No. 18961. INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974. CONCLUDED AT LONDON ON 1 NOVEMBER 1974[1]

AMENDMENTS to the above-mentioned Convention

The amendments were adopted on 17 June 1983 by resolution MSC.6(48) of the Maritime Safety Committee of the International Maritime Organization, in accordance with article VIII(*b*)(iv) of the Convention.

They came into force for all Parties to the Convention on 1 July 1986, i.e., six months after the date on which they were deemed to have been accepted (1 January 1986 as determined by the Maritime Safety Committee), no objection having been notified to the Secretary-General of the International Maritime Organization by any Contracting Government prior to that date, in accordance with article VIII of the said Convention.

RESOLUTION MSC.6(48)[2]
adopted on 17 June 1983

ADOPTION OF AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974[3]

The Maritime Safety Committee,

Noting article VIII(*b*) of the International Convention for the Safety of Life at Sea, 1974,[3] hereafter referred to as "the Convention", concerning the procedure for amending the Annex to the Convention, other than the provisions of chapter I thereof,

Noting further the functions which the Convention confers upon the Maritime Safety Committee for the consideration and adoption of amendments to the Convention,

Having considered at its forty-eighth session amendments to the Convention proposed and circulated in accordance with article VIII(*b*)(i) thereof,

1. Adopts in accordance with article VIII(*b*)(iv) of the Convention amendments to chapters II-1, II-2, III, IV and VII of the Convention, the texts of which are given in the Annex to the present resolution;

2. Determines in accordance with article VIII(*b*)(vi)(2)(*bb*) of the Convention that the amendments to chapters II-1, II-2, III, IV and VII shall be deemed to have been accepted on 1 January 1986 unless prior to this date more than one third of Contracting Governments to the Convention or Contracting Governments the combined merchant fleets of which constitute not less than 50% of the gross tonnage of the world's merchant fleet, have notified their objections to the amendments;

3. Invites Contracting Governments to note that in accordance with article VIII(*b*)(vii)(2) of the Convention the amendments to chapters II-1, II-2, III, IV and VII shall enter into force on 1 July 1986 upon their acceptance in accordance with paragraph 2 above;

[1] United Nations, *Treaty Series*, vol. 1184, p. 2 (authentic Chinese and English texts), vol. 1185, p. 3 (authentic French, Russian and Spanish texts), vol. 1300, No. A-18961 (rectification of authentic English, French, Russian and Spanish texts) and vol. 1331, p. 400 (rectification of authentic Chinese text), and annex A in volumes 1198, 1208, 1226, 1266, 1286, 1300, 1323, 1355, 1370, 1371, 1372, 1391, 1402, 1406, 1408, 1419 and 1428.

[2] Resolution published for information by the Secretariat of the United Nations.

[3] United Nations, *Treaty Series*, vol. 1184, p. 2 (authentic Chinese and English texts), and vol. 1185, p. 3 (authentic French, Russian and Spanish texts).

4. Requests the Secretary-General in conformity with article VIII(*b*)(v) of the Convention to transmit certified copies of the present resolution and the texts of the amendments contained in the Annex to all Contracting Governments to the International Convention for the Safety of Life at Sea, 1974;

5. Further requests the Secretary-General to transmit copies of the resolution and its Annex to Members of the Organization which are not Contracting Governments to the Convention.

1983 AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974

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PART 1

CHAPTER II-1. CONSTRUCTION — SUBDIVISION AND STABILITY, MACHINERY AND ELECTRICAL INSTALLATIONS

Chapter II-1 of the Convention is replaced by the text of chapter II-1 annexed to resolution MSC.1(XLV),[1] further amended as follows:

Regulation 1. APPLICATION

In paragraph 1.1, line 3, delete "1 September 1984" and insert "1 July 1986".

In paragraph 1.3.2, line 2, delete "1 September 1984" and insert "1 July 1986".

Replace the whole of paragraph 2 by:

"Unless expressly provided otherwise, for ships constructed before 1 July 1986 the Administration shall ensure that the requirements which are applicable under chapter II-1 of the International Convention for the Safety of Life at Sea, 1974, as amended by resolution MSC.1(XLV), are complied with."

Delete the footnote.

In paragraph 3, lines 4 and 9, delete "1 September 1984" and insert "1 July 1986".

Delete paragraph 5 and renumber paragraph 6 as paragraph 5.

Regulation 3. DEFINITIONS RELATING TO PARTS C, D AND E

In paragraph 18, delete "fiire" and insert "fire".

Amend paragraph 19 as follows:

"'Chemical tanker' is a cargo ship constructed or adapted and used for the carriage in bulk of any liquid product listed in either:

[1] See p. 353 of this volume.

.1 Chapter 17 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk[1] adopted by the Maritime Safety Committee by resolution MSC.4(48), hereinafter referred to as 'the International Bulk Chemical Code', as may be amended by the Organization; or

.2 Chapter VI of the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted by the Assembly of the Organization by resolution A.212(VII),[2] hereinafter referred to as 'the Bulk Chemical Code', as has been or may be amended by the Organization;

whichever is applicable."

Amend paragraph 20 to read:

"'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 either:

.1 Chapter 19 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk[3] adopted by the Maritime Safety Committee by resolution MSC.5(48) hereinafter referred to as 'the International Gas Carrier Code', as may be amended by the Organization; or

.2 Chapter XIX of the Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk adopted by the Assembly of the Organization by resolution A.328(IX),[4] hereinafter referred to as 'the Gas Carrier Code', as has been or may be amended by the Organization;

whichever is applicable."

Regulation 4. FLOODABLE LENGTH IN PASSENGER SHIPS

Paragraph 1, line 3, delete "andd" and insert "and".

Regulation 5. PERMEABILITY IN PASSENGER SHIPS

Amend paragraph 4.1 to read:

"4.1. In the case of special subdivision required in regulation 6.5, the uniform average permeability throughout the portion of the ship forward of or abaft the machinery space shall be 95-35 b/v where:

b = the volume of the spaces below the margin line and above the tops of floors, inner bottom, or peak tanks, as the case may be, which are appropriated to and used as cargo spaces, coal or oil fuel bunkers, storerooms, baggage and mail rooms, chain lockers and fresh water tanks, forward of or abaft the machinery space; and

v = the whole volume of the portion of the ship below the margin line forward of or abaft the machinery space."

Regulation 6. PERMISSIBLE LENGTH OF COMPARTMENTS IN PASSENGER SHIPS

Paragraph 2.2, line 2, delete "seervice" and insert "service".

Replace the heading of section 5 by "Special subdivision standards for ships complying with regulation III/20.1.2."

Insert new paragraphs 5.3 and 5.4 as follows:

"5.3 The special provisions regarding permeability given in regulation 5.4 shall be employed when calculating the floodable length curves.

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[1] See p. 353 of this volume.

[2] *Resolutions and Other Decisions, Intergovernmental Maritime Consultative Organization Assembly, Seventh Session, 5-15 October 1971*, p. 33.

[3] See p. 421 of this volume.

[4] *Resolutions and Other Decisions, Intergovernmental Maritime Consultative Organization Assembly, Ninth Session, 3-14 November 1975*, p. 90.

5.4 Where the Administration is satisfied that, having regard to the nature and conditions of the intended voyages compliance with the other provisions of this chapter and of chapter II-2 is sufficient, the requirements of this paragraph need not be complied with."

Regulation 41. MAIN SOURCE OF ELECTRICAL POWER AND LIGHTING SYSTEMS

Paragraph 1.3, line 3, insert "of rotation" after "direction".

Regulation 42. EMERGENCY SOURCE OF ELECTRICAL POWER IN PASSENGER SHIPS

Amend sub-paragraph 2.1.1 to read:

".1 At every muster and embarkation station and over the sides as required by regulations III/11.4 and III/15.7".

Insert new sub-paragraph 2.1.2 to read:

".2 In alleyways, stairways and exits giving access to the muster and embarkation stations, as required by regulation III/11.5".

Renumber sub-paragraphs 2.1.2 to 2.1.7 to read 2.1.3 to 2.1.8.

Paragraph 2.3.4, line 2, delete "manual fire alarms" and insert "manually operated call points".

Regulation 43. EMERGENCY SOURCE OF ELECTRICAL POWER IN CARGO SHIPS

Paragraph 1.3, line 10, delete "sppace" and insert "space".

Amend paragraph 2.1 to read:

"2.1 For a period of 3 h, emergency lighting at every muster and embarkation station and over the sides as required by regulations III/11.4 and III/15.7."

Paragraph 2.4.4, line 2, delete "manual fire alarms" and insert "manually operated call points".

Regulation 49. CONTROL OF PROPULSION MACHINERY FROM THE NAVIGATING BRIDGE

Paragraph 3, line 6, delete "the machinery space" and insert "the main machinery space"; delete "the machinery control room" and insert "the main machinery control room".

Paragraph 5, line 3, insert "of the propeller" after "thrust".

Paragraph 6.1, line 1, delete "in case" and insert "in the case".

Paragraph 6.2, line 1, delete "in case" and insert "in the case".

PART 2

CHAPTER II-2. CONSTRUCTION – FIRE PROTECTION, FIRE DETECTION, AND FIRE EXTINCTION

Chapter II-2 of the Convention is replaced by the text of chapter II-2 annexed to resolution MSC.1(XLV), further amended as follows:

Regulation 1. APPLICATION

In paragraph 1.1, line 3, delete "1 September 1984" and insert "1 July 1986".

In paragraph 1.3.2, line 2, delete "1 September 1984" and insert "1 July 1986".

Replace the whole of paragraph 2 by:

"Unless expressly provided otherwise, for ships constructed before 1 July 1986 the Administration shall ensure that the requirements which are applicable under chapter II-2 of the International Convention for the Safety of Life at Sea, 1974, as amended by resolution MSC.1(XLV), are complied with."

In paragraph 3, lines 4 and 9, delete "1 September 1984" and insert "1 July 1986".

Delete the footnote.

Regulation 3. DEFINITIONS

In paragraph 12, correct "main and specie rooms" to read ""mail and specie rooms".

Paragraph 30, amend to:

"'Chemical tanker' is a tanker constructed or adapted and used for the carriage in bulk of any liquid product of a flammable nature listed in either:

.1 Chapter 17 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted by the Maritime Safety Committee by resolution MSC.4(48), hereinafter referred to as 'the International Bulk Chemical Code', as may be amended by the Organization; or

.2 Chapter VI of the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted by the Assembly of the Organization by resolution A.212(VII), hereinafter referred to as 'the Bulk Chemical Code', as has been or may be amended by the Organization;

whichever is applicable."

Paragraph 31, amend to:

"'Gas carrier' is a tanker constructed or adapted and used for the carriage in bulk of any liquefied gas or other products of a flammable nature listed in either:

.1 Chapter 19 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk adopted by the Maritime Safety Committee by resolution MSC.5(48), hereinafter referred to as 'the International Gas Carrier Code', as may be amended by the Organization; or

.2 Chapter XIX of the Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk adopted by the Assembly of the Organization by resolution A.328(IX), hereinafter referred to as 'the Gas Carrier Code', as has been or may be amended by the Organization;

whichever is applicable."

Add an additional paragraph to read:

"32. 'Cargo area' is that part of the ship that contains cargo tanks, slop tanks and cargo pump rooms including pump rooms, cofferdams, ballast and void spaces adjacent to cargo tanks and also deck areas throughout the entire length and breadth of the part of the ship over the above-mentioned spaces."

Regulation 4. FIRE PUMPS, FIRE MAINS, HYDRANTS AND HOSES

In paragraph 3.3.2.6, line 3, delete "room" and insert "station".

Regulation 5. FIXED GAS FIRE-EXTINGUISHING SYSTEMS

In paragraph 2.2, line 2, delete "quantity" and insert "volume".

In paragraph 2.2, line 3, delete "quantities" and insert "volumes".

Regulation 6. FIRE EXTINGUISHERS

In paragraph 7, line 2, delete "provideed" and insert "provided".

Regulation 7. FIRE-EXTINGUISHING ARRANGEMENTS IN MACHINERY SPACES

In paragraph 1.2, lines 1 and 2, delete "air foam equipment" and insert "foam applicator unit".

Regulation 11. SPECIAL ARRANGEMENTS IN MACHINERY SPACES

In the first line of paragraph 8, amend "An approved automatic fire detection and alarm system" to read "A fixed fire detection and alarm system".

Regulation 12. AUTOMATIC SPRINKLER, FIRE DETECTION AND FIRE ALARM SYSTEMS

In paragraph 3, correct "sppaced" to read "spaced".

Regulation 13. FIXED FIRE DETECTION AND FIRE ALARM SYSTEMS

In paragraph 2.1, lines 1, 2, 3 and 5, delete "Manual" and insert "Manually operated".

Regulation 14. FIXED FIRE DETECTION AND FIRE ALARM SYSTEMS FOR PERIODICALLY UNATTENDED MACHINERY SPACES

In paragraph 1, line 1, amend to read "A fixed fire detection and fire alarm system of an approved type in accordance with the".

Regulation 15. ARRANGEMENTS FOR OIL FUEL, LUBRICATING OIL AND OTHER FLAMMABLE OILS

Insert a new paragraph 6 to read:

"6. *Prohibition of carriage of flammable oils in forepeak tanks*

Oil fuel, lubricating oil and other flammable oils shall not be carried in forepeak tanks".

Regulation 20. FIRE CONTROL PLANS

Paragraph 1, lines 14 and 15, delete "national language" and insert "official language of the flag State".

Regulation 26. FIRE INTEGRITY OF BULKHEADS AND DECKS IN SHIPS CARRYING MORE THAN 36 PASSENGERS

Paragraph 2.2, line 1, delete "for the purpose of" and insert "For"; line 10, delete "number".

Paragraph 2.2(1), line 4, delete "fire control and recording stations" and insert "fire control rooms and fire-recording stations".

Paragraph 2.2(5), line 3, delete "Air space" and insert "Air spaces".

Table 26.2, line 5, delete "space" and insert "spaces".

Regulation 27. FIRE INTEGRITY OF BULKHEADS AND DECKS IN SHIPS CARRYING NOT MORE THAN 36 PASSENGERS

Paragraph 2.2(1), line 4, delete "stations" and insert "rooms".

In table 27.1, line 2, column 4; line 3, column 4; line 4, column 4; line 4, column 5, replace B-0[e] by A-0[a]; A-0[a], B-0[e].

Paragraph 4, line 4, delete "this chapter" and insert "this part".

Regulation 32. VENTILATION SYSTEMS

Paragraph 1.4.3.1, line 1, delete "restricted" and insert "low".

Replace Regulation 36 by:

"*Regulation 36.* FIXED FIRE DETECTION AND FIRE ALARM SYSTEMS; AUTOMATIC SPRINKLER, FIRE DETECTION AND FIRE ALARM SYSTEMS

In any ship to which this part applies, there shall be installed throughout each separate zone, whether vertical or horizontal, in all accommodation and service spaces and, where it is considered necessary by the Administration, in control stations, except spaces which afford no substantial fire risk such as void spaces, sanitary spaces, etc., either:

.1 A fixed fire detection and fire alarm system of an approved type and complying with the requirements of regulation 13 and so installed and arranged as to detect the presence of fire in such spaces; or

.2 An automatic sprinkler, fire detection and fire alarm system of an approved type and complying with the requirements of regulation 12 and so installed and arranged as to protect such spaces and in addition a fixed fire detection and fire alarm system of an approved type complying with the requirements of regulation 13 so installed and arranged as to provide smoke detection in corridors, stairways and escape routes within accommodation spaces."

Regulation 37. PROTECTION OF SPECIAL CATEGORY SPACES

Amend the text of paragraph 1.4.1 to read:

"1.4.1. An efficient patrol system shall be maintained in special category spaces. In any such space in which the patrol is not maintained by a continuous fire watch at all times during the voyage there shall be provided a fixed fire detection and fire alarm system of an approved type complying with the requirements of regulation 13. The fixed fire detection system shall be capable of rapidly detecting the onset of fire. The spacing and location of detectors shall be tested to the satisfaction of the Administration taking into account the effects of ventilation and other relevant factors."

Amend the text of paragraph 2.2.1 to read:

"2.2.1. On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, equipment which may constitute a source of ignition of flammable vapours and, in particular, electrical equipment and wiring, shall be installed at least 450 mm above the deck or platform. Electrical equipment installed at more than 450 mm above the deck or platform shall be of a type so enclosed and protected as to prevent the escape of sparks. However, if the Administration is satisfied that the installation of electrical equipment and wiring at less than 450 mm above the deck or platform is necessary for the safe operation of the ship, such electrical equipment and wiring may be installed provided that it is of a type approved for use in an explosive petrol and air mixture."

Regulation 40. FIRE PATROLS, DETECTION, ALARMS AND PUBLIC ADDRESS SYSTEMS

Amend paragraphs 1 and 2 to read:

"1. Manually operated call points complying with the requirements of regulation 13 shall be installed".

"2. A fixed fire detection and fire alarm system of an approved type shall be provided".

Regulation 42. STRUCTURE

In paragraph 1, second line, amend "deck" to read "decks".

Regulation 49. RESTRICTED USE OF COMBUSTIBLE MATERIALS

Amend the text of paragraph 3 to read:

"Primary deck coverings, if applied within accommodation and service spaces and control stations, shall be of approved material which will not readily ignite, or give rise to toxic or explosive hazards at elevated temperatures.**"

Regulation 51. ARRANGEMENTS FOR GASEOUS FUEL FOR DOMESTIC PURPOSES

Delete comma and insert "for the" after "arrangements".

Regulation 52. FIXED FIRE DETECTION AND FIRE ALARM SYSTEMS; AUTOMATIC SPRINKLER, FIRE DETECTION AND FIRE ALARM SYSTEMS

Amend the first three paragraphs to read:

"1. In ships in which method IC is adopted, a fixed fire detection and fire alarm system of an approved type complying with the requirements of regulation 13 shall be so installed and arranged as to provide smoke detection and manually operated call points in all corridors, stairways and escape routes within accommodation spaces.

