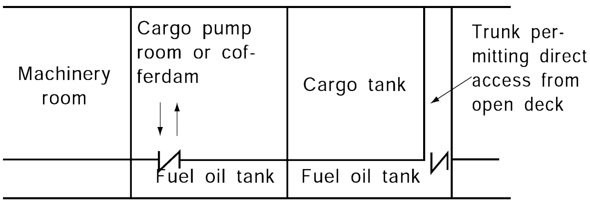


Fig. 7.6.18

(B) Fuel oil tank directly below cargo pump room. (See **Fig 7.6.19** of the Guidance) Access holes are to be to the requirements in this Paragraph, and in consideration of possible cargo leakage, access is to be from the cargo area.

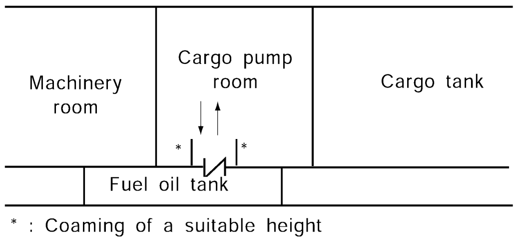


Fig. 7.6.19

(C) For fuel oil tanks given in **Fig 7.6.20,** the requirements in this Paragraph do not apply. Access from the cargo area is desirable.

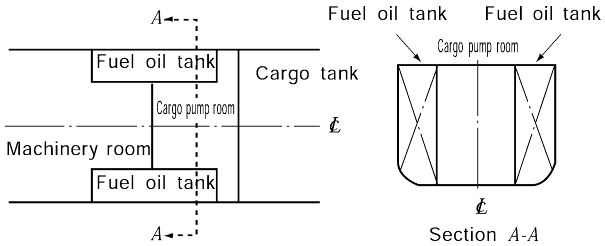


Fig. 7.6.20

(2) For access openings of double bottom, etc., the following requirements are to be complied with : Two access routes are, as a rule, necessary for double bottom or similar other spaces as given in (1) to (3) of **Fig 7.6.21** of the Guidance. The arrangement as given in (4) of **Fig 7.6.21** of the Guidance is not to be accepted. On condition that easy access is provided and an unconscious injured person can be rescued, only one access route may be accepted for a relatively small space. On duct keel, access openings are to be provided at both ends, and an opening led to weather deck is to be provided at intervals not exceeding 60 m.

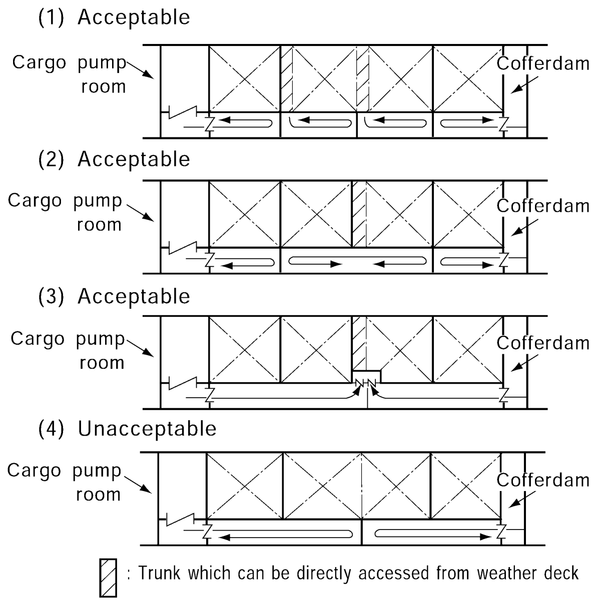


Fig. 7.6.21

(3) Access openings to independent cargo tanks are to be in accordance with the following requirements :
Independent cargo tanks are to be provided with trunks or domes protruding beyond the weather

deck as given in **Fig 7.6.22** of the Guidance and cargo tank hatches are to be provided on the top of these trunks or domes. No opening of any construction is to be provided on the cargo tank wall below the weather deck.

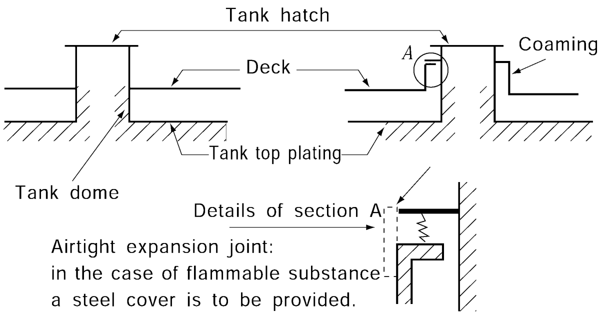


Fig. 7.6.22

2. Minimum clear opening for access through horizontal openings

The minimum opening dimensions are to be 600 mm × 600 mm with rounded corners.

3. Minimum clear opening for access through vertical openings and arrangements of vertical openings

Access openings are to comply with the following requirements:

(1) Opening of 600 mm × 800 mm is to be so oriented that the major axis is taken in the vertical direction. However, where the major axis is difficult to be taken in the vertical direction under the structural reason, horizontal direction may be taken.

(2) At access openings and in the vicinity, no pipes or equipment that interfere with the assurance of access route are to be arranged.

4. Relaxation of opening dimension

Opening dimensions may be as given in **Table 7.6.1** of the Guidance provided that person wearing safety equipment has access to openings and an injured person is easily rescued from the bottom of spaces.

Table 7.6.1 Relaxation of Opening Dimension

Spaces	Minimum dimension (mm)
Cargo Tanks	600×600
Void Spaces, W.B.T	H : 500×500, V : 500×650
F.O.T	H : 450×450, V : 400×500

305. Bilge and ballast arrangements

1. General

(1) The discharge arrangements of permanent ballast tanks adjacent to cargo tanks may be such that ballast pumps in the machinery space are used as given as **Fig 7.6.23** of the Guidance and ballast or bilges are discharged overboard through the eductor in the cargo pump room. In this case, check valve is to be provided between the ballast pump and eductor and spool piece is to be provided on the weather deck within the cargo area.

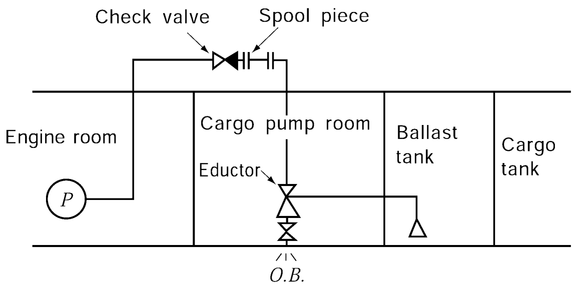
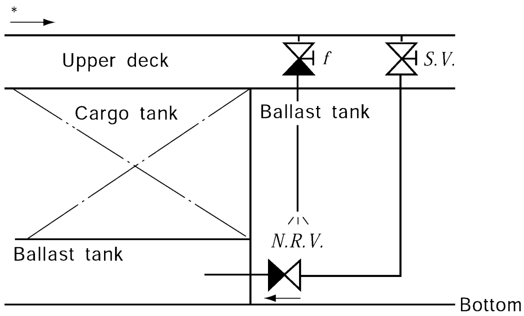


Fig. 7.6.23

(2) The words "ensure filling from tank deck level and check valves are fitted" referred to in **305. 1** of the Rules mean that exclusively used for filling from the weather deck but can not be used for discharging fitted with stop valves on the weather deck or stop valves operable from the weather deck and additionally check valves are provided as given in **Fig 7.6.24** of the Guidance. Further, sufficient consideration is to be taken so as not to cause non-compliance with the damage stability requirements due to damage to pipelines or spillage of dangerous ballast or cargo into other compartments.



* : A line to ensure filling only from the pump in machinery room
N.R.V. : Non-return valve (Check valve)
S.V. : Stop valve
f : Stop valve + check valve or screw-down check valve

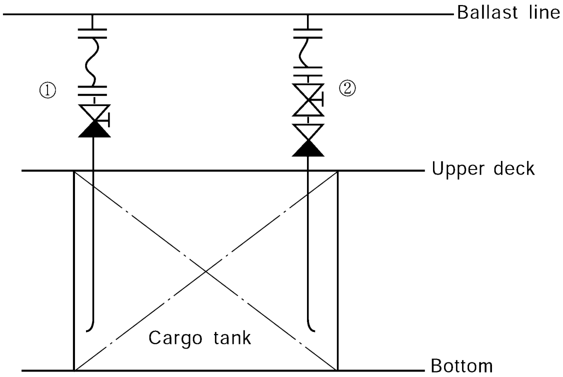
Fig. 7.6.24

(3) Pipelines of ballast tanks adjacent to cargo tanks and not adjacent to cargo tanks are to be basically independent.

2. Filling of ballast in cargo tanks

(1) The case referred to in **305. 2** of the Rules as "the filling line has no permanent connection to cargo tanks or piping and that check valves are fitted" is to be as given in **Fig 7.6.25** of the Guidance. In this case, filling is to be limited to that from the open deck, where spool pieces or hoses and stop valves or check valves are required.

(2) When filling is made from the open deck according to the preceding (1), the piping arrangement in cargo tanks is to be such that the filling pipe is extended as close to the bottom as practicable to minimize generation of static electricity.



① Hose (spool piece) + screw-down check valve
② Hose (spool piece) + stop valve + check valve

Fig 7.6.25

3. Bilge pumping arrangements for the cargo area

Pipes dealing with cargo or cargo residues passing through void spaces, double bottom and ballast tank spaces are to be treated within the bilge cargo spaces of the compartments even when they are segregated from tanks containing cargo or cargo residues by double bulkheads.

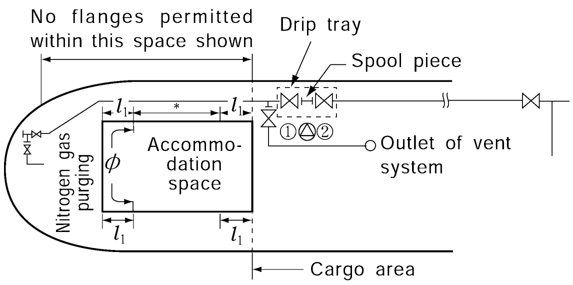
306. Pump and pipeline identification

"Marking" referred to in **306.** of the Rules is to be made by peel-resisting tapes or paint coat to clearly identify respective pipes.

307. Bow or stern loading and unloading arrangements

1. General

The bow or stern loading and unloading arrangements are to be given in **Fig 7.6.26** of the Guidance, as a standard.



l_1 : $L/25$ or 3m, whichever is the greater, but need not exceed 5m.
* : Where inlets, air intakes, openings, etc. are permitted to be provided.
ϕ : Where inlets, air intakes, openings, etc. are not permitted to be provided.
Valve ① : The stop valve required in **307. 3** (1) of the Rules.
Valve ② : The stop valve necessary for fitting/removal of the spool piece.
△ : Spray shield is to provided for valves and spool piece. (portable one may be accepted.)

Fig 7.6.26

2. Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations

All openings such as entrances, to accommodation, service and machinery spaces and control stations, air inlets, rope hatches, openings to machinery casing, openings in escape routes, etc. are to be arranged in areas outside the shaded sections given in **Fig 7.6.27** of the Guidance. The standard height of superstructure is to be as given in **Table 7.6.2** of the Guidance.

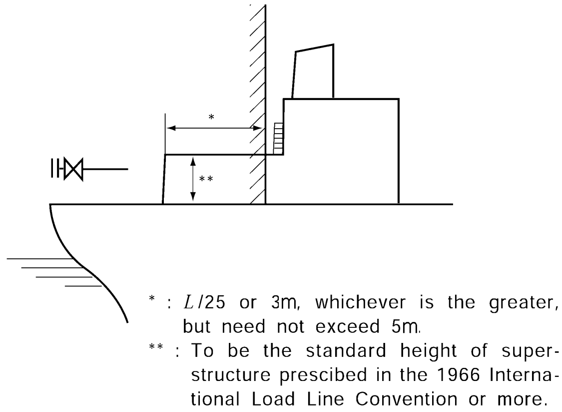


Fig 7.6.27

Table 7.6.2 The Standard Height (m)

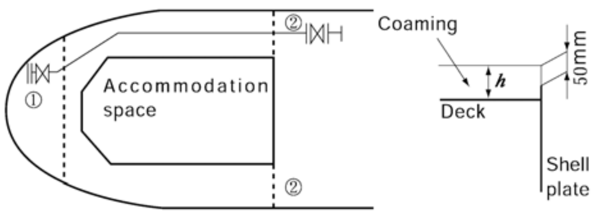
L (m)	Low Poop	Other poop
Not more than 30	0.90	1.80
75	1.20	1.80
Not less than 125	1.80	2.30

3. Escape route

The "escape route" referred to in **307. 6** of the Rules means the escape route from machinery space.

4. Continuous coamings

The "continuous coamings of suitable height" referred to in **307. 7** of the Rules are the coamings provided on the cargo handling machinery and gear with a height above deck of 150 mm or 50 mm above the upper edge of the sheer strake as given **Fig 7.6.28** of the Guidance, whichever is the greater, and are to be arranged in direction of breadth of ships continuously.



(Note)
Coaming ① is required by this Paragraph, and h is not to be less than 50mm.
Coaming ② is the one required under **302. 3** of the Rules.

Fig 7.6.28

5. Fire-extinguishing arrangements

One each monitor for foam fire-extinguishing system and portable foam applicator unit required in the cargo area are to be provided. The hydrant connected with the portable foam applicator unit is to be arranged within the range effective for discharging the fire-extinguishing medium and the portable foam applicator unit is to be stowed in a space ready for immediate use.

Section 5 Cargo Transfer

501. Piping scantlings

1. Design standard for piping

(1) In **501. 6** (1) of the Rules, the minimum thickness of stainless steel pipes is, in general, to be in accordance with the following requirements :
· Cargo pipes passing through ballast tanks : Schedule 40 S
However, the minimum thickness is to satisfy the requirements for thickness of pipes subjected to internal pressure specified in **501. 1** of the Rules.
(2) The protection for cases "Where necessary for mechanical strength" referred to in **501. 6** (2) of the Rules is to be provided as follows :
(A) No protection is required for steel pipes used for ordinary applications.
(B) Where aluminium pipes, stainless steel pipes of which thickness is reduced according to their tensile strength, etc. considered vulnerable to impact loads are used, suitable protection is to be provided.
(C) It is desirable that manifolds are to be made of steel.
(D) Pipes passing through bulkheads or decks, those arranged an elevated space above upper deck, those subjected to load of the loading arms at the manifold may be required to have increased thickness.
(3) In "Flanges, valves and other fittings" referred to in **501. 6** (3) of the Rules, the use of stop valves and expansion joints is to be in accordance with the following requirements :
(A) To comply with the requirements in **Pt 5, Ch 6** of the Rules (for both Class I and Class II pipes).
(B) Since use of expansion joints is not allowed for the cargo pipes within tanks containing the cargo for which special means for the maintenance of product quality are required, expansion of the pipes is to be absorbed by U-bends, etc.
(C) The materials of valves, seals, etc. are not to be of the ones of which use is prohibited.

502. Piping fabrication and joining details

1. Joint of cargo piping

Cargo pipes are to be joined by welded joints except for the flange joints for shut-off valves and expansion joints, spool pieces and equivalent fittings approved in **502. 2** of the Rules and flange joints necessary for painting, lining, assembly, inspection or maintenance. Further, movable anti-acid shields to guard against spray are to be provided at flange welding of cargo pipes above the deck referred to in **1511.** of the Rules.

2. Direct connection of pipes without flanges

Where Class I pipes or Class II pipes are required under **504.** of the Rules for butt-welded joints in **502. 3** (1) of the Rules, the requirements in **Pt 5, Ch 6** of the Rules are to be complied with. The butt welding procedure for cargo pipes (including liquid cargo and vapour cargo) where use of Class III pipes are permitted is to be the same as in Class II pipes. However, nondestructive testing may not be carried out.

3. Expansion joints

The "bellows" referred to in **502. 4** (1) of the Rules are not to be used for cargoes having corrosive or polymerizing nature unless consideration is taken for the cargo drains trapped in the corrugated parts of the joints.

503. Flange connections

1. Standards for flanges

The "standard approved by the Society" referred to in **503. 2** of the Rules means the requirements in **Pt 5, Ch 6, 104.** of the Rules.

504. Tests requirements for piping

1. Application

The classification standard and test requirements for cargo piping are to be in accordance with **Tables 7.6.3** and **7.6.4** of the Guidance.

Table 7.6.3

Ship type	Classification of applicable cargo (See **Table 7.6.4** of the Guidance)	Remark
Type 1	Class I pipes	Irrespective of the design pressure and temperature, the requirements in the left-hand column apply, as a standard. For compatibility between cargo and cargo piping materials, separate investigation is to be made.
Type 2	Class II pipes	
Type 3	Class III pipes	

Notes :
(1) Cargo piping means the piping to transfer liquid cargo and vapour cargo.
(2) Cargo piping for slop tanks arranged in accordance with the requirements of ship type 3 is to be classified into Class III irrespective of the ship type requirements for cargo contained in slop tanks.
(3) Cargo piping passing through the tanks cargo with higher ship type requirements is to comply with the requirements of the piping specified for such cargo.

Table 7.6.4. Test Requirements for Piping

<table>
<tr><th rowspan="2"></th><th rowspan="2">Materials of pipe</th><th rowspan="2">Materials of valves, cocks and pipe fittings</th><th colspan="3">Shop tests for pipe fabrication</th><th rowspan="2">Shop tests for valves and pipe fittings</th><th rowspan="2">Shipboard tests for piping</th></tr>
<tr><th>Welding procedure qualification tests</th><th>Non-destructive tests</th><th>Hydraulic tests</th></tr>
<tr><td>Class I</td><td rowspan="2">Materials complying, as a rule, with the requirements in Pt 2, Ch 1 of the Rules.</td><td rowspan="2">Materials complying, as a rule, with the requirements in Pt 2, Ch 1 of the Rules. However, materials complying with the requirements of KS or equivalent may be accepted at the discretion of the Society.</td><td rowspan="2">To be carried out on piping of Class I or Class II where the following ① to ③ are relevant :
①Joinings between pipes, pipes and valves, and pipes and fittings are made welding for the first time.
② When new welding method is employed.
③ When base material, type of welding materials or type of joints is changed.</td><td>①Radiographic testing for the entire length of butt-welded joints of pipes with nominal diameter exceeding 65A.
②Radiographic testing for the sampled buttwelded joints of pipes with nominal diameter not more than 65A.
③In place of radiographic testings, suitable other non-destructive testing may be accepted.
④ Magneticparticle testing or suitable other for fillet weld of pipes.</td><td rowspan="3">①All pipes of Class Ⅰ, Class Ⅱ and Class Ⅲ, steam pipes, feed pipes, compressed air pipes, fuel oil pipes of which design pressure exceeds 0.35 MPa are to be subjected to hydraulic tests with fittings attached after fabrication at a test pressure 1.5 times the design pressure.
② The test pressure for hydraulic test for pipes with design temperature exceeding 300°C is to be specified separately.
③The hydraulic test for welded joints between pipes or pipes and valves of piping arranged onboard the ship is to be specified separately.</td><td rowspan="2">Valves and fittings of piping of Class I or Class II are subject to hydraulic test at a pressure of 1.5 times the design pressure.</td><td rowspan="3">① All pipes are subject to leak test in their service condition.
② All pipes are to be subjected to preliminary test together with the equipment they serve.
③ Fuel oil pipes and tank heating pipes are to be subjected to leak test at a pressure of 1.5 times the design pressure. However, the test pressure is to be at least 0.4MPa or more.
④ The piping of the refrigerating instal lation is to be sub-jected to the requirements specified in Pt 5, Ch 6, 1205. (4) of the Rules.
⑤ All cargo pipes are to be subjected to the hydraulic test at a pressure of 1.5 times the design pressure.</td></tr>
<tr><td>Class II</td><td>①Radiographic testing or suitable other testing for buttwelded pipes with nominal diameter exceeding 80A.
②Magnetic particle testing or suitable other testing for fillet weld of pipes.</td></tr>
<tr><td>Class III</td><td>Materials complying with the requirements of KS or equivalent</td><td>Materials complying with the requirements of KS or equivalent</td><td></td><td></td><td></td></tr>
</table>

505. Piping arrangement

1. Cargo piping under deck

(1) "the stop valve operable from the weather deck" referred to in **505. 2** of the Rules is to be located in the vicinity of each open end within each tank.

(2) "As an exception ..." specified in **505. 2** of the Rules following is applicable only to the cargo piping arranged in one cargo tank or slop tank adjacent to the cargo pump room as given in the shaded section of **Fig 7.6.29** of the Guidance. In this case, an additional stop valve is to be provided between the bulkhead valve and cargo pump.

(3) The word "leakage" referred to in **505. 2** (1) of the Rules includes the leakage through packing.

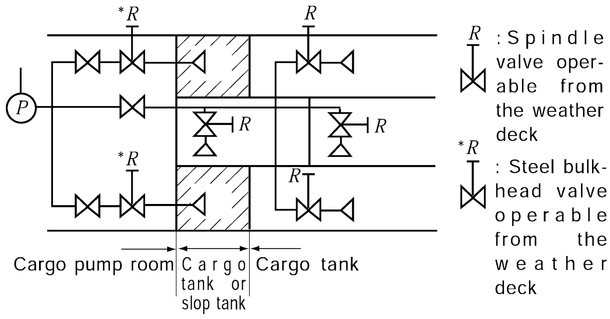


Fig. 7.6.29

506. Cargo transfer control systems

1. General

(1) The "one stop valve capable of being manually operated on each tank filling and discharge line, located near the tank penetration" referred to in **506. 1** (1) of the Rules, for cargo pipes provided in cargo tanks as given in **Fig 7.6.30** of the Guidance may be omitted if there are stop valve specified in **505. 2** of the Rules (stop valve located near the open end and operable from the weather deck) and bulkhead valve provided in the cargo pump room specified in **505. 3** of the Rules.

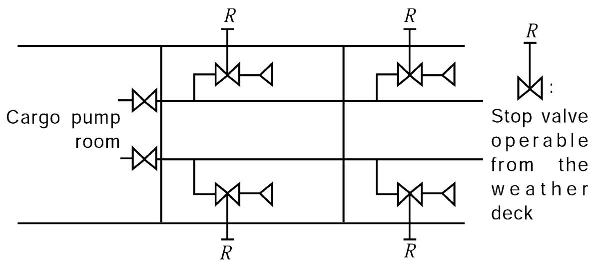


Fig. 7.6.30

(2) Stop valve is not required at the deck penetration of the discharge piping of deep well pump or submerged pump provided independently in each tank, but a stop valve is to be provided near at each penetration of weather deck as given in **Fig 7.6.31** of the Guidance for the direct cargo filling line(piping capable of filling cargo without being led through the cargo pump).

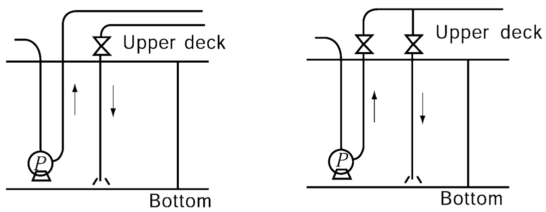


Fig. 7.6.31

(3) When the "direct cargo filling line" specified in the preceding (2) is provided, the open end of such direct cargo filling line for highly flammable and/or toxic chemicals is to be extended to not more than 10 cm above the tank top or sump surface or the filling pipe radius, whichever is the greater.
(4) The "one stop valve" referred to in **506. 1** (2) of the Rules is also required for the hose connection used for the transfer of cargo vapour.
(5) In addition to the preceding (4), a stop valve is required for the hose connection to the shore vapour circulation. When the stop valve is of the portable type for fitting as necessary, stop valves equal to or greater, in number, than the maximum number of tanks scheduled for simultaneous loading of the cargo requiring shore circulation are to be provided at shore for the ship. The restriction to the number of loaded cargo tanks according to the number of these stop valves is to be noted in the Operation Manual of the ship carrying dangerous chemicals in bulk.
(6) It is desirable that the "remote shut-down devices" referred to in **506. 1** (3) of the Rules can be centrally controlled from a place manned at all times during the cargo operation (e.g. cargo control station).

507. Ship's cargo hoses

1. General

(1) The "hoses" referred to in **507. 1** of the Rules are to comply with the following requirements :
  (A) When come in contact with the cargo, hoses are not to be mechanically damaged or caused extreme degrading in their function.
  (B) The materials of cargo hoses are not to give hazardous effects on the cargo.
(2) In the preceding (1), if cargo hoses are integral with the emergency cargo pump or they are submerged in the tank connected to the pump, the requirements in the preceding (1) are to be considered for both the inside and outside surfaces of hoses.

Section 7 Cargo Temperature Control

701. General

1. General

The "cargo heating or cooling system" referred to in **701. 1** of the Rules is to comply with the following requirements :

(1) For possible failure of any component or the whole system serving as a source of heating in ships carrying the cargo requiring heating and to which the requirements in this Chapter apply, means are to be provided so as not to disable cargo heating, cargo operation or not to endanger the safety of the ship.

(2) For the refrigerating installations and insulation materials of ships carrying the cargo requiring cooling to which the requirements in this Chapter apply, the requirements in **Ch 5, Sec 4** to **Sec 7** of the Rules and those specified in **Pt 9, Ch 1** of the Rules for Refrigerating Installations apply correspondingly. Particular attention is to be paid to the cargo since propylene oxide for the refrigerating installation of which detailed requirements are specified.

(3) Cargo requiring heating means the dangerous chemicals with a melting point not less than 15°, as a standard, but if deemed necessary by the Society, heating means for cargo may be required according to the service area and operation condition of the ship. In this case, the temperature measuring equipment specified in **701. 5** of the Rules is to be of the fixed type.

(4) The maximum temperature of steam and heating media within the cargo area is to be adjusted to take into account the temperature class of the cargoes.

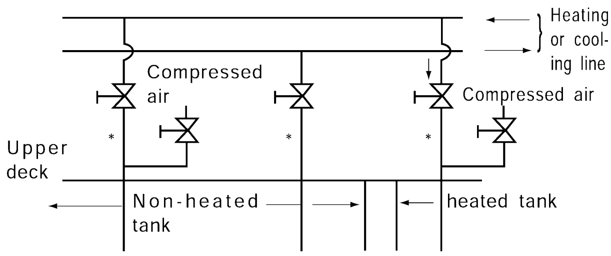
2. Control valves of cargo temperature control system

The "valves to isolate the system for each tank and to allow manual regulation of flow" referred to in **701. 3** of the Rules means the valves provided between the main vapour line and each tank and are capable of regulating flow rate. This also applies to the case of the refrigerating installations. In **Table 7.6.1** of the Rules where carriage of the water prohibiting cargoes to which the requirements of **1516. 2** of the Rules apply is intended, spool pieces are to be provided in addition to these valves.

3. Maintenance of pressure in cargo temperature control system lines

As the provision for the maintenance of the pressure specified in **701. 4** of the Rules, compressed air may be supplied from the deck general service air line fed from the air reservoirs and air compressors in the machinery space to the heating (cooling) piping.

When it is solely planned to carry the heated (cooled) cargo in all tanks, compressed air may be fed from the compressed air main, but if it is intended to carry the heated (cooled) cargo in part of tanks with the rest of tanks used for the carriage of non-heated (non-cooled) cargo, compressed air is to be supplied from the connection on the tank side of the stop valve of the compressed air branch line as given in **Fig 7.6.32** of the Guidance. In case where carriage of the cargo not requiring heating (or cooling) but requiring to inert the tanks and cofferdams adjacent thereto, no air is to be sealed in the line but inert gas is to be filled in. Consideration is to be given so as not to cause dangerous mutual reaction between the sealing medium and the cargo. Where other means are employed for the maintenance of line pressure, the same requirements apply.



* For the heating (cooling) lines led to tanks where water prohibiting cargoes are carried, spool pieces are to be provided on the tank side of the stop valve.
Where the cargo causing harmful reaction with the thermal medium is carried, the heating (cooling) lines are to be emptied, dried and gases are to be filled before cargo loading.

Fig. 7.6.32

4. Means for measuring the cargo temperature

"When overheating or overcooling could result in a dangerous condition" referred to in **701. 5** (4) of the Rules means such a case where the adjacent cargo tanks or fuel oil tanks are heated or cooled to the extent that they suffer from thermal effects. In this case, the temperature sensing ends are to be provided at least at two locations on the liquid surface and bottom of the tank.

5. Circuit operated with heating or cooling medium

(1) The cargoes falling under the requirements in **701. 6** of the Rules are to be those to which application of the requirements of either **1512., 1512. 1** or **1512. 3** specified in **Table 7.6.1** of the Rules is required, but they also apply to the cargo with a notation of "T" in vapour detection of the Table.

(2) "where the medium is sampled to check for the presence of cargo" referred to in **701. 6** (3) of the Rules is to be of the detection tank fitted with a detection cock as given in **Fig 7.6.33** of the Guidance, as a standard. Although provision of a oil observation tank in the machinery space is required for ordinary tankers according to the requirements in **Pt 7, Ch 1, 1002. 9** of the Rules, in the case of carriers carrying dangerous chemicals in bulk, provision in the machinery space is not permitted and such means is to be provided on the weather deck within the cargo area without exception. Means of detection is to be by an effective toxic gas-detecting tube or suitable testing agent. The suitable testing agent is to have been procured from the manufacturer.

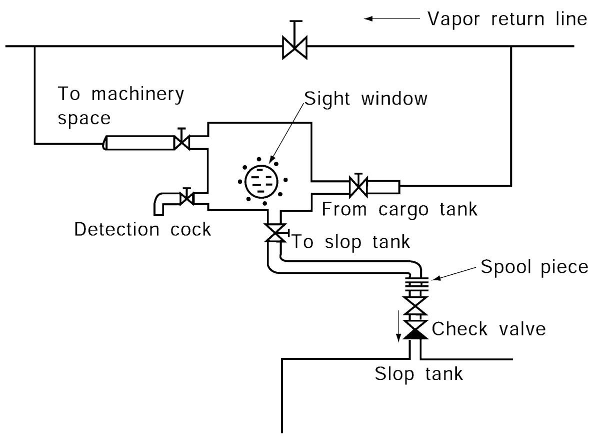


Fig. 7.6.33

Section 8 Cargo Tank Venting and Gas-freeing Arrangements

802. Cargo tank venting

1. Venting systems

(1) "Tank venting systems are to be arranged to prevent entrance of water into the cargo tanks and at the same time, vent outlet are to direct the vapour discharge upwards in the form of unimpeded jets" referred to in **802. 1** of the Rules mean the outlet as given in **Fig 7.6.34** of the Guidance.

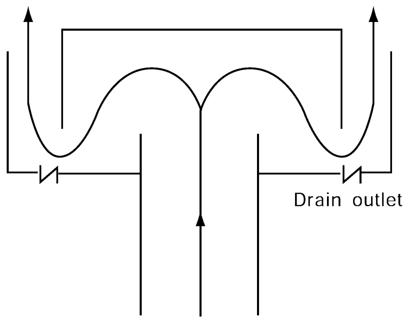


Fig. 7.6.34

2. Provision for drainage of vent lines

The "cargo vent lines are to be self-draining back to the cargo tanks" referred to in **802. 2** of the Rules is to be so arranged that drains of the vent lines will flow into cargo tanks by natural gravitation by heels and trims of the ship. In case where such piping arrangement is impracticable, drain cocks are to be fitted at the location of PV valves and other places where drains tend to accumulate. For drain cocks which are capable of returning drains to the slop tanks when large volume of drains are accumulated, hose connections are to be provided.

3. Provision to protect liquefied head exceeding design head

(1) When the "provision made to ensure that the liquid head in any tank does not exceed the design head of the tank" referred to in **802. 3** of the Rules is designed, the following items are to be considered :
(A) loading and unloading rate
(B) filling of ballast and discharge rate
(C) gas evolution
(D) pressure loss considered resistance coefficient
(E) pressure loss in ventilation system
(F) operating pressure(suction/discharge setting pressure) where high velocity venting valves or relief valves are used
(G) density of equilibrium of the vapour/air mixture
(H) air supply rate by fixed type ventilation system

(2) Except for the case specified in **1519.** of the Rules, no independency is required among liquid level gauges, high liquid level alarm system and overflow control system. The high level alarm system or overflow control system required in **1519.** of the Rules may be used for the prevention of cargo tank overpressure. When the cargo having a larger specific gravity than the design specific gravity is carried in partial loading, the cargo tank is to be provided with the measuring systems required in 1301. of the Rules, and additionally, high liquid level alarm system capable of being set at arbitrary levels is to be provided for the protection of the cargo tank.

(3) The system fitted with valves and flanges for connecting cargo hoses at hatches on the top of cargo tank for preventing cargo tank overpressure as given in **Fig 7.6.35** of the Guidance may be accepted only when either of the following (A) or (B) is relevant :

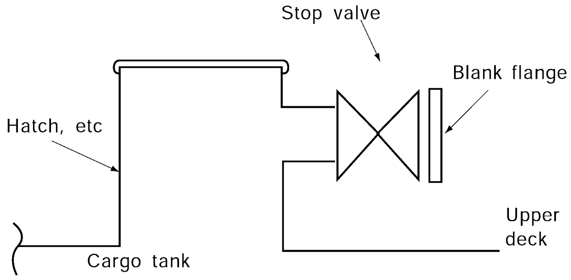


Fig. 7.6.35

(A) Cargo loading is carried out only at ports fully equipped with circulating systems
(B) Where method of cargo transfer to other cargo tanks has been established. In this case, however, cargo loading may be restricted under the requirements for mutual reaction with each other.
In either case of (A) or (B), much difficulty is involved in observing the operational restrictions and hence it is desirable to install the high level alarm or overflow control system specified in **1519.** of the Rules. For tanks carrying the cargo with a flash point of not more than 60°C, provision of the high level alarm system or overflow control system conforming to **Pt 7, Ch 1, 1004. 7** of the Rules is required where spill valves are not to be used. (Spill valves are not deemed equivalent.)

4. Design parameter of venting systems

(1) The size of vent system specified in **802. 4** of the Rules is to be given consideration so that the back pressure produced during the cargo operation at the maximum design loading rate does not exceed either of the following allowable pressures :
(A) Where no special consideration is taken for the strength of tank, the tank design pressure 2.45 m (head)
(B) Where cargo tank is suitably strengthened and the tank has been tested in the presence of the Surveyor of the Society, such tank test head.
(2) The parameters specified in **802. 4** of the Rules are to be considered in sizing of a tank venting system. In a cargo with a boiling point not more than 45°C having a high vapour pressure, the factor exceeding 1.25 may be required in connection to the gas evolution during loading specified in **802. 4** of the Rules.
(3) During the cargo loading/unloading, venting may be carried out through a by-pass line provided for the PV valve or high-speed discharge system. In this case, the height of atmospheric discharge opening of the by-pass line is to comply with the requirements for the height of the discharge outlet of the venting system specified in **803. 3** (1)and **1512. 1** (1) and (2) of the Rules. However, any venting arrangement to discharge the vapour directly by opening the high-speed discharge system is not accepted.

5. High level alarms and overflow control systems specified in the **Ch 6 802. 3** of the Rules are to be type approved by this Society.

803. Types of tank venting systems

1. Open tank venting system

The term "with due regard to cargo segregation" referred to in **803. 1** of the Rules means the design that restricts the ingress of the cargo of a cargo tank into other cargo tanks through vent lines even at times of heavy weather as given in **Fig 7.6.36** of the Guidance. In consideration of possible degrading of product quality due to coming to contact with different dangerous chemicals or their vapours, however, it is desirable that even the open type vent system be of independent design as far as practicable.

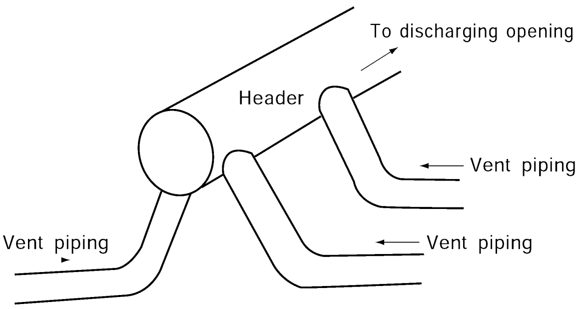


Fig. 7.6.36

2. Controlled tank venting system

(1) The words "such individual vents on the pressure side only may be combined into a common header or headers, with due regard to cargo segregation" referred to in **803. 2** of the Rules mean as follows :

(A) In case where the controlled venting systems of the cargo tanks carrying the cargoes different from each other or the same cargoes are led to a common pipe header, the pressure relief valves and vacuum regulating valves are to be separate from each other, and any other arrangement than that given in **Fig 7.6.37** of the Guidance is unacceptable. This requirement does not apply to tanks where cargoes which react in a dangerous manner are carried.

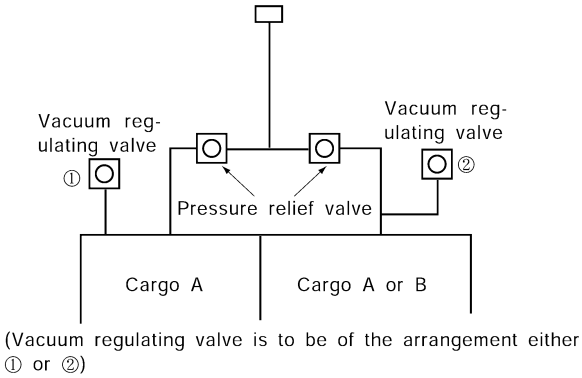


Fig. 7.6.37

(B) When PV valves whose pressure side and vacuum side are led to the common pipe for the vent system of the cargo tank intended to carry cargoes different from each other or the same cargos are used, any arrangement other than the venting system independent for each tank is unacceptable. Accordingly, both the arrangements given as (a) and (b) of **Fig 7.6.38** of the Guidance are unacceptable.

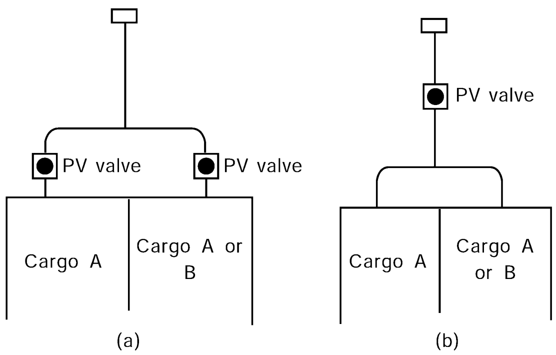


Fig. 7.6.38

(2) The measurement of the height of vent outlet "not less than 6 m above the weather deck" referred to in **803. 4** (1) of the Rules is to be taken as given in **Fig 7.6.39** of the Guidance. As for the height of the opening of the vacuum regulating valve, it is to be not less than 760 mm above the freeboard deck for the cargo to which application of **1516. 1** of the Rules is not required.

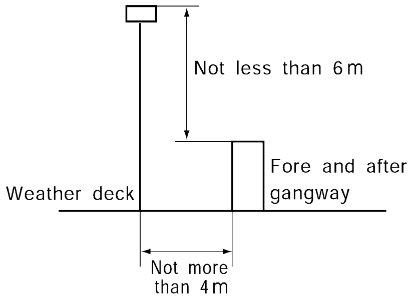


Fig 7.6.39

(3) As the countermeasures against the "freezing of cargo vapour or by icing up in adverse weather conditions" referred to in **803. 7** (3) of the Rules, ships operated in cold zone are to be provided with heating systems, etc. for the prevention thereof. In ships not provided with special heating systems, proper maintenance and inspection work procedures are to have been established.

(4) PV valves referred to **803. 2** of the Rules are to be type approved by the Society. The pressure setting, installation, tests and marking of the PV valves are to comply with the requirements of **Pt 8, Ch 3, 505. 1** of the Guidance.

(5) Devices to prevent the passage of flame(including high velocity valves) referred to **803. 5** and **6** are be type approved by the Society. The design, arrangement, inspection and etc., are to comply with the requirements of **Pt 8, Ch 2, 104. 11** of the Guidance.

805. Cargo tank gas-freeing

1. The method and instruction of cargo tank gas-freeing are to be described on the Cargo Operation Manual in detail.

2. Openings for gas-freeing are to be arranged at places as far as at least the distance specified in **803.** or **1512.** of the Rules from all openings or air intakes of accommodation or service spaces.

Section 9 Environmental Control

901. General

1. Inerting or padding of cargo tanks

(1) The inert gas supply system for ensuring "sufficient inert gas available on the ship to compensate for normal losses during transportation" referred to in **901. 3** (1) of the Rules is to be as follows :

(A) The nitrogen gas generating system that separates nitrogen from the air may be used in combination of the inert gas contained in a pressure vessel as a make-up system at sea.

(B) The required quantity of inert gas to be carried onboard the ship is to be determined for each ship in consideration of the construction and equipment of the ship, but it, as a rule, is to be not less than 5 % of the total volume of cargo spaces to be inerted or expected loss during 30 day voyage, whichever is greater.

(2) Where inerting gas is generated on board by oil-fired inert gas generators according to **901. 3** (1) of the Rules, followings are to comply with. In the case of systems using inert gas from other source, special consideration is to be required.

(A) Inert gas systems are to comply with IMO Res. A.567(14) "Regulation for inert gas systems on chemical tankers". In this resolution, Administration means this Society.

(B) A water seal of inert gas piping device on deck may be replaced by venting valve between two sets of shut-off valve, and following conditions are to be complied with :

(a) Valve is to be operated automatically. Open and close signal is to be obtained directly from the inflow of inert gas or the differential pressure.

(b) The alarm device for valve malfunction is to be installed. For example, the operating situation for blower stop and open of supply valve is to be condition of alarm operation.

(C) In addition to IMO Res A.567(14), following requirements are to be complied with.

(a) Drawings and data to be submitted are to comply with **Pt 8, Ch 1** of the Guidance.

(b) Automatic combustion control capable of producing suitable inert gas under all service conditions is to be fitted to the inert gas generators.

(c) Where two sets of inert gas blowers are provided, total capacity is to be provided equally at two sets, and each blower's capacity is to be 1/3 of total capacity and over.

(d) Materials used in inert gas systems are to be suitable for their intended purpose. In particular those parts or 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 fiber epoxy resin or other equivalent coating material.

(e) The compartment provided with oil burning type inert gas generators is to be fire protection structure such as machinery space of category A.

(f) All devices installed on board are to be satisfied by the Surveyor on the test according to the working condition.

(3) The "means to be provided for monitoring" referred to in **901. 3** (4) of the Rules are to be as follows :

(A) Continuous monitoring system

(a) Continuous monitoring by fixed oxygen content meter, or

(b) Combined use of continuous pressure measurement of tank atmosphere and portable oxygen content meter.

(B) In the case of the cargo where the "closed type" is required for measurement instruments and inerted method is applied, the measurements by a portable oxygen content meter are to be taken at such measuring line from which no cargo is leaked onto the deck during and after the measurements, and means are provided to lead the exhaust gas to the cargo vent lines. In the case of the cargo where the "restricted type" is required, means are to be provided so that the opening for measurement are automatically closed.

2. Environmental control for double hull spaces, etc.

Ventilation, inerting and gas measurement for double hull and double bottom spaces are to comply with **Ch 1, 1009.** to **1011.** of the Rules.

Section 10 Electrical Installations

1001. General

1. Electrical equipment installed in the flammable atmosphere

(1) The words "to the satisfaction of the Society" referred to in **1001. 5** of the Rules are to be in accordance with the following (A) or (B) :
  (A) Those complying with the requirements in **Pt 6, Ch 1, Sec 9** of the Rules, and having apparatus groups and temperature classes given in column i in table of **Sec 17** of the Rules according to the type of gas.
  (B) Explosion-protected electrical equipment in **Pt 6, Ch 1, Sec 9** of the Rules and having type approval by the Society.
  (C) Those approved as having no structural hazard to serve as a source of ignition.

1002. Bonding

1. Bonding

In application to 1002. of the Rules, the electrical bonding is to conform to the requirements of **Pt 6, Ch 1, 104.** of the Rules. In case where the gasketed flange joint are used, the flange bolts only are not considered as an earthing, and the connections and earthing are to be provided with earthing conductors.

Section 11 Fire Protection and Fire Extinction

1102. Cargo pump rooms

1. Fire-extinguishing system for the ships dedicated to the service of a restricted number of cargoes

The term "an appropriate fire-extinguishing system approved by the Society" referred to in **1102. 2** of the Rules means fixed carbon dioxide fire extinguishing system. The fire extinguishing system for ships carrying only the restricted number of cargoes as defined "No-nil requirements" in column j in table of **Sec 17** of the Rules is left to the discretion of the Society.

1103. Cargo area

1. Type of foam concentrate

(1) The "regular protein foam" referred to in **1103. 2** of the Rules means the foam without either any agents or anti-frozen agents added to be leveled the liquid point not higher than 0°C.
(2) Where plural fire extinguishing agents including foam are defined effective in column l in table of **Sec 17** of the Rules, foam fire extinguishing system is to be provided.

2. Arrangements for providing foam

For the purpose of the requirements in **1103. 3** of the Rules, the arrangements for providing foam are to be as follows :

(1) For the deck area of cargo tanks, reference is to be made to **Fig 7.6.40** of the Guidance.
(2) In supplying foams to inside the cargo tanks, access hatches, etc. may be used.

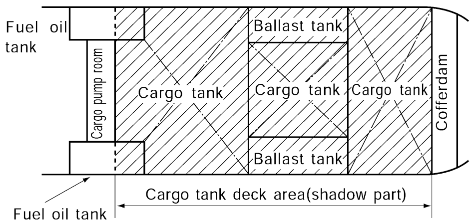


Fig. 7.6.40

3. Rate of supply of foam solution

For the purpose of the requirements in **1103. 5** (3) of the Rules, the minimum capacity of the monitor for ships less than 4,000tons deadweight is to be 1,000 l per minute and the rate of spray may be set at 10 $l/m^2/min$.

4. Specification of monitor and foam applicator

For the purpose of the requirements in **1103. 7** of the Rules, for the monitor and foam applicator for ships less than 4,000 tons deadweight, the requirements in preceding 3 are to apply correspondingly.

5. Requirements of fire main

For the purpose of the requirements in **1103. 12** of the Rules, the fire main is to be capable of discharging at least two lines of water jet on deck, accommodation space, control rooms and machinery space during the fire-fighting operation by foam.

6. Alternative provisions installed in ships dedicated to the carriage of a restricted number of cargoes

The fire extinguishing systems for ships carrying the cargoes defined "No-nil requirements" in column l in table of **Sec 17** of the Rules are left to the discretion of the Society.

7. Portable fire-extinguishing equipment

As portable fire-extinguishing equipment, two fire extinguishers with a capacity of 9 l to 13.5 l using the fire-extinguishing agents suitable for the type of cargo carried are to be provided at each manifold. These fire extinguishers are to be stored at suitable places except for the time of cargo operation.

8. Exclusion of sources of ignition

For the purpose of the requirements in **1103. 15** of the Rules, the windlasses and chain lockers are to be regarded as sources of ignition and are not to be provided in the dangerous compartments given in **1002.** of the Rules. The relevant requirements in **Pt 8, Ch 2** of the Rules are also to be complied with.

1104. Special requirements

1. Special requirements

(1) For ships dedicated to exclusive carriage of one type of cargo relating to the fire-extinguishing installation given in column l in table of **Sec 17** of the Rules, either one of the alternative fire-extinguishing equipment specified therein may be selected and provided notwithstanding the requirements in column l. Further, the fire-extinguishing arrangements in ships carrying only the cargo defined "NF" in column i and "No-nil requirements"in column l in table of **Sec 17** of the Rules are to be such that any places on deck within the cargo area can be covered by water spray from at least two lines of fire nozzles discharged from separate fire hydrants.

(2) The capacity of fire-extinguishing agent of dry chemical fire extinguishers is to be the greater or more of the following capacities :

(A) The capacity required in **Ch 5, 1104. 6** of the Rules.

(B) 1.5 kg/m^2 of the total deck area of the cargo tanks which are expected to carry simultaneously the cargo for which the fire-extinguishing equipment is required. For other requirements for installations, the requirements in **Ch 5, 1104.** of the Rules apply correspondingly.

(3) The "C-water spray" required in column l in table of **Sec 17** of the Rules as the fire-extinguishing equipment of "ammonium solution of 28 % or less" may be replaced with the water spray from the fixed deck foam system.

Section 12 Mechanical Ventilation in the Cargo Area

1201. Spaces normally entered during cargo handling operations

1. Ventilation prior to entering the compartment

For the purpose of the requirements in **1201. 2** of the Rules, the ventilating period before the entrance of person in the compartments is to be 15 minutes as standard.

2. Type of ventilation systems

For the purpose of the requirements in **1201. 4** of the Rules, the ventilation ducts in cargo pump room are to be provided at the upper part of cargo pump room, and in addition, to be arranged in compliance with the requirements in **Pt 7, Ch 1, 105.** of the Rules. Further, the suction openings are to be arranged as far apart as practicable from each other, for instance on a diagonal line of cargo pump room, in consideration of the vapour density of the cargo and air intaking efficiency.

3. Arrangement of ventilation intakes

For the purpose of the requirements in **1201. 6** of the Rules, the ventilation intakes are to be so arranged as to minimize the possibility of recycling hazardous vapours.

4. Arrangement of ventilation ducts

For the purpose of the requirements in **1201. 7** of the Rules, in view of the difficulties involved in the maintenance when protection against the approved type of cargo to be carried is required, the location of ventilation ducts on the bulkhead bounding the cargo pump room and machinery room as given in **Fig 7.6.41** of the Guidance is not allowed.

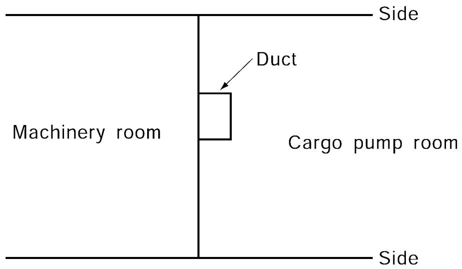


Fig. 7.6.41

5. Requirements of electric motors driving fans

In application of **1201. 8** of the Rules, the ventilation fan "of non-sparking construction" is to be comply with the requirements specified in **Ch 1, 1006. 2** of the Guidance.

6. Spare parts for fan

For the purpose of the requirements in **1201. 9** of the Rules, one spare impeller is to be provided for each type of fan.

7. Protection screens fitted in the opening of ventilation ducts

For the purpose of the requirements in **1201. 10** of the Rules, the protection screens may be of wire gauze of 13 mm × 13 mm mesh. However, the wire gauze is to have suitable strength against the falling impact of foreign objects.

1202. Pump rooms and other enclosed spaces normally entered

1. In application to 1202 of the Rules, the following requirements are to be complied with :

(1) The requirements in **1202.** of the Rules apply irrespective whether the control system of the pumps and valves in the pump room is provided outside the pump room or not.

(2) The pump room and other enclosed spaces normally entered are to have 20 air changes per hour and, in addition, the requirements in **1201.** of the Rules are to be complied with. In enclosed spaces normally entered, the special lockers and storage rooms specified in **1401. 2** of

the Rules and suitable clearly marked locker specified in **1402. 5** of the Rules which are readily accessible for persons are to be included. However, for the enclosed small spaces where the maximum travel distance to the door is 5 m or less, it is difficult to install the fixed ventilation system, portable ventilation system may be permitted.

(3) The ballast pump room where no cargo piping whatever penetrates therethrough or where cargo pipings without having flange joints and valves penetrate therethrough is to be dealt with in accordance with the following requirements :

(A) The exhaust outlet of the mechanical ventilation fans of the ballast pump room may not undergo the restriction to its location specified in **1201. 5** of the Rules.

(B) The exhaust inlet and outlet of the mechanical ventilation fans serving the ballast pump room is to be provided with a protective wire gauge of 13 mm × 13 mm mesh.

(C) For the exhaust ventilation fans of the ballast pump room, spare parts as required for the ventilation fans of cargo pump room are to be provided for each type.

(D) The fire hydrants are to be provided as the fire-extinguishing arrangement of the ballast pump room, but no fixed gas fire-extinguishing system is required.

1203. Spaces not normally entered

1. Spaces not normally entered

The ventilation system provided in spaces not normally entered is not allowed to be the natural ventilation alone. Where a fan is provided in the permanent duct, eight air changes per hour, and where no permanent duct is provided, sixteen air changes per hour are to be provided.

Section 13 Instrumentation

1301. General

1. Types of gauging devices

(1) The openings for the restricted device and closed device of the types of gauging devices referred to in **1301. 1** of the Rules are to comply with the following requirements:

(A) Restricted device :
The inside diameter of the opening is to be not more than 200 mm for both sounding pipe and ullage hatch and to be provided with self-closing type pipe head fitting. For cargo tank sounding/ullage measuring, the device is to be of the gas seal valve capable of being fitted with a measuring device of the construction restricting a massive leakage of cargo vapour. Glazed peeping window is to be provided separately as necessary.

(B) Closed device :
The closed construction is to be of all welded construction, as a rule, but flange construction for periodic inspection which is normally not open may be accepted as the closed device.

(2) In types referred to in **1301. 1** (1), (2) and (3) of the Rules, the closed type may serve commonly with open type and restricted type, and the restricted type, with open type respectively. Namely, the degree of safety is the highest in the closed type followed by the restricted type and then open type, thus it descends in the order of description. In the cargo tank where loading of the cargo required to be provided with the closed devices is expected, restricted devices may be provided in addition to closed devices. In more specific terms, in case where carriage is made of the cargo for which the use of closed devices is required, only the closed devices are to be used, but when carriage is made of the cargo in this tank for which the use of restricted devices is required, either of the closed devices and/or restricted devices may be used. However, for tanks where use of either the closed devised or restricted devices is required, open devices are not to be provided from the safety point of view.

(3) Where peeping windows are provided as a means of gauging device, their construction, liquid and gas sealing performance are to be equivalent to that of tank top, and are to be fitted with protective covers of sufficient strength.

(4) The fitting of a gauging device on the bulkhead of tank with a flange is not allowed under any circumstances. Namely, the gauging device is to be housed in a recessed pipe as shown in **Fig 7.6.42** of the Guidance.

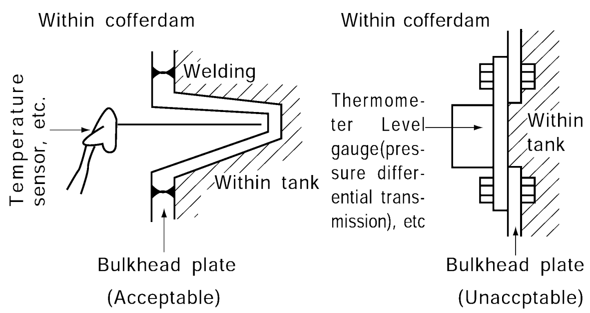


Fig. 7.6.42

(5) The performance and construction of liquid level indicator are to have been approved in accordance with the Guidance for the Approval of Manufacturing Process and Type Approval, Etc.

(6) The tests (pressure, temperature, etc.) and inspection for other gauging devices are to be comply with the following requirements (A) and (B). However, the performance test does not necessarily require a test using the real cargo if as the effect of the device can be verified.

(A) Testing procedure at time of manufacture
Performance tests are to be conducted using the real cargo according to the test plan prepared by the manufacturer. However, in the case of devices which are of the same type previously approved, the performance test using the real cargo may be omitted on approval by the Society. In the case of fixed type device, tests and inspection are to be arranged in accordance with the shipboard test plan approved by the Society.

(B) Reinspection and retesting procedures onboard.
For the gauging devices and equipment fitted onboard the ship, the data specifying the following items (the data are to have been approved by the Society) are to be placed onboard the ship.
(a) Check procedure before use (including the testing procedure)
(b) Check procedure during use (including the testing procedure)
(c) The periodical check procedure established by the manufacturer and service frequency
(d) Service life
(e) Tests and inspection procedures at periodical inspection
(f) Other precautions

1302. Vapour detection

1. Requirements for some products which are not available with toxic vapour detection

In case where a suitable vapour detection instrument for a specific cargo is not available, approval from the Society is to be obtained. However, it is desirable that fixed type vapour detection instruments are installed as far as such are available. At least against carbon disulfide and chlorsulfonic acid, fixed type vapour detection instruments are to be provided.

Section 14 Personnel Protection

1401. Protective equipment

1. Requirements for work clothes and protective equipment

Work clothes and protective equipment specified in the requirements in **1401. 1** of the Rules are to be capable of protecting the entire body of the wearer against cargo splashes in all directions, and the number of sets necessary for those working on deck and in cargo pump room are to be provided. Where one type of work clothes or protective equipment is not sufficient for all prospective types of cargo of the ship, necessary number of sets for respective types of cargo is to be provided.

2. Lockers for work clothes and protective equipment

The protective equipment used for once or more to handle the cargo to which the requirements in **Ch 6** of the Rules apply are, as a rule, to be stored in the lockers provided within the cargo area. One set of these is to be stored in the locker near the cargo pump room at all times. The construction of the special locker for the storage of protective equipment provided in the cargo area is to comply with the requirement in **Pt 3, Ch 17** of the Rules. When this can not be complied with under unavoidable reasons, protective equipment may be stored in the store room or locker having no openings to accommodation space and service space and located outside the cargo area as shown in **Fig 7.6.43** of the Guidance. This requirement does not apply to brand new protective equipment, unused equipment, or equipment which has not been used since undergoing a thorough cleaning process.

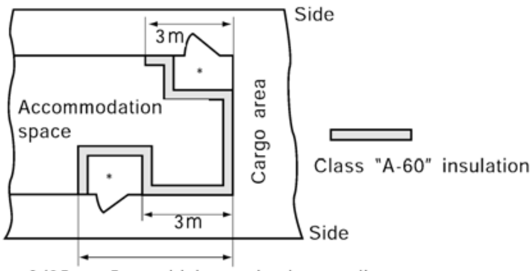


Fig 7.6.43

* : When the storage place of protective equipment is provided within the accommodation space or service space, such is only allowed at areas with openings as specified in **302. 3** of the Rules. In this case, it is desirable to provide showers, etc. within the room. the location of the store room of cargo specimens referred to in **1605. 4** of the Rules is to be dealt with in the same manner as above.

1402. Safety equipment

1. The number of safety equipment is to be determined after carefully studying the arrangement and scheme of shipboard working persons.

2. The safety equipment specified in **1402. 2** of the Rules is to comply with the following requirements :

(1) The term "perform work for at least 20 min." means a capacity in terms of the free air volume at atmospheric pressure is 800 litres or more.
(2) Work clothes and protective equipment of excellent acid-resisting, alkali-resisting and anti-toxic features against the types of prospective cargo are to be used. No duplicated use of work clothes and protective equipment with those required under **1401. 1** of the Rules, in number, is permitted.
(3) The length of the fire-resisting life line is to be 30 m or more so that it can be used also for signalling between the person who enters the enclosed compartment and the other person outside the compartment.
(4) The explosion-proof light is to be capable of lighting for a period not less than 3 hours.

(5) The suits for toxic cargoes are to be fitted with integral gloves and boots.

3. The air compressor referred to in **1402. 3** (2) of the Rules is to be capable of charging the air bottles placed onboard to their maximum working pressure.

4. The additional requirements for the cargo pump room of ships carrying cargo for which no effective vapour detection instruments are provided are to be as given in the following (1) and (2) :

(1) The additional air bottles for the work in the cargo pump room of ships carrying toxic cargo without being provided with effective vapour toxicity detection instruments are to be provided in addition to the number of spare air bottles specified in **1402. 3** of the Rules.

(2) The capacity of the equivalent air bottle in replacement with the low pressure air piping as an additional air breathing apparatus is to be not less than 4,800 litres under the atmospheric pressure.

1403. Emergency equipment

In application to **1403. 2** of the Rules, reference is made to the Medical First Aid Guide for use in Accidents Involving Dangerous Goods (MFAG), which provides advice on the treatment of casualities in accordance with the symptoms exhibited as well as equipment and antidotes that may be appropriate for treating the casualty.

Section 15 Special Requirements

1502. Ammonium nitrate solution, 93 % or less

1. Temperature of the heat exchanging medium in the tank heating system

For the requirements in **1502. 4** of the Rules, the temperature alarm is to be of visible and audible alarm. The detecting temperature is to be the mean temperature within the tank, but the heating system is to be so arranged to avoid uneven heating.

2. Fixed installation for ammonia gas injection system

For the requirements in **1502. 6** of the Rules, where ammonia gas is injected into cargo, the cargo is to be circulated during the injection being made.

3. Type of cargo pump

The sealing system of centrifugal pump is to be of the stuffing box provided with lantern rings as shown in **Fig 7.6.44** of the Guidance and the pressurized fresh water is to be injected into the stuffing box from lantern rings.

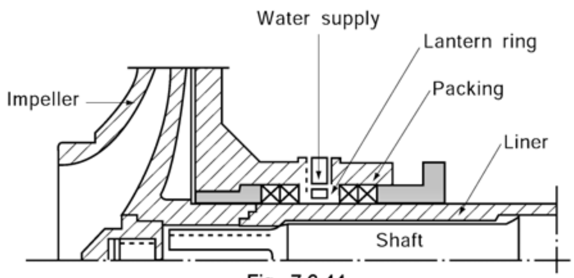


Fig. 7.6.44

1503. Carbon disulphide

1. Opening for emergency sounding

The opening for emergency sounding is to be provided with sluice valve and cock fitted with automatic closing devices. Further, warning signs banning their use other than in emergency cases are to be fitted.

1505. Hydrogen peroxide solutions

1. Fixed water spray system

When the rate and estimated size of the spill referred to in **1505. 1** (10) (B) of the Rules are calculated, the piping and hoses are to be considered to have undergone total loss.

1508. Propylene oxide and mixtures of ethylene oxide/propylene oxide with an ethylene oxide content of not more than 30 % by weight

1. Conditions of carriage

The nitrogen gas produced by the membrane type nitrogen gas generator capable of ensuring a purity of 99 % or more by volume may be used as the nitrogen gas to be sealed.

1510. Sulphur, molten

1. Cargo temperature control system

For the requirements in **1510. 6** of the Rules, the cargo temperature control system may employ manual temperature control trip, etc. provided that the cargo tanks are equipped with cargo temperature indicators and high/low temperature alarms. In this case, tank temperatures are to be so monitored and controlled as not to allow them to exceed 155°C at any points of measurement. In case where the heating medium does not exceed 155°C, the requirements here may be reduced to the temperature indicator only.

2. The double pipes or effective devices are to be provided so that cargo pipe or ventilation pipe is not to be solidified.