2. In ships in which method IIC is adopted, an automatic sprinkler, fire detection and fire alarm system of an approved type complying with the relevant requirements of regulation 12 shall be so installed and arranged as to protect accommodation spaces, galleys and other service spaces, except spaces which afford no substantial fire risk such as void spaces, sanitary spaces, etc. In addition, a fixed fire detection and fire alarm system of an approved type complying with the requirements of regulation 13 shall be so installed and arranged as to provide smoke detection and manually operated call points in all corridors, stairways and escape routes within accommodation spaces.

3. In ships in which method IIIC is adopted, a fixed fire detection and fire alarm system of an approved type complying with the requirements of regulation 13 shall be so installed and arranged as to detect the presence of fire in all accommodation spaces and service spaces, except spaces which afford no substantial fire risk such as void spaces, sanitary spaces, etc."

Delete paragraph 4.

Regulation 53. FIRE PROTECTION ARRANGEMENTS IN CARGO SPACES

In paragraph 1.3, line 4, delete "by" and insert "with".

Amend the first sentence of paragraph 2.1 to read: "There shall be provided a fixed fire detection and fire alarm system of an approved type."

Replace paragraph 2.4.2 by the following:

".2 Above a height of 450 mm from the deck and from each platform for vehicles, if fitted, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, electrical equipment of a type so enclosed and protected as to prevent the escape of sparks shall be permitted as an alternative on condition

that the ventilating system is so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least 10 air changes per hour whenever vehicles are on board."

Regulation 54. SPECIAL REQUIREMENTS FOR SHIPS CARRYING DANGEROUS GOODS

In table 54.2, note *f*, amend "... in addition to those enumerated..." to read "... in addition to meeting the requirements enumerated...".

Amend the first sentence in paragraph 2.3 to read: "A fixed fire detection and fire alarm system of an approved type shall be fitted to all enclosed cargo spaces including closed vehicle deck spaces."

Regulation 55. APPLICATION

Amend paragraph 2 to read:

"Where liquid cargoes other than those referred to in paragraph 1 or liquefied gases which introduce additional fire hazards are intended to be carried, additional safety measures shall be required to the satisfaction of the Administration, having due regard to the provisions of the International Bulk Chemical Code, the Bulk Chemical Code, the International Gas Carrier Code and the Gas Carrier Code, as appropriate."

Amend paragraph 6 to read:

"Chemical tankers and gas carriers shall comply with the requirements of this part, except where alternative and supplementary arrangements are provided to the satisfaction of the Administration, having due regard to the provisions of the International Bulk Chemical Code, the Bulk Chemical Code, the International Gas Carrier Code and the Gas Carrier Code, as appropriate."

Regulation 56. LOCATION AND SEPARATION OF SPACES

Replace the text of the whole regulation by:

"1. Machinery spaces shall be positioned aft of cargo tanks and slop tanks; they shall also be situated aft of cargo pump rooms and cofferdams, but not necessarily aft of the oil fuel bunker tanks. Any machinery space shall be isolated from cargo tanks and slop tanks by cofferdams, cargo pump rooms, oil fuel bunker tanks or permanent ballast tanks. Pump rooms containing pumps and their accessories for ballasting those spaces situated adjacent to cargo tanks and slop tanks and pumps for oil fuel transfer shall be considered as equivalent to a cargo pump room within the context of this regulation, provided that such pump rooms have the same safety standard as that required for cargo pump rooms. However, the lower portion of the pump room may be recessed into machinery spaces of category A to accommodate pumps, provided that the deck head of the recess is in general not more than one third of the moulded depth above the keel, except that in the case of ships of not more than 25,000 tonnes deadweight, where it can be demonstrated that for reasons of access and satisfactory piping arrangements this is impracticable, the Administration may permit a recess in excess of such height, but not exceeding one half of the moulded depth above the keel.

2. Accommodation spaces, main cargo control stations, control stations and service spaces (excluding isolated cargo handling gear lockers) shall be positioned aft of all cargo tanks, slop tanks, cargo pump rooms and cofferdams which isolate cargo or slop tanks from machinery spaces but not necessarily aft of the oil fuel bunker tanks. A recess provided in accordance with paragraph 1 need not be taken into account when the position of these spaces is being determined.

3. However, where deemed necessary, accommodation spaces, control stations, machinery spaces other than those of category A, and service spaces may be permitted forward of the cargo area, provided they are isolated from the cargo tanks and slop tanks by

cofferdams, cargo pump rooms, oil fuel bunker tanks or permanent ballast tanks and subject to an equivalent standard of safety and appropriate availability of fire-extinguishing arrangements being provided to the satisfaction of the Administration. In addition, where deemed necessary for the safety or navigation of the ship, the Administration may permit machinery spaces containing internal combustion machinery not being main propulsion machinery having an output greater than 375 kW to be located forward of the cargo area provided the arrangements are in accordance with the provisions of this paragraph.

4. In combination carriers only:

.1 The slop tanks are to be surrounded by cofferdams except where the boundaries of the slop tanks where slop may be carried on dry cargo voyages are the hull, main cargo deck, cargo pump room bulkhead or oil fuel bunker tank. These cofferdams shall not be open to a double bottom, pipe tunnel, pump room or other enclosed space. Means shall be provided for filling the cofferdams with water and for draining them. Where the boundary of a slop tank is the cargo pump room bulkhead the pump room shall not be open to the double bottom, pipe tunnel or other enclosed space, however, openings provided with gastight bolted covers may be permitted.

.2 Means shall be provided for isolating the piping connecting the pump room with the slop tanks referred to in paragraph 4.1. The means of isolation shall consist of a valve followed by a spectacle flange or a spool piece with appropriate blank flanges. This arrangement shall be located adjacent to the slop tanks, but where this is unreasonable or impracticable it may be located within the pump room directly after the piping penetrates the bulkhead. A separate pumping and piping arrangement shall be provided for discharging the contents of the slop tanks directly over the open deck when the ship is in the dry cargo mode.

.3 Hatches and tank cleaning openings to slop tanks shall only be permitted on the open deck and shall be fitted with closing arrangements. Except where they consist of bolted plates with bolts at watertight spacing, these closing arrangements shall be provided with locking arrangements which shall be under the control of the responsible ship's officer.

.4 Where cargo wing tanks are provided, cargo oil lines below deck shall be installed inside these tanks. However, the Administration may permit cargo oil lines to be placed in special ducts which shall be capable of being adequately cleaned and ventilated and be to the satisfaction of the Administration. Where cargo wing tanks are not provided cargo oil lines below deck shall be placed in special ducts.

5. Where the fitting of a navigation position above the cargo area is shown to be necessary, it shall be for navigation purposes only and it shall be separated from the cargo tank deck by means of an open space with a height of at least 2 m. The fire protection of such a navigation position shall in addition be as required for control spaces in regulation 58.1 and 58.2 and other provisions, as applicable, of this part.

6. Means shall be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by provision of a permanent continuous coaming of a suitable height extending from side to side. Special consideration shall be given to the arrangements associated with stern loading.

7. Exterior boundaries of superstructures and deckhouses enclosing accommodation and including any overhanging decks which support such accommodation, shall be insulated to 'A-60' standard for the whole of the portions which face the cargo area and for 3 m aft of the front boundary. In the case of the sides of those superstructures and deckhouses, such insulation shall be carried as high as is deemed necessary by the Administration.

8.1. Entrances, air inlets and openings to accommodation spaces, service spaces and control stations shall not face the cargo area. They shall be located on the transverse

bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse at a distance of at least 4% of the length of the ship but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area. This distance, however, need not exceed 5 m.

8.2. No doors shall be fitted within the limits specified in paragraph 8.1 except that doors to spaces not having access to accommodation spaces, service spaces and control stations may be permitted by the Administration. Such spaces may be cargo control stations, provision rooms and store-rooms. Where such doors are fitted to spaces located aft of the cargo area, the boundaries of the space shall be insulated to 'A-60' standard, with the exception of the boundary facing the cargo area. Bolted plates for removal of machinery may be fitted within the limits specified in paragraph 8.1. Wheelhouse doors and wheelhouse windows may be located within the limits specified in paragraph 8.1 so long as they are designed to ensure that the wheelhouse can be made rapidly and efficiently gas and vapour tight.

8.3. Windows and sidescuttles facing the cargo area and on the sides of the superstructures and deckhouses within the limits specified in paragraph 8.1 shall be of the fixed (non-opening) type. Such windows and sidescuttles in the first tier on the main deck shall be fitted with inside covers of steel or other equivalent material."

Regulation 58. FIRE INTEGRITY OF BULKHEADS AND DECKS

In table 1, note [b], line 1, delete "b" and insert "b".

Paragraph 4, line 4, delete "these Requirements" and insert "this part".

Regulation 59. VENTING, PURGING, GAS FREEING AND VENTILATION

Paragraph 2, line 16, delete "gas" and insert "vapour"; line 18, delete "gas" and insert "vapour"; lines 16, 17 and 18, "When. . . level." forms part of paragraph 2 and must be moved to that paragraph's margin.

Amend paragraph 3.3 as follows:

In the third sentence, amend "referred to in Regulation 56.1" to read "referred to in regulation 56.4".

In the fourth sentence, amend "cargo tank area" to read "cargo area".

Regulation 61. FIXED DECK FOAM SYSTEMS

In paragraph 1, amend "cargo tank area" to read "cargo tanks deck area".

In paragraph 2, amend "cargo tank area" to read "cargo area" in the second sentence.

In paragraph 3.1, amend "cargo deck area" to read "cargo tanks deck area".

In paragraph 7 in the first and second sentence, amend "cargo deck" to read "cargo tank deck".

In paragraph 8, third line, amend "400 ℓ" to read "400 ℓ/min". In the fourth sentence amend "any cargo tank deck area" to read "any part of the cargo tanks deck area".

Regulation 62. INERT GAS SYSTEMS

In paragraph 1, delete "non fllammable" and insert "non flammable".

In paragraph 9.1, lines 2 and 3, delete "19.2" and insert "19.3" and "19.4" respectively.

In paragraph 10.2, amend "cargo tank area" to read "cargo area".

Replace paragraph 14.1 by:

"14.1 One or more pressure vacuum breaking devices shall be provided to prevent the cargo tanks from being subject to:

.1 A positive pressure in excess of the test pressure of the cargo tank if the cargo were to be loaded at the maximum rated capacity and all other outlets are left shut; and

.2 A negative pressure in excess of 700 mm water gauge if cargo were to be discharged at the maximum rated capacity of the cargo pumps and the inert gas blowers were to fail.

Such devices shall be installed on the inert gas main unless they are installed in the venting system required by regulation 59.1.1 or on individual cargo tanks."

In paragraph 20.1, amend the last line to read "10.2, 10.7, 10.9, 11.3, 11.4, 12, 13.1, 13.2, 13.4.2, 14.2 and 19.8;"

In paragraph 20.2, amend the last line to read "12, 13.1, 13.2 and 14.2."

PART 3

CHAPTER III

The existing text of chapter III is replaced by the following:

LIFE-SAVING APPLIANCES AND ARRANGEMENTS

PART A. GENERAL

Regulation 1. APPLICATION

1. Unless expressly provided otherwise, this chapter shall apply to ships the keels of which are laid or which are at a similar stage of construction on or after 1 July 1986.

2. For the purpose of this chapter the term "a similar stage of construction" means the stage at which:

.1 Construction identifiable with a specific ship begins; and

.2 Assembly of that ship has commenced comprising at least 50 tonnes or 1% of the estimated mass of all structural material, whichever is less.

3. For the purpose of this chapter:

.1 The expression "ships constructed" means "ships the keels of which are laid or which are at a similar stage of construction".

.2 The expression "all ships" means "ships constructed before, on or after 1 July 1986"; the expressions "all passenger ships" and "all cargo ships" shall be construed accordingly.

.3 A cargo ship, whenever built, which is converted to a passenger ship shall be treated as a passenger ship constructed on the date on which such a conversion commences.

4. For ships constructed before 1 July 1986, the Administration shall:

.1 Ensure that, subject to the provisions of [paragraphs] 4.2 and 4.3, the requirements which are applicable under chapter III of the International Convention for the Safety of Life at Sea, 1974, in force prior to 1 July 1986 to new or existing ships as prescribed by that chapter are complied with;

.2 Consider the life-saving appliances and arrangements in ships which do not comply with the requirements referred to in paragraph 4.1, with a view to securing, so far as this is reasonable and practicable and as early as possible, substantial compliance with those requirements;

.3 Ensure that when life-saving appliances or arrangements on such ships are replaced or such ships undergo repairs, alterations or modifications of a major character which involve replacement of, or any addition to, their existing life-saving appliances or arrangements, such life-saving appliances or arrangements, in so far as is reasonable and practicable, comply with the requirements of this chapter. However, if a survival craft is replaced without replacing its launching appliance, or vice versa, the survival craft or launching appliance may be of the same type as that replaced;

.4 Approve the life-saving appliances to be provided in compliance with paragraph 6. The Administration may permit those life-saving appliances provided on board ships prior to 1 July 1991 not to comply fully with the requirements of this chapter as long as they remain in a satisfactory condition;

.5 Except as provided for survival craft and launching appliances referred to in paragraph 4.3, ensure that life-saving appliances replaced or installed on or after 1 July 1991 are evaluated, tested and approved in accordance with the requirements of regulations 4 and 5.

5. With respect to ships constructed before 1 July 1986 the requirements of regulations 8, 9, 10, 18 and 25 and, to the extent prescribed therein, regulation 19 shall apply.

6. With respect to ships constructed before 1 July 1986 the requirements of regulations 6.2.3, 6.2.4, 21.3, 21.4, 26.3, 27.2, 27.3 and 30.2.7 shall apply not later than 1 July 1991.

Regulation 2. EXEMPTIONS

1. The Administration may, if it considers that the sheltered nature and conditions of the voyage are such as to render the application of any specific requirements of this chapter unreasonable or unnecessary, exempt from those requirements individual ships or classes of ships which, in the course of their voyage, do not proceed more than 20 miles from the nearest land.

2. In the case of passenger ships which are employed in special trades for the carriage of large numbers of special trade passengers, such as the pilgrim trade, the Administration, if satisfied that it is impracticable to enforce compliance with the requirements of this chapter, may exempt such ships from those requirements, provided that such ships comply fully with the provisions of:

.1 The rules annexed to the Special Trade Passenger Ships Agreement, 1971;[1] and

.2 The rules annexed to the Protocol on Space Requirements for Special Trade Passenger Ships, 1973.[2]

Regulation 3. DEFINITIONS

For the purpose of this chapter, unless expressly provided otherwise:

1. Certificated person is a person who holds a certificate of proficiency in survival craft issued under the authority of, or recognized as valid by, the Administration in accordance with the requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers,[3] in force; or a person who holds a certificate issued or recognized by the Administration of a State not a Party to that Convention for the same purpose as the convention certificate.

2. Detection is the determination of the location of survivors or survival craft.

3. Embarkation ladder is the ladder provided at survival craft embarkation stations to permit safe access to survival craft after launching.

4. Float-free launching is that method of launching a survival craft whereby the craft is automatically released from a sinking ship and is ready for use.

5. Free-fall launching is that method of launching a survival craft whereby the craft with its complement of persons and equipment on board is released and allowed to fall into the sea without any restraining apparatus.

6. Immersion suit is a protective suit which reduces the body heat-loss of a person wearing it in cold water.

[1] United Nations, *Treaty Series*, vol. 910, p. 61.
[2] United Nations, *Treaty Series*, vol. 1046, p. 317.
[3] *Ibid.*, vol. 1361, p. 2 (authentic Chinese and English texts), and vol. 1362, p. 2 (authentic French, Russian and Spanish texts).

7. Inflatable appliance is an appliance which depends upon non-rigid, gas filled chambers for buoyancy and which is normally kept uninflated until ready for use.

8. Inflated appliance is an appliance which depends upon non-rigid, gas filled chambers for buoyancy and which is kept inflated and ready for use at all times.

9. Launching appliance or arrangement is a means of transferring a survival craft or rescue boat from its stowed position safely to the water.

10. Length is 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 fore-side 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 is measured shall be parallel to the designed waterline.

11. Moulded depth

.1 The moulded depth is the vertical distance measured from the top of the keel to the top of the freeboard deck beam at side. In wood and composite ships the distance is measured from the lower edge of the keel rabbet. Where the form at the lower part of the midship section is of a hollow character, or where thick garboards are fitted, the distance is measured from the point where the line of the flat of the bottom continued inwards cuts the side of the keel.

.2 In ships having rounded gunwales, the moulded depth shall be measured to the point of intersection of the moulded lines of the deck and side shell plating, the lines extending as though the gunwale were of angular design.

.3 Where the freeboard deck is stepped and the raised part of the deck extends over the point at which the moulded depth is to be determined, the moulded depth shall be measured to a line of reference extending from the lower part of the deck along a line parallel with the raised part.

12. Novel life-saving appliance or arrangement is a life-saving appliance or arrangement which embodies new features not fully covered by the provisions of this chapter but which provides an equal or higher standard of safety.

13. Rescue boat is a boat designed to rescue persons in distress and to marshal survival craft.

14. Retrieval is the safe recovery of survivors.

15. Retro-reflective material is a material which reflects in the opposite direction a beam of light directed on it.

16. Short international voyage is an international voyage in the course of which a ship is not more than 200 miles from a port or place in which the passengers and crew could be placed in safety. Neither the distance between the last port of call in the country in which the voyage begins and the final port of destination nor the return voyage shall exceed 600 miles. The final port of destination is the last port of call in the scheduled voyage at which the ship commences its return voyage to the country in which the voyage began.

17. Survival craft is a craft capable of sustaining the lives of persons in distress from the time of abandoning the ship.

18. Thermal protective aid is a bag or suit made of waterproof material with low thermal conductivity.

Regulation 4. EVALUATION, TESTING AND APPROVAL OF LIFE-SAVING APPLIANCES AND ARRANGEMENTS

1. Except as provided in paragraphs 5 and 6, life-saving appliances and arrangements required by this chapter shall be approved by the Administration.