1511. Acids

1. Anti-corrosive treatment

For the purpose of the requirements in **1511. 2** of the Rules, the use of lining or corrosion-resistant materials is to be applied also to the boundary walls of cargo pump room (the bottom and boundaries to a height of 1 m from the bottom). Where the effectiveness of lining or corrosion-resistant materials is not verified, the boundary walls are to be used corrosion-resistant materials. In this case, "lining" is an acid-resistant material that is applied to the tank or piping system in a solid state with a defined elasticity property.

2. Means of guard against the danger of cargo being sprayed and leakage

For the purpose of the requirements in **1511. 4** of the Rules, the shields to guard against the danger of cargo being sprayed and leakage are to be of acid-resistant materials.

3. Segregation of cargo from oil fuel tanks

For the purpose of the requirements in **1511. 6** of the Rules, in segregating cargo tanks carrying cargoes or cargo residues from oil fuel tanks, none of facial contacts, linear contacts and point contacts are accepted.

4. Apparatus for detection of leakage of cargo

For the purpose of the requirements in **1511. 7** of the Rules, the apparatus for detection of leakage of cargo is to be of the pH meter and hydrogen detector. These apparatuses may be of portable ones. Further, alternative means such as litmus papers may also be used.

5. Material of bilge pumping and drainage arrangements in cargo pump room

For the purpose of the requirements in **1511. 8** of the Rules, underneath the cargo pumps and associated flange joints, drain pans are to be provided and the collected drains are to be led to bilge wells through the drain lines. These drain lines are to be formed by corrosion-resistant materials or to be applied with effective coatings. Where the bottom of the cargo pump room and its casing walls to a height of 1m from the bottom are made corrosion-resistant, the requirements may be dispensed with.

1512. Toxic products

1. The tank venting systems referred to in **1512. 2** of the Rules are to be provided with the stop valve on return line to shore installation.

1513. Cargoes protected by additives

In application to **1513. 5** of the Rules, For equivalency arrangements for the carriage of styrene monomer, see MSC/Circ.879 and MSC/Circ.879/Corr.1.

1514. Cargoes with a vapour pressure greater than 0.1013 MPa absolute at 37.8°C

1. For the purpose of the requirements in **1514. 4** of the Rules, the tank venting systems are to be provided with the stop valve on return line to shore installation.

1516. Cargo contamination

1. No contamination of cargo with alkali or acidic materials

In segregating the cargo tanks carrying cargo to which the requirements in **1516.** of the Rules apply and the cargo tanks carrying cargo of either alkalinity or acidity, none of facial contacts, linear contacts and point contacts are accepted. Further, segregation of cargo pipes and tank venting systems is required.

2. No contamination with water

(1) The "permanent ballast or water tanks unless the tanks are empty or dry" referred to in **1516. 2** (3) of the Rules means that the tank casings, frames, etc. are free from attachments of water droplets or from moistened condition. In the cargo tanks adjacent to permanent ballast or water tanks not maintained in dry condition, no cargo to which the requirements in **1516. 2** of the Rules apply is to be carried. In this case, none of linear contacts and point contacts are accepted. However, the cross welding such as **Fig 7.6.45** may be accepted.

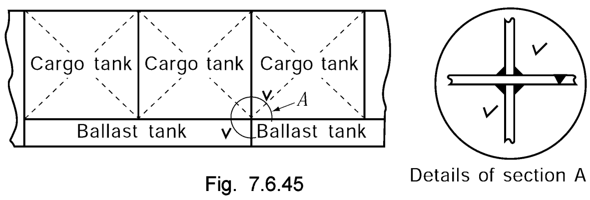


Fig. 7.6.45

(2) Where cargo that reacts dangerously with water is carried in the cargo tank adjacent to ballast tanks, the ballast tank is to be fitted with detachable spool pieces (at outside the tank, e.g. pump room, etc.), the said detachable spool pieces are to be removed after discharging the ballast, and then the open ends are to be blanked off. In this case, the ballast tanks are to be made in dry condition and, at the same time, it is to be ensured that there is no possibility of introducing ballast water thereto by erroneous operation. With permanent ballast tanks not in dry condition or cargo tanks adjacent to water tanks, the carriage of cargo to which the requirements in **1516. 2** of the Rules apply is not allowed. In this case, both linear contacts and point contacts may be not accepted. However, the cross welding such as **Fig 7.6.48** may be accepted. However, the linear contacts and point contacts divided into the cross welding such as **Fig 7.6.48** may be accepted

(3) Where cargo that reacts dangerously with water is heated, the thermal oil installations or the other indirect heating installations are to be provided.

1517. Increased ventilation requirements

1. Increased ventilation requirements

The "work areas or other similar spaces" referred to in **1517.** of the Rules are the service spaces, cargo control rooms and other similar spaces but not include cargo manifolds where cargo operation is carried out.

1518. Special cargo pump room requirements

Under any circumstances, no cargo pump room is arranged directly below open deck. Namely, for tanks carrying the cargo to which the requirements in **1518.** of the Rules apply, either submerged type cargo pump is to be provided therein or cargo pump room is to be provided on open deck.

1519. Overflow control

1. Test of level alarm

In the test of alarms carried out prior to loading, their functions are to be capable of being tested by actual operation of level gauges. When verification by actual operation is impracticable, suitable means to verify that the alarm circuits in normal condition as shown in **Fig 7.6.46** of the

Guidance is to be provided.

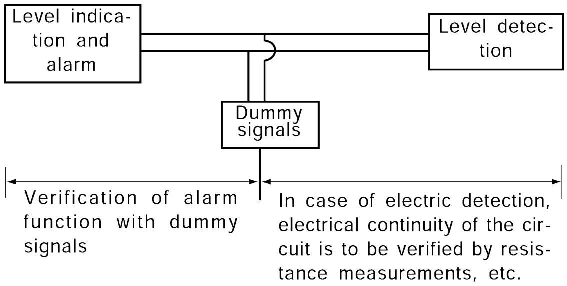


Fig. 7.6.46

2. Independence of high level alarm

For cargoes required to have high level alarm system and overflow control system in the requirements, the provisions of closed type instruments are required in many cases. For such tanks, the following detecting ends are required :

(A) Level gauging devices (**1301.** of the Rules)
(B) High level alarm (**1519. 6** of the Rules)
(C) Overflow controls (**1519. 7** of the Rules)

The above detecting ends (A), (B) and (C) are to be separate from each other. However, only for pipes to which the detecting ends of (B) and (C) (limit switch, float, electric device, etc.) are fitted, they may serve commonly. The electric, pneumatic or hydraulic circuits required for the detecting ends of (A), (B) and (C) are to be independent so that defect in one circuit may not cause functional disability in other circuits. In case where process units are provided on bridge, etc. for the purpose of visual display, the electric circuits concerned are to be independent at least up to the point of display. Power is to be supplied from distribution box.

3. Installation of high level alarm

When modular units are provided in the control room or on bridge as high level alarms specified in **1519. 6** of the Rules, level indicators and visible alarms independent from those (A), (B) and (C) given in the preceding 2 are to be provided. Visible and audible alarms are to be provided also in the cargo areas. Visible alarms are to be provided at such locations readily recognizable also from shore side. In case where no control room is provided, audible and visible alarms are to be provided in the cargo control room. Except for entering the cargo tanks which have thoroughly been washed clean, the testing device for detecting ends is to be provided outside the tank. Simulation test of electric circuit or self-monitoring circuit may be accepted.

Section 16 Operational Requirements

1601. Maximum allowable quantity of cargo per tank

The maximum allowable quantity of cargo specified in **1601.** of the Rules is to be determined in consideration of the thermal expansion of the cargo at temperature of 45°C Care is to be taken so as to ensure that the open ends of the venting system in the tank may not submerge in the cargo but in the gaseous phase under any trim condition of the ship at sea. Further, the maximum allowable quantity of cargo in cases where the tank temperature will possibly exceed 45°C being affected by tank heating is to be determined on the basis of such a temperature.

1604. Opening of and entry into cargo tanks

Covers of the cargo tank specified in **1604.** of the Rules, ullage hole covers and peeping hole covers or tank cleaning hatch covers are not to be opened except for cases where air is intaken in gas free operation, tank washing operation, gauging is taken of the tanks requiring the open devices and restricted devices and during gas detection and when samples are being taken.

1605. Stowage of cargo samples

When the stowage of cargo samples is made within the cargo area, such stowage compartment is to be only accessible directly from the exposed areas of the ship provided with exhaust type independent mechanical ventilating fan capable of ensuring twenty air changes or more per hour. Where it is difficult to install the permanent ventilation system due to the confined stowage compartment, portable ventilation system may be permitted. However, for the stowage small compartment where the maximum travel distance to the door is 5 m or less, it is difficult to install the fixed ventilation system, portable ventilation system may be permitted.

1606. Cargoes not to be exposed to excessive heat

In case where the tank carrying the cargo which is not to be exposed to excessive heat is subjected to tank heating or where the tank is adjacent to other tanks (cargo tanks, oil fuel tanks, etc.) which are heated, fixed type thermometers and temperature alarms are to be provided.

Section 17 Summary of Minimum Requirements

In application to **1** of the Rules, "The Guidance specified separately" means the Annex 7B-1 of this Guidance.

Section 18 List of products to which the Code does not apply

In application to **6** of the Rules, "The Guidance specified separately" means the Annex 7B-2 of this Guidance.

Section 19 Index of Products Carried in Bulk

"The Guidance specified separatedly" means the Annex 7B-3 of this Guidance.

Section 21
Criteria for assigning carriage requirements for products subject to the IBC Code

"The Guidance specified separatedly" means the Annex 7B-4 of the Guidance.

Annex 7A-1 Requirements for Ships not having the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk

Section 1 General

101. Application

1. The construction, equipment and survey of ships intended to be classified as liquefied gas carriers not having the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk are to be in compliance with the requirements in this Annex. "Liquefied gas carrier" in this Annex means a ship designed to contain and carry liquid dangerous cargoes in bulk having a vapour pressure (the pressure is expressed in gauge, and the same is to apply hereinafter) of 2 kg/cm^2 or above at a temperature of 38°C. However, the tests prescribed in **104. 2** (10) of Annex may be omitted by carrying out at the time of initial cargo handling of the ship.

2. General items not specified in this Annex, are to conform to the requirements specified in the relevant Parts of the Rules.

3. As for construction and equipment as well as surveys of liquefied gas carriers intended to carry cargoes having different properties from the liquefied petroleum gas, special consideration is to be paid according to the properties of the cargoes.

4. Loading facilities of liquefied gas carriers which are different from those specified in this Annex may be accepted by the Society, provided that those facilities are deemed equivalent to those required in this Annex.

5. The requirements of **Sec 2** in this Annex apply to pressurized liquefied petroleum gas carrier and the requirements of **Sec 3** apply to low temperature liquefied petroleum gas carriers. Ships, however, which are intended to transport liquefied petroleum gas at temperature below -50°C, are to be at the discretion of the Society.

102. Definitions

The definition of each nomenclature in this Annex is as follows :

1. The "pressurized liquefied petroleum gas carriers" mean the ships intended to contain and transport of the liquefied petroleum gas with the vapour pressure of 0.2 MPa or above at 38°C in storage tanks permanently attached to hull structure at atmospheric temperature and under pressurized condition.

2. The "low temperature liquefied petroleum gas carriers" mean the ships intended to contain and transport liquefied petroleum gas with vapour pressure of 0.2 MPa or above at 38°C, in fixed, independent from hulls and self-supporting type tanks thermally insulated from outside, at or near the atmospheric pressure under refrigerated condition.

3. For the pressurized liquefied petroleum gas carriers, tanks include storage tanks and auxiliary tanks. Storage tank is a storage tank specified in preceding **1** and auxiliary tank is a tank to provide forced pressure head to cargo pumps.

For the low temperature liquefied petroleum gas carriers, tanks are the tanks specified in preceding **2** in which liquefied petroleum gas is loaded.

4. Tank hold is a compartment in which storage tanks of preceding **1** and tanks of preceding **2** are installed.

5. Liquid is liquid phase of liquefied petroleum gas.

6. Gas is gaseous phase of liquefied petroleum gas.

7. Dangerous space is the space where inflammable or explosive substances are placed and where those are stored or are liable to escape into. For ships prescribed in this Annex, at least, following compartments and areas are to be considered as dangerous spaces:

(1) Tank.
(2) Compartment adjoining the tank.
(3) Compartment containing cargo handling machinery and equipment, such as cargo pump room, compressor room, etc.
(4) Zone or semi-enclosed space on open deck, within at least 3 m from any tank outlet, gas/vapour outlet, liquid outlet or cargo pipe flange.
  (A) Openings, as specified above, are the following openings ;
    Tank outlet : Manhole, tank fittings
    Gas outlet : Entrances and ventilation openings of spaces specified in (3), (7) and (8) safety valves, shore connection
    Liquid outlet : Shore connection, overboard discharge pipe
  (B) Flange of cargo pipe is as follows ;
    Cargo pipe means liquid and gas pipe except overboard discharge pipe
    Slip-on and screw type are considered as flanged type.
(5) Zone enclosed by the following width, height and length, on the weather deck:
  (A) Full breadth of the ship ;
  (B) 2.4 m in height above the weather deck ;
  (C) Total length obtained by extending 3 m each in both fore and after directions, with length from leading edge of the foremost storage tank to the trailing edge of the rearmost storage tank.
  (D) In the case of small ships where part of the forecastle deck corresponds to the dangerous space under the requirements of preceding (C) and when electrical equipment other than explosion-protected ones are installed between the leading edge of the foremost storage tank and extension of 3 m in fore direction under an inevitable reason, the following requirements are to be complied with:
    (a) A steel gas barrier is to be provided on the forecastle deck.
    (b) The height of the steel gas barrier is to be 2.4 m or more above the upper deck with the full width of the forecastle deck where the steel gas barrier is installed.
    (c) The steel gas barrier is not to be provided with any opening.
    (d) Electrical equipment is to be at least of the totally enclosed water-proof type.
(6) Exposed area within 2.4 m from the outer surface of storage tank.(in case where the tank is covered by insulator or protective enclosure, the distance is to be measured from its external surface.)
(7) Enclosed or semi-enclosed space where cargo piping is installed.
(8) Compartment where cargo hoses are stored.
(9) Enclosed or semi-enclosed space directly above the dangerous spaces prescribed in (2) or (3) above, except space which is partitioned by gastight bulkheads and is suitably ventilated. "suitably ventilated" means the mechanical ventilation separated from those for compartments specified in preceding (2), (3), (7) and (8), and the air charge rate are not limited.
(10) Any enclosed or semi-enclosed space which has a direct opening to any one of dangerous spaces prescribed in (1) to (9) above.
    The following items are not regarded as the direct openings.
  (A) For windows, manholes, etc.,
    (a) Fixed type gastight portholes
    (b) Bolted, gastight or watertight openings which are not necessary to be opened while the ship is at sea.
  (B) For doors,
    (a) In access opening doors of the living quarters on the upper deck where double, metal self-closing doors are provided in addition to weather-tight doors. Provided, however, that sufficient face-to-face contact is obtained for the self-closing type doors by applying packing to the contact face or by other adequate means.
    (b) In case where double, metal self-closing doors are provided in addition to weather-tight doors for deck storeroom, etc., and the space between the double doors is provided with effective mechanical supply ventilation system.
    In case where double, metal self-closing doors are provided in addition to weather-tight doors, and the space between the double doors is provided with effective mechanic\l supply ventilating system which is interlocked with the non-explosion-protected electrical equipment within the compartment.
    The above (b) may a\so apply to the access opening doors specified in (a) above. The

term "semi-enclosed spaces" specified in (4), (7), (9) and (10) above means the spaces separated by decks and bulkheads where the condition of ventilation is significantly different from that of exposed part of ship.

8. Void space in tank holds is an empty space around tanks in tank holds.

9. Secondary barrier is a structure to hold leaked cargo for more than a fixed period so as not to lower the temperature of main hull structures below that specified in the design.

103. Plans and documents to be approved

Where the loading facilities of liquefied petroleum gas are installed on board, at least, following plans and documents are to be approved by this Society.

Pressurized liquefied petroleum gas carriers

1. Plans and documents to be submitted for approval are as follows:

(1) Specifications for manufacture of tanks including details of welding material and welding procedures.
(2) Overall assembly diagrams and details of tanks and pressure vessels including details of seats for attachment of accessories, nozzles, and also of inner fittings.
(3) Accessory layout on tanks and pressure vessels, detailed drawings of accessories including liquid level gauges, quick closing valves, excess flow valves, etc.
(4) Layout and installation diagrams of storage tanks and auxiliary tanks, details of an deck penetrations and its closing appliances, and details of working benches.
(5) Piping diagrams of liquefied petroleum gas and instrument.
(6) Bilge arrangement and ventilation systems in compartments provided with the loading facilities of liquefied petroleum gas.
(7) Arrangement of safety devices.
(8) Arrangement of sensors for gas detectors.
(9) Details of valves for special purpose, cargo handling hoses, expansion joints, filters, etc. for liquefied petroleum gas.
(10) Constructions of cargo pumps, gas compressors and their prime movers.
(11) Drawings showing dangerous spaces.
(12) Arrangement of earth connections for tanks, piping, equipment, etc.
(13) Electric wiring plans and a table of electrical equipment in dangerous spaces. In this case, the table of electrical equipment is to comply with **Pt 6, Ch 1, 102.** of the Guidance.
(14) Other plans and documents which deemed necessary by the Society.

2. Documents to be submitted for reference are as follows:

(1) Specifications for cargo spaces.
(2) Compositions and physical properties of cargoes including a diagram of saturated vapour pressure within the temperature range from -10°C to 45°C.
(3) Strength calculation sheets of tanks and tank supports and calculation sheets of relieving capacity of safety valves including back pressure calculation of vent pipes.
(4) Piping arrangement of liquefied petroleum gas.
(5) Calculation sheets of filling limits for cargo.
(6) Operation manual prescribed in **106.** of this Annex.

Low temperature liquefied petroleum gas carriers

1. Plans and documents to be submitted for approval are as follows:

(1) Plans given in (5), (6), (9) to (14) of those required for pressurized liquefied petroleum gas carriers.
(2) Manufacturing specifications of tanks (including details of welding procedures, test and inspection plan of welds and tanks, properties of insulation materials and their processing manual).

(3) Construction and details of tanks.
(4) Accessory arrangement on tanks including details of fittings inside the tanks, and details of fittings including level gauges and valves for special purpose.
(5) Details of tank foundations, tank securing devices, deck portions through which tanks penetrate, and closing devices.
(6) Layout and attachment details of heat insulating materials.
(7) Details of secondary barriers, where they are provided.
(8) Details of emergency pressure relief devices from void spaces in tank holds, and details of discharging devices for leaked liquid.
(9) Details of pressure adjusting devices, where void spaces in tank holds are filled by inert gases.
(10) Sectional assembly, details of nozzles, fitting arrangement and details of fittings for various pressure vessels.
(11) Kinds and specifications of materials used for liquefied petroleum gas piping system in connection with the design pressures and/or temperatures.
(12) Piping diagram of refrigerant for re-liquefying devices of vapourized gas.
(13) Arrangements of sensors for gas detectors, temperature indicators, pressure gauges, etc.
(14) Construction of principal parts of re-liquefying devices of vapourized gas in accordance with the requirements for refrigerating devices.

2. Documents to be submitted for reference are as follows :

(1) Documents given in (1), (3) to (6) those required for pressurized liquefied petroleum gas carriers.
(2) Composition and physical properties of cargo including a saturated vapour pressure diagram within the necessary temperature range.
(3) Calculation sheets of capacity of liquefying devices of vapourized gas.

104. Tests and Inspections

Various tests and inspections are to be in accordance with the following requirements as well as the requirements in the relevant Chapters.

1. Pressurized liquefied petroleum gas carriers

(1) Hydrostatic tests
Tanks and pressure vessels, pipes, valves and their fittings for cargo, as well as cargo handling hoses are to be hydrostatically tested at the pressures specified below and are to be satisfactory before installation in the ships.
(A) Tanks and pressure vessels : 1.5 times the design pressure.
(B) Pipes, valves and fittings as well as cargo handling hoses : 2 times the design pressure (or the maximum working pressure).
(C) Cargo compressors and pumps : 1.5 times its maximum working pressure for the pressure parts.
(D) Cargo pipings : In case the welding is carried out at site, tests are to be performed after finishing of welding.

(2) Airtight tests
(A) Tanks and pressure vessels, pipings, valves and their fittings for cargo, as well as cargo handling hoses are to be tested for airtightness at the design pressure (or the maximum working pressure) and are to be satisfactory before installation in the ships.
(B) Piping systems for cargo, after installation in ships, are to be tested for airtightness at a pressure of 90 % or more of the set pressures of relief valves for the piping system and are to be satisfactory.
(C) Cargo compressors and pumps are to be tested for airtightness at the maximum working pressure for their pressure parts.
(D) Cargo pipings are to be tested after finishing of welding, where the welding is carried out at site.

(3) Radiographic tests
Welded joints of piping system for cargo are to be radiographically tested in accordance with the instruction of the Surveyor and are to be satisfactory. For weld joints on the cargo piping, 10 % or more of the joints are to be radiographically tested and the joints tested are to be considered for materials, joint figure, welding position, welding control, experience, etc.

(4) Confirmation tests
Safety valves, relief valves, pressure gauges, thermometers, safety devices, gas detectors, remote control devices, etc. are to be examined of their performance before or after being fitted up.

2. Low temperature liquefied petroleum gas carriers

(1) Tests and surveys of secondary barriers
Where secondary barriers are provided, their effectiveness is to be confirmed by suitable methods at the time of construction. It is also desirable to design them so that effectiveness may be checked at periodical surveys after having been placed in service. In case where the effectiveness of the secondary barriers cannot be checked after having been placed in service, their reliability is to be confirmed by suitable methods at the time of construction.

(2) Welding procedure qualification tests
The welding procedures for use in tank welding are to be those which have been accepted by tests for the welding procedure qualification tests in accordance with the requirements in **Pt 2, Ch 2, Sec 4** of the Rules.

(3) Non-destructive inspections of weld joints
(A) All butt-welded joints of tank plates are to be radiographically examined. Where, however, approved by the Society in consideration of liquid temperature, defect detecting ability, etc., a part of the radiographic examination may be substituted by other types of non-destructive inspections. Even in this case, the radiographic examination is to be carried out for over 20 % of the total butt-welded length and near the intersections of weld lines.
(B) Welded joints for cargo piping are to be radiographically examined satisfactorily in accordance with the instruction of the Surveyor.

(4) Hydraulic tests of tanks
(A) At least one tank or more are to subject to the following tests after their fabrication and before applying heat insulations. Water is to be filled up to the top plate of the tank (excluding the dome, which will be excluded hereinafter) and tanks are to subject to pressure by either pneumatic or hydrostatic pressure corresponding to a water head of either 2.45 m above the tank top plate or up to 0.6 m above the top of hatch opening from the tank top plate, whichever is the greater. Confirmation is to be made that there is no leakage and/or no harmful deformation under such pressure. The remaining tanks may be tested by filling water up to 60 % of the tank depth then applying the pneumatic pressure specified above. However, as for at least one tank, the test pressure or equivalent test water head is to be raised to a pressure 1.2 times the set pressure of the safety valve for overpressure.
(B) Where the structure does not permit inspection of the outer surface of tank plate at the hydrostatic pressure test, any other suitable means to compensate the above is to be proposed for the approval by the Society.

(5) Tests of various pressure vessels
Each pressure vessels and its fittings are to be hydrostatically tested and airtight tested by applying the provisions in preceding 1 (1) and (2) and are to be satisfactory.

(6) Heat insulating materials
Where heat insulations are applied on the tanks, model tests are to be carried out in respect of the method of its application, and confirmation is to be made that the insulations will not come off or break under working condition.

(7) Tank fittings
(A) Safety valves for overpressure, vacuum relief valves and tank fittings not connected to piping are, prior to their installation, to be hydrostatically tested at a pressure of 0.2 MPa and airtight tested at a pressure not less than 0.1 MPa, and are to be satisfactory.
(B) Fittings other than those specified in (A) are, prior to their installation, to be hydrostatically and airtight tested satisfactorily in accordance with (8) (A) and (B) below.

(8) Pipes, valves, pipe fittings, etc. for cargo
(A) Pipes, valves and pipe fittings for cargo and cargo hoses are, prior to their installation in the ship, to be hydrostatically tested satisfactorily at a pressure 2 times the maximum working pressure of the piping system or at a pressure of 1.0 MPa, whichever is the greater.
(B) Pipes, valves, pipe fittings for cargo and cargo hoses are, prior to their installation in the ship, to be airtight tested satisfactorily at the maximum working pressures.
(C) Piping system for cargo is, after installed in the ship, to be airtight tested satisfactorily at a pressure 90 % or more of the set pressure of the relief valve for the piping system.

(9) Confirmation tests
The requirements in preceding **1** (4) are also to apply low temperature liquefied petroleum gas carriers.

(10) Operation tests
The low temperature liquefied petroleum gas carriers are to be confirmed that each of tanks and each of the facilities fulfill the respective conditions initially planned, upon completion of the entire building work and under the fully loaded design condition. In addition, cargo handling facilities are to be inspected under operation with actual cargo.

105. Marking

1. In case of pressurized liquefied petroleum gas carriers, the following particulars are to be marked on each storage tank in a place where easily visible after being installed:

Design pressure, maximum working temperature, capacity, hydrostatic test pressure, date of manufacture, manufacturer's name and manufacturing number.

In case of low temperature liquefied petroleum gas carriers, the following particulars are to be marked in the vicinity of tank dome at a place easily visible:

Tank number, capacity, set pressure of safety valve for overpressure, maximum density of cargo, minimum working temperature, date of manufacture, and manufacturer's name.

2. The maximum working pressure is to be marked on cargo hoses.

3. All pipes connected to tanks are to be marked distinctly either for liquid or gas vapour.

106. Operation manual

Shipbuilders are to supply operation manual to the ship owners outlining operations and maintenance of various facilities for cargo handling as well as safety measures.

Section 2 Pressurized Liquefied Petroleum Gas carriers

201. Arrangement and installation of tanks and compartments containing tanks

1. Arrangement of tanks

Tanks are not to be installed forward of the collision bulkhead nor afterward of the after peak bulkhead.

2. Tank spaces on weather decks

When tanks are either on weather decks or partly projecting out of weather decks, the tanks or protruded parts are to satisfy the following requirements:

(1) Not to interfere with the crew's traffic and working.
(2) To be kept sufficiently from living quarters, boats, embarkation places, fire hydrants and machinery or instruments liable to cause explosion of gas.

3. Distance between tanks and hull structure

(1) The distance between tanks and hull structure such as inner edge of side frames (excepting frames specially provided), inner edge of bulkhead members (excepting girders) and top of inner plating of double bottoms is not to be less than 380 mm for maintenance and inspection, unless otherwise approved by the Society.
(2) For ships of 60 m or more in length, the distance between tanks and side plating is not to be less than 610 mm. And, for ships of single bottom construction, the distance between tanks and bottom plating is not to be less than 610 mm.
(3) Where two or more tanks are installed, the distance between tanks is not to be less than 380 mm, unless specially approved by the Society.

4. Location of manholes

Manhole and accessories of tanks are to be provided above weather decks.

5. Tank supports

Tanks are to be supported securely on steel foundations arranged to avoid excessive concentration of load near the support.

6. Compartments for tank installation

Compartments for tank installation are to be watertight and not to contain any possible source for igniting liquefied petroleum gas (i.e. heat or spark sources, electric equipment, etc.). The spaces are not to have any air communication with other compartments containing such ignition sources.

7. Watertightness of weather deck

In case where tanks penetrate through weather decks, their watertightness is to be in compliance with the requirements specified in **Pt 4, Ch 2 of** the Rules.

8. Earthing

Each tank is to be electrically earthed effectively.

202. Tanks and pressure vessels

1. Application

Tanks and pressure vessels for cargo (hereinafter referred to as "pressure vessel") are to be of welded construction and are to be in compliance with the requirements for welded pressure vessels Class 1 specified in **Pt 5, Ch 5** of the Rules, except those specified in this Section.

2. Materials

The materials for tanks and pressure vessels are to have good weldability and notch toughness at low temperatures to which they may be exposed. The materials used are subject to the Society's approval in respect of design and fabrication procedure.

3. Minimum thickness of shell and end plates

The thickness of shell and end plates of tanks and pressure vessels is not to be less than 8 mm. However, in cases where tanks and pressure vessels are not used for storing liquid continuously nor exceed 900 mm in diameter, the thickness may be reduced to 6 mm.

4. Manholes

The tank is to be provided with a manhole of not less than 275 mm × 375 mm or of diameter not less than 375 mm on or close to tank top. Where access trunk is fitted up to any tank, the inside diameter of trunk is not to be less than 750 mm.

203. Pipes, valves, pipe fittings, pressure vessel fittings and tank accessories for cargo

1. Materials and workmanship

(1) Valves, flanges, pipe fittings, pressure vessel fittings and tank accessories are to be of construction suitable for liquefied petroleum gas transported, and are to be made of steel or other materials approved by the Society.
(2) Valve seats, packings, gaskets, etc. are to be of material which has suitable properties against the corrosion by the liquid. The materials for gaskets of manholes or flanges are to withstand temperature of 530°C without failure.
(3) Pipes subjected to liquid or gas pressure are to be seamless or electric-resistance welded steel pipes.
(4) The workmanship of piping specified in preceding (3) is to comply with the requirements for Class 1 piping specified in **Pt 5, Ch 6** of the Rules.

2. Maximum working pressure of cargo piping system

(1) The maximum working pressure of piping system is defined as that during ordinary service.

Where additional pressure is applied on the system by pump, compressor, etc., this maximum pressure is to be properly adjusted taking account of such additional pressure.

(2) Where the maximum working pressure of piping system is less than 1.0 MPa, the pipes and pipe fittings are to be so designed as to withstand a pressure not less than 1.0 MPa, except for those of vent lines specified in **Par. 12** below.

3. Pipe joints

(1) Pipe joints are to be butt weld or flanged coupling, and flanges are to be joined to pipes by welding.

(2) Pipe flanges are to be of 2.0MPa or above in nominal pressure stipulated by KS (Korean Industrial Standard) or equivalent thereto, except for those of vent lines specified in 12 below.

(3) Screw joints of KS B 0222, only with the dimensions of PT25 or under, may be used in places where they can be shut off from tanks, liquid pressure vessels and main pipes for cargo transfer, and furthermore where inspection can be made easily.

4. Expansion joints

Where expansion joints are used in piping subject to pressure of tank or pressure vessel, or delivery pressure of pumps or compressors, they are to be bent pipes made of seamless or electric- resistance welded steel pipes, or to be approved corrugated expansion joints or the equivalent.

5. Relief valves in pipe lines

Relief valves are to be fitted up on pipe lines which are filled with liquid and closed, and consequently where an excessive pressure may occur. Escaping gas from relief valves is to be led to a main discharge line of safety valves on storage tanks.

6. Pipe supports

Piping is to be provided with adequate supports to prevent its own weight being exerted on valves and their fittings as well as to prevent its excessive vibration.

7. Bonding and earthing

Each pipe line is to be electrically connected and to be earthed effectively.

8. Tank accessories and valves

(1) Each storage tank is to be provided with shut-off valves for filling and discharging liquid or gas, safety valves, level gauges, thermometer wells and a pressure gauge, all of which are to be installed above the weather deck, and suitable access means are also to be provided for facilitating the operation. Where tanks are installed under the weather deck, these access means are to be placed on a trunk or a dome positioned on the weather deck. All connections to tanks are to be protected against mechanical damage.

(2) Manually operated stop valves for all the connections other than for safety valves and level gauging devices are to be provided as close to tanks as practicable.