2. Before giving approval to life-saving appliances and arrangements, the Administration shall ensure that such life-saving appliances and arrangements:

.1 Are tested, to confirm that they comply with the requirements of this chapter, in accordance with the recommendations of the Organization;* or

.2 Have successfully undergone, to the satisfaction of the Administration, tests which are substantially equivalent to those specified in those recommendations.

3. Before giving approval to novel life-saving appliances or arrangements, the Administration shall ensure that such appliances or arrangements:

.1 Provide safety standards at least equivalent to the requirements of this chapter and have been evaluated and tested in accordance with the recommendations of the Organization;** or

.2 Have successfully undergone, to the satisfaction of the Administration, evaluation and tests which are substantially equivalent to those recommendations.

4. Procedures adopted by the Administration for approval shall also include the conditions whereby approval would continue or would be withdrawn.

5. Before accepting life-saving appliances and arrangements that have not been previously approved by the Administration, the Administration shall be satisfied that life-saving appliances and arrangements comply with the requirements of this chapter.

6. Life-saving appliances required by this chapter for which detailed specifications are not included in part C shall be to the satisfaction of the Administration.

Regulation 5. PRODUCTION TESTS

The Administration shall require life-saving appliances to be subjected to such production tests as are necessary to ensure that the life-saving appliances are manufactured to the same standard as the approved prototype.

PART B. SHIP REQUIREMENTS

SECTION I. PASSENGER SHIPS AND CARGO SHIPS

Regulation 6. COMMUNICATIONS

1. Paragraphs 2.3 and 2.4 apply to all ships. With respect to ships constructed before 1 July 1986, paragraphs 2.3 and 2.4 shall apply not later than 1 July 1991.

2. *Radio life-saving appliances*

2.1. *Portable radio apparatus for survival craft*

2.1.1. A portable radio apparatus for survival craft complying with the requirements of regulation IV/14 shall be provided. The portable radio apparatus shall be stowed in a protected and easily accessible position ready to be moved to any survival craft in an emergency, except that in the case of a ship with lifeboats stowed in widely separated positions fore and aft, the portable radio apparatus shall be stowed in the vicinity of the lifeboats which are furthest away from the ship's main transmitter.

2.1.2. The requirements of paragraph 2.1.1 need not be complied with if a radio installation complying with the requirements of regulation IV/13 is fitted in a lifeboat on each side of the ship or in the stern-launched lifeboat referred to in regulation 26.1.2.1.

* Reference is made to the "Recommendation on testing of life-saving appliances" to be submitted to the Assembly of the Organization at its thirteenth session for adoption.

** Reference is made to the "Code of practice for the evaluation, testing and acceptance of prototype novel life-saving appliances and arrangements" to be submitted to the Assembly of the Organization at its thirteenth session for adoption.

2.1.3. On ships engaged on voyages of such duration that in the opinion of the Administration portable radio apparatus for survival craft is unnecessary, the Administration may allow such equipment to be dispensed with.

2.2. *Radiotelegraph installation for lifeboats*

On passenger ships engaged on international voyages which are not short international voyages:

.1 Where the total number of persons on board is more than 199 but less than 1,500, a radiotelegraph installation complying with the requirements of regulation IV/13 shall be fitted in at least one of the lifeboats required by regulation 20.1.1.1;

.2 Where the total number of persons on board is 1,500 or more, at least one lifeboat on each side shall be so fitted.

2.3. *Survival craft emergency position-indicating radio beacons*

One manually activated emergency position-indicating radio beacon complying with the requirements of regulation IV/14-1 shall be carried on each side of the ship. They shall be so stowed that they can be rapidly placed in any survival craft other than the liferaft or liferafts required by regulation 26.1.4.

2.4. *Two-way radiotelephone apparatus*

2.4.1. Two-way radiotelephone apparatus complying with the requirements of regulation IV/14-3 shall be provided for communication between survival craft, between survival craft and ship and between ship and rescue boat. An apparatus need not be provided for every survival craft; however, at least three apparatus shall be provided on each ship. This requirement may be complied with by other apparatus used on board provided such apparatus is not incompatible with the appropriate requirements of regulation IV/14-3.

2.4.2. For ships constructed before 1 July 1986 such apparatus need only comply with the frequency requirements of regulation IV/14-3.

3. *Distress flares*

Not less than 12 rocket parachute flares, complying with the requirements of regulation 35, shall be carried and be stowed on or near the navigating bridge.

4. *On-board communications and alarm systems*

4.1. An emergency means comprised of either fixed or portable equipment or both shall be provided for two-way communications between emergency control stations, muster and embarkation stations and strategic positions on board.

4.2. A general emergency alarm system complying with the requirements of regulation 50 shall be provided and shall be used for summoning passengers and crew to muster stations and to initiate the actions included in the muster list. The system shall be supplemented by either a public address system or other suitable means of communication.

Regulation 7. PERSONAL LIFE-SAVING APPLIANCES

1. *Lifebuoys*

1.1. Lifebuoys complying with the requirements of regulation 31.1 shall be:

.1 So distributed as to be readily available on both sides of the ship and as far as practicable on all open decks extending to the ship's side; at least one shall be placed in the vicinity of the stern;

.2 So stowed as to be capable of being rapidly cast loose, and not permanently secured in any way.

1.2. At least one lifebuoy on each side of the ship shall be fitted with a buoyant lifeline complying with the requirements of regulation 31.4 equal in length to not less than twice the height at which it is stowed above the waterline in the lightest seagoing condition, or 30 m, whichever is the greater.

1.3. Not less than one half of the total number of lifebuoys shall be provided with self-igniting lights complying with the requirements of regulation 31.2; not less than two of these shall also be provided with self-activating smoke signals complying with the requirements of regulation 31.3 and be capable of quick release from the navigating bridge; lifebuoys with lights and those with lights and smoke signals shall be equally distributed on both sides of the ship and shall not be the lifebuoys provided with lifelines in compliance with the requirements of paragraph 1.2.

1.4. Each lifebuoy shall be marked in block capitals of the Roman alphabet with the name and port of registry of the ship on which it is carried.

2. *Lifejackets*

2.1. A lifejacket complying with the requirements of regulation 32.1 or 32.2 shall be provided for every person on board the ship and, in addition:

.1 A number of lifejackets suitable for children equal to at least 10% of the number of passengers on board shall be provided or such greater number as may be required to provide a lifejacket for each child;

.2 A sufficient number of lifejackets shall be carried for persons on watch and for use at remotely located survival craft stations.

2.2. Lifejackets shall be so placed as to be readily accessible and their position shall be plainly indicated. Where, due to the particular arrangements of the ship, the lifejackets provided in compliance with the requirements of paragraph 2.1 may become inaccessible, alternative provisions shall be made to the satisfaction of the Administration which may include an increase in the number of lifejackets to be carried.

3. *Immersion suits*

3.1. An immersion suit, of an appropriate size, complying with the requirements of regulation 33 shall be provided for every person assigned to crew the rescue boat.

Regulation 8. MUSTER LIST AND EMERGENCY INSTRUCTIONS

1. This regulation applies to all ships.

2. Clear instructions to be followed in the event of an emergency shall be provided for every person on board.

3. Muster lists complying with the requirements of regulation 53 shall be exhibited in conspicuous places throughout the ship including the navigating bridge, engine-room and crew accommodation spaces.

4. Illustrations and instructions in appropriate languages shall be posted in passenger cabins and be conspicuously displayed at muster stations and other passenger spaces to inform passengers of:

.1 Their muster station;

.2 The essential actions they must take in an emergency;

.3 The method of donning lifejackets.

Regulation 9. OPERATING INSTRUCTIONS

1. This regulation applies to all ships.

2. Posters or signs shall be provided on or in the vicinity of survival craft and their launching controls and shall:

.1 Illustrate the purpose of controls and the procedures for operating the appliance and give relevant instructions or warnings;

.2 Be easily seen under emergency lighting conditions;

.3 Use symbols in accordance with the recommendations of the Organization.

Regulation 10. MANNING OF SURVIVAL CRAFT AND SUPERVISION

1. This regulation applies to all ships.

2. There shall be a sufficient number of trained persons on board for mustering and assisting untrained persons.

3. There shall be a sufficient number of crew members, who may be deck officers or certificated persons, on board for operating the survival craft and launching arrangements required for abandonment by the total number of persons on board.

4. A deck officer or certificated person shall be placed in charge of each survival craft to be used. However, the Administration, having due regard to the nature of the voyage, the number of persons on board and the characteristics of the ship, may permit persons practised in the handling and operation of liferafts to be placed in charge of liferafts in lieu of persons qualified as above. A second-in-command shall also be nominated in the case of lifeboats.

5. The person in charge of the survival craft shall have a list of the survival craft crew and shall see that the crew under his command are acquainted with their duties. In lifeboats the second-in-command shall also have a list of the lifeboat crew.

6. Every lifeboat required to carry a radiotelegraph installation complying with the requirements of regulation 6.2.2 shall have a person assigned who is capable of operating the equipment.

7. Every motorized survival craft shall have a person assigned who is capable of operating the engine and carrying out minor adjustments.

8. The master shall ensure the equitable distribution of persons referred to in paragraphs 2, 3 and 4 among the ship's survival craft.

Regulation 11. SURVIVAL CRAFT MUSTER AND EMBARKATION ARRANGEMENTS

1. Lifeboats and liferafts for which approved launching appliances are required shall be stowed as close to accommodation and service spaces as possible.

2. Muster stations shall be provided close to the embarkation stations. Each muster station shall have sufficient space to accommodate all persons assigned to muster at that station.

3. Muster and embarkation stations shall be readily accessible from accommodation and work areas.

4. Muster and embarkation stations shall be adequately illuminated by lighting supplied from the emergency source of electrical power required by regulation II-1/42 or II-1/43, as appropriate.

5. Alleyways, stairways and exits giving access to the muster and embarkation stations shall be lighted. Such lighting shall be capable of being supplied by the emergency source of electrical power required by regulation II-1/42 or II-1/43, as appropriate.

6. Davit-launched survival craft muster and embarkation stations shall be so arranged as to enable stretcher cases to be placed in survival craft.

7. An embarkation ladder complying with the requirements of regulation 48.7 extending, in a single length, from the deck to the waterline in the lightest seagoing condition under unfavourable conditions of trim and with the ship listed not less than 15° either way shall be provided at each launching station or at every two adjacent launching stations. However, the Administration may permit such ladders to be replaced by approved devices to afford access to the survival craft when waterborne, provided that there shall be at least one embarkation ladder on each side of the ship. Other means of embarkation may be permitted for the liferafts required by regulation 26.1.4.

8. Where necessary, means shall be provided for bringing the davit-launched survival craft against the ship's side and holding them alongside so that persons can be safely embarked.

Regulation 12. LAUNCHING STATIONS

Launching stations shall be in such positions as to ensure safe launching having particular regard to clearance from the propeller and steeply overhanging portions of the hull and so that, as far as possible, survival craft, except survival craft specially designed for free-fall launching, can be launched down the straight side of the ship. If positioned forward, they shall be located abaft the collision bulkhead in a sheltered position and, in this respect, the Administration shall give special consideration to the strength of the launching appliance.

Regulation 13. STOWAGE OF SURVIVAL CRAFT

1. Each survival craft shall be stowed:

.1 So that neither the survival craft nor its stowage arrangements will interfere with the operation of any other survival craft or rescue boat at any other launching station;

.2 As near the water surface as is safe and practicable and, in the case of a survival craft other than a liferaft intended for throw-overboard launching, in such a position that the survival craft in the embarkation position is not less than 2 m above the waterline with the ship in the fully loaded condition under unfavourable conditions of trim and listed up to 20° either way, or to the angle at which the ship's weatherdeck edge becomes submerged, whichever is less;

.3 In a state of continuous readiness so that two crew members can carry out preparations for embarkation and launching in less than 5 min;

.4 Fully equipped as required by this chapter;

.5 As far as practicable, in a secure and sheltered position and protected from damage by fire and explosion.

2. Lifeboats for lowering down the ship's side shall be stowed as far forward of the propeller as practicable. On cargo ships of 80 m in length and upwards but less than 120 m in length, each lifeboat shall be so stowed that the after end of the lifeboat is not less than the length of the lifeboat forward of the propeller. On cargo ships of 120 m in length and upwards and passenger ships of 80 m in length and upwards, each lifeboat shall be so stowed that the after end of the lifeboat is not less than 1.5 times the length of the lifeboat forward of the propeller. Where appropriate, the ship shall be so arranged that lifeboats, in their stowed positions, are protected from damage by heavy seas.

3. Lifeboats shall be stowed attached to launching appliances.

4. In addition to meeting the requirements of regulations 23 and 29, liferafts shall be so stowed as to permit manual release from their securing arrangements.

5. Davit-launched liferafts shall be stowed within reach of the lifting hooks, unless some means of transfer is provided which is not rendered inoperable within the limits of trim and list prescribed in paragraph 1.2 or by ship motion or power failure.

6. Liferafts intended for throw-overboard launching shall be so stowed as to be readily transferable for launching on either side of the ship unless liferafts, of the aggregate capacity required by regulation 26.1 to be capable of being launched on either side, are stowed on each side of the ship.

Regulation 14. STOWAGE OF RESCUE BOATS

Rescue boats shall be stowed:

.1 In a state of continuous readiness for launching in not more than 5 min;

.2 In a position suitable for launching and recovery;

.3 So that neither the rescue boat nor its stowage arrangements will interfere with the operation of any survival craft at any other launching station;

.4 If it is also a lifeboat, in compliance with the requirements of regulation 13.

Regulation 15. SURVIVAL CRAFT LAUNCHING AND RECOVERY ARRANGEMENTS

1. Launching appliances complying with the requirements of regulation 48 shall be provided for all survival craft except:

.1 Survival craft which are boarded from a position on deck which is less than 4.5 m above the waterline in the lightest seagoing condition and which either:

.1.1 Have a mass of not more than 185 kg; or

.1.2 Are stowed for launching directly from the stowed position under unfavourable conditions of trim of up to 10° and with the ship listed not less than 20° either way;

.2 Survival craft having a mass of not more than 185 kg and which are carried in excess of the survival craft for 200% of the total number of persons on board the ship.

2. Each lifeboat shall be provided with an appliance which is capable of launching and recovering the lifeboat.

3. Launching and recovery arrangements shall be such that the appliance operator on the ship is able to observe the survival craft at all times during launching and for lifeboats during recovery.

4. Only one type of release mechanism shall be used for similar survival craft carried on board the ship.

5. Preparation and handling of survival craft at any one launching station shall not interfere with the prompt preparation and handling of any other survival craft or rescue boat at any other station.

6. Falls, where used, shall be long enough for the survival craft to reach the water with the ship in its lightest seagoing condition, under unfavourable conditions of trim and with the ship listed not less than 20° either way.

7. During preparation and launching, the survival craft, its launching appliance, and the area of water into which it is to be launched shall be adequately illuminated by lighting supplied from the emergency source of electrical power required by regulation II-1/42 or II-1/43, as appropriate.

8. Means shall be available to prevent any discharge of water on to survival craft during abandonment.

9. If there is a danger of the survival craft being damaged by the ship's stabilizer wings, means shall be available, powered by an emergency source of energy, to bring the stabilizer wings inboard; indicators operated by an emergency source of energy shall be available on the navigating bridge to show the position of the stabilizer wings.

10. If lifeboats complying with the requirements of regulation 42 or 43 are carried, a davit span shall be provided, fitted with not less than two lifelines of sufficient length to reach the water with the ship in its lightest seagoing condition, under unfavourable conditions of trim and with the ship listed not less than 20° either way.

Regulation 16. RESCUE BOAT EMBARKATION, LAUNCHING AND RECOVERY ARRANGEMENTS

1. The rescue boat embarkation and launching arrangements shall be such that the rescue boat can be boarded and launched in the shortest possible time.

2. If the rescue boat is one of the ship's survival craft, the embarkation arrangements and launching station shall comply with the requirements of regulations 11 and 12.

3. Launching arrangements shall comply with the requirements of regulation 15. However, all rescue boats shall be capable of being launched, where necessary utilizing painters, with the ship making headway at speeds up to 5 knots in calm water.

4. Rapid recovery of the rescue boat shall be possible when loaded with its full complement of persons and equipment. If the rescue boat is also a lifeboat, rapid recovery shall be

possible when loaded with its lifeboat equipment and the approved rescue boat complement of at least six persons.

Regulation 17. LINE-THROWING APPLIANCES

A line-throwing appliance complying with the requirements of regulation 49 shall be provided.

Regulation 18. ABANDON SHIP TRAINING AND DRILLS

1. This regulation applies to all ships.

2. *Manuals*

A training manual complying with the requirements of regulation 51 shall be provided in each crew messroom and recreation room or in each crew cabin.

3. *Practice musters and drills*

3.1. Each member of the crew shall participate in at least one abandon ship drill and one fire drill every month. The drills of the crew shall take place within 24 h of the ship leaving a port if more than 25% of the crew have not participated in abandon ship and fire drills on board that particular ship in the previous month. The Administration may accept other arrangements that are at least equivalent for those classes of ship for which this is impracticable.

3.2. On a ship engaged on an international voyage which is not a short international voyage, musters of the passengers shall take place within 24 h after their embarkation. Passengers shall be instructed in the use of the lifejackets and the action to take in an emergency. If only a small number of passengers embark at a port after the muster has been held it shall be sufficient, instead of holding another muster, to draw the attention of these passengers to the emergency instructions required by regulations 8.2 and 8.4.

3.3. On a ship engaged on a short international voyage, if a muster of the passengers is not held on departure, the attention of the passengers shall be drawn to the emergency instructions required by regulations 8.2 and 8.4.

3.4. Each abandon ship drill shall include:

.1 Summoning of passengers and crew to muster stations with the alarm required by regulation 6.4.2 and ensuring that they are made aware of the order to abandon ship specified in the muster list;

.2 Reporting to stations and preparing for the duties described in the muster list;

.3 Checking that passengers and crew are suitably dressed;

.4 Checking that lifejackets are correctly donned;

.5 Lowering of at least one lifeboat after any necessary preparation for launching;

.6 Starting and operating the lifeboat engine;

.7 Operation of davits used for launching liferafts.

3.5. Different lifeboats shall, as far as practicable, be lowered in compliance with the requirements of paragraph 3.4.5 at successive drills.

3.6. Drills shall, as far as practicable, be conducted as if there were an actual emergency.

3.7. Each lifeboat shall be launched with its assigned operating crew aboard and manoeuvred in the water at least once every 3 months during an abandon ship drill. The Administration may allow ships operating on short international voyages not to launch the lifeboats on one side if their berthing arrangements in port and their trading patterns do not permit launching of lifeboats on that side. However, all such lifeboats shall be lowered at least once every 3 months and launched at least annually.

3.8. As far as is reasonable and practicable, rescue boats other than lifeboats which are also rescue boats, shall be launched each month with their assigned crew aboard and

manoeuvred in the water. In all cases this requirement shall be complied with at least once every 3 months.

3.9. If lifeboat and rescue boat launching drills are carried out with the ship making headway, such drills shall, because of the dangers involved, be practised in sheltered waters only and under the supervision of an officer experienced in such drills.

3.10. Emergency lighting for mustering and abandonment shall be tested at each abandon ship drill.

4. *On-board training and instructions*

4.1. On-board training in the use of the ship's life-saving appliances, including survival craft equipment, shall be given as soon as possible but not later than 2 weeks after a crew member joins the ship. However, if the crew member is on a regularly scheduled rotating assignment to the ship, such training shall be given not later than 2 weeks after the time of first joining the ship.

4.2. Instructions in the use of the ship's life-saving appliances and in survival at sea shall be given at the same interval as the drills. Individual instruction may cover different parts of the ship's life-saving system, but all the ship's life-saving equipment and appliances shall be covered within any period of 2 months. Each member of the crew shall be given instructions which shall include but not necessarily be limited to:

.1 Operation and use of the ship's inflatable liferafts;

.2 Problems of hypothermia, first-aid treatment for hypothermia and other appropriate first-aid procedures;

.3 Special instructions necessary for use of the ship's life-saving appliances in severe weather and severe sea conditions.

4.3. On-board training in the use of davit-launched liferafts shall take place at intervals of not more than 4 months on every ship fitted with such appliances. Whenever practicable this shall include the inflation and lowering of a liferaft. This liferaft may be a special liferaft intended for training purposes only, which is not part of the ship's life-saving equipment; such a special liferaft shall be conspicuously marked.

5. *Records*

The date when musters are held, details of abandon ship drills and fire drills, drills of other life-saving appliances and on-board training shall be recorded in such log-book as may be prescribed by the Administration. If a full muster, drill or training session is not held at the appointed time, an entry shall be made in the log-book stating the circumstances and the extent of the muster, drill or training session held.

Regulation 19. OPERATIONAL READINESS, MAINTENANCE AND INSPECTIONS

1. This regulation applies to all ships. The requirements of paragraphs 3 and 6.2 shall be complied with, as far as is practicable, on ships constructed before 1 July 1986.

2. *Operational readiness*

Before the ship leaves port and at all times during the voyage, all life-saving appliances shall be in working order and ready for immediate use.

3. *Maintenance*

3.1. Instructions for on-board maintenance of life-saving appliances complying with the requirements of regulation 52 shall be provided and maintenance shall be carried out accordingly.

3.2. The Administration may accept, in lieu of the instructions required by paragraph 3.1, a shipboard planned maintenance programme which includes the requirements of regulation 52.

4. *Maintenance of falls*

Falls used in launching shall be turned end for end at intervals of not more than 30 months and be renewed when necessary due to deterioration of the falls or at intervals of not more than 5 years, whichever is the earlier.

5. *Spares and repair equipment*

Spares and repair equipment shall be provided for life-saving appliances and their components which are subject to excessive wear or consumption and need to be replaced regularly.

6. *Weekly inspection*

The following tests and inspections shall be carried out weekly:

.1 All survival craft, rescue boats and launching appliances shall be visually inspected to ensure that they are ready for use;

.2 All engines in lifeboats and rescue boats shall be run ahead and astern for a total period of not less than 3 min provided the ambient temperature is above the minimum temperature required for starting the engine. In special cases the Administration may waive this requirement for ships constructed before 1 July 1986;

.3 The general emergency alarm system shall be tested.

7. *Monthly inspections*

Inspection of the life-saving appliances, including lifeboat equipment, shall be carried out monthly using the checklist required by regulation 52.1 to ensure that they are complete and in good order. A report of the inspection shall be entered in the log-book.

8. *Servicing of inflatable liferafts, inflatable lifejackets and inflated rescue boats*

8.1. Every inflatable liferaft and inflatable lifejacket shall be serviced:

.1 At intervals not exceeding 12 months. However, in cases where it appears proper and reasonable, the Administration may extend this period to 17 months;

.2 At an approved servicing station which is competent to service them, maintains proper servicing facilities and uses only properly trained personnel.*

8.2. All repairs and maintenance of inflated rescue boats shall be carried out in accordance with the manufacturer's instructions. Emergency repairs may be carried out on board the ship; however, permanent repairs shall be effected at an approved servicing station.

9. *Periodic servicing of hydrostatic release units*

Hydrostatic release units shall be serviced:

.1 At intervals not exceeding 12 months. However, in cases where it appears proper and reasonable, the Administration may extend this period to 17 months;

.2 At a servicing station which is competent to service them, maintains proper servicing facilities and uses only properly trained personnel.

SECTION II. PASSENGER SHIPS (ADDITIONAL REQUIREMENTS)

Regulation 20. SURVIVAL CRAFT AND RESCUE BOATS

1. *Survival craft*

1.1. Passenger ships engaged on international voyages which are not short international voyages shall carry:

* Reference is made to the "Recommendation on the conditions for the approval of servicing stations for inflatable liferafts" adopted by the Organization by resolution A.333 (IX).[1]

[1] *Resolutions and Other Decisions, Intergovernmental Maritime Consultative Organization Assembly, Ninth Session, 3-14 November 1975*, p. 195.

.1 Lifeboats complying with the requirements of regulation 42, 43, or 44 on each side of such aggregate capacity as will accommodate not less than 50% of the total number of persons on board. The Administration may permit the substitution of lifeboats by liferafts of equivalent total capacity provided that there shall never be less than sufficient lifeboats on each side of the ship to accommodate 37.5% of the total number of persons on board. The liferafts shall comply with the requirements of regulation 39 or 40 and shall be served by launching appliances equally distributed on each side of the ship; and

.2 In addition, liferafts complying with the requirements of regulation 39 or 40 of such aggregate capacity as will accommodate at least 25% of the total number of persons on board. These liferafts shall be served by at least one launching appliance on each side which may be those provided in compliance with the requirements of paragraph 1.1.1 or equivalent approved appliances capable of being used on both sides. However, stowage of these liferafts need not comply with the requirements of regulation 13.5.

1.2. Passenger ships engaged on short international voyages and complying with the special standards of subdivision prescribed by regulation II-1/6.5 shall carry:

.1 Lifeboats complying with the requirements of regulation 42, 43 or 44 equally distributed, as far as practicable, on each side of the ship and of such aggregate capacity as will accommodate at least 30% of the total number of persons on board and liferafts complying with requirements of regulation 39 or 40 of such aggregate capacity that, together with the lifeboat capacity, the survival craft will accommodate the total number of persons on board. The liferafts shall be served by launching appliances equally distributed on each side of the ship; and

.2 In addition, liferafts complying with the requirements of regulation 39 or 40 of such aggregate capacity as will accommodate at least 25% of the total number of persons on board. These liferafts shall be served by at least one launching appliance on each side which may be those provided in compliance with the requirements of paragraph 1.2.1 or equivalent approved appliances capable of being used on both sides. However, stowage of these liferafts need not comply with the requirements of regulation 13.5.

1.3. Passenger ships engaged on short international voyages and not complying with the special standard of subdivision prescribed by regulation II-1/6.5, shall carry survival craft complying with the requirements of paragraph 1.1.

1.4. All survival craft required to provide for abandonment by the total number of persons on board shall be capable of being launched with their full complement of persons and equipment within a period of 30 min from the time the abandon ship signal is given.

1.5. In lieu of meeting the requirements of paragraph 1.1, 1.2 or 1.3, passenger ships of less than 500 tons gross tonnage where the total number of persons on board is less than 200, may comply with the following:

.1 They shall carry on each side of the ship, liferafts complying with the requirements of regulation 39 or 40 and of such aggregate capacity as will accommodate the total number of persons on board.

.2 Unless the liferafts required by paragraph 1.5.1 can be readily transferred for launching on either side of the ship, additional liferafts shall be provided so that the total capacity available on each side will accommodate 150% of the total number of persons on board.

.3 If the rescue boat required by paragraph 2.2 is also a lifeboat complying with the requirements of regulation 42, 43 or 44, it may be included in the aggregate capacity required by paragraph 1.5.1, provided that the total capacity available on either side of the ship is at least 150% of the total number of persons on board.

.4 In the event of any one survival craft being lost or rendered unserviceable, there shall be sufficient survival craft available for use on each side to accommodate the total number of persons on board.

2. *Rescue boats*

2.1. Passenger ships of 500 tons gross tonnage and over shall carry at least one rescue boat complying with the requirements of regulation 47 on each side of the ship.

2.2. Passenger ships of less than 500 tons gross tonnage shall carry at least one rescue boat complying with the requirements of regulation 47.

2.3. A lifeboat may be accepted as a rescue boat provided it also complies with the requirements for a rescue boat.

3. *Marshalling of liferafts*

3.1. The number of lifeboats and rescue boats that are carried on passenger ships shall be sufficient to ensure that in providing for abandonment by the total number of persons on board not more than six liferafts need be marshalled by each lifeboat or rescue boat.

3.2. The number of lifeboats and rescue boats that are carried on passenger ships engaged on short international voyages and complying with the special standards of subdivision prescribed by regulation II-1/6.5 shall be sufficient to ensure that in providing for abandonment by the total number of persons on board not more than nine liferafts need be marshalled by each lifeboat or rescue boat.

Regulation 21. PERSONAL LIFE-SAVING APPLIANCES

1. *Lifebuoys*

1.1. A passenger ship shall carry not less than the number of lifebuoys complying with the requirements of regulations 7.1 and 31 prescribed in the following table:

Length of ship in metres	*Minimum number of lifebuoys*
Under 60	8
60 and under 120	12
120 and under 180	18
180 and under 240	24
240 and over	30

1.2. Notwithstanding regulation 7.1.3, passenger ships of under 60 m in length shall carry not less than six lifebuoys provided with self-igniting lights.

2. *Lifejackets*

In addition to the lifejackets required by regulation 7.2, every passenger ship shall carry lifejackets for not less than 5% of the total number of persons on board. These lifejackets shall be stowed in conspicuous places on deck or at muster stations.

3. *Lifejacket lights*

3.1. This paragraph applies to all passenger ships. With respect to passenger ships constructed before 1 July 1986, the requirements of this paragraph shall apply not later than 1 July 1991.

3.2. On passenger ships engaged on international voyages which are not short international voyages each lifejacket shall be fitted with a light complying with the requirements of regulation 32.3.

4. *Immersion suits and thermal protective aids*

4.1. This paragraph applies to all passenger ships. With respect to passenger ships constructed before 1 July 1986, the requirements of this paragraph shall apply not later than 1 July 1991.

4.2. Passenger ships shall carry for each lifeboat on the ship at least three immersion suits complying with the requirements of regulation 33 and, in addition, a thermal protective aid complying with the requirements of regulation 34 for every person to be accommodated in

the lifeboat and not provided with an immersion suit. These immersion suits and thermal protective aids need not be carried:

.1 For persons to be accommodated in totally or partially enclosed lifeboats; or

.2 If the ship is constantly engaged on voyages in warm climates where, in the opinion of the Administration, thermal protective aids are unnecessary.

4.3. The provisions of paragraph 4.2.1 also apply to totally or partially enclosed lifeboats not complying with the requirements of regulation 42, 43 or 44, provided they are carried on ships constructed before 1 July 1986.

Regulation 22. SURVIVAL CRAFT AND RESCUE BOAT EMBARKATION ARRANGEMENTS

1. On passenger ships, survival craft embarkation arrangements shall be designed for:

.1 All lifeboats to be boarded and launched either directly from the stowed position or from an embarkation deck but not both;

.2 Davit-launched liferafts to be boarded and launched from a position immediately adjacent to the stowed position or from a position to which, in compliance with the requirements of regulation 13.5, the liferaft is transferred prior to launching.

2. Rescue boat arrangements shall be such that the rescue boat can be boarded and launched directly from the stowed position with the number of persons assigned to crew the rescue boat on board. Notwithstanding the requirements of paragraph 1.1, if the rescue boat is also a lifeboat and the other lifeboats are boarded and launched from an embarkation deck, the arrangements shall be such that the rescue boat can also be boarded and launched from the embarkation deck.

Regulation 23. STOWAGE OF LIFERAFTS

On passenger ships, every liferaft shall be stowed with its painter permanently attached to the ship and with a float-free arrangement complying with the requirements of regulation 38.6 so that, as far as practicable, the liferaft floats free and, if inflatable, inflates automatically when the ship sinks.

Regulation 24. MUSTER STATIONS

Every passenger ship shall, in addition to complying with the requirements of regulation 11, have passenger muster stations which shall:

.1 Be in the vicinity of, and permit ready access for the passengers to, the embarkation stations unless in the same location;

.2 Have ample room for marshalling and instruction of the passengers.

Regulation 25. DRILLS

1. This regulation applies to all passenger ships.

2. On passenger ships, an abandon ship drill and fire drill shall take place weekly.

SECTION III. CARGO SHIPS (ADDITIONAL REQUIREMENTS)

Regulation 26. SURVIVAL CRAFT AND RESCUE BOATS

1. *Survival craft*

1.1. Cargo ships shall carry:

.1 One or more lifeboats complying with the requirements of regulation 44 of such aggregate capacity on each side of the ship as will accommodate the total number of persons on board. The Administration may, however, permit cargo ships (except oil tankers, chemical tankers and gas carriers) operating under favourable climatic conditions and in suitable

areas, to carry lifeboats complying with the requirements of regulation 43, provided the limits of the trade area are specified in the Cargo Ship Safety Equipment Certificate; and

.2 In addition, a liferaft or liferafts, complying with the requirements of regulation 39 or 40, capable of being launched on either side of the ship and of such aggregate capacity as will accommodate the total number of persons on board. If the liferaft or liferafts cannot be readily transferred for launching on either side of the ship, the total capacity available on each side shall be sufficient to accommodate the total number of persons on board.

1.2. In lieu of meeting the requirements of paragraph 1.1, cargo ships may carry:

.1 One or more lifeboats, complying with the requirements of regulation 44, capable of being free fall launched over the stern of the ship of such aggregate capacity as will accommodate the total number of persons on board; and

.2 In addition, one or more liferafts complying with the requirements of regulation 39 or 40, on each side of the ship, of such aggregate capacity as will accommodate the total number of persons on board. The liferafts on at least one side of the ship shall be served by launching appliances.

1.3. In lieu of meeting the requirements of paragraph 1.1 or 1.2, cargo ships of less than 85 m in length other than oil tankers, chemical tankers and gas carriers, may comply with the following:

.1 They shall carry on each side of the ship, one or more liferafts complying with the requirements of regulation 39 or 40 and of such aggregate capacity as will accommodate the total number of persons on board.

.2 Unless the liferafts required by paragraph 1.3.1 can be readily transferred for launching on either side of the ship, additional liferafts shall be provided so that the total capacity available on each side will accommodate 150% of the total number of persons on board.

.3 If the rescue boat required by paragraph 2 is also a lifeboat complying with the requirements of regulation 43 or 44, it may be included in the aggregate capacity required by paragraph 1.3.1, provided that the total capacity available on either side of the ship is at least 150% of the total number of persons on board.

.4 In the event of any one survival craft being lost or rendered unserviceable, there shall be sufficient survival craft available for use on each side to accommodate the total number of persons on board.

1.4. Cargo ships where the survival craft are stowed in a position which is more than 100 m from the stem or stern shall carry, in addition to the liferafts required by paragraphs 1.1.2 and 1.2.2, a liferaft stowed as far forward or aft, or one as far forward and another as far aft, as is reasonable and practicable. Notwithstanding the requirements of regulation 29, such liferaft or liferafts may be securely fastened so as to permit manual release and need not be of the type which can be launched from an approved launching device.

1.5. With the exception of the survival craft referred to in regulation 15.1.1, all survival craft required to provide for abandonment by the total number of persons on board shall be capable of being launched with their full complement of persons and equipment within a period of 10 min from the time the abandon ship signal is given.

1.6. Chemical tankers and gas carriers carrying cargoes emitting toxic vapours or gases* shall carry, in lieu of lifeboats complying with the requirements of regulation 43 or 44, lifeboats complying with the requirements of regulation 45.

* Reference is made to products for which emergency escape respiratory protection is required in chapter 17 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) adopted by the Maritime Safety Committee by resolution MSC.4(48) and in chapter 19 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) adopted by the Maritime Safety Committee by resolution MSC.5(48).

1.7. Oil tankers, chemical tankers and gas carriers carrying cargoes having a flashpoint not exceeding 60° C (closed cup test) shall carry, in lieu of lifeboats complying with the requirements of regulation 43 or 44, lifeboats complying with the requirements of regulation 46.

2. *Rescue boats*

Cargo ships shall carry at least one rescue boat complying with the requirements of regulation 47. A lifeboat may be accepted as a rescue boat, provided that it also complies with the requirements for a rescue boat.