(3) For tanks whose content is discharged outward with the level gauge opening exceeding 1.4 mm in diameter, excess flow valves are to be provided.

(4) Thermometer wells are to be terminated in liquid spaces and connections to the tank wall is to be welded or flanged and gastight lids are to be provided.

(5) A pressure gauge is to be fitted up at the highest location of each tank or its vicinity.

(6) Where the inside diameter of the pressure gauge exceeds 1.4 mm, the connecting pipe is to be provided with an excess flow valve.

(7) The excess flow valve is to close automatically at the flow rate of gas or liquid specified by the maker. Piping including fittings and accessories protected by an excess flow valve, is to have a capacity greater than the rated flow of the excess valve. Excess flow valves may be provided with a bypass not exceeding 1 mm in diameter to equalize pressures.

9. Valves and accessories attached to pressure vessels

The requirements in preceding 8 are to be applied, as far as possible, to valves and accessories attached to pressure vessels.

10. Filling and discharge pipes of tanks

(1) Either of the following valves is to be provided for each filling pipe:

(A) One check valve and one excess flow valve.

(B) One duplicate check valve.
(C) Two check valves.

(2) Except pipes to which filling connections, safety valves and liquid level gauges are provided, all liquid or gas connections to tanks are to be provided with automatic excess flow valves or internal-type quick shut-off valves being always closed except during filling or discharging operation. Such valves are to be provided with emergency shut-off devices by remote control with fusible plugs to melt at temperatures below 104°C thereby closing the shut-off valves automatically in case of fire, in addition to general shut-off devices.

(3) Where filling and discharging are to be performed through single connection and a screw-type stop valve and a quick shut-off valve specified in preceding (2) are provided, non-return valves or excess flow valves may be dispensed with.

(4) Excess flow valves, internal-type quick shut-off valves or non-return valves are to be fitted on the interior or exterior walls of tanks. Where, however, these valves are fitted up on the exterior walls of tanks, care is to be taken so that any undue strain may not cause breakage between the tanks and the valves.

11. Safety valves

(1) Two or more safety valves are to be fitted on each tank, and are to be set to blow-off steam automatically at a pressure not exceeding the design pressure of each tank.
Safety valves are to be among the following and other types of safety valves are to be approved by the Society whenever they are used.
(A) High lift type
The valve lift is to be 1/15 and above, below 1/7 the inside diameter of valve seat. The required areas of steam passages at the chest inlet and outlet are not to be less than the same and 2 times the required valve seat area respectively.
(B) Full bore type
The valve seat is not to be less than 1.15 times the area at the throat.
The area of steam passage at the valve seat is not to be less than 1.05 times the area at the throat, when the valve is open. And the minimum steam passage area at the outlet is not to be less than 2 times the area at the valve seat when the valve is open.

(2) The total capacity of safety valves on each tank is to be sufficient to relieve the volume obtained from the following formula at a pressure not exceeding 1.2 times the approved working pressure. However, for tanks lagged with insulating material, the required quantity of discharge of safety valves may be reduced within the range down to $W_r/2$ depending on the degree of heat insulation effectiveness, where approved by the Society.

$$W_r = 1.56 \times \frac{A^{0.82}}{L_h} 10^5$$

where :
W_r : Required discharge quantity(kg/h)
A : The following value depending on the shape and dimensions of each tank:
$D_t \times (U + 0.3\,D_t)$-------for tanks of cylindrical form having dished or semi-elliptical heads.
$D_t \times U$ --------------- for tanks of cylindrical form having hemispherical heads.
D_t^2 ------------------ for spherical tanks.
D_t : Outside diameter of tanks(m)
U : Overall external length of tanks(m)
L_h : Latent heat for vaporization of cargo at 1.2 times the approved working pressure of tanks(kcal/kg)

The discharge quantity of safety valves is following formula.

$$W = KCA(10P+1)\sqrt{\frac{M}{ZT}}$$

where :

W : Discharge quantity(kg/h)

A : πDL (cm^2) for high lift type

$\frac{\pi}{4}D_t^2$ (cm^2) for full bore type

D : Diameter of disc seat hole (cm)

L : Valve lift (cm)

D_t : Diameter of discharge part (cm).

P : Pressure 1.2 times the limit pressure of tanks(MPa)

M : Atomic weight of fluid

T : Absolute temperature of fluid at P (K)

Z : Compression coefficient of fluid gas at P and T (in case of uncertainty : 1)

K : 0.65

$$C = 387\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

k : Specific heat ratio of fluid at P and T (It may be value at normal condition)

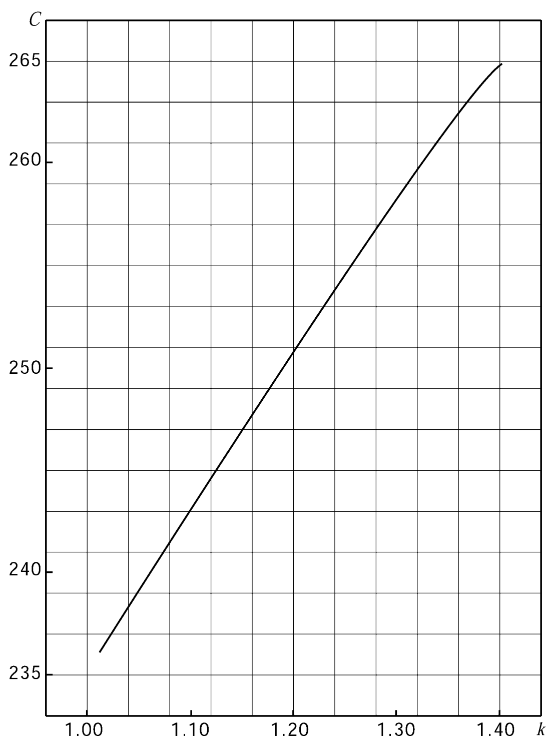


Fig. 1 Relationship between C and k

(3) Safety valves are to be attached to tanks near the highest part of vapour space so as to be able to discharge vapour gas during operation. No shut-off valve is to be fitted between the tanks and the safety valves, except where a set of interlocking type shut-off valves is so arranged that

when one of them is closed the others are automatically opened. In this case, total capacity of two or more safety valves opened are at all times to satisfy the requirements in preceding (2).

(4) One or more safety valves are to be fitted on each pressure vessel for liquid. The capacity and attachment of safety valves are generally to be in accordance with the requirements of preceding (1), (2) and (3) respectively.

12. Vent pipes for safety valves and relief valves

(1) Discharge from safety valves and relief valves is to be led to vent pipes.
(2) Stop valves are not to be fitted to vent pipes.
(3) Vent pipes are to be so designed as to prevent mechanical injury, intrusion of rain or snow and accumulation of drain.
(4) Vent pipes of safety valves on storage tanks are to be capable of discharging a quantity given in **Table 1** of this Annex according to the number of tanks connected to the vent pipe without interfering effective discharge from safety valves by excessive back pressure.

Table 1. Total Valve Discharge

Number of tanks	1 and 2	3	4	5	6 and more
Total valve discharge (%)	100	90	80	70	60

(5) Openings of vent pipes are to be located at a position of 4.5 m or more above the top of tank. Where a deckhouse is situated within horizontal distance of 15 m from the opening, openings are also to be located at a place 3 m higher above the top of deckhouse. At opening of each vent pipe, an effective frame arrester is to be provided.

13. Level gauges

(1) Level gauges of storage tanks are to be in compliance with the following requirements:
  (A) Level gauges are to be capable of indicating the highest level of liquid which will be loaded in the range from -7°C to 45°C.
  (B) Level gauges may be of any of the following types:
  Rotary tube type, slip tube type, fixed tube type, magnet type, automatic float type or similar types having equivalent effectiveness.
  (C) Level gauges of float type or magnet type are to be used in conjunction with tube type level gauges.
  (D) Where a level gauge is connected to a lead pipe fitted on the exterior of a tank, an automatic shut-off valve in case of failure of the lead pipe is to be fitted as close to the tank as practicable. Where, however, the lead pipe is of sufficiently robust construction, the automatic shut-off valve may be omitted.
  (E) A flat type sight glass may be equipped on an automatic float tape reading level gauge. In this case, the glass is to satisfy the requirements specified in (4) below and to be protected effectively by a metallic cover.
(2) Level gauges of intermediate tanks are to be in compliance with the requirements in preceding (1) (B) to (E). But, in case where a self-closing valve or an excess flow valve is equipped in conjunction with the manual stop valve at the connected part of the tank, flat glass type level gauges may be used.
(3) Flat glass type level gauges of pressure vessels are to be in compliance with the requirements in (2) above.
(4) The flat type sight glasses used in level gauges are to be made of heat treated high strength materials and the thickness is not to be less than 12.7 mm.
(5) Round type glass level gauges are not to be used in any case.

204. Cargo handling facilities

1. Application

The requirements in **204.** apply to cargo handling facilities with compressors and liquid pumps or compressors only. Where any other type of facilities than those mentioned above is intended to be provided, full particulars of the installation are to be submitted to be the Society for approval.

2. Location of cargo handling facilities

Cargo handling facilities are not to be located on the weather deck except in compartments in which piping and/or compressors are installed.

3. Cargo hoses

Cargo hoses are to be of suitable material to resist against chemical action of liquid and to be designed for a bursting pressure not less than 5 times the maximum working pressure to which they may be subjected.

4. Connection to shore pipe

(1) In the vicinity of connections between the shore pipes for cargo handling (for both liquid and gas) and the loading headers of ships, shut-off valves are to be provided, each of which can shut off each connection from shore pipes. Adequate shut-off valves are to be fitted on the connections so as to be able to release pressures in the pipes connected to the shore.
(2) The connections with shore pipes are to be arranged so that they may be electrically connected to each other.

5. Pumps and compressors

(1) Pumps and compressors are to be capable of transporting liquefied petroleum gas effectively and are to be so constructed as to minimize gas leakage as far as practicable and free from sparking.
(2) Pumps and compressors are not to be used for purposes other than cargo handling of liquefied petroleum gas.
(3) Where pumps or compressors are driven by engines located in an adjacent compartment, gastight glands are to be provided at portions where driving shafts pass through the bulkhead and alignment of shaft center is to be easily adjusted.
(4) Relief valves or other overpressure protection devices are to be provided on the delivery side of pumps or compressors, except where overpressure is not anticipated. Discharged liquid from the relief valve provided on a pump is to be led to the suction of the pump and the discharge from that provided on a compressor is to be led to the discharge pipe of safety valves on storage tanks, respectively.
(5) Pressure gauges are to be fitted on the delivery side of the pumps and compressors.
(6) Compressors are to be arranged so that no liquid may be sucked in. For this purpose, where an auxiliary tank is provided, suitable means are to be provided to stop the compressors automatically when the liquid level in the intermediate tank reaches the predetermined level.

6. Installation of pumps and compressors

Pumps and compressors are to be installed on the weather deck or in the compartments isolated from adjacent compartments by gastight bulkheads.

205. Ventilation, drainage, etc.

1. Ventilation system

(1) An independent mechanical ventilation system of exhaust type capable of changing the air at a rate of 20 times or more the compartment volume per hour is to be installed in each compartment in which pumps and/or compressors are installed and isolated from adjacent compartment by gastight bulkheads.
(2) An independent mechanical ventilation of supply type having the capacity specified in preceding (1) is to be provided in each compartment in which electric motors or electrical equipment are installed and petroleum gas is liable to intrude.
(3) An effective ventilation system is to be provided for tank holds.
(4) Outlet ends of exhaust pipes of compartments to the atmosphere which come under the provisions in preceding (1) and (2) are to be situated at a distance of 3 m or more from the entrances of companions, deckhouses or superstructures, except where compartments communicated to these entrances are safe spaces from danger of gas explosion.

2. Ventilation system of engine rooms and other compartments containing ignition sources

(1) The ventilation system of engine rooms and other compartments with possible ignition sources

in them is to be of air supply type. Openings of air inlet and outlet are to be placed as high as possible from tank top and possibly apart from ventilation openings of tanks, tank holds and compartments in which pumps and/or compressors are installed, and/or outlet ends of vent pipes from the safety valves.

(2) The ventilation openings of compartments, where the internal combustion engines, boilers or non-explosion-proof type electric equipment are installed, are to be so arranged as to prevent accidental introduction of gas through ventilation openings into the compartments, particularly in the event of failure of cargo handling equipment.

3. Bilge system

(1) The bilge system for the tank holds, pump rooms and compressor rooms for liquefied petroleum gas is to be independent from those of the other compartments.

(2) Not less than 2 sets of power pumps are to be provided in the compartments or on the deck for the purpose of drainage of the tank holds and the pump and/or compressor rooms. The capacity of each pump (Q) is not to be less than following formula. For ships less than 50 m in length, however, 2 sets of manual pumps may be substituted for one power pump.

$$Q = 0.575\,d^2 \ (\mathrm{m^3/h})$$

d : Inside diameter of the main bilge suction specified in preceding (4) (cm).

(3) Where ejectors or eductors are used instead of power pumps, their details are to be submitted to the Society for approval.

(4) The inside diameter of the main bilge suction pipe is to be as specified in **Pt 5, Ch 6, 404. 1** of the Rules.

(5) One of the power pumps specified in preceding (2) may be substituted by a suitable independent power pump in the engine room connected to an emergency suction pipe, which is provided in the tank and the inside diameter of which is not to be less than that of the main bilge suction pipe specified in preceding (4). In this case, the suction pipe is to be of independent bilge suction and a shut-off valve and a blank flange are to be provided in the engine room at the place where the pipe passes through the watertight bulkhead with a notice "For emergency use only" posted near the valve.

4. Cooling devices

Suitable cooling devices are to be provided on storage tanks to keep the liquid temperature in the tanks always below 45°C due to the rise of ambient temperature.

5. Prevention of discharging fire particle through exhaust pipe

Provisions are to be made to prevent discharging fire particles through exhaust pipes of boilers, internal combustion engines or cooking appliances.

6. Installation of equipment containing ignition sources

Any equipment containing ignition sources is not to be installed in the dangerous spaces specified in **102.** (7) of this Annex.

7. Gas detectors

An appropriate number of gas detector probes are to be arranged in tank holds, and a device which automatically detects gas concentration in the tank holds is to be installed.

206. Electrical installations

1. Application

Electrical installations are to be in compliance with the requirements in **206.** as well as the requirements in **Pt 6, Ch 1** of the Rules.

2. Power distribution system

The system of power distribution is to be one of the following types;

(1) Direct current with two insulated wires

(2) Single-phase two insulated wires
(3) Three-phase three insulated wires.
Earth indicating lamps or their alternative means and capacitors used for radio noise suppression may be earthed.

3. Switchboard, section board and power distribution board

Every outgoing circuit from switchboards, section boards or distribution boards is to be provided with a multi-pole circuit breaker or a multi-pole linked switch arranged to interrupt the circuit on each pole simultaneously.

4. Wiring in dangerous spaces

No cable is to be installed in the dangerous spaces specified in **102.** (7) of this Annex. Where it is inevitable to install cables in such spaces, the cables are to comply with the following requirements:

(1) Cables are of the type listed below.
Where corrosion may be anticipated, impervious sheath or equivalent protection is to be applied over steel armour for corrosion protection;
(A) Lead sheath armoured
(B) Impervious sheath armoured
(C) Mineral insulated metallic sheathed
(2) Cables installed is spaces which are always exposed to liquid or vapour of cargo are to be of a type which is not liable to be corroded by liquid or gas, nor to be damaged at the temperature and pressure encountered in any working condition.
(3) Cables are to be installed in the vicinity of the center line of the hull as far as practicable.
(4) Cables are to be installed sufficiently separated from decks, bulkheads, tanks and various pipes.
(5) Where cables pass through bulkheads which constitute the partitions between the dangerous space and the safety spaces or through decks, the sections are to be gastight.
(6) Cables installed in regular corridors or decks are to be properly protected from mechanical damages. Cables and their supports are to be attached so as to withstand expansion, contraction and other actions of the hull structure.
(7) Wiring between the electrical equipment in dangerous spaces and the switches or control devices thereof in safety zones are to have sealing boxes installed on the side of switches or control devices so as to maintain gastightness.
(8) Wiring and cables of intrinsically safe type circuit are to be of exclusive use, and they are to be installed separately from cables for general circuits.

5. Electrical installations in dangerous spaces

(1) No electrical installation is to be provided in the dangerous spaces specified in **102.** (7) of this Annex. Where it is inevitable to provide electrical installations in such spaces, they are to comply with the following requirements:
(A) In all dangerous spaces
Intrinsically safe type electrical equipment may be installed.
(B) In the dangerous spaces specified in **102.** (7) (A) of this Annex
Submerged type electric motors installed in tanks are to be of an explosion-proof type approved by the Society.
(C) In the dangerous spaces specified in **102.** (7) (B), (C) or (H) of this Annex
(a) Electrical sounding devices with enclosed covering may be installed. However, their cables are to be run in galvanized steel pipes of heavy gauge, and pipe joints are to be gastight.
(b) When cables for cathodic anti-corrosion devices from external power sources are installed through these compartments, for protection of the hull, they are to comply with the requirements in preceding (a).
(c) Explosion-proof lighting fittings considered suitable by the Society may be installed. However, the lighting fittings are to be arranged on at least two independent circuits, and are to be controlled by double-pole switches which are connected to locking devices of lighting fittings installed in safety zones outside the compartment. In addition, the lighting fittings and their corresponding double-pole switches are to be clearly labelled for identification.
(d) Where power supply cables to electrical equipment other than mentioned in preceding

(a), (b) and (c) are led through these spaces, their cables are to be kept to essential minimum, and the cables are to be run in galvanized steel pipes of heavy gauge which are maintained gastight. Cable expansion bends are not to be provided.

(D) In dangerous spaces specified in **102.** (7) (D), (G) or (I) of this Annex.
  (a) Explosion-proof electrical equipment considered suitable by the Society may be installed.
  (b) Cables may be installed through these spaces, however, as a rule, cable expansion bends are not to be provided.

(E) In dangerous spaces specified in **102.** (7) (E), (F) or (J) of this Annex.
The requirements in (D) may be applied. In addition, the cables may be provided with expansion and contraction portions.

(2) Where cargo pumps or compressors are driven by electric motors, the electric motors are to be installed in separate compartments which are partitioned by gastight bulkheads or decks from the compartments where pumps or compressors are installed. In case where it is difficult to comply with the above requirements, the documents are to be submitted in advance to the Society for approval.

(3) Where the separate compartments specified in preceding (2) conform to each of the requirements below, electrical equipment in those compartments may be of types other than explosion-proof type:
  (A) The construction, where the shafts pass through bulkheads or decks, is to comply with the requirements in **204. 5** (3) of this Annex.
  (B) Direct openings are not to be provided to the dangerous spaces specified in **102.** (7) of this Annex.
  (C) Air supply type mechanical ventilation devices, with adequate safety measures, are to be installed.

(4) Where the dangerous spaces are illuminated by lamps installed in safety zones through bulkheads or decks, one of the following requirements is to be satisfied :
  (A) To be illuminated from the safety zones through gastight glass windows fitted on bulkheads or decks. However, the gastight glass windows are not to reduce strength or watertightness of the bulkheads or decks to which the windows are fitted.
  (B) Explosion-proof bulkhead lighting fittings considered suitable by the Society are to be used. However, their fittings to bulkheads or decks are to be gastight, and the electric lamps are to be replaced from the safe side.

(5) It is recommended that the electrical equipment used for measuring, monitoring, controlling or communication are of intrinsically safe type.

6. Portable lighting appliances

Portable lighting appliances for use in dangerous spaces are to be of self-contained battery lamps of explosion-proof type or of explosion-proof type considered suitable by the Society.

Section 3 Low Temperature Liquefied Petroleum Gas carriers

301. Structural arrangements

1. Size of tanks

The inner length of tanks is to be $0.2L$ or less. For ships less than 100m in L, the length of tanks is to be followings and over.

$$0.1L + 10 \ \text{(m)}$$

2. Doble bottom

Unless specially approved by the Society, double bottoms are to be provided.

3. Cofferdams

Cofferdams are to be provided between the tank holds and the main engine rooms as well as the boiler rooms. The cofferdams may be concurrently used as tanks for storage of oil having a flashing point exceeding 60°C, ballast tanks, cargo pump rooms, etc. Further, in case where non-combustible insulations are applied on bulkheads between the tank holds and the main engine rooms as well as the boiler rooms, the above cofferdams may be omitted in accordance with the following requirements.

(1) This insulation in bulkheads is to be provided at the side of main engine rooms and of boiler rooms.

(2) For insulation materials, the fire test are to be carried out in accordance with the followings:

(A) Test specimen

The test specimen which is insulated on steel plate by the actual workmanship is to be complied with IMO Res. 754(18).

(B) Fire test

The specimen is to be exposed in a test furnace to the temperatures corresponding approximately to the Standard Time-Temperature Curve.

At the end of the first 5 minutes	576°C
At the end of the first 10 minutes	679°C
At the end of the first 15 minutes	738°C
At the end of the first 30 minutes	841°C
At the end of the first 60 minutes	945°C

(C) Criteria

The average surface temperature rise of steel plates is not to be more than 140°C, and the temperature rise recorded by any of the individual surface is not to be more than 180°C above its initial temperature at any of the individual surface during 1 hour test duration.

4. Arrangement of tanks

(1) Tanks are not to be provided forward of the collision bulkhead nor aftward of the after peak bulkhead.

(2) Hull structural members, tanks, insulations, etc. are to be arranged so that at least one surface of hull structure and each tank may be seen, and the distance between the hull structure and the tank, except where the Society specially approved as to be adequate for maintenance and inspection, is not to be less than 380 mm from the inner edge of side frames excluding special frames, the inner edge of bulkhead members excluding girders and the lower edge of deck members excluding girders, and is not to be less than 610 mm from the top of inner bottom plating. Further, the distance between the tank and the side plating is not to be less than 900 mm. The arrangement of tanks is to comply with **201** of this Annex.

5. Emergency facilities

(1) Emergency pressure relief devices are to be provided in the void spaces in tank holds. For leaked cargo, suitable discharging devices are to be provided.

(2) As a safeguard for the hull structure against major damage or failure of the tanks, devices are to be provided to throw away the cargo within a tank or tanks which have been damaged.

6. Gas detection, temperature detection, etc.

(1) Pressure relief valves are to be provided in the void spaces in tank holds so that pressures in void spaces may not rise above the predetermined pressure.

(2) To detect any leakage of cargo, a suitable number of probes for gas detectors are to be located in the void spaces in tank holds, and devices to automatically detect gas concentration are to be provided. They are to automatically indicate position and concentration of leaked gas at the location where they are placed for surveillance, either in voyage or during cargo handling. They are also to be set so that a warning signal may be issued when gas concentration exceeds at least 1/5 of the lower explosion limit value.

(3) The hull structures, which are liable to be cooled by leakage, etc. of cargo, are to be provided with temperature probes at suitable positions. They are to automatically indicate position and temperature of leaked gas at the locations where they are placed for surveillance, either in voyage or during cargo handling. They are also to be set so that a warning signal may be issued when temperature around probe becomes excessively low.

7. Watertightness of weather deck

The watertightness of weather decks around the domes of tanks is to comply with the requirements in **Pt 4, Ch 2** of the Rules.

8. Earthing

Each tank is to be electrically earthed effectively.

302. Hull Structures

1. Grades of steel in accordance with usage

(1) Where secondary barriers are provided:
Where secondary barriers are provided and layout are arranged so that hull structures may not be cooled excessively even in case of cargo leakage from tanks, the grades of steel used for hull structures are to be as specified in **Pt 3, Ch 1, 405.** and **406.** of the Rules.

(2) Where secondary barriers are not provided:

(A) At both atmospheric and sea water temperatures of 5°C and under normal conditions, the temperatures of the steel used for main hull structure are not to be equal to or lower than those listed below, depending on each grade.

RA steel	0°C
RB or RD steel	-10°C
RE steel	-20°C

(B) In case of leakage of cargo liquid from tanks, the temperatures of the steel used for main hull structure, at atmospheric and sea water temperatures of 5°C, are not to be equal to or lower than those listed below, depending on each grade.

RA steel	-10°C
RB or RD steel	-30°C
RE steel	-50°C

However, for steel plates more than 15 mm in thickness, and where their temperatures become below -35°C, steel for low temperature service specified in **Pt 2, Ch 1, 304.** of the Rules is to be used. When the temperatures of hull structure, the following condition is to be considered.

A. Ship condition
- A-1 Voyage with design load draft and design seagoing speed
- A-2 The hull is to be kept full load draft after damage outbreak, and trim and heeling are considered O condition.

B. Tank damage condition
- B-1 The damaged tank is to be one. However, in case watertight bulkheads are to be comparted in tank, one compartment may be considered.
- B-2 The damaged part is to be on the bottom. the plates of vertical, tops and etc. may not be considered.
- B-3 When the tank is damaged, it is considered that tank, support, equipment, hull, etc, are not deformed and not destruct regarding cargo as leakage and flowing out.
- B-4 It is happened in a twinkle that cargos leak and flow out, and the remained liquid level in the damaged tank and the liquid level in the empty spaces is to be equal immediately.

C. Boundary condition
- C-1 Damage is perceptible immediately.
- C-2 It is to be stationary vapour of +5°C in the compartments adjacent to vicinity empty spaces.
- C-3 The radiation of sunlight is to be ignored.
- C-4 Insulation material, supporting equipment and materials in the vicinity empty spaces are not to suck the cargo liquid except the materials for the discretion of the Society
- C-6 The phase of vapour in the vicinity empty spaces of damaged tank is that the evaporating gas is to rise at a uniform speed.
- C-7 The compartments filled with vapour other than the vicinity empty spaces of damaged tank are to be circulated naturally.

C-8 Vapour and liquid in the same compartment may be at the same temperature.
C-9 Vapour in the tank and phase of vapour in the vicinity empty spaces may be at the same pressure.
C-10 The gas movement in the insulating material may be ignored.
C-11 The humidity may be ignored.
C-12 The effect of paint may be ignored.

D. Calculation condition
D-1 The humidity distribution and the heat transfer are to be in normal condition. However, it is to be in abnormal condition instantaneously after damage break out.
D-2 Sea water is to be 1025 kg/m^3 of density, -2.5°C of freezing point, and others are marked with the property of fresh water.
D-3 The temperature of cargo is to be equal.
D-4 Heat transfer rate may be calculated by using the following values.

			Heat transfer rate ($kcal/m^2h℃$)
Atmosphere	↔	Hull	10
Outside sea water	↔	Hull	2000
Stationary vapour	↔	Hull or liquid	5
Stationary sea water	↔	Hull	100
Cargo liquid	↔	Hull adjacent to sea water	3000
Cargo liquid	↔	Hull adjacent to air	200

D-5 It may be considered that the temperature distribution on object without direction is not to equal generally.
D-6 Bone may be analyzed with fin.
D-7 It may be treated two dimensional problem.
D-8 The temperature of members is to be center temperature of the plate thickness, and the temperature of girder webs is to be average temperature of direction of web depth.

2. Hull structural members

Main structural members for hull referred to preceding **1.** (2) mean the members of **Table 2** of this Annex.

Table 2. Main Structural Members for Hull

Upper deck	Single hull	Deck, longitudinal beams, transverse beams, longitudinal & transverse girders
	Double hull (Topside tanks)	Inner shell plate, stiffeners, girders
Side	Single hull	Shell plates, transverse frame, side longitudinals, special frames
	Double hull	Longitudinal bulkhead plates, longitudinal bulkhead stiffeners and girders
Bilge hopper		Slopping plates, stiffeners, girders
Double bottom		Inner bottom plates, longitudinals, reverse frames of open floors
Transverse bulkhead		Bulkhead plates, stiffeners and girders
Others		Brackets (except tripping brackets)
(Note) Above girders are included girder plates and face. However, stiffeners on girder plates are not included.		

3. Material classes

In case the calculation for hull temperature is omitted, material classes for main structural members for hull are to be those specified in **Table 3.** of this Annex.

Table 3. Material Classes

Member			Steel grades
Upper deck	Single hull	Deck, longitudinal beams, transverse beams, longitudinal girders and brackets	*RB* or *RD*
	Double hull (Topside tanks)	Inner shell plates	*RB* or *RD*
Side	Single hull	All main structural member	*RE*
	Double hull	Longitudinal bulkhead plates Main structure member (except above)	*RE*, *RT*-35 in case of $t \geq 15$ *RB* or *RD*
Bilge hopper		Slopping plates Main structure member (except above)	*RE*, *RT*-35 in case of $t \geq 15$ *RB* or *RD*
Double bottom		Inner bottom plates Main structure member (except above)	*RE*, *RT*-35 in case of $t \geq 15$ *RB* or *RD*
Transverse bulkhead		Bulkhead plates Main structural member (except above)	*RE*, *RT*-35 in case of $t \geq 15$ *RB* or *RD*
Tank support material		Materials for integrated tank support Materials for unintegrated tank support	Equivalent of tank material *RB* or *RD*

(Note)
1. Main structural members mean members specified in **Table 2.**
2. The steel grades except main structural members specified in **Table 2** are to comply with **Pt 3, Ch 1, 405.** of the Rules.
3. *t* is thicknes

303. Tanks

1. Materials

The steel materials used in important parts of tanks are to be those specified in **Table 4** of this Annex or their equivalents.

Table 4 Kinds and Grades of Steel for Use in Tanks

Range of temperatures in service T (°C)	Thickness t (mm)		
	$t \leq 15$	$15 < t \leq 20$	$20 < t$
$-10 < T \leq 0$	*RB*	*RD*	*RE*
$-25 \leq T \leq -10$	*RE*, *RL* 24*A*		
$-35 \leq T < -25$	*RL* 24*A* or *RE* (for $t \leq 9$)		*RL* 24*B*, *RL* 33 or *RL* 37
$-50 \leq T < -35$	*RL* 24*B*, *RL* 33, *RL* 37		Material considered suitable by the Society.

2. Workmanship

(1) Tanks are to be shaped so that excessive stress concentration may be avoided, and any corners are to be smoothly rounded.
(2) The joining of tank plates are to be butt joints welded from both sides, except where specially approved by the Society.

3. Manholes

A manhole of each tank is to be provided above the weather deck, and its size is not to be less than 275 mm × 375 mm nor of diameter less than 375 mm.

4. Layout and scantlings of tank material

(1) The materials of which tanks are built are to be of sufficient strength in consideration of internal pressure of cargo, increased load due to inclination of tanks as well as dynamic loads due to ship motion, etc. However, the scantlings are to be in accordance with the following:

(A) The thickness of tank plates is not to be less than obtained from the following formula or 7 mm, whichever is the greater:

$$3.42S\sqrt{h}\times\sqrt{\frac{41}{\alpha}}+2.2 \ (\mathrm{mm})$$

where

S : Spacing of stiffeners (m)

α : Specified minimum tensile strength of material used ($\mathrm{kg/mm^2}$)

h : Distance from the lower edge of tank plate to the top of hatch opening (m)

(B) The section modulus of stiffeners on tank plates is not to be less than obtained from the following formula:

$$CShl^2\frac{41}{\alpha} \ (\mathrm{cm}^3)$$

where:

C and l : As specified in **Pt 3, Ch 15, 203.** of the Rules.

α and S : As specified in preceding (A)

h : Distance from the mid-point of l for vertical stiffeners, or from the mid-point of distance between the adjacent stiffeners for horizontal stiffeners, to the top of hatch opening (m)

(C) The depth, thickness of webs and face area of girders to support stiffeners on tank plates are not to be less than obtained from the following formulae respectively.