3. In addition to their lifeboats, cargo ships constructed before 1 July 1986 shall carry not later than 1 July 1991:

.1 One or more liferafts of such aggregate capacity as will accommodate the total number of persons on board. The liferaft or liferafts shall be equipped with a lashing or an equivalent means of securing the liferaft which will automatically release it from a sinking ship;

.2 Where the survival craft are stowed in a position which is more than 100 m from the stem or stern, in addition to the liferafts required by paragraph 3.1, a liferaft stowed as far forward or aft, or one as far forward and another as far aft, as is reasonable and practicable. Notwithstanding the requirements of paragraph 3.1, such liferaft or liferafts may be securely fastened so as to permit manual release.

Regulation 27. PERSONAL LIFE-SAVING APPLIANCES

1. *Lifebuoys*

1.1. Cargo ships shall carry not less than the number of lifebuoys complying with the requirements of regulations 7.1 and 31 prescribed in the following table:

Length of ship in metres	*Minimum number of lifebuoys*
Under 100	8
100 and under 150	10
150 and under 200	12
200 and over	14

1.2. Self-igniting lights for lifebuoys on tankers required by regulation 7.1.3 shall be of an electric battery type.

2. *Lifejacket lights*

2.1. This paragraph applies to all cargo ships. With respect to cargo ships constructed before 1 July 1986, this paragraph shall apply not later than 1 July 1991.

2.2. On cargo ships, each lifejacket shall be fitted with a light complying with the requirements of regulation 32.3.

3. *Immersion suits and thermal protective aids*

3.1. This paragraph applies to all cargo ships. With respect to cargo ships constructed before 1 July 1986, this paragraph shall apply not later than 1 July 1991.

3.2. Cargo ships shall carry for each lifeboat on the ship at least three immersion suits complying with the requirements of regulation 33 or, if the Administration considers it necessary and practicable, one immersion suit complying with the requirements of regulation 33 for every person on board the ship; however, the ship shall carry in addition to the thermal protective aids required by regulations 38.5.1.24, 41.8.31 and 47.2.2.13, thermal protective aids complying with the requirements of regulation 34 for persons on board not provided with immersion suits. These immersion suits and thermal protective aids need not be required if the ship:

.1 Has totally enclosed lifeboats on each side of the ship of such aggregate capacity as will accommodate the total number of persons on board; or

.2 Has totally enclosed lifeboats capable of being launched by free-fall over the stern of the ship of such aggregate capacity as will accommodate the total number of persons on board and which are boarded and launched directly from the stowed position, together with liferafts on each side of the ship of such aggregate capacity as will accommodate the total number of persons on board; or

.3 Is constantly engaged on voyages in warm climates where, in the opinion of the Administration, immersion suits are unnecessary.

3.3. Cargo ships complying with the requirements of regulation 26.1.3 shall carry immersion suits complying with the requirements of regulation 33 for every person on board unless the ship:

.1 Has davit-launched liferafts; or

.2 Has liferafts served by equivalent approved appliances capable of being used on both sides of the ship and which do not require entry into the water to board the liferaft; or

.3 Is constantly engaged on voyages in warm climates where, in the opinion of the Administration, immersion suits are unnecessary.

3.4. The immersion suits required by this regulation may be used to comply with the requirements of regulation 7.3.

3.5 The totally enclosed lifeboats referred to in paragraphs 3.2.1 and 3.2.2 carried on cargo ships constructed before 1 July 1986 need not comply with the requirements of regulation 44.

Regulation 28. SURVIVAL CRAFT EMBARKATION AND LAUNCHING ARRANGEMENTS

1. Cargo ship survival craft embarkation arrangements shall be so designed that lifeboats can be boarded and launched directly from the stowed position and davit-launched liferafts can be boarded and launched from a position immediately adjacent to the stowed position or from a position to which the liferaft is transferred prior to launching in compliance with the requirements of regulation 13.5.

2. On cargo ships of 20,000 tons gross tonnage and upwards, lifeboats shall be capable of being launched, where necessary utilizing painters, with the ship making headway at speeds up to 5 knots in calm water.

Regulation 29. STOWAGE OF LIFERAFTS

On cargo ships, every liferaft, other than those required by regulation 26.1.4, shall be stowed with its painter permanently attached to the ship and with a float-free arrangement complying with the requirements of regulation 38.6 so that the liferaft floats free and, if inflatable, inflates automatically when the ship sinks.

PART C. LIFE-SAVING APPLIANCE REQUIREMENTS

SECTION I. GENERAL

Regulation 30. GENERAL REQUIREMENTS FOR LIFE-SAVING APPLIANCES

1. Paragraph 2.7 applies to all ships. With respect to ships constructed before 1 July 1986, paragraph 2.7 shall apply not later than 1 July 1991.

2. Unless expressly provided otherwise or unless, in the opinion of the Administration having regard to the particular voyages on which the ship is constantly engaged, other requirements are appropriate, all life-saving appliances prescribed in this part shall:

.1 Be constructed with proper workmanship and materials;

.2 Not be damaged in stowage throughout the air temperature range −30° C to +65° C;

.3 If they are likely to be immersed in seawater during their use, operate throughout the seawater temperature range −1° C to +30° C;

.4 Where applicable, be rot-proof, corrosion-resistant, and not be unduly affected by seawater, oil or fungal attack;

.5 Where exposed to sunlight, be resistant to deterioration;

.6 Be of a highly visible colour on all parts where this will assist detection;

.7 Be fitted with retro-reflective material where it will assist in detection and in accordance with the recommendations of the Organization*;

.8 If they are to be used in a seaway, be capable of satisfactory operation in that environment.

3. The Administration shall determine the period of acceptability of life-saving appliances which are subject to deterioration with age. Such life-saving appliances shall be marked with a means for determining their age or the date by which they must be replaced.

SECTION II. PERSONAL LIFE-SAVING APPLIANCES

Regulation 31. LIFEBUOYS

1. *Lifebuoy specification*

Every lifebuoy shall:

.1 Have an outer diameter of not more than 800 mm and an inner diameter of not less than 400 mm;

.2 Be constructed of inherently buoyant material; it shall not depend upon rushes, cork shavings or granulated cork, any other loose granulated material or any air compartment which depends on inflation for buoyancy;

.3 Be capable of supporting not less than 14.5 kg of iron in fresh water for a period of 24 hr;

.4 Have a mass of not less than 2.5 kg;

.5 Not sustain burning or continue melting after being totally enveloped in fire for a period of 2 s;

.6 Be constructed to withstand a drop into the water from the height at which it is stowed above the waterline in the lightest seagoing condition or 30 m, whichever is the greater, without impairing either its operating capability or that of its attached components;

.7 If it is intended to operate the quick-release arrangement provided for the self-activated smoke signals and self-igniting lights, have a mass sufficient to operate the quick-release arrangement or 4 kg, whichever is the greater;

.8 Be fitted with a grabline not less than 9.5 mm in diameter and not less than 4 times the outside diameter of the body of the buoy in length. The grabline shall be secured at four equidistant points around the circumference of the buoy to form four equal loops.

2. *Lifebuoy self-igniting lights*

Self-igniting lights required by regulation 7.1.3 shall:

.1 Be such that they cannot be extinguished by water;

.2 Be capable of either burning continuously with a luminous intensity of not less than 2 cd in all directions of the upper hemisphere or flashing (discharge flashing) at a rate of not less than 50 flashes per minute with at least the corresponding effective luminous intensity;

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* Reference is made to the "Recommendation on retro-reflective tapes on life-saving appliances" adopted by the Organization in resolution A.274(VIII).[1]

[1] *Resolutions and Other Decisions, Intergovernmental Maritime Consultative Organization Assembly, Eighth Session, 13-23 November 1973*, p. 96.

.3 Be provided with a source of energy capable of meeting the requirement of paragraph 2.2 for a period of at least 2 hr;

.4 Be capable of withstanding the drop test required by paragraph 1.6.

3. *Lifebuoy self-activating smoke signals*

Self-activating smoke signals required by regulation 7.1.3 shall:

.1 Emit smoke of a highly visible colour at a uniform rate for a period of at least 15 min when floating in calm water;

.2 Not ignite explosively or emit any flame during the entire smoke emission time of the signal;

.3 Not be swamped in a seaway;

.4 Continue to emit smoke when fully submerged in water for a period of at least 10 s;

.5 Be capable of withstanding the drop test required by paragraph 1.6.

4. *Buoyant lifelines*

Buoyant lifelines required by regulation 7.1.2 shall:

.1 Be non-kinking;

.2 Have a diameter of not less than 8 mm;

.3 Have a breaking strength of not less than 5 kN.

Regulation 32. LIFEJACKETS

1. *General requirements for lifejackets*

1.1. A lifejacket shall not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 s.

1.2. A lifejacket shall be so constructed that:

.1 After demonstration, a person can correctly don it within a period of 1 min without assistance;

.2 It is capable of being worn inside-out or is clearly capable of being worn in only one way and, as far as possible, cannot be donned incorrectly;

.3 It is comfortable to wear;

.4 It allows the wearer to jump from a height of at least 4.5 m into the water without injury and without dislodging or damaging the lifejacket.

1.3. A lifejacket shall have sufficient buoyancy and stability in calm fresh water to:

.1 Lift the mouth of an exhausted or unconscious person not less than 120 mm clear of the water with the body inclined backwards at an angle of not less than 20° and not more than 50° from the vertical position;

.2 Turn the body of an unconscious person in the water from any position to one where the mouth is clear of the water in not more than 5 s.

1.4. A lifejacket shall have buoyancy which is not reduced by more than 5% after 24 h submersion in fresh water.

1.5. A lifejacket shall allow the person wearing it to swim a short distance and to board a survival craft.

1.6. Each lifejacket shall be fitted with a whistle firmly secured by a cord.

2. *Inflatable lifejackets*

A lifejacket which depends on inflation for buoyancy shall have not less than two separate compartments and comply with the requirements of paragraph 1 and shall:

.1 Inflate automatically on immersion, be provided with a device to permit inflation by a single manual motion and be capable of being inflated by mouth;

.2 In the event of loss of buoyancy in any one compartment be capable of complying with the requirements of paragraphs 1.2, 1.3 and 1.5;

.3 Comply with the requirements of paragraph 1.4 after inflation by means of the automatic mechanism.

3. *Lifejacket lights*

3.1. Each lifejacket light shall:

.1 Have a luminous intensity of not less than 0.75 cd;

.2 Have a source of energy capable of providing a luminous intensity of 0.75 cd for a period of at least 8 h;

.3 Be visible over as great a segment of the upper hemisphere as is practicable when attached to a lifejacket.

3.2. If the light referred to in paragraph 3.1 is a flashing light it shall, in addition:

.1 Be provided with a manually operated switch;

.2 Not be fitted with a lens or curved reflector to concentrate the beam;

.3 Flash at a rate of not less than 50 flashes per minute with an effective luminous intensity of at least 0.75 cd.

Regulation 33. IMMERSION SUITS

1. *General requirements for immersion suits*

1.1. The immersion suit shall be constructed with waterproof materials such that:

.1 It can be unpacked and donned without assistance within 2 min, taking into account any associated clothing*, and a lifejacket if the immersion suit is to be worn in conjunction with a lifejacket;

.2 It will not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 s;

.3 It will cover the whole body with the exception of the face. Hands shall also be covered unless permanently attached gloves are provided;

.4 It is provided with arrangements to minimize or reduce free air in the legs of the suit;

.5 Following a jump from a height of not less than 4.5 m into the water there is no undue ingress of water into the suit.

1.2. An immersion suit which also complies with the requirements of regulation 32 may be classified as a lifejacket.

1.3. An immersion suit shall permit the person wearing it, and also wearing a lifejacket if the immersion suit is to be worn in conjunction with a lifejacket, to:

.1 Climb up and down a vertical ladder at least 5 m in length;

.2 Perform normal duties during abandonment;

.3 Jump from a height of not less than 4.5 m into the water without damaging or dislodging the immersion suit, or being injured; and

.4 Swim a short distance through the water and board a survival craft.

1.4 An immersion suit which has buoyancy and is designed to be worn without a lifejacket shall be fitted with a light complying with the requirements of regulation 32.3 and the whistle prescribed by regulation 32.1.6.

* Reference is made to paragraph 3.1.3.1 of the "Recommendation on testing of life-saving appliances" to be submitted to the Assembly of the Organization at its thirteenth session for adoption.

1.5. If the immersion suit is to be worn in conjunction with a lifejacket, the lifejacket shall be worn over the immersion suit. A person wearing such an immersion suit shall be able to don a lifejacket without assistance.

2. *Thermal performance requirements for immersion suits*

2.1. An immersion suit made of material which has no inherent insulation shall be:

.1 Marked with instructions that it must be worn in conjunction with warm clothing;

.2 So constructed that, when worn in conjunction with warm clothing, and with a lifejacket if the immersion suit is to be worn with a lifejacket, the immersion suit continues to provide sufficient thermal protection, following one jump by the wearer into the water from a height of 4.5 m, to ensure that when it is worn for a period of 1 h in calm circulating water at a temperature of 5° C, the wearer's body core temperature does not fall more than 2° C.

2.2. An immersion suit made of material with inherent insulation, when worn either on its own or with a lifejacket, if the immersion suit is to be worn in conjunction with a lifejacket, shall provide the wearer with sufficient thermal insulation, following one jump into the water from a height of 4.5 m, to ensure that the wearer's body core temperature does not fall more than 2° C after a period of 6 h immersion in calm circulating water at a temperature of between 0° C and 2° C.

2.3. The immersion suit shall permit the person wearing it with hands covered to pick up a pencil and write after being immersed in water at 5° C for a period of 1 h.

3. *Buoyancy requirements*

A person in fresh water wearing either an immersion suit complying with the requirements of regulation 32, or an immersion suit with a lifejacket, shall be able to turn from a face-down to a face-up position in not more than 5 s.

Regulation 34. THERMAL PROTECTIVE AIDS

1. A thermal protective aid shall be made of waterproof material having a thermal conductivity of not more than 0.25 W/(m-K) and shall be so constructed that, when used to enclose a person, it shall reduce both the convective and evaporative heat loss from the wearer's body.

2. The thermal protective aid shall:

.1 Cover the whole body of a person wearing a lifejacket with the exception of the face. Hands shall also be covered unless permanently attached gloves are provided;

.2 Be capable of being unpacked and easily donned without assistance in a survival craft or rescue boat;

.3 Permit the wearer to remove it in the water in not more than 2 min, if it impairs ability to swim.

3. The thermal protective aid shall function properly throughout an air temperature range −30° C to +120° C.

SECTION III. VISUAL SIGNALS

Regulation 35. ROCKET PARACHUTE FLARES

1. The rocket parachute flare shall:

.1 Be contained in a water-resistant casing;

.2 Have brief instructions or diagrams clearly illustrating the use of the rocket parachute flare printed on its casing;

.3 Have integral means of ignition;

.4 Be so designed as not to cause discomfort to the person holding the casing when used in accordance with the manufacturer's operating instructions.

2. The rocket shall, when fired vertically, reach an altitude of not less than 300 m. At or near the top of its trajectory, the rocket shall eject a parachute flare, which shall:

.1 Burn with a bright red colour;

.2 Burn uniformly with an average luminous intensity of not less than 30,000 cd;

.3 Have a burning period of not less than 40 s;

.4 Have a rate of descent of not more than 5 m/s;

.5 Not damage its parachute or attachments while burning.

Regulation 36. HAND FLARES

1. The hand flare shall:

.1 Be contained in a water-resistant casing;

.2 Have brief instructions or diagrams clearly illustrating the use of the hand flare printed on its casing;

.3 Have a self-contained means of ignition;

.4 Be so designed as not to cause discomfort to the person holding the casing and not endanger the survival craft by burning or glowing residues when used in accordance with the manufacturer's operating instructions.

2. The hand flare shall:

.1 Burn with a bright red colour;

.2 Burn uniformly with an average luminous intensity of not less than 15,000 cd;

.3 Have a burning period of not less than 1 min;

.4 Continue to burn after having been immersed for a period of 10 s under 100 mm of water.

Regulation 37. BUOYANT SMOKE SIGNALS

1. The buoyant smoke signal shall:

.1 Be contained in a water-resistant casing;

.2 Not ignite explosively when used in accordance with the manufacturer's operating instructions;

.3 Have brief instructions or diagrams clearly illustrating the use of the buoyant smoke signal printed on its casing.

2. The buoyant smoke signal shall:

.1 Emit smoke of a highly visible colour at a uniform rate for a period of not less than 3 min when floating in calm water;

.2 Not emit any flame during the entire smoke emission time;

.3 Not be swamped in a seaway;

.4 Continue to emit smoke when submerged in water for a period of 10 s under 100 mm of water.

SECTION IV. SURVIVAL CRAFT

Regulation 38. GENERAL REQUIREMENTS FOR LIFERAFTS

1. *Construction of liferafts*

1.1. Every liferaft shall be so constructed as to be capable of withstanding exposure for 30 days afloat in all sea conditions.

1.2. The liferaft shall be so constructed that when it is dropped into the water from a height of 18 m, the liferaft and its equipment will operate satisfactorily. If the liferaft is to be stowed at a height of more than 18 m above the waterline in the lightest seagoing condition, it shall be of a type which has been satisfactorily drop-tested from at least that height.

1.3. The floating liferaft shall be capable of withstanding repeated jumps on to it from a height of at least 4.5 m above its floor both with and without the canopy erected.

1.4. The liferaft and its fittings shall be so constructed as to enable it to be towed at a speed of 3 knots in calm water when loaded with its full complement of persons and equipment and with one of its sea-anchors streamed.

1.5. The liferaft shall have a canopy to protect the occupants from exposure which is automatically set in place when the liferaft is launched and waterborne. The canopy shall comply with the following:

.1 It shall provide insulation against heat and cold by means of either two layers of material separated by an air gap or other equally efficient means. Means shall be provided to prevent accumulation of water in the air gap;

.2 Its interior shall be of a colour that does not cause discomfort to the occupants;

.3 Each entrance shall be clearly indicated and be provided with efficient adjustable closing arrangements which can be easily and quickly opened from inside and outside the liferaft so as to permit ventilation but exclude seawater, wind and cold. Liferafts accommodating more than eight persons shall have at least two diametrically opposite entrances;

.4 It shall admit sufficient air for the occupants at all times, even with the entrances closed;

.5 It shall be provided with at least one viewing port;

.6 It shall be provided with means for collecting rain water;

.7 It shall have sufficient headroom for sitting occupants under all parts of the canopy.