Depth of girder: 143 l (mm) or 2.5 a (mm), whichever is the greater.

Thickness of web : $0.01d_0 + 2.0$ (mm). However, in any case, the thickness of web is not to be less than obtained from the following formula:

$$0.0417C\frac{Shl}{d_1}\times\frac{41}{\alpha}+1.5 \ (\mathrm{mm})$$

Face area : $71.3\frac{Shl}{d_0}\times\frac{41}{\alpha}-\frac{d_0t}{600} \ (\mathrm{cm}^2)$

where

C, S, l and d_1 : As specified in **Pt 3, Ch 15, 204.** of the Rules.

d_0 : Depth of girders (mm)

a : Depth of slots for stiffeners (mm)

t : Thickness of webs of girders

α : As specified in preceding (A)

h : Distance from the mid-point of l for vertical girders, or from the mid-point of S for horizontal girders, to the top of hatch opening (m)

(2) Plates, stiffeners and girders of wash bulkheads provided in tanks are to be of sufficient strength in consideration of the size of tanks as well as of their opening ratio.

The scantlings of wash bulkheads are not to be less than obtained in accordance with **Pt 3, Ch 15** of the Rules by taking h_s obtained from the following formula instead of h. However, h_s is to be not less than 2.0.

$$h_s = \rho\left(0.176 - \frac{0.025}{100}L\right)(1-a)l_t$$

where

ρ : Specific gravity of cargo

L : Length of ship (m)

a : Opening rate of plates

l_t : Length of tanks (m)

304. Tank supports and fixings

1. Tank supports

Tank supports are to be made of suitable materials and are to be so constructed as to avoid any excessive load concentration on the hull structure as well as the tanks. They are also to be capable of coping with expansion or contraction due to change in tank temperature and are also to be of sufficient strength in consideration of the tank weight as well as the forces due to ship motion by rolling, pitching, etc.

2. Stopper of movement

Means of preventing movement of the tanks is to be provided so that the tanks may not move due to ship motion. This means of preventing the movement is to be capable of coping with expansion or contraction due to change in tank temperature and are also to be of sufficient strength in consideration of the forces due to ship motion by rolling, pitching, etc.

3. Prevention means of tank floating

Tanks are to be provided with devices to prevent floating of tanks, when void spaces in tank holds are flooded due to maritime disaster or other causes, thereby causing considerable damage to the hull structure by the floating of empty tanks.

305. Heat insulation

1. Heat insulation of tanks

Periphery of tanks is to be effectively heat insulated so as not to cool the hull excessively.

2. Heat insulating materials

The insulating materials are to be such that they withstand external forces applied during service and that their properties will not change remarkably when in contact with cargo.

306. Tank fittings

1. General

(1) Tanks are to be provided with necessary fittings for cargo handling as well as for safety.
(2) The openings provided on tanks are to be provided on domes extending above the weather deck, except where specially approved by the Society.
(3) No flexible coupling other than of bending tube type, is to be provided between the tank and the valve fitted to the tank.

2. Materials

Materials for tank fittings are to be such that they are not easily affected by cargo and they reserve sufficient mechanical properties at the lowest cargo temperature.

3. Stop valves

(1) A manual stop valve is to be provided on each piping connected to the tank, as close to the tank dome as possible, except the safety valves, vacuum relief valves and level gauges. Where the valve is remote-controlled, it is to be capable of being opened or closed manually.
(2) No stop valve is to be provided between the tank and the safety valves as well as the vacuum relief valves.

4. Pressure gauges and alarm devices for low pressure

A pressure gauging device which suitably indicates gas pressure in the tank is to be provided on each tank. It is to be of such type that the tank pressure can be checked near the dome and further the pressure is to be read at place from which surveillance is carried out in voyage and during cargo handling. Further, an alarm device is to be provided which operates at a pressure higher than the set pressure of the vacuum relief valve, when tank pressure decreases.

5. Thermometers

Means are to be provided for determining the temperature of the tank walls. Measuring points are to be arranged so that the temperature difference of the tank walls may be indicated.

6. Liquid level gauges and alarm devices

A liquid level gauging device is to be provided in each tank to determine the level of the liquid without opening the tank. Independent high level alarms are to be provided, which are to issue alarm signal at places where cargo handling is being watched or controlled.

7. Overpressure safety valves

(1) Two or more safety valves against overpressure are to be provided on each tank at the uppermost point of gas part. In case of pilot-type safety valves, a separate pressure detecting terminal is to be provided respectively.
(2) The total capacity of safety valves against overpressure is to be such that it is capable of discharging the amount specified in (A) or (B), whichever is the greater, at a pressure not exceeding 1.2 times the set pressure:
   (A) The total amount of gas at ambient temperature of 45°C by adding the amount of gas generated due to heat input into the tank to the gas quantity discharged during loading at a full capacity.
   (B) The quantity of gas to be generated by heat input into the tank in case of fire, represented by the amount of gas generated from the heat quantity obtained from the following formula. Where, however, specially approved by the Society in consideration of the hull structure and tank structure, the coefficient of 12,200 in the following formula may be reduced in the range down to 6,100. Further, where the shape construction, and layout of the tanks differ from those set forth in **102**. (2) of the Annex or where application of the following formula is not considered practical, the calculation method will be decided in each case.

$$Q_h = 12{,}200\,A^{0.82}$$

where

Q_h : Heat input ($\mathrm{kcal/h}$)

A : Total surface area of the tank, excluding the surface area below the minimum draught in ballast condition (m^2)

8. Protection devices of tank against vacuum

The following protection devices are at least to be provided so as not to cause dangerous vacuum condition in each tank:

(1) Automatic stopping devices at low pressure for machinery, such as cargo pumps and refrigerating facilities which may cause vacuum condition in the tank. The pressure detecting arrangement of the automatic stopping device is to be separate from that of low pressure alarm specified in preceding **Par. 4.** However, the automatic stopping device may be considered as the alarm device, where the Society considers it to be equivalent to the alarm device in respect of its design.

(2) Vacuum relief valve which copes with the maximum unloading rate of the tank.

9. Precooling of tanks

Precooling arrangements are to be made on the tanks so as not to generate dangerous thermal stress at the time of loading.

307. Cargo piping systems

1. Application

The piping systems are to comply with the requirements in **307.** as well as with those for Class 1 piping specified **Pt 5, Ch 6** of the Rules.

2. Arrangement

All of the cargo pipings other than those installed in tanks, pump rooms and gas compressor rooms, are to be installed on the weather decks, except where approved by the Society.

3. Maximum working pressure, materials and others for cargo piping system

(1) The maximum working pressure of piping system is defined as the maximum value of the pressure of the system in ordinary service. Where additional pressure is applied by pumps, compressors, etc., the maximum value is to be decided taking account of such an additional pressure.
(2) Even where the maximum working pressure of the piping system is less than 0.5 MPa, the pipe and pipe fittings are to be so designed as to withstand the standard pressure of 0.5 MPa, except that of vent lines in **12.** below.
(3) The materials for the piping facilities are such that they are not easily affected by cargo and that they have sufficient mechanical properties even at the lowest cargo temperature.

4. Pipe joints

(1) Pipe joints, other than those for piping within tanks and those for vent piping, are to be butt-welded or flanged couplings, and the pipes and flanges are to be welded.
(2) Pipe flanges other than those for vent piping are generally to be of raised-face type.
(3) Screw joints of KS B 0222 with dimensions of PT 25 or less may be used at visible locations where they can be shut off by valves from tanks and pressure vessels for liquid and from the main pipes for cargo handling.

5. Expansion joints

Expansion joints are to be provided at suitable locations within the piping system to prevent generation of excessive stress due to expansion or contraction. The expansion joints are to be bent pipes or to be of other approved construction.

6. Prevention of mis-handling

(1) The piping devices for a number of tanks, some of which are for exclusive use for a certain cargo, are to be so arranged that an exclusive piping is to be provided individually for each different cargo, except where the common use of piping or mixing of cargoes will not cause any trouble.
(2) Where exclusive pipings are connected each other, means to avoid mis-operation is to be provided.

7. Shore connections

(1) At the connections between shore pipes for cargo handling (for both liquid and gas) and load headers of ship, shut-off valves are to be provided, each of which can be remotely shut off in case of emergency. The valves are to be such that they can shut off from other easily accessible locations than the regular place as well.
(2) Connections between shore pipes and ship's piping are to be so arranged as to be electrically connected each other.

8. Relief valves in pipe lines

A relief valve is to be provided on each pipe line in which the pressure may possibly rise above the maximum working pressure and on each pipe line in which the liquid may possibly be locked.

9. Pipe supports and fixings

All pipe lines are to be provided with adequate supports to prevent the weight of pipe lines from acting on valves and fittings and also to prevent excessive vibration. Pipe lines for use at low temperature are to be fixed so that adjoining hull structures may not be cooled excessively.

10. Earthing

Each pipe line is to be electrically connected and earthed effectively.

11. Cargo hoses

Cargo hoses equipped in ships are to be of materials not easily affected by cargoes and to be of suitable mechanical properties even at the working temperature, and are to be designed for a bursting pressure not less than 5 times the maximum working pressure (at least 2.5 MPa) to which they may be subjected.

12. Vent pipes

(1) Discharge from safety valves and relief valves is to be led to vent pipes. However, discharge from relief valves in pipe lines may be led into tanks, where effectiveness of relief valves is not lowered.
(2) The provisions in **203. 12** (2), (3) and (4) of this Annex are to apply.
(3) Each outlet end of vent pipes is to be located at a position 1/3 of the ship's breadth above the weather deck and where it is not liable to impair safety of the ship as far as practicable. At each outlet of the vent pipes, a suitable flame arrester is to be provided, and it is to be arranged so that the discharge may not blow out downward from the horizontal.

308. Cargo refrigerating facilities

1. Refrigerating facilities

At least two sets of refrigerating facilities are to be provided, and each of them is to be arranged for immediate use by switching.

2. Capacity

The capacity of refrigerating facilities is to be sufficient to maintain the cargo at the specified temperature, even in case where one set is out of service for 24 hours a day and only the remaining set or sets are in operation.

3. Re-liquefying facilities

(1) Where refrigerating facilities are of a type in which refrigerant is used, **Pt 9, Ch 1, 401. 1 to 4, 403. 3, 4, 404.** and **405.** of the Rules are to be applied to these refrigerating facilities.
(2) Where refrigerating facilities are of a type in which gas is directly liquefied under pressure, **204. 5** (1), (3) to (6) and 6 of this Annex as well as **Pt 9, Ch 1, 401. 1** to **4, 403. 4** (2), **404. 4** and **405.** of the Rules are to be applied.
(3) As for pressure vessels subjected to pressure of liquid and gas, the approved working pressure is to be at least 0.5 MPa and the requirements in **202. 1** to **4** of this Annex as well as **Pt 5, Ch 5** of the Rules are to be applied. As for safety valves, level gauges and other fittings, the requirements in **203. 9, 11, 13** (3) to (5) of this Annex are to be applied.

4. Automatic stopping devices against low pressure

The automatic stopping devices of refrigerating facilities specified in **306. 8** (1) of this Annex are to be so adjusted as to stop at a higher pressure than the set pressure of the vacuum relief valve on the tank. In addition, this automatic stopping device is not to lose its effectiveness even when the refrigerating facility is manually operated.

5. Earthing

All machinery and equipment for liquid and gas are to be earthed effectively.

309. Cargo handling facilities

1. Cargo handling facilities

In addition to the regular cargo pump facilities, any ship is to be provided with stand-by units and the units may be as follows:

(1) In case of a tank provided with two or more pumps, the stand-by units may be omitted in spite of being used.
(2) The stripper pump may be permitted with stand-by units.
(3) The eductor may be permitted with stand-by units.

2. Materials

The materials for cargo handling facilities are to be suitable for kind of cargo and temperature to be encountered in service.

3. Cargo pumps

The requirements in **204. 5** (1) to (5) of this Annex are also to apply.

4. Automatic stopping and remote stopping devices of cargo pumps

(1) Any pump is to be provided with an automatic stopping device or its equivalent to operate when liquid level in the tank reaches the predetermined low level, so as to protect the pump as well as its driving machinery.
(2) The automatic stopping device to operate at low pressure set forth in **306. 8** (1) of this Annex is to be so adjusted as to automatically stop at a higher pressure than the set pressure of the vacuum relief valve on the tank.
(3) The pumps are to be stopped from a remote location where cargo handling is watched or controlled.

5. Gas compressors and accessories

Where compressors are installed for delivery and loading of gas, the requirements in **308. 3** (2), (3) and **308. 4** of this Annex are to apply.

6. Earthing

All machinery and equipment for liquid and gas are to be electrically earthed effectively.

310. Ventilation system, etc.

1. Ventilation system, etc.

(1) The requirements in **205. 1** (1), (2), (4), 2 and **5** of this Annex are to apply.
(2) Tank holds are to be provided with bilge discharging facilities. The bilge suction pipe, however, is not to be led to non-dangerous spaces in the ship.

2. Installation of equipment causing ignition sources

Equipment which may cause ignition sources is not to be installed in the dangerous spaces specified in **102**. (7) of this Annex.

311. Electrical installations

1. Application

The electrical installations are to comply with these requirements as well as the requirements in **206.** of this Annex.

2. Power supply to cargo refrigerating facilities

Where all the machinery of the cargo refrigerating facilities specified in 308. of this Annex are electrically driven, the power supply is to be arranged from two or more generators, and the power supply to electric motors are to be made from circuits divided into at least two or more groups, through a main switch board or equivalent distribution board. ⚓

Annex 7A-2 Guidelines for the Evaluation of the Adequacy of Type C Tank Vent Systems

101. General

1. The tank outlet to the pressure relief valves is to remain in the vapour phase at the 98% liquid level, 15° of heel angle and 0.015 L of pitch angle.

2. Pressure relief valves which have been sized in accordance with **Pt 7, Ch 5, Sec 8** of the Rules, are to have adequate capacity.

3. To assure adequate relieving capacity condition, followings are to be complied with :

(1) The pressure drop in the vent pipe from the cargo tank to the pressure relief valve inlet ($\triangle p_{inlet}$) is not to exceed 3% of MARVS, at the pressure relief valve capacity required in Rules from equation **103.** (1) below, at 1.2 times maximum allowable relief valve setting (gauge pressure, hereafter MARVS) on all vapour flow.

(2) The blowdown ($\triangle p_{dose}$) is not to be less than $\triangle p_{inlet}$ + 0.02 × MARVS at the installed rated vapour capacity where required to assure stable operation of the pressure relief valve. This calculation is to be carried out at MARVS on all vapour flow. Pilot-operated valves can tolerate higher inlet-pipe pressure losses when the pilot senses at a point that is not affected by the inlet-pipe pressure drop.

4. The built-up back pressure in the vent piping from the pressure relief valve outlet to the location of discharge to the atmosphere, and including any vent pipe interconnections which joint other tanks, is not to exceed the following values :

(1) For unbalanced pressure relief valves : 3 % MARVS.
Special consideration may be given in cases where the back pressure exceeds 10 % of MARVS at a tank pressure of 1.2 × MARVS; and

(2) For balanced pressure relief valves and pilot-operated pressure relief valves as advised by manufacturer : normally 30 % of MARVS for balanced pressure relief valves and 50 % of MARVS for pilot-operated pressure relief valves,
when assuming isenthalpic expansion of saturated liquid, at 1.2 × MARVS, through the pressure relief valve with the vent piping under fire exposure.

5. The built-up back pressure in the vent piping may be estimated by the procedures outlined in **102.**

6. A more accurate procedure for evaluating tank vent systems on flashing two-phase flow is to be consulted if these simplified procedures of **102.** do not demonstrate compliance with the preceding **3** and **4.**

102. Procedures

The following procedures are to be complied with to demonstrate the adequacy of a tank vent system to limit the pressure rise in a cargo tank to not greater than 1.2 × MARVS during all conditions, including fire conditions implicit in **Pt 7, Ch 5, 805. 2** of the Rules.

(1) Prepare a simplified flow sheet of the cargo tank vent system, identifying the fittings and the actual diameters and lengths of pipe.
Divide the system into sections between nodes at changes in pipe diameter and at inter-connections with flows from other relief valves.
List the fittings and their dynamic loss coefficients. Calculate the external surface area of the piping sections between the nodes.

(2) Calculate the pressure relief valve capacity (Q_{GCC}) of each tank pressure relief valve, in $\mathrm{m^3/s}$ of air at standard conditions in accordance with **Pt 7, Ch 5, 805. 2** of the Rules and note the installed rated capacity (Q_{IR}) of each pressure relief valve in $\mathrm{m^3/s}$ air at standard conditions at 1.2 × MARVS. The calculation is to be done for the highest gas factor of the products included in the cargo list. N-Butane has often the highest value for gas factor "G" in the Rules and usual1y determines the Rule minimum capacity.
Determine the mass flows for cargo conditions at 1.2 × MARVS through each pressure relief valve for the pressure relief valve capacity and for the installed rated capacity for both all vapour flow and for two phase cargo flow. Also calculate the mass flow at MARVS for the installed rated capacity on all vapour flow.

Equation in **103.** (1) may be used for all vapour mass flow and equations in **103.** (2), (3) and (4) may be used for two phase mass flow. Equation in **103.** (2) may be applied to multi-component mixtures whose boiling point range does not exceed 100 K.

(3) Estimate all the vapour flow pressure drop in the pipe from the cargo tank connection inlet flange, working from the known tank pressure towards the pressure relief valve. This pressure drop is calculated by using the difference in stagnation pressures. Therefore, the second term of equation in **103.** (5) (A) may be used for pipe sections of constant diameter. For contractions, equation in **103.** (5) (B) may be used.

(4) Check that the pressure drop at each pressure relief valve inlet complies with **101. 3** (1), at the pressure relief valve capacity for all vapour flow to assure adequate relief capacity. For the calculation, the vapour mass flow of product (W_g) from equation in **103.** (1) is to be used.
For control purposes, **101. 3** (1) is to be repeated using the pressure relief valve two-phase flow (W', equation in **103.** (4)) at 1.2 × MARVS and **101. 3** (2) by using the installed rated two-phase flow at MARVS. Both calculations are to give a smaller inlet pressure loss than the corresponding all vapour pressure loss.
Check that the blowdown ($\triangle p_{close}$) complies with **101. 3** (2) to assure stable operation.

(5) Estimate the two-phase flow pressure in the discharge pipe at the location of discharge to the atmosphere. Equation in **103.** (6) may be used, with the pressure relief valve two-phase mass flow (W') to assure adequate relief capacity, to check if the exit pressure is greater than 0.1 MPa.

(6) Estimate the vapour fraction and two-phase density in the vent pipe at the exit to the atmosphere, assuming transfer of the fire heat flux of 108 $\mathrm{kW/m^2}$ through the uninsulated vent piping. Equations in **103.** (7) and (8) may be used.

(7) Estimate the built-up back pressure at the pressure relief valve outlet flange, commencing from the known vent pipe exit pressure, calculating the pressure drop between pipe nodes and working, section by section, back up the pipe to the pressure relief valve.
Equations in **103.** (7), (8) and (5) (A) may be used with iteration until the upstream node absolute pressure, vapour fraction and specific volume are justified and assuming that vapour is saturated.
At pipe diameter expansion fittings where fluid velocity is reduced, a pressure recovery generally occurs. This recovery is overestimated in case of two-phase flow when dynamic loss coefficients for single-phase flow are used. For the purpose of these guidelines, the static exit pressure of a conical expansion fitting is assumed to be equal to the static inlet pressure.

(8) Estimate the choking pressure(p_{ec}) at the exit of every section with the mass flux (G_p) in that section for the pipeline between the pressure relief valve and the vent exit. Equation in **103.** (6) may be used.
Compare the pressure distribution along the vent line as derived from preceding (5) to (7), with the different choking pressures for each section as derived from equation in **103.** (6).
If choking pressure at any location exceeds the corresponding calculated pressure derived from preceding (5) to (7), the calculation as described in preceding (5) to (7) is to be repeated commencing from choking point location and corresponding choking pressure, working back up the pipe to the pressure relief valve.
If choking pressure at more than one location exceeds the corresponding calculated pressure derived from preceding (5) to (7), the commencing point of the recalculation is to be taken as the choking location point giving the highest built-up back pressure.

(9) Check that the built-up back pressure at each pressure relief valve outlet complies with **101. 4.** at the pressure relief valve capacity for two-phase mass flow (W'), to assure stable operation of the valves, thus assuring adequate relief capacity.

(10) For conventional unbalanced valves only :
  (A) If back pressure as derived from preceding (5) to (8) is within the range of 10 % to 20 % of MARVS, an additional evaluation is to be performed in order to decide whether the system is acceptable.
  (B) The system is to perform with the following requirement: with one valve closed and all others discharging at the installed rated pressure relief valve capacity, and the back pressure is to be less than 10 % of MARVS.

103. Equations

The following equations may be used to demonstrate the adequacy of the vent system.

(1) For all vapour mass flow rate from tank through pressure relief valves

$$W_g = \frac{71 \cdot 10^3 \cdot F \cdot A^{0.82}}{h_{fg}} \quad (\mathrm{kg/s})$$

where

F : Fire exposure factor according to **Pt 7, Ch 5, 805.** of the Rules

A : External surface area of type C tank (m^2)

h_{fg} : Latent heat of vaporization of cargo at 1.2 × MARVS ($\mathrm{J/kg}$)

(2) For isenthalpic flashing mass flux of liquid through pressure relief valve orifice
This equation is valid for multi-component mixtures whose boiling point range does not exceed 100 K.

$$G_v \approx h_{fg} \cdot \rho_g \left(\frac{1}{T_0 \cdot c} \right)^{\frac{1}{2}} \quad (\mathrm{kg/m^2 s})$$

where

h_{fg} : Latent heat of vaporization of cargo at 1.2 × MARVS ($\mathrm{J/kg}$)

p_g : Vapour density 1.2 × MARVS and corresponding boiling temperature ($\mathrm{kg/m^3}$)

T_0 : Temperature of cargo at 1.2 × MARVS (K)

c : Liquid specific heat at 1.2 × MARVS ($\mathrm{J/kgK}$)

(3) For two-phase mass flow rate through pressure relief valve is installed

$$W = G_v \cdot K_w \cdot A_v \quad (\mathrm{kg/s})$$

where

G_v : being taken from preceding (2) ($\mathrm{kg/m^2 s}$)

K_w : Pressure relief valve discharge coefficient on water(approx. 0.8 × measured K_d on air)

A_v : Actual orifice area of pressure relief valve (m^2)

(4) For pressure relief valve capacity for two-phase mass flow

$$W' = G_v \cdot K_w \cdot A_v \frac{Q_{GCC}}{Q_{IR}} \quad (\mathrm{kg/s})$$

where

Q_{GCC} : Pressure relief valve capacity of air at standard conditions in accordance with **Pt 7, Ch 5, 805. 2** of the Rules ($\mathrm{m^3/s}$)

Q_{IR}: Installed rated pressure relief valve capacity of air at T=273K and p=0.1013 MPa ($\mathrm{m^3/s}$)

(5) For the calculation of the static pressure difference in a pipe section of constant diameter in which the mass flux (G_p) is constant

(A) $$\Delta p = G_p^2 (v_e - v_i) + \frac{1}{2} \cdot G_p^2 \left(\frac{v_e + v_i}{2} \right) \left(4f \frac{L}{D} + \Sigma N \right) \quad (\mathrm{Pa})$$

where

G_p : Mass flux through the pipe section

$$G_P = \frac{W}{\pi D^2/4} \text{ or } \frac{W'}{\pi \cdot D^2/4} \quad (\mathrm{kg/m^2/s})$$

v_e : Two-phase specific volume at pipe section exit ($\mathrm{m^3/kg}$)
v_i : Two-phase specific volume at pipe section inlet ($\mathrm{m^3/kg}$)
f : Fanning friction factor f = 0.005 for two-phase fully turbulent flow
L : Length of pipe section (m)
D : Diameter of pipe section (m)
ΣN : Sum of dynamic loss coefficients for fittings in the pipe section, $N = 4f \cdot L/D$ equivalent (typical values of N are given in **Table 5**)

Table 5 Typical Values for Dynamic Loss Coefficient for Vent System Fittings

Fitting	$N(=4f \cdot L/D)$
Inlet pipe from tank to Pressure relief valve	
- Square-edged inlet	0.5
- Protruding conical inlet	0.15
- Conical reduction	0.10
Discharge piping from Pressure relief valve to mast vent exit	
- 45° bend	0.2
- 45° single-mitre elbow	0.45
- 90° long redius bend	0.3
- 90°short radius bend	0.5
- 90° double-mitre elbow	0.6
- Soft-tee	0.3
- Hard-tee	1.1
- Cowl mast vent exit	2.25
- Top-hat mast vent exit	4.5
- Flame screen(**Pt 7, Ch 5, 1710.** of the Rules)	1.4
(Note) N may vary with pipe diameter	

(B) For contractions, the difference in stagnation pressure is defined by :

$$\Delta p = \frac{1}{2} \cdot G_{p,e}^2 \cdot v_i N \quad (\mathrm{Pa})$$

where
N : Dynamic loss coefficients of the contraction
$G_{p,e}$: Mass flux at the exit of the contraction ($\mathrm{kg/m^2s}$)
v_i : Specific volume at the inlet of the contraction ($\mathrm{m^3/kg}$)

(6) For two-phase critical chocking pressure at vent mast exit or exit from any vent pipe section

$$p_{ec} = G_p \left(\frac{p_0 \omega}{\rho_0} \right)^{\frac{1}{2}} \quad (\mathrm{Pa})$$

where

G_p : as defined in preceding (5) (A)

p_0 : Cargo vapour pressure in tank at inlet to pressure relief valve (P_a)

ρ_0 : Cargo liquid density in tank at inlet to pressure relief valve at p_0 and T_0 ($\mathrm{kg/m^3}$)

ω : Compressible flow parameter in tank at inlet to pressure relief valve

$$= \alpha_0 + (1-\alpha_0)\frac{\rho_0 \cdot c \cdot T_0 \cdot p_0 \cdot (v_{go}-v_{fo})^2}{(h_{go}-h_{fo})^2}$$

where

α_0 : Inlet void fraction or vapour volume fraction at inlet to pressure relief valve
0, when assuming isenthalpic expansion of saturated liquid, at 1.2 × MARVS, through the pressure relief valve

c : See preceding (2)

T_0 : See preceding (2)

$(v_{go}-v_{fo})$: Difference in gaseous and liquid specific volume at temperature T_0 at inlet to pressure relief valve ($\mathrm{m^3/kg}$)

$(h_{go}-h_{fo})$: Difference in gaseous and liquid enthalpy at temperature T_o at inlet to pressure relief valve ($\mathrm{J/kg}$)

(7) For exit quality, or vapour mass fraction at pipe section exit

$$x_e = \frac{h_{fo} - h_{fe} + 1000 \cdot q \cdot \Sigma \frac{a}{W}}{h_{fg}}$$

(e.g. x_e = 0.3 ≡ 30 % quality ≡ 30 % vapour + 70 % liquid by mass)

where

h_{fo} : Liquid enthalpy in tank at inlet to pressure relief valve ($\mathrm{J/kg}$)

h_{fe} : Liquid enthalpy at back pressure at pipe section exit ($\mathrm{J/kg}$)

h_{fg} : Latent heat of vaporization at pipe section exit ($\mathrm{J/kg}$)

q : Heat flux from fire exposure into vent pipe equal to 108 $\mathrm{kW/m^2}$

a : Heated external surface area of vent pipe section ($\mathrm{m^2}$)

W : Mass flow rate in vent pipe section ($\mathrm{kg/s}$)

(8) For two-phase density(ρ) and specific volume (v)

$$\rho = \frac{\rho_g}{x} \quad (\mathrm{kg/m^3})$$

where

ρ_g : Saturated vapour density at pipe section inlet or exit ($\mathrm{kg/m^3}$)

x : Vapour fraction at pipe section inlet or exit

$$v = \frac{1}{\rho} \quad (\mathrm{m^3/kg})$$

Annex 7B-1 Table of Summary of Minimum Requirements

Product name (column a)	The product name shall be used in the shipping document for any cargo offered for bulk shipments. Any additional name may be included in brackets after the product name. In some cases, the product names are not identical with the names given in previous issues of the Code
UN number (column b)	Deleted
Pollution category (column c)	The letter X, Y, Z means the pollution category assigned to each product under MARPOL Annex II
Hazards (column d)	*S* means that the product is included in the Rules because of its safety hazards; *P* means that the product is included in the Rules because of its pollution hazards; and *S*/*P* means that the product is included in the Rules because of both its safety and pollution hazards.
Ship type (column e)	1 : ship type 1 2 : ship type 2 3 : ship type 3
Tank type (column f)	1 : independent tank 2 : integral tank G : gravity tank P : pressure tank
Tank vents (column g)	Cont. : controlled venting Open : open venting
Tank environmental control (column h)	Inert : inerting Pad : liquid or gas padding Dry : drying Vent : natural or forced ventilation No : no special requirements under this code
Electrical equipment (column i)	Temperature classes (i') ; T1 to T6, - : indicates no requirements, blank : no information Apparatus groups(i") ; IIA, IIB or IIC, - : indicates no requirements, blank : no information Flash point (i''') ; Yes : flashpoint exceeding 60°C No : flashpoint not exceeding 60°C NF : nonflammable product
Gauging (column j)	O : open gauging R : restricted gauging C : closed gauging
Vapour detection (column k)	F : flammable vapours T : toxic vapours No : indicates no special requirements under this Code
Fire protection (column l)	A : alcohol-resistant foam or multi-purpose foam B : regular foam, encompasses all foams that are not of an alcohol-resistant type, including fluoroprotein and aqueous-film-forming foam (AFFF) C : water-spray D : dry chemical No : no special requirements under this chapter
Materials of construction (column m)	Deleted
Emergency equipment (column n)	Yes : see 1403. 1 No : no special requirements under this Chapter
Specific and operational requirements (column o)	When specific reference is made to chapter 15 and /or 16, these requirements shall be additional to the requirements in any other column.

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Acetic acid	X	S/P	3	2G	Cont	No	T1	IIA	No	R	F	A	Yes	1511.2 to 1511.4, 1511.6 to 1511.8, 1519.6, 1602.7(16.2.9)(*)
Acetic anhydride	Z	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	A	Yes	1511.2 to 1511.4, 1511.6 to 1511.8, 1519.6
Acetochlor	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Acetone cyanohydrin	Y	S/P	2	2G	Cont	No	T1	IIA	Yes	C	T	A	Yes	1512., 1513., 1517. to 1519., 1606.1 to 1606.3
Acetonitrile	Z	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	A	No	1512., 1519.6
Acetonitrile (Low purity grade)	Y	S/P	3	2G	Cont	No	T1	IIA	No	R	F-T	A	No	1512.3, 1512.4, 1519.6
Acid oil mixture from soyabean, corn (maize) and sunflower oil refining	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Acrylamide solution(50% or less)	Y	S/P	2	2G	Open	No			NF	C	No	No	No	1512.3, 1513., 1519.6, 1606.1, 1602.7(16.2.9)(*)
Acrylic acid	Y	S/P	2	2G	Cont	No	T2	IIA	No	C	F-T	A	Yes	1511.2 to 1511.4, 1511.6 to 1511.8, 1512.3, 1512.4, 1513., 1517., 1519., 1606.1, 1602.7(16.2.9)(*)
Acrylonitrile	Y	S/P	2	2G	Cont	No	T1	IIB	No	C	F-T	A	Yes	1512., 1513., 1517., 1519.
Acrylonitrile-Styrene copolymer dispersion in polyether polyol	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Adiponitrile	Z	S/P	3	2G	Cont	No		IIB	Yes	R	T	A	No	1602.7(16.2.9)(*)
Alachlor technical (90% or more)	X	S/P	2	2G	Open	No			Yes	O	No	AC	No	1519.6, 1602.7(16.2.9)(*)
Alcohol (C9-C11) poly (2.5-9) ethoxylate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Alcohol (C6-C17) (secondary) poly(3-6)ethoxylates	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Alcohol (C6-C17) (secondary) poly(7-12)ethoxylates	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, l602.6, 1602.7(16.2.9)(*)
Alcohol (C12-C16) poly(1-6)ethoxylates	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Alcohol (C12-C16) poly(20+)ethoxylates	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Alcohol (C12-C16) poly(7-19)ethoxylates	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Alcohols (C13+)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Alcohols (C8-C11), primary, linear and essentially linear	Y	S/P	2	2G	Cont	No	-	-	Yes	R	T	ABC	No	1512.3, 1512.4, 1519.6, 1602.6, 1602.7(16.2.9)(*)
Alcohols (C12-C13), primary, linear and essentially linear	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Alcohols (C14-C18), primary, linear and essentially linear	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6
Alkanes (C6-C9)	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Iso-and cyclo-alkanes (C10-C11)	Y	P	3	2G	Cont	No	-	-	No	R	F	A	No	1519.6
Iso-and cyclo-alkanes (C12+)	Y	P	3	2G	Cont	No	-	-	No	R	F	A	No	
n-Alkanes (C10+)	Y	P	3	2G	Cont	No	-	-	No	R	F	A	No	1519.6
Alkaryl polyethers(C9-C20)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Alkenyl(C11+)amide	X	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Alkenyl (C16-C20) succinic anhydride	Z	S/P	3	2G	Cont	No			Yes	C	T	No	Yes	1512., 1517., 1519.
Alkyl acrylate-vinylpyridine copolymer in toluene	Y	P	2	2G	Cont	No			NO	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Alkylaryl phosphate mixtures (more than 40% Diphenyl tolyl phosphate, less than 0.02% ortho-isomers)	X	S/P	1	2G	Cont	No	T1	IIA	Yes	C	T	ABC	No	1512., 1517., 1519.
Alkylated (C4-C9) hindered phenols	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	BD	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Alkylbenzene, alkylindane, alkylindene mixture (each C12-C17)	Z	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Alkyl benzene distillation bottoms	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6
Alkylbenzene mixtures (containing at least 50% of toluene)	Y	S/P	3	2G	Cont	No	T1	IIA	No	C	F-T	ABC	No	1512., 1517., 1519..6
Alkyl(C3-C4) benzenes	Y	P	2	2G	Cont	No			NO	R	F	A	No	1519.6
Alkyl (C5-C8) benzenes	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Alkyl(C9+)benzenes	Y	P	3	2G	Open	No	-	-	Yes	O	No	AB	No	
Alkyl(C11-C17) benzene sulphonic acid	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Alkylbenzene sulphonic acid, sodium salt solution	Y	S/P	2	2G	Open	No	-	-	NF	O	No	No	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Alkyl (C12+) dimethylamine	X	S/P	1	2G	Cont	No	-	-	Yes	C	T	BCD	Yes	1512., 1517., 1519.
Alkyl dithiocarbamate (C19-C35)	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Alkyldithiothiadiazole (C6-C24)	Y	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Alkyl ester copolymer (C4-C20)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Alkyl (C8-C10)/(C12-C14):(40% or less/60% or more) polyglucoside solution (55% or less)	Y	P	3	2G	Open	No			Yes	O	No	No	No	1519.6, 1602.6, 1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i"	i'''	j	k	l	n	o
Alkyl (C8-C10)/(C12-C14):(60% or more/40% or less) polyglucoside solution(55% or less)	Y	P	3	2G	Open	No			Yes	O	No	No	No	1602.6, 1602.7(16.2.9)(*)
Alkyl(C7-C9) nitrates	Y	S/P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1520., 1606.1, 1606.2, 1606.3
Alkyl(C7-C11)phenol poly(4-12) ethoxylate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Alkyl (C8-C40) phenol sulphide	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Alkyl (C8-C9) phenylamine in aromatic solvents	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Alkyl (C9-C15) phenyl propoxylate	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Alkyl (C8-C10)/(C12-C14):(50%/50%) polyglucoside solution (55% or less)	Y	P	3	2G	Open	No			Yes	O	No	No	No	1602.6, 1602.7(16.2.9)(*)
Alkyl (C12-C14) polyglucoside solution (55% or less)	Y	P	3	2G	Open	No			Yes	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Alkyl (C8-C10) polyglucoside solution (65% or less)	Y	P	3	2G	Open	No			Yes	O	No	No	No	1602.6
Alkyl(C10-C20, saturated and unsaturated) phosphite	Y	P	2	2G	Open	No			Yes	O	No	A	No	1602.7(16.2.9)(*)
Alkyl sulphonic acid ester of phenol	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Allyl alcohol	Y	S/P	2	2G	Cont	No	T2	IIB	No	C	F-T	A	Yes	1512., 1517., 1519.
Allyl chloride	Y	S/P	2	2G	Cont	No	T2	IIA	No	C	F-T	A	Yes	1512., 1517., 1519.
Aluminium sulphate solution	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
2-(2-Aminoethoxy) ethanol	Z	S/P	3	2G	Open	No			Yes	O	No	AD	No	1519.6
Aminoethyldiethanolamine/ Aminoethylethanolamine solution	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Aminoethyl ethanolamine	Z	S/P	3	2G	Open	No	T2	IIA	Yes	O	No	A	No	
N-Aminoethylpiperazine	Z	S/P	3	2G	Cont	No			Yes	R	T	A	No	1519.6, 1602.7(16.2.9)(*)
2-Amino-2-methyl-1-propanol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Ammonia aqueous (28% or less)	Y	S/P	2	2G	Cont	No			NF	R	T	ABC	Yes	1519.6
Ammonium hydrogen phosphate solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Ammonium lignosulphonate solutions	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Ammonium nitrate solution (93% or less)	Z	S/P	2	1G	Open	No			NF	O	No	No	No	1502., 1511.4, 1511.6, 1518., 1519.6, 1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Ammonium polyphosphate solution	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	
Ammonium sulphate solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Ammonium sulphide solution (45% or less)	Y	S/P	2	2G	Cont	No			No	C	F-T	A	Yes	1512., 1517., 1519., 1606.1 to 1606.3
Ammonium thiosulphate solution(60% or less)	Z	P	3	2G	Open	No			NF	O	No	No	No	1602.7(16.2.9)(*)
Amyl acetate (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
n-Amyl alcohol	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Amyl alcohol, primary	Z	P	3	2G	Cont	No			No	R	F	AB	No	
sec-Amyl alcohol	Z	P	3	2G	Cont	No			No	R	F	AB	No	
tert-Amyl alcohol	Z	P	3	2G	Cont	No			No	R	F	A	No	
tert-Amyl methyl ether	X	P	2	2G	Cont	No	T3		No	R	F	A	No	1519.6
Aniline	Y	S/P	2	2G	Cont	No	T1	IIA	Yes	C	T	A	No	1512., 1517., 1519.
Aryl polyolefins (C11-C50)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Aviation alkylates (C8 paraffins and iso-paraffins BPT 95 - 120℃)	X	P	2	2G	Cont	No			No	R	F	B	No	1519.6
Barium long chain (C11-C50) alkaryl sulphonate	Y	S/P	2	2G	Open	No			Yes	O	No	AD	No	1512.3, 1519., 1602.6, 1602.7(16.2.9)(*)
Benzene and mixtures having 10% benzene or more(i)	Y	S/P	3	2G	Cont	No	T1	IIA	No	C	F-T	AB	No	1512.1, 1517., 1519.6, 1602.7(16.2.9)(*)
Benzene sulphonyl chloride	Z	S/P	3	2G	Cont	No			Yes	R	T	AD	No	1519.6, 1602.7(16.2.9)(*)
Benzenetricarboxylic acid, trioctyl ester	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Benzyl acetate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Benzyl alcohol	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Benzyl chloride	Y	S/P	2	2G	Cont	No	T1	IIA	Yes	C	T	AB	Yes	1512., 1513., 1517., 1519.
Brake fluid base mix: Poly (2-8)alkylene (C2-C3) glycols/Polyalkylene (C2-C10) glycols monoalkyl (C1-C4) ethers and their borate esters	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	
Bromochloromethane	Z	S/P	3	2G	Cont	No			NF	R	T	No	No	
Butene oligomer	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Butyl acetate (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Butyl acrylate (all isomers)	Y	S/P	2	2G	Cont	No	T2	IIB	No	R	F-T	A	No	1513., 1519.6, 1606.1, 1606.2
tert-Butyl alcohol	Z	P	3	2G	Cont	No			No	R	F	A	No	
Butylamine (all isomers)	Y	S/P	2	2G	Cont	No			No	R	F-T	A	Yes	1512., 1517., 1519.6
Butylbenzene (all isomers)	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Butyl benzyl phthalate	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Butyl butyrate (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Butyl/Decyl/Cetyl/Eicosyl methacrylate mixture	Y	S/P	2	2G	Cont	No			Yes	R	No	AD	No	1513., 1519.6, 1606.1, 1606.2
Butylene glycol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
1,2-Butylene oxide	Y	S/P	3	2G	Cont	Inert	T2	IIB	No	R	F	AC	No	1508.1 to 1508.7, 1508.12, 1508.13, 1508.16 to 1508.19, 1508.21, 1508.25, 1508.27, 1508.29, 1519.6
n-Butyl ether	Y	S/P	3	2G	Cont	Inert	T4	IIB	No	R	F-T	A	No	1504.6, 1512, 1519.6
Butyl methacrylate	Z	S/P	3	2G	Cont	No		IIA	No	R	F-T	AD	No	1513., 1519.6, 1606.1, 1606.2
n-Butyl propionate	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Butyraldehyde (all isomers)	Y	S/P	3	2G	Cont	No	T3	IIA	No	R	F-T	A	No	1519.6
Butyric acid	Y	S/P	3	2G	Cont	No			Yes	R	No	A	No	1511.2 to 1511.4, 1511.6 to 1511.8, 1519.6
gamma-Butyrolactone	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6
Calcium carbonate slurry	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Calcium hydroxide slurry	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Calcium hypochlorite solution (15% or less)	Y	S/P	2	2G	Cont	No			NF	R	No	No	No	1519.6
Calcium hypochlorite solution (more than 15%)	X	S/P	1	2G	Cont	No			NF	R	No	No	No	1519,1602.7(16.2.9)(*)
Calcium lignosulphonate solutions	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Calcium long-chain alkaryl sulphonate(C11-C50)	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Calcium long-chain alkyl(C5-C10) phenate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Calcium long-chain alkyl(C11-C40) phenate	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Calcium long-chain alkyl phenate sulphide (C8-C40)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Calcium long-chain alkyl salicylate(C13+)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Calcium nitrate/Magnesium nitrate/Potassium chloride solution	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
epsilon-Caprolactam (molten or aqueous solutions)	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Carbolic oil	Y	S/P	2	2G	Cont	No			Yes	C	F-T	A	No	1512., 1519.6, 1602.7(16.2.9)(*)
Carbon disulphide	Y	S/P	2	1G	Cont	Pad+ inert	T6	IIC	No	C	F-T	C	Yes	1503., 1512., 1519.
Carbon tetrachloride	Y	S/P	2	2G	Cont	No			NF	C	T	No	Yes	1512., 1517., 1519.6
Cashew nut shell oil(untreated)	Y	S/P	2	2G	Cont	No			Yes	R	T	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Castor oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Cetyl/Eicosyl methacrylate mixture	Y	S/P	2	2G	Open	No			Yes	O	No	AD	No	1513., 1519.6, 1602.7(16.2.9)(*), 1606.1, 1606.2
Chlorinated paraffins (C10-C13)	X	P	1	2G	Open	No			Yes	O	No	A	No	1519., 1602.6
Chlorinated paraffins (C14-C17) (with 50% chlorine or more, and less than 1% C13 or shorter chains)	X	P	1	2G	Open	No	-	-	Yes	O	No	A	No	1519.
Chloroacetic acid (80% or less)	Y	S/P	2	2G	Cont	No			NF	C	No	No	No	1511.2, 1511.4, 1511.6 to 1511.8, 1512.3, 1519., 1602.7(16.2.9)(*)
Chlorobenzene	Y	S/P	2	2G	Cont	No	T1	IIA	No	R	F-T	AB	No	1519.6
Chloroform	Y	S/P	3	2G	Cont	No			NF	R	T	No	Yes	1512., 1519.6
Chlorohydrins (crude)	Y	S/P	2	2G	Cont	No		IIA	No	C	F-T	A	No	1512., 1519.
4-Chloro-2-methylphenoxyacetic acid, dimethylamine salt solution	Y	P	2	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
o-Chloronitrobenzene	Y	S/P	2	2G	Cont	No			Yes	C	T	ABD	No	1512., 1517., 1518., 1519., 1602.6, 1602.7(16.2.9)(*)
1-(4-Chlorophenyl)-4,4-dimethyl-pentan-3-one	Y	P	2	2G	Open	No			Yes	O	No	ABD	No	1519.6, 1602.6, 1602.7(16.2.9)(*),
2-or 3-Chloropropionic acid	Z	S/P	3	2G	Open	No			Yes	O	No	A	No	1511.2 to 1511.4, 1511.6 to 1511.8, 1602.7(16.2.9)(*)
Chlorosulphonic acid	Y	S/P	1	2G	Cont	No			NF	C	T	No	Yes	1511.2 to 1511.8, 1512., 1516.1(15.16.2)(*), 1519.
m-Chlorotoluene	Y	S/P	2	2G	Cont	No			No	R	F-T	AB	No	1519.6
o-Chlorotoluene	Y	S/P	2	2G	Cont	No			No	R	F-T	AB	No	1519.6
p-Chlorotoluene	Y	S/P	2	2G	Cont	No			No	R	F-T	AB	No	1519.6, 1602.7(16.2.9)(*)
Chlorotoluenes (mixed isomers)	Y	S/P	2	2G	Cont	No			No	R	F-T	AB	No	1519.6
Choline chloride solutions	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Citric acid (70% or less)	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Coal tar	X	S/P	2	2G	Cont	No	T2	IIA	Yes	R	No	BD	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Coal tar naphtha solvent	Y	S/P	2	2G	Cont	No	T3	IIA	No	R	F-T	AD	No	1519.6, 1602.7(16.2.9)(*)
Coal tar pitch (molten)	X	S/P	2	1G	Cont	No	T2	IIA	Yes	R	No	BD	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Cocoa butter	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Coconut oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Coconut oil fatty acid	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Coconut oil fatty acid methyl ester	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Copper salt of long chain (C17+) alkanoic acid	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Corn Oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Cotton seed oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Creosote (coal tar)	X	S/P	2	2G	Cont	No	T2	IIA	Yes	R	T	AD	No	1512.3, 1512.4, 1519.6, 1602.6, 1602.7(16.2.9)(*)
Cresols (all isomers)	Y	S/P	2	2G	Open	No	T1	IIA	Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Cresylic acid, dephenolized	Y	S/P	2	2G	Open	No			Yes	O	No	AB	No	1519.6
Cresylic acid, sodium salt solution	Y	S/P	2	2G	Open	No			Yes	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Crotonaldehyde	Y	S/P	2	2G	Cont	No	T3	IIB	No	R	F-T	A	Yes	1512., 1517., 1519.6
1,5,9-Cyclododecatriene	X	S/P	1	2G	Cont	No			Yes	R	T	A	No	1513., 1519., 1606.1, 1606.2
Cycloheptane	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Cyclohexane	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Cyclohexanol	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Cyclohexanone	Z	S/P	3	2G	Cont	No	T2	IIA	No	R	F-T	A	No	1519.6
Cyclohexanone, Cyclohexanol mixture	Y	S/P	3	2G	Cont	No			Yes	R	F-T	A	No	1519.6
Cyclohexyl acetate	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Cyclohexylamine	Y	S/P	3	2G	Cont	No	T3	IIA	No	R	F-T	AC	No	1519.6
1,3-Cyclopentadiene dimer (molten)	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Cyclopentane	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Cyclopentene	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
p-Cymene	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Decahydronaphthalene	Y	P	2	2G	Cont	No			No	R	F	AB	No	1519.6
Decanoic acid	X	P	2	2G	Open	No			Yes	O	No	A	No	1602.7(16.2.9)(*)
Decene	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Decyl acrylate	X	S/P	1	2G	Open	No	T3	IIA	Yes	O	No	ACD	No	1513., 1519., 1606.1, 1606.2
Decyl alcohol (all isomers)	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)(e)
Decyloxytetrahydrothiophene dioxide	X	S/P	2	2G	Cont	No			Yes	R	T	A	No	1519.6, 1602.7(16.2.9)(*)
Diacetone alcohol	Z	P	3	2G	Cont	No			No	R	F	A	No	
Dialkyl (C8-C9) diphenylamines	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Dialkyl (C7-C13) phthalates	X	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Dibromomethane	Y	S/P	2	2G	Cont	No			NF	R	T	No	No	1512.3, 1519.
Dibutylamine	Y	S/P	3	2G	Cont	No	T2	IIA	No	R	F-T	ACD	No	1519.6
Dibutyl hydrogen phosphate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
2,6-Di-tert-butylphenol	X	P	1	2G	Open	No	-	-	Yes	O	No	ABCD	No	1519., 1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i"	i"'	j	k	l	n	o
Dibutyl phthalate	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Dichlorobenzene (all isomers)	X	S/P	2	2G	Cont	No	T1	IIA	Yes	R	T	ABD	No	1519.6
3,4-Dichloro-1-butene	Y	S/P	2	2G	Cont	No			No	C	F-T	ABC	Yes	1512.3, 1517., 1519.6
1,1-Dichloroethane	Z	S/P	3	2G	Cont	No	T2	IIA	No	R	F-T	A	Yes	1519.6
Dichloroethyl ether	Y	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	A	No	1519.6
1,6-Dichlorohexane	Y	S/P	2	2G	Cont	No			No	R	T	AB	No	1519.6
2,2'-Dichloroisopropyl ether	Y	S/P	2	2G	Cont	No			Yes	R	T	ACD	No	1512., 1517., 1519.
Dichloromethane	Y	S/P	3	2G	Cont	No	T1	IIA	Yes	R	T	No	No	1519.6
2,4-Dichlorophenol	Y	S/P	2	2G	Cont	Dry			Yes	R	T	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
2,4-Dichlorophenoxyacetic acid, diethanolamine salt solution	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
2,4-Dichlorophenoxyacetic acid, dimethylamine salt solution(70% or less)	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
2,4-Dichlorophenoxyacetic acid, triisopropanolamine salt solution	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
1,1-Dichloropropane	Y	S/P	2	2G	Cont	No			No	R	F-T	AB	No	1512., 1519.6
1,2-Dichloropropane	Y	S/P	2	2G	Cont	No	T1	IIA	No	R	F-T	AB	No	1512., 1519.6
1,3-Dichloropropene	X	S/P	2	2G	Cont	No	T2	IIA	No	C	F-T	AB	Yes	1512., 1517. to 1519.
Dichloropropene/Dichloropropane mixtures	X	S/P	2	2G	Cont	No			No	C	F-T	ABD	Yes	1512., 1517. to 1519.
2,2-Dichloropropionic acid	Y	S/P	3	2G	Cont	Dry			Yes	R	No	A	No	1511.2, 1511.4, 1511.6, 1511.7, 1511.8, 1519.6, 1602.7(16.2.9)(*)
Diethanolamine	Y	S/P	3	2G	Open	No	T1	IIA	Yes	O	No	A	No	1602.6,1602.7(16.2.9)(*)
Diethylamine	Y	S/P	3	2G	Cont	No	T2	IIA	No	R	F-T	A	Yes	1512., 1519.6
Diethylaminoethanol	Y	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	AC	No	1519.6
2,6-Diethylaniline	Y	S/P	3	2G	Open	No			Yes	O	No	BCD	No	1519.6, 1602.7(16.2.9)(*)
Diethylbenzene	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Diethylene glycol dibutyl ether	Z	S/P	3	2G	Open	No	-	-	Yes	O	No	A	No	
Diethylene glycol diethyl ether	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	
Diethylene glycol phthalate	Y	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Diethylenetriamine	Y	S/P	3	2G	Open	No	T2	IIA	Yes	O	No	A	No	1519.6
Diethylenetriaminepentaacetic acid, pentasodium salt solution	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	
Diethyl ether	Z	S/P	2	1G	Cont	Inert	T4	IIB	No	C	F-T	A	Yes	1504., 1514., 1519.
Di-(2-ethylhexyl) adipate	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6
Di-(2-ethylhexyl) phosphoric acid	Y	S/P	2	2G	Open	No			Yes	O	No	AD	No	1519.6
Diethyl phthalate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Diethyl sulphate	Y	S/P	2	2G	Cont	No			Yes	C	T	A	No	1519.6

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Diglycidyl ether of bisphenol A	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Diglycidyl ether of bisphenol F	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6
Diheptyl phthalate	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6
Di-n-hexyl adipate	X	P	1	2G	Open	No			Yes	O	No	A	No	1519.
Dihexyl phthalate	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6
Diisobutylamine	Y	S/P	2	2G	Cont	No			No	R	F-T	ACD	No	1512.3, 1519.6
Diisobutylene	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Diisobutyl ketone	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Diisobutyl phthalate	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Diisononyl adipate	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Diisooctyl phthalate	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Diisopropanolamine	Z	S/P	3	2G	Open	No	T2	IIA	Yes	O	No	A	No	1602.7(16.2.9)(*)
Diisopropylamine	Y	S/P	2	2G	Cont	No	T2	IIA	No	C	F-T	A	Yes	1512., 1519.
Diisopropylbenzene (all isomers)	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Diisopropylnaphthalene	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
N,N-Dimethylacetamide	Z	S/P	3	2G	Cont	No	-	-	Yes	C	T	ACD	No	1512., 1517.
N,N-Dimethylacetamide solution (40% or less)	Z	S/P	3	2G	Cont	No			Yes	R	T	B	No	1512.1, 1517.
Dimethyl adipate	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Dimethylamine solution (45% or less)	Y	S/P	3	2G	Cont	No	T2	IIA	No	R	F-T	ACD	No	1512., 1519.6
Dimethylamine solution (greater than 45% but not greater than 55%)	Y	S/P	2	2G	Cont	No			No	C	F-T	ACD	Yes	1512., 1517., 1519.
Dimethylamine solution (greater than 55% but not greater than 65%)	Y	S/P	2	2G	Cont	No			No	C	F-T	ACD	Yes	1512., 1514., 1517., 1519.
N,N-Dimethylcyclohexylamine	Y	S/P	2	2G	Cont	No			No	R	F-T	AC	No	1512., 1517., 1519.6
Dimethyl disulphide	Y	S/P	2	2G	Cont	No	T3	IIA	No	R	F-T	B	No	1512.3, 1512.4, 1519.6
N,N-Dimethyldodecylamine	X	S/P	1	2G	Open	No			Yes	O	No	B	No	1519.
Dimethylethanolamine	Y	S/P	3	2G	Cont	No	T3	IIA	No	R	F-T	AD	No	1519.6
Dimethylformamide	Y	S/P	3	2G	Cont	No	T2	IIA	No	R	F-T	AD	No	1519.6
Dimethyl glutarate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Dimethyl hydrogen phosphite	Y	S/P	3	2G	Cont	No			Yes	R	T	AD	No	1512.1, 1519.6
Dimethyl octanoic acid	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Dimethyl phthalate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Dimethylpolysiloxane	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6
2,2-Dimethylpropane-1,3-diol (molten or solution)	Z	P	3	2G	Open	No	-	-	Yes	O	No	AB	No	1602.7(16.2.9)(*)
Dimethyl succinate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i"	i'''	j	k	l	n	o
Dinitrotoluene (molten)	X	S/P	2	2G	Cont	No			Yes	C	T	A	No	1512., 1517., 1519., 1521., 1602.6, 1602.7(16.2.9)(*), 1606.4
Dinonyl phthalate	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Dioctyl phthalate	X	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6
1,4-Dioxane	Y	S/P	2	2G	Cont	No	T2	IIB	No	C	F-T	A	No	1512., 1519., 1602.7(16.2.9)(*)
Dipentene	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Diphenyl	X	P	2	2G	Open	No			Yes	O	No	B	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Diphenylamine (molten)	Y	P	2	2G	Open	No	-	-	Yes	O	No	BD	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Diphenylamine, reaction product with 2,2,4-Trimethylpentene	Y	S/P	1	2G	Open	No			Yes	O	No	A	No	1519., 1602.6
Diphenylamines, alkylated	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Diphenyl/Diphenyl ether mixtures	X	P	2	2G	Open	No			Yes	O	No	B	No	1519.6, 1602.7(16.2.9)(*)
Diphenyl ether	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Diphenyl ether/Diphenyl phenyl ether mixture	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Diphenylmethane diisocyanate	Y	S/P	2	2G	Cont	Dry	-	-	Yes (a)	C	T(a)	ABC (b)D	No	1512., 1516.1(15.16.2)(*), 1517., 1519.6, 1602.6, 1602.7(16.2.9)(*)
Diphenylol propane-epichlorohydrin resins	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Di-n-propylamine	Y	S/P	2	2G	Cont	No			No	R	F-T	A	No	1512.3, 1519.6
Dipropylene glycol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Dithiocarbamate ester (C7-C35)	X	P	2	2G	Open	No			Yes	O	No	AD	No	1519.6, 1602.7(16.2.9)(*)
Ditridecyl adipate	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Ditridecyl phthalate	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Diundecyl phthalate	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Dodecane (all isomers)	Y	P	2	2G	Cont	No			No	R	F	AB	No	1519.6
tert-Dodecanethiol	X	S/P	1	2G	Cont	No	-	-	Yes	C	T	ABD	Yes	1512., 1517., 1519.
Dodecene (all isomers)	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Dodecyl alcohol	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Dodecylamine/Tetradecylamine mixture	Y	S/P	2	2G	Cont	No			Yes	R	T	AD	No	1519.6, 1602.7(16.2.9)(*)
Dodecylbenzene	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Dodecyl diphenyl ether disulphonate solution	X	S/P	2	2G	Open	No			NF	O	No	No	No	1519.6, 1602.6
Dodecyl hydroxypropyl sulphide	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Dodecyl methacrylate	Z	S/P	3	2G	Open	No			Yes	O	No	A	No	1513.

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Dodecyl/Octadecyl methacrylate mixture	Y	S/P	3	2G	Open	No	-	-	Yes	O	No	A	No	1513., 1519.6, 1602.6, 1606.1, 1606.2
Dodecyl/Pentadecyl methacrylate mixture	Y	S/P	2	2G	Open	No			Yes	O	No	AD	No	1513., 1519.6, 1606.1, 1606.2
Dodecyl phenol	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6
Dodecyl Xylene	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Drilling brines (containing zinc salts)	X	P	2	2G	Open	No			Yes	O	No	No	No	1519.6
Drilling brines, including: calcium bromide solution, calcium chloride solution and sodium chloride solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Epichlorohydrin	Y	S/P	2	2G	Cont	No		IIB	No	C	F-T	A	Yes	1512., 1517., 1519.6
Ethanolamine	Y	S/P	3	2G	Open	No	T2	IIA	Yes	O	F-T	A	No	1602.7(16.2.9)(*)
2-Ethoxyethyl acetate	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Ethoxylated long chain (C16+) alkyloxyalkylamine	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Ethyl acetate	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Ethyl acetoacetate	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Ethyl acrylate	Y	S/P	2	2G	Cont	No	T2	IIB	No	R	F-T	A	Yes	1513., 1519.6, 1606.1, 1606.2
Ethylamine	Y	S/P	2	1G	Cont	No	T2	IIA	No	C	F-T	CD	Yes	1512., 1514., 1519.6
Ethylamine solutions (72% or less)	Y	S/P	2	2G	Cont	No			No	C	F-T	AC	Yes	1512., 1514., 1517., 1519.
Ethyl amyl ketone	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Ethylbenzene	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Ethyl tert-butyl ether	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Ethyl butyrate	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Ethylcyclohexane	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
N-Ethylcyclohexylamine	Y	S/P	2	2G	Cont	No			No	R	F-T	A	No	1519.6
S-Ethyl dipropylthiocarbamate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1602.7(16.2.9)(*)
Ethylene chlorohydrin	Y	S/P	2	2G	Cont	No	T2	IIA	No	C	F-T	AD	Yes	1512., 1517., 1519.
Ethylene cyanohydrin	Y	S/P	3	2G	Open	No		IIB	Yes	O	No	A	No	1519.6
Ethylenediamine	Y	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	A	No	1519.6, 1602.7(16.2.9)(*)
Ethylenediaminetetraacetic acid, tetrasodium salt solution	Y	S/P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Ethylene dibromide	Y	S/P	2	2G	Cont	No			NF	C	T	No	Yes	1512., 1519.6, 1602.7(16.2.9)(*)
Ethylene dichloride	Y	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	AB	No	1519.
Ethylene glycol	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Ethylene glycol acetate	Y	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Ethylene glycol butyl ether acetate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Ethylene glycol diacetate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6

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Ethylene glycol methyl ether acetate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Ethylene glycol monoalkyl ethers	Y	S/P	3	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Ethylene glycol phenyl ether	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Ethylene glycol phenyl ether/Diethylene glycol phenyl ether mixture	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Ethylene oxide/Propylene oxide mixture with an Ethylene oxide content of not more than 30% by mass	Y	S/P	2	1G	Cont	Inert	T2	IIB	No	C	F-T	AC	No	1508., 1512., 1514., 1519.
Ethylene-vinyl acetate copolymer (emulsion)	Y	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Ethyl-3-ethoxypropionate	Y	P	3	2G	Cont	No			No	R	No	A	No	1519.6
2-Ethylhexanoic acid	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6
2-Ethylhexyl acrylate	Y	S/P	3	2G	Open	No	T3	IIB	Yes	O	No	A	No	1513., 1519.6, 1606.1, 1606.2
2-Ethylhexylamine	Y	S/P	2	2G	Cont	No			No	R	F-T	A	No	1512., 1519.6
2-Ethyl-2-(hydroxymethyl) propane-1,3-diol (C8-C10) ester	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Ethylidene norbornene	Y	S/P	2	2G	Cont	No			No	R	F-T	AD	No	1512.1, 1519.6
Ethyl methacrylate	Y	S/P	3	2G	Cont	No	T2	IIA	No	R	F-T	AD	No	1513., 1519.6, 1606.1, 1606.2
N-Ethylmethylallylamine	Y	S/P	2	2G	Cont	No	T2	IIB	No	C	F	AC	Yes	1512.3, 1517., 1519.
Ethyl propionate	Y	P	3	2G	Open	No			No	R	F	A	No	1519.6
2-Ethyl-3-propylacrolein	Y	S/P	3	2G	Cont	No		IIA	No	R	F-T	A	No	1519.6, 1602.7(16.2.9)(*)
Ethyl Toluene	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Fatty acid (saturated C13+)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Fatty acid methyl esters (m)	Y	S/P	2	2G	Cont	No	-	-	Yes	R	T	ABC	No	1512.3, 1512.4, 1519.6, 1602.6, 1602.7(16.2.9)(*)
Fatty acid, (C16+)	Y	P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6,
Fatty acid, 12+	Y	S/P	2	2G	Cont	No	-	-	Yes	R	T	ABC	No	1502.3, 1512.4, 1519.6, 1602.6, 1602.7(16.2.9)(*)
Fatty acid, C8-C10	Y	S/P	2	2G	Cont	No	-	-	Yes	R	T	ABC	No	1512.3, 1512.4, 1519., 1602.6, 1602.7(16.2.9)(*)
Fatty acids, essentially linear (C6-C18) 2-ethylhexyl ester	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6
Ferric chloride solutions	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1511., 1519.6, 1602.7(16.2.9)(*)
Ferric nitrate/Nitric acid solution	Y	S/P	2	2G	Cont	No			NF	R	T	No	Yes	1511., 1519.
Fish oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Fluorosilicic acid (20-30%) in water solution	Y	S/P	3	1G	Cont	No	-	-	NF	R	T	No	Yes	1511., 1519.6,