2. *Minimum carrying capacity and mass of liferafts*

2.1. No liferaft shall be approved which has a carrying capacity of less than six persons calculated in accordance with the requirements of regulation 39.3 or 40.3, as appropriate.

2.2. Unless the liferaft is to be launched by an approved launching appliance complying with the requirements of regulation 48 and is not required to be portable, the total mass of the liferaft, its container and its equipment shall not be more than 185 kg.

3. *Liferaft fittings*

3.1. Lifelines shall be securely becketed around the inside and outside of the liferaft.

3.2. The liferaft shall be provided with arrangements for adequately siting and securing in the operating position the antenna provided with the portable radio apparatus required by regulation 6.2.1.

3.3. The liferaft shall be fitted with an efficient painter of length equal to not less than twice the distance from the stowed position to the waterline in the lightest seagoing condition or 15 m whichever is the greater.

4. *Davit-launched liferafts*

4.1. In addition to the above requirements, a liferaft for use with an approved launching appliance shall:

.1 When the liferaft is loaded with its full complement of persons and equipment, be capable of withstanding a lateral impact against the ship's side at an impact velocity of not less than 3.5 m/s and also a drop into the water from a height of not less than 3 m without damage that will affect its function;

.2 Be provided with means for bringing the liferaft alongside the embarkation deck and holding it securely during embarkation.

4.2. Every passenger ship davit-launched liferaft shall be so arranged that it can be rapidly boarded by its full complement of persons.

4.3. Every cargo ship davit-launched liferaft shall be so arranged that it can be boarded by its full complement of persons in not more than 3 min from the time the instruction to board is given.

5. *Equipment*

5.1. The normal equipment of every liferaft shall consist of:

.1 One buoyant rescue quoit, attached to not less than 30 m of buoyant line;

.2 One knife of the non-folding type having a buoyant handle and lanyard attached and stowed in a pocket on the exterior of the canopy near the point at which the painter is attached to the liferaft. In addition, a liferaft which is permitted to accommodate 13 persons or more shall be provided with a second knife which need not be of the non-folding type;

.3 For a liferaft which is permitted to accommodate not more than 12 persons, one buoyant bailer. For a liferaft which is permitted to accommodate 13 persons or more, two buoyant bailers;

.4 Two sponges;

.5 Two sea-anchors each with a shock-resistant hawser and tripping line, one being spare and the other permanently attached to the liferaft in such a way that when the liferaft inflates or is waterborne it will cause the liferaft to lie oriented to the wind in the most stable manner. The strength of each sea-anchor and its hawser and tripping line shall be adequate for all sea conditions. The sea-anchors shall be fitted with a swivel at each end of the line and shall be of a type which is unlikely to turn inside-out between its shroud lines;

.6 Two buoyant paddles;

.7 Three tin openers. Safety knives containing special tin-opener blades are satisfactory for this requirement;

.8 One first-aid outfit in a waterproof case capable of being closed tightly after use;

.9 One whistle or equivalent sound signal;

.10 Four rocket parachute flares complying with the requirements of regulation 35;

.11 Six hand flares complying with the requirements of regulation 36;

.12 Two buoyant smoke signals complying with the requirements of regulation 37;

.13 One waterproof electric torch suitable for Morse signalling together with one spare set of batteries and one spare bulb in a waterproof container;

.14 An efficient radar reflector;

.15 One daylight signalling mirror with instructions on its use for signalling to ships and aircraft;

.16 One copy of the life-saving signals referred to in regulation V/16 on a waterproof card or in a waterproof container;

.17 One set of fishing tackle;

.18 A food ration totalling not less than 10,000 kJ for each person the liferaft is permitted to accommodate; these rations shall be kept in airtight packaging and be stowed in a watertight container;

.19 Watertight receptacles containing a total of 1.5 ℓ of fresh water for each person the liferaft is permitted to accommodate, of which 0.5 ℓ per person may be replaced by a desalting apparatus capable of producing an equal amount of fresh water in 2 days;

.20 One rustproof graduated drinking vessel;

.21 Six doses of anti-seasickness medicine and one seasickness bag for each person the liferaft is permitted to accommodate;

.22 Instructions on how to survive;

.23 Instructions for immediate action;

.24 Thermal protective aids complying with the requirements of regulation 34 sufficient for 10% of the number of persons the liferaft is permitted to accommodate or two, whichever is the greater.

5.2. The marking required by regulations 39.7.3.5 and 40.7.7 on liferafts equipped in accordance with paragraph 5.1 shall be "SOLAS A PACK" in block capitals of the Roman alphabet.

5.3. In the case of passenger ships engaged on short international voyages of such a nature and duration that, in the opinion of the Administration, not all the items specified in paragraph 5.1 are necessary, the Administration may allow the liferafts carried on any such ships to be provided with the equipment specified in paragraphs 5.1.1 to 5.1.6 inclusive, 5.1.8, 5.1.9, 5.1.13 to 5.1.16 inclusive and 5.1.21 to 5.1.24 inclusive and one half of the equipment specified in paragraphs 5.1.10 to 5.1.12 inclusive. The marking required by regulations 39.7.3.5 and 40.7.7 on such liferafts shall be "SOLAS B PACK" in block capitals of the Roman alphabet.

5.4. Where appropriate the equipment shall be stowed in a container which, if it is not an integral part of, or permanently attached to, the liferaft, shall be stowed and secured inside the liferaft and be capable of floating in water for at least 30 min without damage to its contents.

6. *Float-free arrangements for liferafts*

6.1. *Painter system*

The liferaft painter system shall provide a connection between the ship and the liferaft and shall be so arranged as to ensure that the liferaft when released and, in the case of an inflatable liferaft, inflated is not dragged under by the sinking ship.

6.2. *Weak link*

If a weak link is used in the float-free arrangement, it shall:

.1 Not be broken by the force required to pull the painter from the liferaft container;

.2 If applicable, be of sufficient strength to permit the inflation of the liferaft;

.3 Break under a strain of 2.2±0.4 kN.

6.3. *Hydrostatic release units*

If a hydrostatic release unit is used in the float-free arrangements, it shall:

.1 Be constructed of compatible materials so as to prevent malfunction of the unit. Galvanizing or other forms of metallic coating on parts of the hydrostatic release unit shall not be accepted;

.2 Automatically release the liferaft at a depth of not more than 4 m;

.3 Have drains to prevent the accumulation of water in the hydrostatic chamber when the unit is in its normal position;

.4 Be so constructed as to prevent release when seas wash over the unit;

.5 Be permanently marked on its exterior with its type and serial number;

.6 Be provided with a document or identification plate stating the date of manufacture, type and serial number;

.7 Be such that each part connected to the painter system has a strength of not less than that required for the painter.

Regulation 39. INFLATABLE LIFERAFTS

1. Inflatable liferafts shall comply with the requirements of regulation 38 and, in addition, shall comply with the requirements of this regulation.

2. *Construction of inflatable liferafts*

2.1. The main buoyancy chamber shall be divided into not less than two separate compartments, each inflated through a non-return inflation valve on each compartment. The buoyancy chambers shall be so arranged that, in the event of any one of the compartments being damaged or failing to inflate, the intact compartments shall be able to support, with positive freeboard over the liferaft's entire periphery, the number of persons which the liferaft is permitted to accommodate, each having a mass of 75 kg and seated in their normal positions.

2.2. The floor of the liferaft shall be waterproof and shall be capable of being sufficiently insulated against cold either:

.1 By means of one or more compartments that the occupants can inflate, or which inflate automatically and can be deflated and reinflated by the occupants; or

.2 By other equally efficient means not dependent on inflation.

2.3. The liferaft shall be inflated with a non-toxic gas. Inflation shall be completed within a period of 1 min at an ambient temperature of between 18° C and 20° C and within a period of 3 min at an ambient temperature of −30° C. After inflation the liferaft shall maintain its form when loaded with its full complement of persons and equipment.

2.4. Each inflatable compartment shall be capable of withstanding a pressure equal to at least 3 times the working pressure and shall be prevented from reaching a pressure exceeding twice the working pressure either by means of relief valves or by a limited gas supply. Means shall be provided for fitting the topping-up pump or bellows required by paragraph 10.1.2 so that the working pressure can be maintained.

3. *Carrying capacity of inflatable liferafts*

The number of persons which a liferaft shall be permitted to accommodate shall be equal to the lesser of:

.1 The greatest whole number obtained by dividing by 0.096 the volume, measured in cubic metres, of the main buoyancy tubes (which for this purpose shall include neither the arches nor the thwarts if fitted) when inflated; or

.2 The greatest whole number obtained by dividing by 0.372 the inner horizontal cross-sectional area of the liferaft measured in square metres (which for this purpose may include the thwart or thwarts, if fitted) measured to the innermost edge of the buoyancy tubes; or

.3 The number of persons having an average mass of 75 kg, all wearing lifejackets, that can be seated with sufficient comfort and headroom without interfering with the operation of any of the liferaft's equipment.

4. *Access into inflatable liferafts*

4.1. At least one entrance shall be fitted with a semi-rigid boarding ramp to enable persons to board the liferaft from the sea so arranged as to prevent significant deflation of the liferaft if the ramp is damaged. In the case of a davit-launched liferaft having more than one entrance, the boarding ramp shall be fitted at the entrance opposite the bowsing lines and embarkation facilities.

4.2. Entrances not provided with a boarding ramp shall have a boarding ladder, the lowest step of which shall be situated not less than 0.4 m below the liferaft's light waterline.

4.3. There shall be means inside the liferaft to assist persons to pull themselves into the liferaft from the ladder.

5. *Stability of inflatable liferafts*

5.1. Every inflatable liferaft shall be so constructed that, when fully inflated and floating with the canopy uppermost, it is stable in a seaway.

5.2. The stability of the liferaft when in the inverted position shall be such that it can be righted in a seaway and in calm water by one person.

5.3. The stability of the liferaft when loaded with its full complement of persons and equipment shall be such that it can be towed at speeds of up to 3 knots in calm water.

6. *Inflatable liferaft fittings*

6.1. The breaking strength of the painter system including its means of attachment to the liferaft, except the weak link required by regulation 38.6, shall be not less than 10.0 kN for a liferaft permitted to accommodate nine persons or more, and not less than 7.5 kN for any other liferaft. The liferaft shall be capable of being inflated by one person.

6.2. A manually controlled lamp visible on a dark night with a clear atmosphere at a distance of at least 2 miles for a period of not less than 12 h shall be fitted to the top of the liferaft canopy. If the light is a flashing light it shall flash at a rate of not less than 50 flashes per minute for the first 2 h of operation of the 12 h operating period. The lamp shall be powered by a sea-activated cell or a dry chemical cell and shall light automatically when the liferaft inflates. The cell shall be of a type that does not deteriorate due to damp or humidity in the stowed liferaft.

6.3. A manually controlled lamp shall be fitted inside the liferaft capable of continuous operation for a period of at least 12 h. It shall light automatically when the liferaft inflates and be of sufficient intensity to enable reading of survival and equipment instructions.

7. *Containers for inflatable liferafts*

7.1. The liferaft shall be packed in a container that is:

.1 So constructed as to withstand hard wear under conditions encountered at sea;

.2 Of sufficient inherent buoyancy, when packed with the liferaft and its equipment, to pull the painter from within and to operate the inflation mechanism should the ship sink;

.3 As far as practicable watertight, except for drain holes in the container bottom.

7.2. The liferaft shall be packed in its container in such a way as to ensure, as far as possible, that the waterborne liferaft inflates in an upright position on breaking free from its container.

7.3. The container shall be marked with:

.1 Maker's name or trade mark;

.2 Serial number;

.3 Name of approved authority and the number of persons it is permitted to carry;

.4 SOLAS;

.5 Type of emergency pack enclosed;

.6 Date when last serviced;

.7 Length of painter;

.8 Maximum permitted height of stowage above waterline (depending on drop-test height and length of painter);

.9 Launching instructions.

8. *Markings on inflatable liferafts*

The liferaft shall be marked with:

.1 Maker's name or trade mark;

.2 Serial number;

.3 Date of manufacture (month and year);

.4 Name of approving authority;

.5 Name and place of servicing station where it was last serviced;

.6 Number of persons it is permitted to accommodate over each entrance in characters not less than 100 mm in height of a colour contrasting with that of the liferaft.

9. *Davit-launched inflatable liferafts*

9.1. In addition to complying with the above requirements, a liferaft for use with an approved launching appliance shall, when suspended from its lifting hook or bridle, withstand a load of:

.1 4 times the mass of its full complement of persons and equipment, at an ambient temperature and a stabilized liferaft temperature of 20 ± 3 ° C with all relief valves inoperative; and

.2 1.1 times the mass of its full complement of persons and equipment at an ambient temperature and a stabilized liferaft temperature of −30 ° C with all relief valves operative.

9.2. Rigid containers for liferafts to be launched by a launching appliance shall be so secured that the container or parts of it are prevented from falling into the sea during and after inflation and launching of the contained liferaft.

10. *Additional equipment for inflatable liferafts*

10.1. In addition to the equipment required by regulation 38.5, every inflatable liferaft shall be provided with:

.1 One repair outfit for repairing punctures in buoyancy compartments;

.2 One topping-up pump or bellows.

10.2. The knives required by regulation 38.5.1.2 shall be safety knives.

Regulation 40. RIGID LIFERAFTS

1. Rigid liferafts shall comply with the requirements of regulation 38 and, in addition, shall comply with the requirements of this regulation.

2. *Construction of rigid liferafts*

2.1. The buoyancy of the liferaft shall be provided by approved inherently buoyant material placed as near as possible to the periphery of the liferaft. The buoyant material shall be fire-retardant or be protected by a fire-retardant covering.

2.2 The floor of the liferaft shall prevent the ingress of water and shall effectively support the occupants out of the water and insulate them from cold.

3. *Carrying capacity of rigid liferafts*

The number of persons which a liferaft shall be permitted to accommodate shall be equal to the lesser of:

.1 The greatest whole number obtained by dividing by 0.096 the volume, measured in cubic metres, of the buoyancy material multiplied by a factor of 1 minus the specific gravity of that material; or

.2 The greatest whole number obtained by dividing by 0.372 the horizontal cross-sectional area of the floor of the liferaft measured in square metres; or

.3 The number of persons having an average mass of 75 kg, all wearing lifejackets, that can be seated with sufficient comfort and headroom without interfering with the operation of any of the liferaft's equipment.

4. *Access into rigid liferafts*

4.1. At least one entrance shall be fitted with a rigid boarding ramp to enable persons to board the liferaft from the sea. In the case of a davit-launched liferaft having more than one entrance, the boarding ramp shall be fitted at the entrance opposite to the bowsing and embarkation facilities.

4.2. Entrances not provided with a boarding ramp shall have a boarding ladder, the lowest step of which shall be situated not less than 0.4 m below the liferaft's light waterline.

4.3. There shall be means inside the liferaft to assist persons to pull themselves into the liferaft from the ladder.

5. *Stability of rigid liferafts*

5.1. Unless the liferaft is capable of operating safely whichever way up it is floating, its strength and stability shall be such that it is either self-righting or can be readily righted in a seaway and in calm water by one person.

5.2. The stability of a liferaft when loaded with its full complement of persons and equipment shall be such that it can be towed at speeds of up to 3 knots in calm water.

6. *Rigid liferaft fittings*

6.1. The liferaft shall be fitted with an efficient painter. The breaking strength of the painter system, including its means of attachment to the liferaft, except the weak link required by regulation 38.6, shall be not less than 10.0 kN for liferafts permitted to accommodate nine persons or more, and not less than 7.5 kN for any other liferaft.

6.2. A manually controlled lamp visible on a dark night with a clear atmosphere at a distance of at least 2 miles for a perlod of not less than 12 h shall be fitted to the top of the liferaft canopy. If the light is a flashing light it shall flash at a rate of not less than 50 flashes per minute for the first 2 h of operation of the 12 h operating period. The lamp shall be powered by a sea-activated cell or a dry chemical cell and shall light automatically when the liferaft canopy is set in place. The cell shall be of a type that does not deteriorate due to damp or humidity in the stowed liferaft.

6.3. A manually controlled lamp shall be fitted inside the liferaft, capable of continuous operation for a period of at least 12 h. It shall light automatically when the canopy is set in place and be of sufficient intensity to enable reading of survival and equipment instructions.

7. *Markings on liferafts*

The liferaft shall be marked with:

.1 Name and port of registry of the ship to which it belongs;

.2 Maker's name or trade mark;

.3 Serial number;

.4 Name of approving authority;

.5 Number of persons it is permitted to accommodate over each entrance in characters not less than 100 mm in height of a colour contrasting with that of the liferaft;

.6 SOLAS;

.7 Type of emergency pack enclosed;

.8 Length of painter;

.9 Maximum permitted height of stowage above waterline (drop-test height);

.10 Launching instructions.

8. *Davit-launched rigid liferafts*

In addition to the above requirements, a rigid liferaft for use with an approved launching appliance shall, when suspended from its lifting hook or bridle, withstand a load of 4 times the mass of its full complement of persons and equipment.

Regulation 41. GENERAL REQUIREMENTS FOR LIFEBOATS

1. *Construction of lifeboats*

1.1. All lifeboats shall be properly constructed and shall be of such form and proportions that they have ample stability in a seaway and sufficient freeboard when loaded with their full complement of persons and equipment. All lifeboats shall have rigid hulls and shall be capable of maintaining positive stability when in an upright position in calm water and loaded with their full complement of persons and equipment and holed in any one location below the waterline, assuming no loss of buoyancy material and no other damage.

1.2. All lifeboats shall be of sufficient strength to:

.1 Enable them to be safely lowered into the water when loaded with their full complement of persons and equipment; and

.2 Be capable of being launched and towed when the ship is making headway at a speed of 5 knots in calm water.

1.3. Hulls and rigid covers shall be fire-retardant or non-combustible.

1.4. Seating shall be provided on thwarts, benches or fixed chairs fitted as low as practicable in the lifeboat and constructed so as to be capable of supporting the number of persons each weighing 100 kg for which spaces are provided in compliance with the requirements of paragraph 2.2.2.

1.5. Each lifeboat shall be of sufficient strength to withstand a load, without residual deflection on removal of that load:

.1 In the case of boats with metal hulls, 1.25 times the total mass of the lifeboat when loaded with its full complement of persons and equipment; or

.2 In the case of other boats, twice the total mass of the lifeboat when loaded with its full complement of persons and equipment.

1.6. Each lifeboat shall be of sufficient strength to withstand, when loaded with its full complement of persons and equipment and with, where applicable, skates or fenders in position, a lateral impact against the ship's side at an impact velocity of at least 3.5 m/s and also a drop into the water from a height of at least 3 m.

1.7. The vertical distance between the floor surface and the interior of the enclosure or canopy over 50% of the floor area shall be:

.1 Not less than 1.3 m for a lifeboat permitted to accommodate nine persons or less;

.2 Not less than 1.7 m for a lifeboat permitted to accommodate 24 persons or more;

.3 Not less than the distance as determined by linear interpolation between 1.3 m and 1.7 m for a lifeboat permitted to accommodate between nine and 24 persons.

2. *Carrying capacity of lifeboats*

2.1. No lifeboat shall be approved to accommodate more than 150 persons.

2.2. The number of persons which a lifeboat shall be permitted to accommodate shall be equal to the lesser of:

.1 The number of persons having an average mass of 75 kg, all wearing lifejackets, that can be seated in a normal position without interfering with the means of propulsion or the operation of any of the lifeboat's equipment; or

.2 The number of spaces that can be provided on the seating arrangements in accordance with Figure 1. The shapes may be overlapped as shown, provided footrests are fitted and there is sufficient room for legs and the vertical separation between the upper and lower seat is not less than 350 mm.

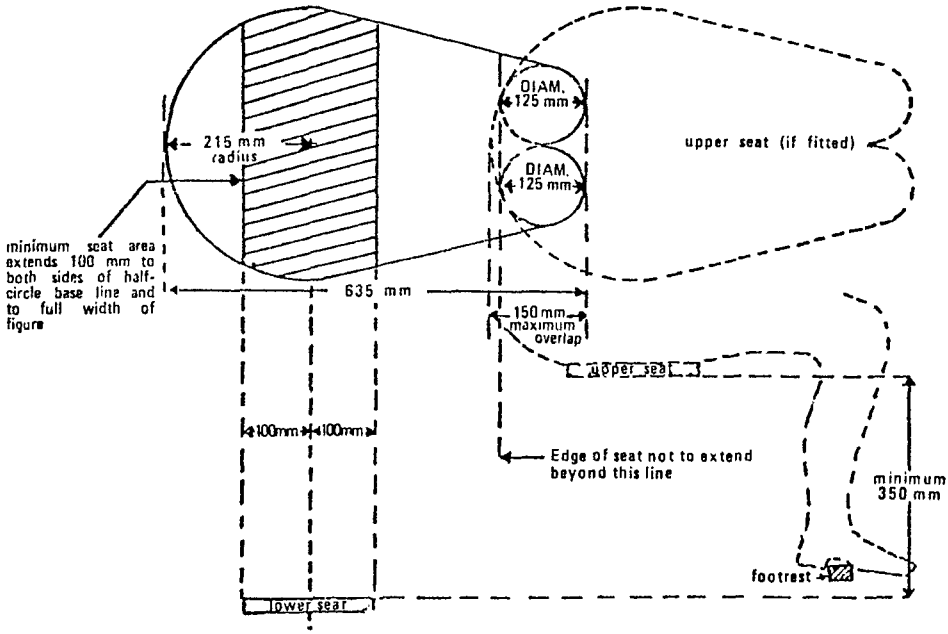

FIGURE 1

2.3. Each seating position shall be clearly indicated in the lifeboat.

3. *Access into lifeboats*

3.1. Every passenger ship lifeboat shall be so arranged that it can be rapidly boarded by its full complement of persons. Rapid disembarkation shall also be possible.

3.2 Every cargo ship lifeboat shall be so arranged that it can be boarded by its full complement of persons in not more than 3 min from the time the instruction to board is given. Rapid disembarkation shall also be possible.

3.3. Lifeboats shall have a boarding ladder that can be used on either side of the lifeboat to enable persons in the water to board the lifeboat. The lowest step of the ladder shall be not less than 0.4 m below the lifeboat's light waterline.

3.4. The lifeboat shall be so arranged that helpless people can be brought on board either from the sea or on stretchers.

3.5. All surfaces on which persons might walk shall have a non-skid finish.

4. *Lifeboat buoyancy*

All lifeboats shall have inherent buoyancy or shall be fitted with inherently buoyant material which shall not be adversely affected by seawater, oil or oil products, sufficient to float the lifeboat with all its equipment on board when flooded and open to the sea. Additional inherently buoyant material, equal to 280 N of buoyant force per person, shall be provided for the number of persons the lifeboat is permitted to accommodate. Buoyant material, unless in addition to that required above, shall not be installed external to the hull of the lifeboat.

5. *Lifeboat freeboard and stability*

All lifeboats, when loaded with 50% of the number of persons the lifeboat is permitted to accommodate seated in their normal positions to one side of the centreline, shall have a free-

board, measured from the waterline to the lowest opening through which the lifeboat may become flooded, of at least 1.5% of the lifeboat's length or 100 mm, whichever is the greater.

6. *Lifeboat propulsion*

6.1. Every lifeboat shall be powered by a compression ignition engine. No engine shall be used for any lifeboat if its fuel has a flashpoint of 43° C or less (closed cup test).

6.2. The engine shall be provided with either a manual starting system, or a power starting system with two independent rechargeable energy sources. Any necessary starting aids shall also be provided. The engine starting systems and starting aids shall start the engine at an ambient temperature of −15° C within 2 min of commencing the start procedure unless, in the opinion of the Administration having regard to the particular voyages in which the ship carrying the lifeboat is constantly engaged, a different temperature is appropriate. The starting systems shall not be impeded by the engine casing, thwarts or other obstructions.

6.3. The engine shall be capable of operating for not less than 5 min after starting from cold with the lifeboat out of the water.

6.4. The engine shall be capable of operating when the lifeboat is flooded up to the centreline of the crank shaft.

6.5. The propeller shafting shall be so arranged that the propeller can be disengaged from the engine. Provision shall be made for ahead and astern propulsion of the lifeboat.

6.6. The exhaust pipe shall be so arranged as to prevent water from entering the engine in normal operation.

6.7. All lifeboats shall be designed with due regard to the safety of persons in the water and to the possibility of damage to the propulsion system by floating debris.

6.8. The speed of a lifeboat when proceeding ahead in calm water, when loaded with its full complement of persons and equipment and with all engine-powered auxiliary equipment in operation, shall be at least 6 knots and at least 2 knots when towing a 25-person liferaft loaded with its full complement of persons and equipment or its equivalent. Sufficient fuel, suitable for use throughout the temperature range expected in the area in which the ship operates, shall be provided to run the fully loaded lifeboat at 6 knots for a period of not less than 24 h.

6.9. The lifeboat engine, transmission and engine accessories shall be enclosed in a fire-retardant casing or other suitable arrangements providing similar protection. Such arrangements shall also protect persons from coming into accidental contact with hot or moving parts and protect the engine from exposure to weather and sea. Adequate means shall be provided to reduce the engine noise. Starter batteries shall be provided with casings which form a watertight enclosure around the bottom and sides of the batteries. The battery casings shall have a tight fitting top which provides for necessary gas venting.

6.10. The lifeboat engine and accessories shall be designed to limit electromagnetic emissions so that engine operation does not interfere with the operation of radio life-saving appliances used in the lifeboat.

6.11. Means shall be provided for recharging all engine-starting, radio and searchlight batteries. Radio batteries shall not be used to provide power for engine starting. Means shall be provided for recharging lifeboat batteries from the ship's power supply at a supply voltage not exceeding 55 V which can be disconnected at the lifeboat embarkation station.

6.12. Water-resistant instructions for starting and operating the engine shall be provided and mounted in a conspicuous place near the engine starting controls.

7. *Lifeboat fittings*

7.1. All lifeboats shall be provided with at least one drain valve fitted near the lowest point in the hull, which shall automatically open to drain water from the hull when the lifeboat is not waterborne and shall automatically close to prevent entry of water when the lifeboat is waterborne. Each drain valve shall be provided with a cap or plug to close the valve, which

shall be attached to the lifeboat by a lanyard, a chain, or other suitable means. Drain valves shall be readily accessible from inside the lifeboat and their position shall be clearly indicated.

7.2. All lifeboats shall be provided with a rudder and tiller. When a wheel or other remote steering mechanism is also provided the tiller shall be capable of controlling the rudder in case of failure of the steering mechanism. The rudder shall be permanently attached to the lifeboat. The tiller shall be permanently installed on, or linked to, the rudder stock; however, if the lifeboat has a remote steering mechanism, the tiller may be removable and securely stowed near the rudder stock. The rudder and tiller shall be so arranged as not to be damaged by operation of the release mechanism or the propeller.

7.3. Except in the vicinity of the rudder and propeller, a buoyant lifeline shall be becketed around the outside of the lifeboat.

7.4. Lifeboats which are not self-righting when capsized shall have suitable handholds on the underside of the hull to enable persons to cling to the lifeboat. The handholds shall be fastened to the lifeboat in such a way that, when subjected to an impact sufficient to cause them to break away from the lifeboat, they break away without damaging the lifeboat.

7.5. All lifeboats shall be fitted with sufficient watertight lockers or compartments to provide for the storage of the small items of equipment, water and provisions required by paragraph 8. Means shall be provided for the storage of collected rainwater.

7.6. Every lifeboat to be launched by a fall or falls shall be fitted with a release mechanism complying with the following requirements:

.1 The mechanism shall be so arranged that all hooks are released simultaneously.

.2 The mechanism shall have two release capabilities as follows:

.2.1 A normal release capability which will release the lifeboat when it is waterborne or when there is no load on the hooks;

.2.2 An on-load release capability which will release the lifeboat with a load on the hooks. This release shall be so arranged as to release the lifeboat under any conditions of loading from no-load with the lifeboat waterborne to a load of 1.1 times the total mass of the lifeboat when loaded with its full complement of persons and equipment. This release capability shall be adequately protected against accidental or premature use;

.3 The release control shall be clearly marked in a colour that contrasts with its surroundings;

.4 The mechanism shall be designed with a factor of safety of 6 based on the ultimate strength of the materials used, assuming the mass of the lifeboat is equally distributed between the falls.

7.7. Every lifeboat shall be fitted with a release device to enable the forward painter to be released when under tension.

7.8. Every lifeboat shall be provided with a permanently installed earth connection and arrangements for adequately siting and securing in the operating position the antenna provided with the portable radio apparatus required by regulation 6.2.1.

7.9. Lifeboats intended for launching down the side of a ship shall have skates and fenders as necessary to facilitate launching and prevent damage to the lifeboat.

7.10. A manually controlled lamp visible on a dark night with a clear atmosphere at a distance of at least 2 miles for a period of not less than 12 h shall be fitted to the top of the cover or enclosure. If the light is a flashing light, it shall initially flash at a rate of not less than 50 flashes per minute over the first 2 h of operation of the 12 h operating period.

7.11. A lamp or source of light shall be fitted inside the lifeboat to provide illumination for not less than 12 h to enable reading of survival and equipment instructions; however, oil lamps shall not be permitted for this purpose.

7.12. Unless expressly provided otherwise, every lifeboat shall be provided with effective means of bailing or be automatically self-bailing.

7.13. Every lifeboat shall be so arranged that an adequate view forward, aft and to both sides is provided from the control and steering position for safe launching and manoeuvring.

8. *Lifeboat equipment*

All items of lifeboat equipment, whether required by this paragraph or elsewhere in this chapter, with the exception of boat-hooks which shall be kept free for fending off purposes, shall be secured within the lifeboat by lashings, storage in lockers or compartments, storage in brackets or similar mounting arrangements or other suitable means. The equipment shall be secured in such a manner as not to interfere with any abandonment procedures. All items of lifeboat equipment shall be as small and of as little mass as possible and shall be packed in a suitable and compact form. Except where otherwise stated, the normal equipment of every lifeboat shall consist of:

.1 Sufficient buoyant oars to make headway in calm seas. Thole pins, crutches or equivalent arrangements shall be provided for each oar provided. Thole pins or crutches shall be attached to the boat by lanyards or chains;

.2 Two boat-hooks;

.3 A buoyant bailer and two buckets;

.4 A survival manual;

.5 A binnacle containing an efficient compass which is luminous or provided with suitable means of illumination. In a totally enclosed lifeboat, the binnacle shall be permanently fitted at the steering position; in any other lifeboat, it shall be provided with suitable mounting arrangements;

.6 A sea-anchor of adequate size fitted with a shock-resistant hawser and a tripping line which provides a firm hand grip when wet. The strength of the sea-anchor, hawser and tripping line shall be adequate for all sea conditions;

.7 Two efficient painters of a length equal to not less than twice the distance from the stowage position of the lifeboat to the waterline in the lightest seagoing condition or 15 m, whichever is the greater. One painter attached to the release device required by regulation 41.7.7 shall be placed at the forward end of the lifeboat and the other shall be firmly secured at or near the bow of the lifeboat ready for use;

.8 Two hatchets, one at each end of the lifeboat;

.9 Watertight receptacles containing a total of 3 ℓ of fresh water for each person the lifeboat is permitted to accommodate, of which 1 ℓ per person may be replaced by a de-salting apparatus capable of producing an equal amount of fresh water in 2 days;

.10 A rustproof dipper with lanyard;

.11 A rustproof graduated drinking vessel;

.12 A food ration totalling not less than 10,000 kJ for each person the lifeboat is permitted to accommodate; these rations shall be kept in airtight packaging and be stowed in a watertight container;

.13 Four rocket parachute flares complying with the requirements of regulation 35;

.14 Six hand flares complying with the requirements of regulation 36;

.15 Two buoyant smoke signals complying with the requirements of regulation 37;

.16 One waterproof electric torch suitable for Morse signalling together with one spare set of batteries and one spare bulb in a waterproof container;

.17 One daylight signalling mirror with instructions for its use for signalling to ships and aircraft;

.18 One copy of the life-saving signals prescribed by regulation V/16 on a waterproof card or in a waterproof container;

.19 One whistle or equivalent sound signal;

.20 A first-aid outfit in a waterproof case capable of being closed tightly after use;

.21 Six doses of anti-seasickness medicine and one seasickness bag for each person;

.22 A jack-knife to be kept attached to the boat by a lanyard;

.23 Three tin openers;

.24 Two buoyant rescue quoits, attached to not less than 30 m of buoyant line;

.25 A manual pump;

.26 One set of fishing tackle;

.27 Sufficient tools for minor adjustments to the engine and its accessories;

.28 Portable fire-extinguishing equipment suitable for extinguishing oil fires;

.29 A searchlight capable of effectively illuminating a light-coloured object at night having a width of 18 m at a distance of 180 m for a total period of 6 h and of working for not less than 3 h continuously;

.30 An efficient radar reflector;

.31 Thermal protective aids complying with the requirements of regulation 34 sufficient for 10% of the number of persons the lifeboat is permitted to accommodate or two, whichever is the greater.

.32 In the case of ships engaged on voyages of such a nature and duration that, in the opinion of the Administration, the items specified in paragraphs 8.12 and 8.26 are unnecessary, the Administration may allow these items to be dispensed with.

9. *Lifeboat markings*

9.1. The dimensions of the lifeboat and the number of persons which it is permitted to accommodate shall be marked on it in clear permanent characters.

9.2. The name and port of registry of the ship to which the lifeboat belongs shall be marked on each side of the lifeboat's bow in block capitals of the Roman alphabet.

9.3. Means of identifying the ship to which the lifeboat belongs and the number of the lifeboat shall be marked in such a way that they are visible from above.

Regulation 42. PARTIALLY ENCLOSED LIFEBOATS

1. Partially enclosed lifeboats shall comply with the requirements of regulation 41 and in addition shall comply with the requirements of this regulation.

2. Every partially enclosed lifeboat shall be provided with effective means of bailing or be automatically self-bailing.

3. Partially enclosed lifeboats shall be provided with permanently attached rigid covers extending over not less than 20% of the length of the lifeboat from the stem and not less than 20% of the length of the lifeboat from the aftermost part of the lifeboat. The lifeboat shall be fitted with a permanently attached foldable canopy which together with the rigid covers completely encloses the occupants of the lifeboat in a weatherproof shelter and protects them from exposure. The canopy shall be so arranged that:

.1 It is provided with adequate rigid sections or battens to permit erection of the canopy;

.2 It can be easily erected by not more than two persons;

.3 It is insulated to protect the occupants against heat and cold by means of not less than two layers of material separated by an air gap or other equally efficient means; means shall be provided to prevent accumulation of water in the air gap;

.4 Its exterior is of a highly visible colour and its interior is of a colour which does not cause discomfort to the occupants;

.5 It has entrances at both ends and on each side, provided with efficient adjustable closing arrangements which can be easily and quickly opened and closed from inside or outside so

as to permit ventilation but exclude seawater, wind and cold; means shall be provided for holding the entrances securely in the open and closed position;

.6 With the entrances closed, it admits sufficient air for the occupants at all times;

.7 It has means for collecting rainwater;

.8 The occupants can escape in the event of the lifeboat capsizing.

4. The interior of the lifeboat shall be of a highly visible colour.

5. The radiotelegraph installation required by regulation 6.2.2 shall be installed in a cabin large enough to accommodate both the equipment and the person using it. No separate cabin is required if the construction of the lifeboat provides a sheltered space to the satisfaction of the Administration.