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Formaldehyde solutions (45% or less)	Y	S/P	3	2G	Cont	No	T2	IIB	No	R	F-T	A	Yes	1519.6, 1602.7(16.2.9)(*)
Formamide	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Formic acid	Y	S/P	3	2G	Cont	No	T1	IIA	No	R	T(g)	A	Yes	1511.2 to 1511.4, 1511.6 to 1511.8, 1519.6, 1602.7(16.2.9)(*)
Furfural	Y	S/P	3	2G	Cont	No	T2	IIB	No	R	F-T	A	No	1519.6
Furfuryl alcohol	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Glucitol/glycerol blend propoxylated (containing less than 10% amines)	Z	S/P	3	2G	Cont	No	-	-	Yes	R	T	ABC	No	1512.3, 1512.4, 1519.6
Glutaraldehyde solutions (50% or less)	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6
Glycerol monooleate	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Glycerol propoxylated	Z	S/P	3	2G	Cont	No	-	-	Yes	R	T	ABC	No	1512.3, 1512.4, 1519.6
Glycerol propoxylated and ethoxylated	Z	P	3	2G	Open	No	-	-	Yes	O	No	ABC	No	
Glycerol/sucrose blend propoxylated and ethoxylated	Z	P	3	2G	Open	No	-	-	Yes	O	No	ABC	No	
Glyceryl triacetate	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Glycidyl ester of C10 trialkylacetic acid	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Glycine, sodium salt solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Glycolic acid solution (70% or less)	Z	S/P	3	2G	Open	No	-	-	NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Glyoxal solution (40% or less)	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Glyoxylic acid solution (50 % or less)	Y	S/P	3	2G	Open	No	-	-	Yes	O	No	ACD	No	1511.2, 1511.3, 1511.4, 1511.6, 1511.7, 1511.8, 1519.6, 1602.7(16.2.9)(*), 1606.1, 1606.2, 1606.3
Glyphosate solution (not containing surfactant)	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Groundnut oil	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Heptane (all isomers)	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
n-Heptanoic acid	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Heptanol (all isomers) (d)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Heptene (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Heptyl acetate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
1-Hexadecylnaphthalene / 1,4-bis(hexadecyl)naphthalene mixture	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Hexamethylenediamine adipate (50% in water)	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Hexamethylenediamine (molten)	Y	S/P	2	2G	Cont	No			Yes	C	T	C	Yes	1512., 1517., 1518., 1519.6, 1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Hexamethylenediamine solution	Y	S/P	3	2G	Cont	No			Yes	R	T	A	No	1519.6
Hexamethylene diisocyanate	Y	S/P	2	1G	Cont	Dry	T1	IIB	Yes	C	T	AC (b)D	Yes	1512., 1517., 1516.1(15.16.2)(*), 1518., 1519.
Hexamethylene glycol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Hexamethyleneimine	Y	S/P	2	2G	Cont	No			No	R	F-T	AC	No	1519.6
Hexane (all isomers)	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
1,6-Hexanediol, distillation overheads	Y	S/P	3	2G	Cont	No	-	-	Yes	O	No	A	No	1512.3, 1512.4, 1519.6, 1602.7(16.2.9)(*)
Hexanoic acid	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6
Hexanol	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6
Hexene (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Hexyl acetate	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Hydrochloric acid	Z	S/P	3	1G	Cont	No			NF	R	T	No	Yes	1511.
Hydrogen peroxide solutions (over 60% but not over 70% by mass)	Y	S/P	2	2G	Cont	No			NF	C	No	No	No	1505.1, 1519.6
Hydrogen peroxide solutions(over 8% but not over 60% by mass)	Y	S/P	3	2G	Cont	No			NF	C	No	No	No	1505.2, 1518., 1519.6
2-Hydroxyethyl acrylate	Y	S/P	2	2G	Cont	No			Yes	C	T	A	No	1512., 1513., 1519.6, 1606.1, 1606.2
N-(Hydroxyethyl)ethylenediaminetriacetic acid, trisodium salt solution	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
2-Hydroxy-4-(methylthio)butanoic acid	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Illipe oil	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Isoamyl alcohol	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Isobutyl alcohol	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Isobutyl formate	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Isobutyl methacrylate	Z	P	3	2G	Cont	No	-	-	No	R	F	A	No	1512., 1513., 1517., 1606.1, 1606.2
Isophorone	Y	S/P	3	2G	Cont	No			Yes	R	No	A	No	1519.6
Isophoronediamine	Y	S/P	3	2G	Cont	No			Yes	R	T	A	No	1602.7(16.2.9)(*)
Isophorone diisocyanate	X	S/P	2	2G	Cont	Dry			Yes	C	T	ABD	No	1512., 1516.1(15.16.2)(*), 1517., 1519.6
Isoprene	Y	S/P	3	2G	Cont	No	T3	IIB	No	R	F	B	No	1513., 1514., 1519.6, 1606.1, 1606.2
Isopropanolamine	Y	S/P	3	2G	Open	No	T2	IIA	Yes	O	F-T	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Isopropyl acetate	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Isopropylamine	Y	S/P	2	2G	Cont	No	T2	IIA	No	C	F-T	CD	Yes	1512., 1514., 1519.
Isopropylamine(70% or less) solution	Y	S/P	2	2G	Cont	No			No	C	F-T	CD	Yes	1512., 1519.6, 1602.7(16.2.9)(*)
Isopropylcyclohexane	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Isopropyl ether	Y	S/P	3	2G	Cont	Inert			No	R	F	A	No	1504.6, 1513.3, 1519.6

a	c	d	e	f	g	h	i'	i"	i"'	j	k	l	n	o
Lactic acid	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Lactonitrile solution (80% or less)	Y	S/P	2	1G	Cont	No			Yes	C	T	ACD	Yes	1512., 1513., 1517. to 1519., 1606.1, 1606.2, 1606.3
Lard	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Latex, ammonia(1% or less) inhibited	Y	S/P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Latex: Carboxylated styrene-Butadiene copolymer; Styrene-Butadiene rubber	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Lauric acid	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Ligninsulphonic acid, sodium salt solution	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Linseed oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Liquid chemical wastes	X	S/P	2	2G	Cont	No			No	C	F-T	A	Yes	1512., 1519.6, 2005.1
Long-chain alkaryl polyether (C11-C20)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Long-chain alkaryl sulphonic acid(C16-C60)	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Long-chain alkylphenate/Phenol sulphide mixture	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
L-Lysine solution (60% or less)	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Magnesium chloride solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Magnesium long-chain alkaryl sulphonate(C11-C50)	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Magnesium long-chain alkyl salicylate(C11+)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Maleic anhydride	Y	S/P	3	2G	Cont	No			Yes	R	No	AC (f)	No	1602.7(16.2.9)(*)
Mango kernel oil	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Mercaptobenzothiazol, sodium salt solution	X	S/P	2	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Mesityl oxide	Z	S/P	3	2G	Cont	No	T2	IIB	No	R	F-T	A	No	1519.6
Metam sodium solution	X	S/P	1	2G	Open	No			NF	O	No	No	No	1519., 1602.7(16.2.9)(*)
Methacryclic acid - alkoxypoly (alkylene oxide) methacrylate copolymer, sodium salt aqueous solution (45% or less)	Z	S/P	3	2G	Open	No	-	-	NF	O	No	AC	No	1602.7(16.2.9)(*)
Methacrylic acid	Y	S/P	3	2G	Cont	No			Yes	R	T	A	No	1513., 1519.6, 1602.7(16.2.9)(*), 1606.1

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Methacrylic resin in Ethylene dichloride	Y	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	AB	No	1519., 1602.7(16.2.9)(*)
Methacrylonitrile	Y	S/P	2	2G	Cont	No			No	C	F-T	A	Yes	1512., 1513., 1517., 1519.
3-Methoxy-1-butanol	Z	P	3	2G	Cont	No			No	R	F	A	No	
3-Methoxybutyl acetate	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6
N-(2-Methoxy-1-methyl ethyl)-2-ethyl-6-methyl chloroacetanilide	X	P	1	2G	Open	No			Yes	O	No	A	No	1519., 1602.6
Methyl acetate	Z	P	3	2G	Cont	No			No	R	F	A	No	
Methyl acetoacetate	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Methyl acrylate	Y	S/P	2	2G	Cont	No	T1	IIB	No	R	F-T	A	Yes	1513., 1519.6, 1606.1, 1606.2
Methyl alcohol	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Methylamine solutions (42% or less)	Y	S/P	2	2G	Cont	No			No	C	F-T	ACD	Yes	1512., 1517., 1519.
Methylamyl acetate	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Methylamyl alcohol	Z	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Methyl amyl ketone	Z	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Methylbutenol	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Methyl tert-butyl ether	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Methyl butyl ketone	Y	P	3	2G	Cont	No			No	R	F	AB	No	1519.6
Methylbutynol	Z	P	3	2G	Cont	No			No	R	F	A	No	
Methyl butyrate	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Methylcyclohexane	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Methylcyclopentadiene dimer	Y	P	2	2G	Cont	No			No	R	F	B	No	1519.6
Methylcyclopentadienyl manganese tricarbonyl	X	S/P	1	1G	Cont	No	-	-	Yes	C	T	ABCD	Yes	1512., 1518., 1519., 1602.7(16.2.9)(*)
Methyl diethanolamine	Y	S/P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6
2-Methyl-6-ethyl aniline	Y	S/P	3	2G	Open	No			Yes	O	No	AD	No	1519.6
Methyl ethyl ketone	Z	P	3	2G	Cont	No			No	R	F	A	No	
2-Methyl-5-ethyl pyridine	Y	S/P	3	2G	Open	No		IIA	Yes	O	No	AD	No	1519.6
Methyl formate	Z	S/P	2	2G	Cont	No			No	R	F-T	A	Yes	1512., 1514., 1519.
2-Methyl-2-hydroxy-3-butyne	Z	S/P	3	2G	Cont	No		IIA	No	R	F-T	ABD	No	1519.6, 1602.7(16.2.9)(*)
Methyl isobutyl ketone	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Methyl methacrylate	Y	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	A	No	1513., 1519.6, 1606.1, 1606.2
3-Methyl-3-methoxybutanol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Methyl naphthalene (molten)	X	S/P	2	2G	Cont	No			Yes	R	No	AD	No	1519.6
2-Methyl-1,3-propanediol	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	
2-Methylpyridine	Z	S/P	2	2G	Cont	No			No	C	F	A	No	1512.3, 1519.6
3-Methylpyridine	Z	S/P	2	2G	Cont	No			No	C	F	AC	No	1512.3, 1519.
4-Methylpyridine	Z	S/P	2	2G	Cont	No			No	C	F-T	A	No	1512.3, 1519., 1602.7(16.2.9)(*)
N-Methyl-2-pyrrolidone	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6

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Methyl salicylate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
alpha-Methylstyrene	Y	S/P	2	2G	Cont	No	T1	IIB	No	R	F-T	AD (j)	No	1513., 1519.6, 1606.1, 1606.2
3-(methylthio)propionaldehyde	Y	S/P	2	2G	Cont	No	T3	IIA	No	C	F-T	BC	Yes	1512., 1517., 1519.
Molybdenum polusulfide long chain alkyl dithiocarbamide complex	Y	S/P	2	2G	Cont	No	-	-	Yes	C	T	ABC	Yes	1512., 1517., 1519., 1602.6, 1602.7(16.2.9)(*)
Morpholine	Y	S/P	3	2G	Cont	No	T2	IIA	No	R	F	A	No	1519.6
Motor fuel anti-knock compounds (containing lead alkyls)	X	S/P	1	1G	Cont	No	T4	IIA	No	C	F-T	AC	Yes	1506., 1512., 1518., 1519.
Myrcene	X	P	2	2G	Cont	No	-	-	No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Naphthalene (molten)	X	S/P	2	2G	Cont	No	T1	IIA	Yes	R	No	AD	No	1519.6, 1602.7(16.2.9)(*)
Naphthalenesulphonic acid-Formaldehyde copolymer, sodium salt solution	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Neodecanoic acid	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Nitrating acid (mixture of sulphuric and nitric acids)	Y	S/P	2	2G	Cont	No			NF	C	T	No	Yes	1511., 1516.1(15.16.2)(*), 1517., 1519.
Nitric acid (70% and over)	Y	S/P	2	2G	Cont	No			NF	C	T	No	Yes	1511., 1519.
Nitric acid (less than 70%)	Y	S/P	2	2G	Cont	No			NF	R	T	No	Yes	1511., 1519.
Nitrilotriacetic acid, trisodium salt solution	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
Nitrobenzene	Y	S/P	2	2G	Cont	No	T1	IIA	Yes	C	T	AD	No	1512., 1517. to 1519., 1602.7(16.2.9)(*)
Nitroethane	Y	S/P	3	2G	Cont	No		IIB	No	R	F-T	A(f)	No	1519.6, 1606.1, 1606.2, 1606.4
Nitroethane(80%)/Nitropropane(20%)	Y	S/P	3	2G	Cont	No		IIB	No	R	F-T	A(f)	No	1519.6, 1606.1 to 1606.3
Nitroethane, 1-Nitropropane (each 15% or more) mixture	Y	S/P	3	2G	Cont	No	-	-	No	R	F	A	No	1519.6, 1602.6, 1606.1, 1606.2, 1606.3
o-Nitrophenol (molten)	Y	S/P	2	2G	Cont	No			Yes	C	T	AD	No	1512., 1519.6, 1602.6, 1602.7(16.2.9)(*)
1-or 2-Nitropropane	Y	S/P	3	2G	Cont	No	T2	IIB	No	R	F-T	A	No	1519.6
Nitropropane (60%)/Nitroethane (40%) mixture	Y	S/P	3	2G	Cont	No			No	R	F-T	A(f)	No	1519.6
o- or p-Nitrotoluenes	Y	S/P	2	2G	Cont	No		IIB	Yes	C	T	AB	No	1512., 1517., 1519.6
Nonane (all isomers)	X	P	2	2G	Cont	No			No	R	F	BC	No	1519.6
Nonanoic acid (all isomers)	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Non-edible industrial grade palm oil	Y	S/P	2	2G	Cont	No	-	-	Yes	R	No	ABC	No	1512.3, 1512.4, 1519.6, 1602.6, 1602.7(16.2.9)(*)
Nonene (all isomers)	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Nonyl alcohol (all isomers)	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Nonyl methacrylate monomer	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)

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Nonylphenol	X	P	1	2G	Open	No			Yes	O	No	A	No	1519., 1602.6, 1602.7(16.2.9)(*)
Nonylphenol poly(4+) ethoxylate	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Noxious liquid,NF,(1) n.o.s.(trade name..., contains...)ST1,Cat.X	X	P	1	2G	Open	No	-	-	Yes	O	No	A	No	1519., 1602.6
Noxious liquid,F,(2) n.o.s.(trade name..., contains...)ST1,Cat.X	X	P	1	2G	Cont	No	T3	IIA	No	R	F	A	No	1519., 1602.6
Noxious liquid,NF,(3) n.o.s.(trade name..., contains...)ST2,Cat.X	X	P	2	2G	Open	No	-		Yes	O	No	A	No	1519., 1602.6
Noxious liquid,F,(4) n.o.s.(trade name..., contains...)ST2,Cat.X	X	P	2	2G	Cont	No	T3	IIA	No	R	F	A	No	1519., 1602.6
Noxious liquid,NF,(5) n.o.s.(trade name..., contains...)ST2,Cat.Y	Y	P	2	2G	Open	No	-		Yes	O	No	A	No	1519., 1602.6, 1602.7(16.2.9)(*)(l)
Noxious liquid,F,(6) n.o.s.(trade name..., contains...)ST2,Cat.Y	Y	P	2	2G	Cont	No	T3	IIA	No	R	F	A	No	1519., 1602.6, 1602.7(16.2.9)(*)(l)
Noxious liquid,NF,(7) n.o.s.(trade name..., contains...)ST3,Cat.Y	Y	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519., 1602.6, 1602.7(16.2.9)(*)(l)
Noxious liquid,F,(8) n.o.s.(trade name..., contains...)ST3,Cat.Z	Y	P	3	2G	Cont	No	T3	IIA	No	R	F	A	No	1519., 1602.6, 1602.7(16.2.9)(*)(l)
Noxious liquid,NF,(9) n.o.s.(trade name..., contains...)ST3,Cat.Z	Z	P	3	2G	Open	No	-		Yes	O	No	A	No	
Noxious liquid,F,(10) n.o.s.(trade name..., contains...)ST3,Cat.Z	Z	P	3	2G	Cont	No	T3	IIA	No	R	F	A	No	
Octane (all isomers)	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Octanoic acid (all isomers)	Y	P	3	2G	Open	No	-	-	Yes	O	No	AB	No	1519.6
Octanol (all isomers)	Y	P	2	2G	Open	No			Yes	O	No	A	No	
Octene (all isomers)	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
n-Octyl acetate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Octyl aldehydes	Y	P	3	2G	Cont	No	-	-	No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Octyl decyl adipate	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Olefin-Alkyl ester copolymer (molecular weight 2000+)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Olefin mixtures(C5-C7)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Olefin mixtures(C5-C15)	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Olefins (C13+, all isomers)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
alpha-Olefins(C6-C18) mixtures	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Oleic acid	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)

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Oleum	Y	S/P	2	2G	Cont	No			NF	C	T	No	Yes	1511.2 to 1511.8, 1512.1, 1516.1(15.16.2)(*), 1517., 1519., 1602.6
Oleylamine	X	S/P	2	2G	Cont	No			Yes	R	T	A	No	1519.6, 1602.7(16.2.9)(*)
Olive oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Oxygenated aliphatic hydrocarbon mixture	Z	S/P	3	2G	Open	No	-	-	Yes	O	No	ABC	No	
Palm acid oil	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm fatty acid oil distillate	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm kernel acid oil	Y	S/P	2	2G	Open	No			Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm kernel oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm kernel olein	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm kernel stearin	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm mid-fraction	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm oil fatty acid methyl ester	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Palm olein	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Palm stearin	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Paraffin wax	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Paraldehyde	Z	S/P	3	2G	Cont	No	T3	IIB	No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Paraldehyde-ammonia reaction product	Y	S/P	2	2G	Cont	No			No	C	F-T	A	No	1512.3, 1519.
Pentachloroethane	Y	S/P	2	2G	Cont	No			NF	R	T	No	No	1512., 1517., 1519.6
1,3-Pentadiene	Y	P	3	2G	Cont	No			No	R	F-T	AB	No	1513., 1519.6, 1606.1 to 1606.3
Pentaethylenehexamine	X	S/P	2	2G	Open	No			Yes	O	No	B	Yes	1519.
Pentane (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1514., 1519.6
Pentanoic acid	Y	P	3	2G	Open	No			Yes	O	No	AB	No	1519.6
n-Pentanoic acid (64%)/2-Methyl butyric acid (36%) mixture	Y	S/P	2	2G	Open	No	T2		Yes	C	No	AD	No	1511.2 to 1511.4, 1511.6 to 1511.8, 1512.3, 1519.
Pentene (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1514., 1519.6
n-Pentyl propionate	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Perchloroethylene	Y	S/P	2	2G	Cont	No			NF	R	T	No	No	1512.1, 1512.2, 1519.6
Petrolatum	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)

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Phenol	Y	S/P	2	2G	Cont	No	T1	IIA	Yes	C	T	A	No	1512., 1519., 1602.7(16.2.9)(*)
1-Phenyl-1-xylyl ethane	Y	P	3	2G	Open	No			Yes	O	No	AB	No	
Phosphate esters, alkyl (C12-C14)amine	Y	P	2	2G	Cont	No	-	-	N	R	F	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Phosphoric acid	Z	S/P	3	2G	Open	No			NF	O	No	No	No	1511.1 to 1511.4, 1511.6 to 1511.8, 1602.7(16.2.9)(*)
Phosphorous, yellow or white	X	S/P	1	1G	Cont	Pad+ (vent or inert)			No (c)	C	No	C	Yes	1507., 1519., 1602.7(16.2.9)(*)
Phthalic anhydride (molten)	Y	S/P	2	2G	Cont	No	T1	IIA	Yes	R	No	AD	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
alpha-Pinene	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
beta-Pinene	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Pine oil	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyacrylic acid solution (40% or less)	Z	S/P	3	2G	Open	No	-	-	Yes	O	No	AC	No	
Polyalkyl (C18-C22) acrylate in xylene	Y	P	2	2G	Cont	No			No	R	F	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Poly(2-8)alkylene glycol monoalkyl (C1-C6) ether	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	
Poly(2-8)alkylene glycol monoalkyl (C1-C6) ether acetate	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Polyalkyl (C10-C20) methacrylate	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyalkyl (C10-C18) methacrylate/ethylene-propylene copolymer mixture	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polybutene	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Polybutenyl succinimide	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Poly(2+)cyclic aromatics	X	P	1	2G	Cont	No			Yes	R	No	AD	No	1519., 1602.6, 1602.7(16.2.9)(*)
Polyethyler (molecular weight 1350+)	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6
Polyethylene glycol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Polyethylene glycol dimethyl ether	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Polyethylene polyamines	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Polyethylene polyamines (more than 50% C5-C20 paraffin oil)	Y	S/P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Polyferric sulphate solution	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6
Poly(iminoethylene)-graft-N-poly(ethyleneoxy) solution (90% or less)	Z	S/P	3	2G	Open	No	-	-	NF	O	No	AC	No	1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Polyisobutenamine in aliphatic (C10-C14) solvent	Y	P	3	2G	Open	No	T3	IIA	Yes	O	No	A	No	1519.6
Polyisobutenyl anhydride adduct	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Poly(4+)isobutylene	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Polymethylene polyphenyl isocyanate	Y	S/P	2	2G	Cont	Dry			Yes (a)	C	T(a)	A	No	1512., 1516.1(15.16.2)(*), 1519.6, 1602.7(16.2.9)(*)
Polyolefin (molecular weight 300+)	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefin amide alkeneamine (C17+)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Polyolefin amide alkeneamine borate (C28-C250)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefinamine (C28-C250)	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Polyolefinamine in alkyl (C2-C4) benzenes	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefinamine in aromatic solvent	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefin aminoester salts (molecular weight 2000+)	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefin anhydride	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefin ester (C28-C250)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefin phenolic amine (C28-C250)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Polyolefin phosphorosulphide, barium derivative (C28-C250)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Poly(20)oxyethylene sorbitan monooleate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Poly(5+) propylene	Y	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Polypropylene glycol	Z	S/P	3	2G	Cont	No			Yes	O	No	ABC	No	1519.6
Polysiloxane	Y	P	3	2G	Cont	No			No	R	F	AB	No	1519.6, 1602.7(16.2.9)(*)
Potassium chloride solution(10% or more)	Z	S/P	3	2G	Open	No	-	-	NF	O	No	A	No	1602.7(16.2.9)(*)
Potassium hydroxide solution	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6
Potassium oleate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Potassium thiosulphate (50% or less)	Y	P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
n-Propanolamine	Y	S/P	3	2G	Open	No			Yes	O	No	AD	No	1519.6, 1602.7(16.2.9)(*)
beta-Propiolactone	Y	S/P	2	2G	Cont	No		IIA	Yes	R	T	A	No	1519.6
Propionaldehyde	Y	S/P	3	2G	Cont	No			No	R	F-T	A	Yes	1517., 1519.6
Propionic acid	Y	S/P	3	2G	Cont	No	T1	IIA	No	R	F	A	Yes	1511.2 to 1511.4, 1511.6 to 1511.8, 1519.6
Propionic anhydride	Y	S/P	3	2G	Cont	No	T2	IIA	Yes	R	T	A	No	1519.6

a	c	d	e	f	g	h	i'	i"	i"'	j	k	l	n	o
Propionitrile	Y	S/P	2	1G	Cont	No	T1	IIB	No	C	F-T	AD	Yes	1512., 1517. to 1519.
n-Propyl acetate	Y	P	3	2G	Cont	No			No	R	F	AB	No	1519.6
n-propyl alcohol	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
n-Propylamine	Z	S/P	2	2G	Cont	Inert	T2	IIA	No	C	F-T	AD	Yes	1512., 1519.
Propylbenzene (all isomers)	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Propylene glycol methyl ether acetate	Z	P	3	2G	Cont	No			No	R	F	A	No	
Propylene glycol monoalkyl ether	Z	P	3	2G	Cont	No			No	R	F	AB	No	
Propylene glycol phenyl ether	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Propylene oxide	Y	S/P	2	2G	Cont	Inert	T2	IIB	No	C	F-T	AC	No	1508., 1512.1, 1514., 1519.
Propylene tetramer	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Propylene trimer	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Pyridine	Y	S/P	2	2G	Cont	No	T1	IIA	No	R	F	A	No	1519.6
Pyrolysis gasoline(containing benzene)	Y	S/P	2	2G	Cont	No	T3	IIA	No	C	F-T	AB	No	1512., 1517., 1519.6
Rapeseed oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Rapeseed oil (low erucic acid containing less than 4% free fatty acids)	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Rape seed oil fatty acid methyl esters	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6
Resin oil, distilled	Y	S/P	2	2G	Cont	No	T1	IIA	No	C	F-T	ABC	No	1512., 1517., 1519.6
Rice bran oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Rosin	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Safflower oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Shea butter	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Sodium alkyl(C14-C17) sulphonates (60-65% solution)	Y	P	2	2G	Open	No			NF	O	No	No	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Sodium aluminosilicate slurry	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Sodium benzoate	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Sodium borohydride (15% or less)/Sodium hydroxide solution	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Sodium carbonate solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Sodium chlorate solution (50% or less)	Z	S/P	3	2G	Open	No			NF	O	No	No	No	1509., 1519.6, 1602.7(16.2.9)(*)
Sodium dichromate solution (70% or less)	Y	S/P	2	2G	Open	No			NF	C	No	No	No	1512.3, 1519.

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Sodium hydrogen sulphide (6% or less)/Sodium carbonate (3% or less) solution	Z	P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Sodium hydrogen sulphite solution (45% or less)	Z	S/P	3	2G	Open	No			NF	O	No	No	No	1602.7(16.2.9)(*)
Sodium hydrosulphide/Ammonium sulphide solution	Y	S/P	2	2G	Cont	No			No	C	F-T	A	Yes	1512., 1514., 1517., 1519., 1606.1 to 1606.3
Sodium hydrosulphide solution (45% or less)	Z	S/P	3	2G	Cont	Vent or pad (gas)			NF	R	T	No	No	1519.6, 1602.7(16.2.9)(*)
Sodium hydroxide solution	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Sodium hypochlorite solution (15% or less)	Y	S/P	2	2G	Cont	No	-	-	NF	R	No	No	No	1519.6
Sodium nitrite solution	Y	S/P	2	2G	Open	No			NF	O	No	No	No	1512.3(1), 1512.3(2), 1519., 1602.7(16.2.9)(*)
Sodium petroleum sulphonate	Y	S/P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6
Sodium poly(4+) acrylate solutions	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	1602.7(16.2.9)(*)
Sodium silicate solution	Y	P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Sodium sulphide solution (15% or less)	Y	S/P	3	2G	Cont	No			NF	C	T	No	No	1519.6, 1602.7(16.2.9)(*)
Sodium sulphite solution (25% or less)	Y	P	3	2G	Open	No			NF	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Sodium thiocyanate solution (56% or less)	Y	P	3	2G	Open	No			Yes	O	No	No	No	1519.6, 1602.7(16.2.9)(*)
Soyabean oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Styrene monomer	Y	S/P	3	2G	Cont	No	T1	IIA	No	R	F	AB	No	1513., 1519.6, 1606.1, 1606.2
Sulphohydrocarbon(C3-C88)	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Sulpholane	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Sulphur (molten)	Z	S	3	1G	Open	Vent or pad (gas)	T3		Yes	O	F-T	No	No	1510., 1602.7(16.2.9)(*)
Sulphuric acid	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1511., 1516.1(15.16.2)(*), 1519.6
Sulphuric acid, spent	Y	S/P	3	2G	Open	No			NF	O	No	No	No	1511., 1516.1(15.16.2)(*), 1519.6
Sulphurized fat (C14-C20)	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Sulphurized polyolefinamide alkene (C28-C250) amine	Z	P	3	2G	Open	No	-	-	Yes	O	No	A	No	
Sunflower seed oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)

a	c	d	e	f	g	h	i'	i"	i'''	j	k	l	n	o
Tall oil, crude	Y	S/P	2	2G	Cont	No	-	-	Yes	C	T	ABC	Yes	1512., 1517., 1519., 1602.6
Tall oil, distilled	Y	P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6
Tall oil fatty acid(resin acids less than 20%)	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6
Tall oil pitch	Y	S/P	2	2G	Cont	No	-	-	Yes	C	T	ABC	Yes	1512., 1517., 1519., 1602.6, 1602.7(16.2.9)(*)
Tallow	Y	P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Tallow fatty acid	Y	P	2	2G	Open	No	-	-	Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Tetrachloroethane	Y	S/P	2	2G	Cont	No			NF	R	T	No	No	1512., 1517., 1519.6
Tetraethylene glycol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Tetraethylene pentamine	Y	S/P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Tetrahydrofuran	Z	S	3	2G	Cont	No	T3	IIB	No	R	F-T	A	No	1519.6
Tetrahydronaphthalene	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Tetramethylbenzene (all isomers)	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Titanium dioxide slurry	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
Toluene	Y	P	3	2G	Cont	No			No	R	F	A	No	1519.6
Toluenediamine	Y	S/P	2	2G	Cont	No			Yes	C	T	AD	Yes	1512., 1517., 1519., 1602.6, 1602.7(16.2.9)(*)
Toluene diisocyanate	Y	S/P	2	2G	Cont	Dry	T1	IIA	Yes	C	F-T	AC (b)D	Yes	1512., 1516.1(15.16.2)(*), 1517., 1519., 1602.7(16.2.9)(*)
o-Toluidine	Y	S/P	2	2G	Cont	No			Yes	C	T	A	No	1512., 1517., 1519.
Tributyl phosphate	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
1,2,3-Trichlorobenzene (molten)	X	S/P	1	2G	Cont	No			Yes	C	T	ACD	Yes	1512.1, 1517., 1519., 1602.6, 1602.7(16.2.9)(*)
1,2,4-Trichlorobenzene	X	S/P	1	2G	Cont	No			Yes	R	T	AB	No	1519., 1602.7(16.2.9)(*)
1,1,1-Trichloroethane	Y	P	3	2G	Open	No			Yes	O	No	A	No	1519.6
1,1,2-Trichloroethane	Y	S/P	3	2G	Cont	No			NF	R	T	No	No	1512.1, 1519.6
Trichloroethylene	Y	S/P	2	2G	Cont	No	T2	IIA	Yes	R	T	No	No	1512., 1517., 1519.6
1,2,3-Trichloropropane	Y	S/P	2	2G	Cont	No			Yes	C	T	ABD	No	1512., 1517., 1519.
1,1,2-Trichloro-1,2,2-Trifluoroethane	Y	P	2	2G	Open	No			NF	O	No	No	No	1519.6
Tricresyl phosphate (containing 1% or more ortho-isomer)	Y	S/P	1	2G	Cont	No	T2	IIA	Yes	C	No	AB	No	1512.3, 1519., 1602.6
Tricresyl phosphate (containing less than 1% ortho-isomer)	Y	S/P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6
Tridecane	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6
Tridecanoic acid	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Tridecyl acetate	Z	P	3	2G	Open	No	-	-	Yes	O	No	AB	No	1519.6
Triethanolamine	Z	S/P	3	2G	Open	No		IIA	Yes	O	No	A	No	1602.7(16.2.9)(*)
Triethylamine	Y	S/P	2	2G	Cont	No	T2	IIA	No	R	F-T	AC	Yes	1512., 1519.6

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Triethylbenzene	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Triethylenetetramine	Y	S/P	2	2G	Open	No	T2	IIA	Yes	O	No	A	No	1519.6
Triethyl phosphate	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Triethylphosphite	Z	S/P	3	2G	Cont	No			No	R	F-T	AB	No	1512.1, 1519.6, 1602.7(16.2.9)(*)
Triisopropanolamine	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Triisopropylated phenyl phosphates	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6
Trimethylacetic acid	Y	S/P	2	2G	Cont	No			Yes	R	No	A	No	1511.2 to 1511.8, 1519.6, 1602.6, 1602.7(16.2.9)(*)
Trimethylamine solution (30% or less)	Z	S/P	2	2G	Cont	No			No	C	F-T	AC	Yes	1512., 1514., 1519., 1602.7(16.2.9)(*)
Trimethylbenzene (all isomers)	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Trimethylol propane propoxylated	Z	S/P	3	2G	Open	No	-	-	Yes	O	No	ABC	No	
2,2,4-Trimethyl-1,3-pentane diol diisobutyrate	Z	P	3	2G	Open	No			Yes	O	No	AB	No	
2,2,4-Trimethyl-1,3-pentane diol-1-isobutyrate	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
1,3,5-Trioxane	Y	S/P	3	2G	Cont	No			No	R	F	AD	No	1519.6, 1602.7(16.2.9)(*)
Tripropylene glycol	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Trixylyl phosphate	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.6
Tung oil	Y	S/P	2 (k)	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Turpentine	X	P	2	2G	Cont	No			No	R	F	A	No	1519.6
Undecanoic acid	Y	P	2	2G	Open	No			Yes	O	No	A	No	1602.6, 1602.7(16.2.9)(*)
1-Undecene	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Undecyl alcohol	X	P	2	2G	Open	No			Yes	O	No	A	No	1519.6, 1602.7(16.2.9)(*)
Urea/Ammonium nitrate solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Urea/Ammonium nitrate solution (containing less than 1% free ammonia)	Z	S/P	3	2G	Cont	No			NF	R	T	A	No	1602.7(16.2.9)(*)
Urea/Ammonium phosphate solution	Y	P	2	2G	Open	No			Yes	O	No	A	No	1519.6
Urea solution	Z	P	3	2G	Open	No			Yes	O	No	A	No	
Valeraldehyde (all isomers)	Y	S/P	3	2G	Cont	Inert	T3	IIB	No	R	F-T	A	No	1504.6, 1519.6
Vegetable acid oil (m)	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Vegetable fatty acid distillates (m)	Y	S/P	2	2G	Open	No	-	-	Yes	O	No	ABC	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Vinyl acetate	Y	S/P	3	2G	Cont	No	T2	IIA	No	R	F	A	No	1513., 1519.6, 1606.1, 1606.2
Vinyl ethyl ether	Z	S/P	2	1G	Cont	Inert	T3	IIB	No	C	F-T	A	Yes	1504., 1513., 1514., 1519., 1606.1, 1606.2
Vinylidene chloride	Y	S/P	2	2G	Cont	Inert	T2	IIA	No	R	F-T	B	Yes	1513., 1514., 1519.6, 1606.1, 1606.2

a	c	d	e	f	g	h	i'	i''	i'''	j	k	l	n	o
Vinyl neodecanoate	Y	S/P	2	2G	Open	No			Yes	O	No	AB	No	1513., 1519.6, 1606.1, 1606.2
Vinyltoluene	Y	S/P	2	2G	Cont	No		IIA	No	R	F	AB	No	1513., 1519.6, 1606.1, 1606.2
Waxes	Y	P	2	2G	Open	No	-	-	Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
White spirit, low(15-20%) aromatic	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)
Xylenes	Y	P	2	2G	Cont	No			No	R	F	A	No	1519.6, 1602.7(16.2.9)(*)(h)
Xylenes/ethylbenzene (10% or more) mixture	Y	P	2	2G	Cont	No	-	-	No	R	F	A	No	1519.6
Xylenol	Y	S/P	2	2G	Open	No		IIA	Yes	O	No	AB	No	1519.6, 1602.7(16.2.9)(*)
Zinc alkaryl dithiophosphate (C7-C16)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6, 1602.7(16.2.9)(*)
Zinc alkenyl carboxamide	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6
Zinc alkyl dithiophosphate (C3-C14)	Y	P	2	2G	Open	No			Yes	O	No	AB	No	1519.6, 1602.6

Notes ;

Subindex (a)	If the product to be carried contains flammable solvents such that the flashpoint does not exceed 60℃, then special electrical systems and a flammable-vapour detector shall be provided.
Subindex (b)	Although water is suitable for extinguishing open-air fires involving chemicals to which this footnote applies, water shall not be allowed to contaminate closed tanks containing these chemicals because of the risk of hazardous gas generation.
Subindex (c)	Phosphorus, yellow or white is carried above its autoignition temperature and therefore flashpoint is not appropriate. Electrical equipment requirements may be similar to those for substances with a flashpoint above 60℃.
Subindex (d)	Requirements are based on those isomers having a flashpoint of 60℃, or less; some isomers have a flashpoint greater than 60℃, and therefore the requirements based on flammability would not apply to such isomers.
Subindex (e)	Applies to n-decyl alcohol only.
Subindex (f)	Dry chemical shall not be used as fire extinguishing media
Subindex (g)	Confined spaces shall be tested for both formic acid vapours and carbon monoxide gas, a decomposition product.
Subindex (h)	Applies to p-xylene only.
Subindex (i)	For mixtures containing no other components with safety hazards and where the pollution category is Y or less
Subindex (j)	Only certain alcohol-resistant foams are effective
Subindex (k)	Requirements for Ship Type identified in column e might be subject to regulation 4.1.3 of Annex II of MARPOL 73/78
Subindex (l)	Applicable when the melting point is equal to or greater than 0°C.
Subindex (m)	From vegetable oils specified in the IBC Code.
Subindex (*)	The number in a parenthesis in the column "o" is the number of IBC Code equivalent to the number of this regulation.

Annex 7B-2 List of products to which the Code does not apply

Product name	Pollution Category
Acetone	Z
Alcoholic beverages, n.o.s.	Z
Apple juice	OS
n-Butyl alcohol	Z
sec-Butyl alcohol	Z
Calcium nitrate solutions (50% or less)	Z
Clay slurry	OS
Coal slurry	OS
Diethylene glycol	Z
Ethyl alcohol	Z
Ethylene carbonate	Z
Glucose solution	OS
Glycerine	Z
Hexamethylenetetramine solutions	Z
Hexylene glycol	Z
Hydrogenated starch hydrolysate	OS
Isopropyl alcohol	Z
Kaolin slurry	OS
Lecithin	OS
Magnesium hydroxide slurry	Z
Maltitol solution	OS
N-Methylglucamine solution (70% or less)	Z
Methyl propyl ketone	Z
Molasses	OS
Noxious liquid, (11) n.o.s. (trade name ...., contains ....) Cat. Z	Z
Non-noxious liquid, (12) n.o.s. (trade name ...., contains ....) Cat. OS	OS
Polyaluminium chloride solution	Z
Polyglycerin, sodium salt solution (containing less than 3% sodium hydroxide)	Z
Potassium formate solutions	Z
Propylene carbonate	Z
Propylene glycol	Z
Sodium acetate solutions	Z
Sodium sulphate solutions	Z
Sorbitol solution	OS
Sulphonated polyacrylate solution	Z
Tetraethyl silicate monomer/oligomer (20% in ethanol)	Z
Triethylene glycol	Z
Vegetable protein solution (hydrolysed)	OS
Water	OS

Annex 7B-3 Index of Products Carried in Bulk

1. For the Chapter 19 of IBC Code, the first column of the Index of Products Carried in Bulk (hereafter referred to as .the Index.) provides the so called Index Name. Where the Index Name is in capital and in bold, the Index Name is identical to the Product Name in either chapter 17 or chapter 18. The second column listing the relevant Product Name is therefore empty. Where the Index Name is in non-bold lower case it reflects a synonym for which the Product Name in either chapter 17 or chapter 18 is given in the second column. The relevant chapter of the IBC Code is reflected in the third column. The fourth column gives the UN Numbers of products, which were available up to February 2001.

2. The Index has been developed for information purposes only. None of the Index Names indicated in non-bold lower case in the first column shall be used as Product Name on the shipping document.

3. Prefixes forming an integral part of the name are shown in ordinary (roman) type and are taken into account in determining the alphabetical order of entries. These include such prefixes as:

Mono Di Tri Tetra Penta Iso Bis Neo Ortho Cyclo

4. Prefixes that are disregarded for purposes of alphabetical order are in italics and include the following:

n- (normal-)

sec- (secondary-)

tert- (tertiary-)

o- (ortho-)

m- (meta-)

p- (para-)

N-

O-

sym- (symmetrical)

uns- (unsymmetrical)

dl-

cis-

trans-

(E)-

(Z)-

alpha- (α-)

beta- (β-)

gamma- (ɣ-)

epsilon- (ε-)

Annex 7B-4 Criteria for assigning carriage requirements for products subject to the IBC Code

101. Introduction

1. The following criteria are guidelines for the determination of pollution classification and assignment of appropriate carriage requirements for bulk liquid cargoes being considered as candidates for entry into the IBC Code or annexes 1, 3 or 4 of MEPC.2/Circs.

2. In developing such criteria, every effort has been made to follow the criteria and cut off points developed under the Global Harmonized System (GHS).

3. Although the criteria are intended to be closely defined in order to establish a uniform approach, it must be emphasized that these are guidelines only and, where human experience or other factors indicates the need for alternative arrangements, these shall always be taken into account. Where deviations from the criteria have been recognized, they shall be properly recorded with justifications.

102. Contents

This chapter contains the following:
(1) minimum safety and pollution criteria for products subject to chapter 17 of the IBC Code;
(2) criteria used to assign the minimum carriage requirements for products, which meet the safety or pollution criteria to make them subject to chapter 17 of the IBC Code;
(3) criteria used for special requirements in chapter 15 of the IBC Code to be included in column o of chapter 17 of the IBC Code;
(4) criteria used for special requirements in chapter 16 of the IBC Code to be included in column o of chapter 17 of the IBC Code; and
(5) definitions of properties used within this chapter.

103. Minimum safety and pollution criteria for products subject to chapter 17 of the IBC Code

Products are deemed to be hazardous and subject to chapter 17 of the IBC Code if they meet one or more of the following criteria:
(1) inhalation LC_{50} < 20 mg/l/4h (see definitions in paragraph 107.1(1));
(2) dermal LD_{50} < 2000 mg/kg (see definitions in paragraph 107.1(2));
(3) oral LD_{50} < 2000 mg/kg (see definitions in paragraph 107.1(3));
(4) toxic to mammals by prolonged exposure (see definitions in paragraph 2107.2);
(5) cause skin sensitization (see definitions in paragraph 107.3);
(6) cause respiratory sensitization (see definitions in paragraph 2107.4);
(7) corrosive to skin (see definitions in paragraph 107.5);
(8) have a Water Reactive Index (WRI) of > 1 (see definitions in paragraph 107.6);
(9) require inertion, inhibition, stabilization, temperature control or tank environmental control in order to prevent a hazardous reaction (see definitions in paragraph 107.10);
(10) flash point < 23℃; and have an explosive/flammability range (expressed as a percentage by volume in air) of > 20%;
(11) autoignition temperature of < 200℃; and
(12) classified as pollution category X or Y or meeting the criteria for rules 11 to 13 under paragraph 104.5(1).

104. Criteria used to assign the minimum carriage requirements for products, which meet the minimum safety or pollution criteria to make them subject to chapter 17 of the IBC Code

1. Column a - Product Name

The International Union of Pure and Applied Chemistry (IUPAC) name shall be used as far as possible but, where this is unnecessarily complex, then a technically correct and unambiguous alternative chemical name may be used.

2. Column b . Deleted

3. Column c - Pollution Category

Column c identifies the pollution category assigned to each product under Annex II of MARPOL 73/78.

4. Column d - Hazards

An .S. is assigned to column d if any of the safety criteria described in paragraphs 103.1.(1) to 103.1.(11) are met.

A .P. is assigned to column d if the product meets the criteria for assigning Ship Type 1 to 3 as defined by rules 1 to 14 in paragraph 104.5.

5. Column e - Ship Type

(1) The basic criteria for assigning Ship Types based on the GESAMP Hazard Profile are shown in the table below. An explanation of the details in the columns is provided in appendix 1 of MARPOL Annex II. Selected rules, identified in this table, are specified in section (2) for assigning specific Ship Types.

Number	A1	A2	B1	B2	D3	E2	Ship Type
1			≥5				1
2	≥4	NR	4		CMRTNI		
3	≥4	NR			CMRTNI		2
4			4				
5	≥4		3				
6		NR	3				
7				≥1			
8						Fp	
9					CMRTNI	F	
10			≥2			S	
11	≥4						3
12		NR					
13			≥1				
14	All other category Y Substances						
15	All other category Z Substances, All "Other Substances" (OS)						NA

(2) The Ship Type is assigned according to the following criteria:

(A) Ship Type 1:
Inhalation LC_{50} < 0.5 mg/l/4h; and/or
Dermal LD_{50} < 50 mg/kg; and/or
Oral LD_{50} < 5 mg/kg; and/or
Autoignition temperature < 65℃; and/or
Explosive range > 50% v/v in air and the flash point < 23℃; and/or
Rules 1 or 2 of the table shown in (1)

(B) Ship Type 2:
Inhalation LC_{50} > 0.5 mg/l/4h - < 2 mg/l/4h; and/or
Dermal LD_{50} > 50 mg/kg - < 1000 mg/kg; and/or
OralLD50 > 5 mg/kg - < 300 mg/kg; and/or
WRI=2;
Autoignition temperature < 200℃; and/or
Explosive range > 40% v/v in air and the flash point < 23℃; and/or

Any of the rules 3 to 10 of the table shown in (1)

(C) Ship Type 3:
Any of the minimum safety or pollution criteria for bulk liquid cargoes subject to chapter 17 of the IBC Code not meeting the requirements for ship types 1 or 2 and not meeting rule 15 of the table shown in (1)

6. Column f - Tank type

(1) The tank type is assigned according to the following criteria:

(A) Tank type 1G:
Inhalation LC_{50} < 0.5 mg/l/4h; and/or
Dermal LD_{50} < 200 mg/kg); and/or
Autoignition temperature < 65℃; and/or
Explosive range > 40% v/v in air and the flash point < 23℃; and/or
WRI=2

(B) Tank type 2G:
Any of the minimum safety or pollution criteria for bulk liquid cargoes subject to chapter 17 or the IBC Code not meeting the requirements for tank type 1G.

7. Column g - Tank vents

(1) The tank venting arrangements are assigned according to the following criteria:

(A) Controlled:
Inhalation LC_{50} < 10 mg/l/4h; and/or
Toxic to mammals by prolonged exposure; and/or
Respiratory sensitizer; and/or
Special carriage control needed; and/or
Flash point < 60℃
Corrosive to skin (< 4 h exposure)

(B) Open:
Any of the minimum safety or pollution criteria for bulk liquid cargoes subject to chapter 17 or the IBC Code not meeting the requirements for controlled tank vents.

8. Column h - Tank environmental control

(1) The Tank environmental control conditions are assigned according to the following criteria:

(A) Inert:
Autoignition temperature < 200℃; and/or
Reacts with air to cause a hazard; and/or
Explosive range > 40% and the flash point < 23℃.
Dry: WRI > 1

(B) Pad : Only applies to specific products identified on a case by case basis.

(C) Vent: Only applies to specific products identified on a case by case basis.

(D) No: Where the above criteria do not apply, (inerting requirements may be required under SOLAS)

9. Column i - Electrical equipment

(1) If the flash point of the product is < 60℃ or the product is heated to within 15℃ of its flash point then the electrical equipment required are assigned according to the following criteria, else .-. is assigned in column i. and i...

(A) Column i. - Temperature class:
T1 Autoignition temperature > 450℃
T2 Autoignition temperature > 300℃ but < 450℃
T3 Autoignition temperature > 200℃ but < 300℃
T4 Autoignition temperature > 135℃ but < 200℃
T5 Autoignition temperature > 100℃ but < 135℃
T6 Autoignition temperature > 85℃ but < 100℃

(B) Column i.. - Apparatus group:

Apparatus group	MESG at 20 ℃ (mm)	MIC ratio product/methane
IIA	≥ 0.9	> 0.8
IIB	0.5 < but < 0.9	0.45 ≤ but ≤ 0.8
IIC	≤ 0.5	< 0.45

(a) The tests shall be carried out in accordance with the procedures described in IEC 60079-1-1:2002 and IEC 79-3.
(b) For gases and vapours it is sufficient to make only one determination of either the Maximum Experimental Safe Gap (MESG) or the Minimum Igniting Current (MIC) provided that:
(i) for Group IIA: the MESG > 0.9 mm or the MIC ratio > 0.9.
(ii) for Group IIB: the MESG is > 0.55 mm and < 0.9 mm; or the MIC ratio is > 0.5 and <0.8.
(iii) for Group IIC: the MESG is < 0.5 mm or the MIC ratio is <0.45.
(c) It is necessary to determine both the MESG and the MIC ratio when:
(i) The MIC ratio determination only has been made, and the ratio is between 0.8 and 0.9, when an MESG determination will be required;
(ii) The MIC ratio determination only has been made, and the ratio is between 0.45 and 0.5, when an MESG determination will be required; or
(iii) The MESG only has been found, and is between 0.5 mm and 0.55 mm, when an MIC ratio determination will be required.
(C) Column i... Flash point: > 60℃ : Yes
< 60℃ : No
Non-flammable : NF

10. Column j - Gauging

(1) The type of gauging equipment permitted is assigned according to the following criteria:
(A) Closed:
Inhalation LC_{50} < 2 mg/l/4h; and/or
Dermal LD_{50} < 1000 mg/kg; and/or
Toxic to mammals by prolonged exposure; and/or
Respiratory sensitizer; and/or
Corrosive to skin (< 3 min exposure).
(B) Restricted:
Inhalation LC50 > 2 - < 10 mg/l/4h; and/or
Special carriage control indicates Inerting required; and/or
Corrosive to skin (>3 min - < 1 h exposure); and/or
Flash point < 60℃.
(C) Open:
Any of the minimum safety or pollution criteria for bulk liquid cargoes subject to chapter 17 or the IBC Code not meeting the requirements for closed or restricted gauging.

11. Column k - Vapour detection

(1) The type of vapour detection equipment required is determined by the following criteria:
(A) Toxic (T) :
Inhalation LC_{50} < 10 mg/l/4h, and/or
Respiratory sensitizer; and/or
Toxic by prolonged exposure.
(B) Flammable (F) : Flash point < 60℃
(C) No : Where the above criteria do not apply.

12. Column l - Fire protection equipment

(1) The appropriate fire-fighting media are defined as being appropriate according to the following criteria related to the properties of the product:
(A) Solubility > 10% (>100000 mg/l) : A Alcohol-resistant foam.
(B) Solubility < 10% (<100000 mg/l/4h) : A Alcohol-resistant foam; and/or : B Regular foam.
(C) WRI = 0 : C Water spray (generally used as a coolant and can be used with A and/or B providing that the WRI=0).

(D) WRI >1 : D Dry chemical.
(E) No : No requirements under this Code.
(2) Note: all appropriate media shall be listed.

13. Column m . Deleted.

14. Column n - Emergency Equipment

(1) The requirement to have personnel emergency equipment on board is identified by .Yes. in column n according to the following criteria:
Inhalation LC_{50} < 2 mg/l/4h; and/or
Respiratory sensitizer; and/or
Corrosive to skin (< 3 min exposure); and/or
WRI=2
(2) No: indicates that the above criteria do not apply.

105. Criteria for special requirements in chapter 15 to be included in column o

1. The assignment of special requirements in column o shall normally follow clear criteria based on the data supplied in the reporting form. Where it is considered appropriate to deviate from such criteria, this shall be clearly documented in such a way that it can easily be retrieved on demand.

2. The criteria for making reference to the special requirements identified in chapters 15 and 16 are defined below with comments where relevant.

3. Paragraphs 15.2 to 15.10 and 15.20

Paragraphs 15.2 to 15.10 and 15.20 identify specific products by name with special carriage requirements that cannot be easily accommodated in any other way.

4. Paragraph 15.11 - Acids

Paragraph 15.11 applies to all acids unless they:
(1) are organic acids - when only paragraphs 15.11.2 to 15.11.4 and paragraphs 15.11.6 to 15.11.8 apply; or
(2) do not evolve hydrogen - when paragraph 15.11.5 need not apply.

5. Paragraph 15.12 - Toxic products

(1) All of paragraph 15.12 is added to column o according to the following criteria:
Inhalation LC_{50} < 2 mg/l/4h; and/or
the product is a respiratory sensitizer; and/or
the product is toxic to mammals by prolonged exposure.
(2) Paragraph 15.12.3 is added to column o according to the following criteria:
Inhalation LC_{50} > 2 - < 10 mg/l/4h; and/or
Dermal LD_{50} < 1000 mg/kg; and/or
Oral LD_{50} < 300 mg/kg.
(3) Paragraph 15.12.4 is added to column o according to the following criterion:
Inhalation LC_{50} > 2 - < 10 mg/l/4h.

6. Paragraph 15.13 - Cargoes protected by additives

The requirement to assign paragraph 15.13 to column o is based on the information related to the products tendency to polymerise, decompose, oxidise or undergo other chemical changes which may cause a hazard under normal carriage conditions and which would be prevented by the addition of appropriate additives.

7. Paragraph 15.14 - Cargoes with a vapour pressure greater than atmospheric at 37.8℃ The requirement to assign paragraph 15.14 to column o is based on the following criterion : Boiling point < 37.8℃

8. Paragraph 15.16 - Cargo contamination

Paragraph 15.16.1 is deleted.
Paragraph 15.16.2 is added to column o according to the following criterion:
WRI > 1

9. Paragraph 15.17 - Increased ventilation requirements

Paragraph 15.17 shall be added to column o according to the following criteria:
Inhalation LC_{50} > 0.5 - < 2 mg/l/4h; and/or
Respiratory sensitizer; and/or
Toxic to mammals by prolonged exposure; and/or
Corrosive to skin (< 1 h exposure time).

10. Paragraph 15.18 - Special cargo pump-room requirements

Paragraph 15.18 shall be added to column o according to the following criterion:
Inhalation LC_{50} < 0.5 mg/l/4h

11. Paragraph 15.19 - Overflow control

(1) Paragraph 15.19 shall be added to column o according to the following criteria:
Inhalation LC_{50} < 2 mg/l/4h; and/or
Dermal LD_{50} < 1000 mg/kg; and/or
Oral LD_{50} < 300 mg/kg; and/or
Respiratory sensitizer; and/or
Corrosive to skin (< 3 min exposure); and/or
Autoignition temperature < 200℃; and/or
Explosive range > 40% v/v in air and flash point < 23℃; and/or
Classified as ship type 1 on pollution grounds.

(2) Only paragraph 15.19.6 shall apply if the product has any of the following properties:
Inhalation LC_{50} > 2 mg/l/4h - < 10 mg/l/4h; and/or
Dermal LD_{50} > 1000 mg/kg - < 2000 mg/kg; and/or
Oral LD_{50} > 300 mg/kg - < 2000 mg/kg; and/or
Skin sensitizer; and/or
Corrosive to skin (> 3 min - < 1 h exposure); and/or
Flash point <60℃; and/or
Classified as ship type 2 on pollution grounds; and/or
Pollution category X or Y.

12. Paragraph 15.21 . Temperature sensors

Paragraph 15.21 is added to column o according to the heat sensitivity of the product. This requirement is related to pumps in cargo pump rooms only.

106. Criteria for special requirements in chapter 16 to be included in column o

1. Paragraphs 16.1 to 16.2.5 and 16.3 to 16.5

These apply to all cargoes and so are not referenced specifically in column o.

2. Paragraph 16.2.6

Paragraph 16.2.6 is added to column o for products, which meet the following criteria:
Pollution Category X or Y and viscosity > 50 mPa.s at 20℃

3. Paragraph 16.2.7

Paragraph 16.2.7 is added to column o for products, which meet the following criterion:
Melting point > 0℃.

4. Paragraph 16.6 . Cargo not to be exposed to excessive heat

Paragraphs 16.6.2 to 1606.4 are added to column o for products, which are identified as requiring temperature control during carriage.

107. Definitions

1. Acute mammalian toxicity

(1) Acutely toxic by inhalation*

Inhalation toxicity (LC_{50})	
Hazard level	mg/l/4h
High	≤ 0.5
Moderately high	0.5 < but ≤ 2
Moderate	2 < but ≤ 10
Slight	10 < but ≤ 20
Negligible	20 <

(2) Acutely toxic in contact with skin

Dermal toxicity (LD_{50})	
Hazard Level	mg/kg
High	≤ 50
Moderately high	50 < but ≤ 200
Moderate	200 < but ≤ 1000
Slight	1000 < but ≤ 2000
Negligible	2000 <

(3) Acutely toxic if swallowed

Oral toxicity (LD_{50})	
Hazard Level	mg/kg
High	≤ 5
Moderately high	5 < but ≤ 50
Moderate	50 < but ≤ 300
Slight	300 < but ≤ 2000
Negligible	2000 <

* All inhalation toxicity data are assumed to be associated with vapours and not mists or sprays, unless indicated otherwise.

2. Toxic to mammals by prolonged exposure

(1) A product is classified as toxic by prolonged exposure if it meets any of the following criteria: it is known to be, or suspected of being a carcinogen, mutagen, reprotoxic, neurotoxic, immunotoxic or exposure below the lethal dose is known to cause specific organ oriented systemic toxicity (TOST) or other related effects.

(2) Such effects may be identified from the GESAMP Hazard Profile of the product or other recognized sources of such information.

3. Skin sensitization

(1) A product is classified as a skin sensitizer:
if there is evidence in humans that the substance can induce sensitization by skin contact in a substantial number of persons; or
where there are positive results from an appropriate animal test.

(2) When an adjuvant type test method for skin sensitization is used, a response of at least 30% of the animals is considered as positive. For a non-adjuvant test method a response of at least 15% of the animals is considered positive.

(3) When a positive result is obtained from the Mouse Ear Swelling Test (MEST) or the Local Lymph Node Assay (LLNA), this may be sufficient to classify the product as a skin sensitizer.

4. Respiratory sensitization

A product is classified as a respiratory sensitizer:

(1) if there is evidence in humans that the substance can induce specific respiratory hypersensitivity; and/or
(2) where there are positive results from an appropriate animal test; and/or
(3) where the product is identified as a skin sensitizer and there is no evidence to show that it is not a respiratory sensitizer.

5. Corrosive to skin*

Hazard Level	Exposure time to cause full thickness necrosis of skin	Observation time
Severely corrosive to skin	≤ 3 min	≤ 1 h
Highly corrosive to skin	3 min < but ≤ 1 h	≤ 14 days
Moderately corrosive to skin	1 h < but ≤ 4 h	≤ 14 days

* Products that are corrosive to skin are, for the purpose of assigning relevant carriage requirements, deemed to be corrosive by inhalation.

6. Water reactive substances

These are classified into three groups as follows:

Water reactive index (WRI)	Definition
2	Any chemical which, in contact with water, may produce a toxic, flammable or corrosive gas or aerosol.
1	Any chemical which, in contact with water, may generate heat or produce a non-toxic, non-flammable or non corrosive gas.
0	Any chemical which, in contact with water, would not undergo a reaction to justify a valve of 1 or 2.

7. Air reactive substances

Air reactive substances are products which react with air to cause a potentially hazardous situation, e.g. the formation of peroxides which may cause an explosive reaction.

8. Electrical apparatus - Temperature Class (for products which either have a flashpoint of < 60℃ or are heated to within 15℃ of their flashpoint)

(1) The Temperature Class is defined by the International Electrotechnical Commission (IEC) as: The highest temperature attained under practical conditions of operation within the rating of the apparatus (and recognized overloads, if any, associated therewith) by any part of any surface, the exposure of which to an explosive atmosphere may involve a risk.
(2) The Temperature Class of the electrical apparatus is assigned by selecting the Maximum Surface Temperature which is closest to, but less than, the product's autoignition temperature (see 21.4.9.(1)(A)).

9. Electrical apparatus - Apparatus group (for products with a flashpoint of < 60℃)

(1) This refers to intrinsically safe and associated electrical apparatus for explosive gas atmospheres which the IEC divide into the following groups:
    (A) Group I: for mines susceptible to firedamp (not used by IMO); and
    (B) Group II: for applications in other industries - further sub-divided according to its Maximum Experimental Safe Gap (MESG) and/or the Minimum Igniting Current (MIC) of the gas/vapour into groups IIA, IIB and IIC.
(2) This property cannot be determined from other data associated with the product; it has to be either measured or assigned by assimilation with related products in an homologous series.

10. Special carriage control conditions

(1) Special carriage control conditions refer to specific measures that need to be taken in order to either prevent a hazardous reaction. They include:

(A) Inhibition: the addition of a compound (usually organic) that retards or stops an undesired chemical reaction such as corrosion, oxidation or polymerization;

(B) Stabilization: the addition of a substance (stabilizer) that tends to keep a compound, mixture or solution from changing its form or chemical nature. Such stabilizers may retard a reaction rate, preserve a chemical equilibrium, act as antioxidants, keep pigments and other components in emulsion form or prevent the particles in colloidal suspension from precipitating;

(C) Inertion: the addition of a gas (usually nitrogen) in the ullage space of a tank that prevents the formation of a flammable cargo/air mixture;

(D) Temperature control: the maintenance of a specific temperature range for the cargo in order to prevent a hazardous reaction or to keep the viscosity low enough to allow the product to be pumped; and

(E) Padding and venting: only applies to specific products identified on a case by case basis.

11. Flammable cargoes

(1) A cargo is defined as flammable according to the following criteria:

IBC Code descriptor	Flash point (degree Centigrade)
Highly flammable	$<$ 23
Flammable	23 $\leq$ but $\leq$ 60

(2) It should be noted that flash points of mixtures and aqueous solutions need to be measured unless all of the components are non-flammable.

(3) It should be noted that the carriage of bulk liquid cargoes which have a flash point of <60℃ is subject to other SOLAS regulations. ⚓

Rules for the Classification of Steel Ships
Guidance Relating to the Rules for the Classification of Steel Ships

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90 Gajeongbukro, 23-7 Jang-Dong, Yuseong-Gu,
DAEJEON, KOREA
TEL : +82 42 869 9114
FAX : +82 42 862 6011
Website : http://www.krs.co.kr