Regulation 43. SELF-RIGHTING PARTIALLY ENCLOSED LIFEBOATS

1. Self-righting partially enclosed lifeboats shall comply with the requirements of regulation 41 and in addition shall comply with the requirements of this regulation.

2. *Enclosure*

2.1. Permanently attached rigid covers shall be provided extending over not less than 20% of the length of the lifeboat from the stem and not less than 20% of the length of the lifeboat from the aftermost part of the lifeboat.

2.2. The rigid covers shall form two shelters. If the shelters have bulkheads they shall have openings of sufficient size to permit easy access by persons each wearing an immersion suit or warm clothes and a lifejacket. The interior height of the shelters shall be sufficient to permit persons easy access to their seats in the bow and stern of the lifeboat.

2.3. The rigid covers shall be so arranged that they include windows or translucent panels to admit sufficient daylight to the inside of the lifeboat with the openings or canopies closed so as to make artificial light unnecessary.

2.4. The rigid covers shall have railings to provide a secure handhold for persons moving about the exterior of the lifeboat.

2.5. Open parts of the lifeboat shall be fitted with a permanently attached foldable canopy so arranged that:

.1 It can be easily erected by not more than two persons in not more than 2 min;

.2 It is insulated to protect the occupants against cold by means of not less than two layers of material separated by an air gap or other equally efficient means.

2.6. The enclosure formed by the rigid covers and canopy shall be so arranged:

.1 As to allow launching and recovery operations to be performed without any occupant having to leave the enclosure;

.2 That it has entrances at both ends and on each side, provided with efficient adjustable closing arrangements which can be easily and quickly opened and closed from inside or outside so as to permit ventilation but exclude seawater, wind and cold; means shall be provided for holding the entrances securely in the open and in the closed position;

.3 That with the canopy erected and all entrances closed, sufficient air is admitted for the occupants at all times;

.4 That it has means for collecting rainwater;

.5 That the exterior of the rigid covers and canopy and the interior of that part of the lifeboat covered by the canopy is of a highly visible colour. The interior of the shelters shall be of a colour which does not cause discomfort to the occupants;

.6 That it is possible to row the lifeboat.

3. *Capsizing and re-righting*

3.1. A safety belt shall be fitted at each indicated seating position. The safety belt shall be so designed as to hold a person of a mass of 100 kg securely in place when the lifeboat is in a capsized position.

3.2. The stability of the lifeboat shall be such that it is inherently or automatically self-righting when loaded with its full or a partial complement of persons and equipment and the persons are secured with safety belts.

4. *Propulsion*

4.1. The engine and transmission shall be controlled from the helmsman's position.

4.2. The engine and engine installation shall be capable of running in any position during capsize and continue to run after the lifeboat returns to the upright or shall automatically stop on capsizing and be easily restarted after the lifeboat returns to the upright and the water has been drained from the lifeboat. The design of the fuel and lubricating systems shall prevent the loss of fuel and the loss of more than 250 ml of lubricating oil from the engine during capsize.

4.3. Air-cooled engines shall have a duct system to take in cooling air from, and exhaust it to, the outside of the lifeboat. Manually operated dampers shall be provided to enable cooling air to be taken in from, and exhausted to, the interior of the lifeboat.

5. *Construction and fendering*

5.1. Notwithstanding regulation 41.1.6, a self-righting partially enclosed lifeboat shall be so constructed and fendered as to ensure that the lifeboat renders protection against harmful accelerations resulting from an impact of the lifeboat, when loaded with its full complement of persons and equipment, against the ship's side at an impact velocity of not less than 3.5 m/s.

5.2. The lifeboat shall be automatically self-bailing.

Regulation 44. TOTALLY ENCLOSED LIFEBOATS

1. Totally enclosed lifeboats shall comply with the requirements of regulation 41 and in addition shall comply with the requirements of this regulation.

2. *Enclosure*

Every totally enclosed lifeboat shall be provided with a rigid watertight enclosure which completely encloses the lifeboat. The enclosure shall be so arranged that:

.1 It protects the occupants against heat and cold;

.2 Access to the lifeboat is provided by hatches which can be closed to make the lifeboat watertight;

.3 Hatches are positioned so as to allow launching and recovery operations to be performed without any occupant having to leave the enclosure;

.4 Access hatches are capable of being opened and closed from both inside and outside and are equipped with means to hold them securely in open positions;

.5 It is possible to row the lifeboat;

.6 It is capable, when the lifeboat is in the capsized position with the hatches closed and without significant leakage, of supporting the entire mass of the lifeboat, including all equipment, machinery and its full complement of persons;

.7 It includes windows or translucent panels on both sides which admit sufficient daylight to the inside of the lifeboat with the hatches closed to make artificial light unnecessary;

.8 Its exterior is of a highly visible colour and its interior of a colour which does not cause discomfort to the occupants;

.9 Handrails provide a secure handhold for persons moving about the exterior of the lifeboat, and aid embarkation and disembarkation;

.10 Persons have access to their seats from an entrance without having to climb over thwarts or other obstructions;

.11 The occupants are protected from the effects of dangerous subatmospheric pressures which might be created by the lifeboat's engine.

3. *Capsizing and re-righting*

3.1. A safety belt shall be fitted at each indicated seating position. The safety belt shall be designed to hold a person of a mass of 100 kg securely in place when the lifeboat is in a capsized position.

3.2. The stability of the lifeboat shall be such that it is inherently or automatically self-righting when loaded with its full or a partial complement of persons and equipment and all entrances and openings are closed watertight and the persons are secured with safety belts.

3.3. The lifeboat shall be capable of supporting its full complement of persons and equipment when the lifeboat is in the damaged condition prescribed in regulation 41.1.1 and its stability shall be such that in the event of capsizing, it will automatically attain a position that will provide an above-water escape for its occupants.

3.4. The design of all engine exhaust pipes, air ducts and other openings shall be such that water is excluded from the engine when the lifeboat capsizes and re-rights.

4. *Propulsion*

4.1. The engine and transmission shall be controlled from the helmsman's position.

4.2. The engine and engine installation shall be capable of running in any position during capsize and continue to run after the lifeboat returns to the upright or shall automatically stop on capsizing and be easily restarted after the lifeboat returns to the upright. The design of the fuel and lubricating systems shall prevent the loss of fuel and the loss of more than 250 ml of lubricating oil from the engine during capsize.

4.3. Air cooled engines shall have a duct system to take in cooling air from, and exhaust it to, the outside of the lifeboat. Manually operated dampers shall be provided to enable cooling air to be taken in from, and exhausted to, the interior of the lifeboat.

5. *Construction and fendering*

Notwithstanding regulation 41.1.6, a totally enclosed lifeboat shall be so constructed and fendered as to ensure that the lifeboat renders protection against harmful accelerations resulting from an impact of the lifeboat, when loaded with its full complement of persons and equipment, against the ship's side at an impact velocity of not less than 3.5 m/s.

6. *Free-fall lifeboats*

A lifeboat arranged for free-fall launching shall be so constructed that it is capable of rendering protection against harmful accelerations resulting from being launched, when loaded with its full complement of persons and equipment, from at least the maximum height at which it is designed to be stowed above the waterline with the ship in its lightest seagoing condition, under unfavourable conditions of trim of up to 10° and with the ship listed not less than 20° either way.

Regulation 45. LIFEBOATS WITH A SELF-CONTAINED AIR SUPPORT SYSTEM

In addition to complying with the requirements of regulations 41 and 44, a lifeboat with a self-contained air support system shall be so arranged that, when proceeding with all entrances and openings closed, the air in the lifeboat remains safe and breathable and the engine runs normally for a period of not less than 10 min. During this period the atmospheric pressure inside the lifeboat shall never fall below the outside atmospheric pressure nor shall it exceed it by

more than 20 mbar. The system shall have visual indicators to indicate the pressure of the air supply at all times.

Regulation 46. FIRE-PROTECTED LIFEBOATS

1. In addition to complying with the requirements of regulations 41, 44 and 45, a fire-protected lifeboat when waterborne shall be capable of protecting the number of persons it is permitted to accommodate when subjected to a continuous oil fire that envelops the lifeboat for a period of not less than 8 min.

2. *Water spray system*

A lifeboat which has a water spray fire-protection system shall comply with the following:

.1 Water for the system shall be drawn from the sea by a self-priming motor pump. It shall be possible to turn "on" and turn "off" the flow of water over the exterior of the lifeboat;

.2 The seawater intake shall be so arranged as to prevent the intake of flammable liquids from the sea surface;

.3 The system shall be arranged for flushing with fresh water and allowing complete drainage.

SECTION V. RESCUE BOATS

Regulation 47. RESCUE BOATS

1. *General requirements*

1.1. Except as provided by this regulation, all rescue boats shall comply with the requirements of regulations 41.1 to 41.7.4 inclusive and 41.7.6, 41.7.7, 41.7.9, 41.7.12 and 41.9.

1.2. Rescue boats may be either of rigid or inflated construction or a combination of both and shall:

.1 Be not less than 3.8 m and not more than 8.5 m in length;

.2 Be capable of carrying at least five seated persons and a person lying down.

1.3. Rescue boats which are a combination of rigid and inflated construction shall comply with the appropriate requirements of this regulation to the satisfaction of the Administration.

1.4. Unless the rescue boat has adequate sheer, it shall be provided with a bow cover extending for not less than 15% of its length.

1.5. Rescue boats shall be capable of manoeuvring at speeds up to 6 knots and maintaining that speed for a period of at least 4 h.

1.6. Rescue boats shall have sufficient mobility and manoeuvrability in a seaway to enable persons to be retrieved from the water, marshal liferafts and tow the largest liferaft carried on the ship when loaded with its full complement of persons and equipment or its equivalent at a speed of at least 2 knots.

1.7. A rescue boat shall be fitted with an inboard engine or outboard motor. If it is fitted with an outboard motor, the rudder and tiller may form part of the engine. Notwithstanding the requirements of regulation 41.6.1, petrol-driven outboard engines with an approved fuel system may be fitted in rescue boats provided the fuel tanks are specially protected against fire and explosion.

1.8. Arrangements for towing shall be permanently fitted in rescue boats and shall be sufficiently strong to marshal or tow liferafts as required by paragraph 1.6.

1.9. Rescue boats shall be fitted with weathertight stowage for small items of equipment.

2. *Rescue boat equipment*

2.1. All items of rescue boat equipment, with the exception of boat-hooks which shall be kept free for fending off purposes, shall be secured within the rescue boat by lashings, storage

in lockers or compartments, storage in brackets or similar mounting arrangements, or other suitable means. The equipment shall be secured in such a manner as not to interfere with any launching or recovery procedures. All items of rescue boat equipment shall be as small and of as little mass as possible and shall be packed in suitable and compact form.

2.2. The normal equipment of every rescue boat shall consist of:

.1 Sufficient buoyant oars or paddles to make headway in calm seas. Thole pins, crutches or equivalent arrangements shall be provided for each oar. Thole pins or crutches shall be attached to the boat by lanyards or chains;

.2 A buoyant bailer;

.3 A binnacle containing an efficient compass which is luminous or provided with suitable means of illumination;

.4 A sea-anchor and tripping line with a hawser of adequate strength not less than 10 m in length;

.5 A painter of sufficient length and strength, attached to the release device complying with the requirements of regulation 41.7.7 and placed at the forward end of the rescue boat;

.6 One buoyant line, not less than 50 m in length, of sufficient strength to tow a liferaft as required by paragraph 1.6;

.7 One waterproof electric torch suitable for Morse signalling, together with one spare set of batteries and one spare bulb in a waterproof container;

.8 One whistle or equivalent sound signal;

.9 A first-aid outfit in a waterproof case capable of being closed tightly after use;

.10 Two buoyant rescue quoits, attached to not less than 30 m of buoyant line;

.11 A searchlight capable of effectively illuminating a light-coloured object at night having a width of 18 m at a distance of 180 m for a total period of 6 h and of working for at least 3 h continuously;

.12 An efficient radar reflector.

.13 Thermal protective aids complying with the requirements of regulation 34 sufficient for 10% of the number of persons the rescue boat is permitted to accommodate or two, whichever is the greater.

2.3. In addition to the equipment required by paragraph 2.2, the normal equipment of every rigid rescue boat shall include:

.1 A boat-hook;

.2 A bucket;

.3 A knife or hatchet.

2.4. In addition to the equipment required by paragraph 2.2 the normal equipment of every inflated rescue boat shall consist of:

.1 A buoyant safety knife;

.2 Two sponges;

.3 An efficient manually operated bellows or pump;

.4 A repair kit in a suitable container for repairing punctures;

.5 A safety boat-hook.

3. *Additional requirements for inflated rescue boats*

3.1. The requirements or regulations 41.1.3 and 41.1.5 do not apply to inflated rescue boats.

3.2. An inflated rescue boat shall be constructed in such a way that, when suspended by its bridle or lifting hook:

.1 It is of sufficient strength and rigidity to enable it to be lowered and recovered with its full complement of persons and equipment;

.2 It is of sufficient strength to withstand a load of 4 times the mass of its full complement of persons and equipment at an ambient temperature of $20 \pm 3°C$ with all relief valves inoperative;

.3 It is of sufficient strength to withstand a load of 1.1 times the mass of its full complement of persons and equipment at an ambient temperature of $-30°C$, with all relief valves operative.

3.3. Inflated rescue boats shall be so constructed as to be capable of withstanding exposure:

.1 When stowed on an open deck on a ship at sea;

.2 For 30 days afloat in all sea conditions.

3.4. In addition to complying with the requirements of regulation 41.9, inflated rescue boats shall be marked with a serial number, the maker's name or trade mark and the date of manufacture.

3.5. The buoyancy of an inflated rescue boat shall be provided by either a single tube subdivided into at least five separate compartments of approximately equal volume or two separate tubes neither exceeding 60% of the total volume. The buoyancy tubes shall be so arranged that, in the event of any one of the compartments being damaged, the intact compartments shall be able to support the number of persons which the rescue boat is permitted to accommodate, each having a mass of 75 kg, when seated in their normal positions with positive freeboard over the rescue boat's entire periphery.

3.6. The buoyancy tubes forming the boundary of the inflated rescue boat shall on inflation provide a volume of not less than $0.17 m^3$ for each person the rescue boat is permitted to accommodate.

3.7. Each buoyancy compartment shall be fitted with a non-return valve for manual inflation and means for deflation. A safety relief valve shall also be fitted unless the Administration is satisfied that such an appliance is unnecessary.

3.8. Underneath the bottom and on vulnerable places on the outside of the inflated rescue boat, rubbing strips shall be provided to the satisfaction of the Administration.

3.9. Where a transom is fitted it shall not be inset by more than 20% of the overall length of the rescue boat.

3.10. Suitable patches shall be provided for securing the painters fore and aft and the becketed lifelines inside and outside the boat.

3.11. The inflated rescue boat shall be maintained at all times in a fully inflated condition.

SECTION VI. LAUNCHING AND EMBARKATION APPLIANCES

Regulation 48. LAUNCHING AND EMBARKATION APPLIANCES

1. *General requirements*

1.1. Each launching appliance together with all its lowering and recovery gear shall be so arranged that the fully equipped survival craft or rescue boat it serves can be safely lowered against a trim of up to 10° and a list of up to 20° either way:

.1 When boarded, as required by regulation 22 or 28, by its full complement of persons;

.2 Without persons in the survival craft or rescue boat.

1.2. Notwithstanding the requirements of paragraph 1.1, lifeboat launching appliances for oil tankers, chemical tankers and gas carriers with a final angle of heel greater than 20° cal-

culated in accordance with the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the 1978 Protocol related thereto[1] and the recommendations of the Organization*, as applicable, shall be capable of operating at the final angle of heel on the lower side of the ship.

1.3. A launching appliance shall not depend on any means other than gravity or stored mechanical power which is independent of the ship's power supplies to launch the survival craft or rescue boat it serves in the fully loaded and equipped condition and also in the light condition.

1.4. A launching mechanism shall be so arranged that it may be actuated by one person from a position on the ship's deck, and from a position within the survival craft or rescue boat; the survival craft shall be visible to the person on deck operating the launching mechanism.

1.5. Each launching appliance shall be so constructed that a minimum amount of routine maintenance is necessary. All parts requiring regular maintenance by the ship's crew shall be readily accessible and easily maintained.

1.6. The winch brakes of a launching appliance shall be of sufficient strength to withstand:

.1 A static test with a proof load of not less than 1.5 times the maximum working load; and

.2 A dynamic test with a proof load of not less than 1.1 times the maximum working load at maximum lowering speed.

1.7. The launching appliance and its attachments other than winch brakes shall be of sufficient strength to withstand a static proof load on test of not less than 2.2 times the maximum working load.

1.8. Structural members and all blocks, falls, padeyes, links, fastenings and all other fittings used in connection with launching equipment shall be designed with not less than a minimum factor of safety on the basis of the maximum working load assigned and the ultimate strength of the material used for construction. A minimum factor of safety of 4.5 shall be applied to all davit and winch structural members, and a minimum factor of safety of 6 shall be applied to falls, suspension chains, links and blocks.

1.9. Each launching appliance shall, as far as practicable, remain effective under conditions of icing.

1.10. A lifeboat launching appliance shall be capable of recovering the lifeboat with its crew.

1.11. The arrangements of the launching applicance shall be such as to enable safe boarding of the survival craft in accordance with the requirements of regulations 38.4.2, 38.4.3, 41.3.1 and 41.3.2.

2. *Launching appliances using falls and a winch*

2.1. Falls shall be of rotation-resistant and corrosion-resistant steel wire rope.

2.2. In the case of a multiple drum winch, unless an efficient compensatory device is fitted, the falls shall be so arranged as to wind off the drums at the same rate when lowering, and to wind on to the drums evenly at the same rate when hoisting.

2.3. Every rescue boat launching appliance shall be fitted with a powered winch motor of such capacity that the rescue boat can be raised from the water with its full complement of persons and equipment.

* Reference is made to the damage stability requirements of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) adopted by the Maritime Safety Committee by resolution MSC.4(48) and the International Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk (IGC Code) adopted by the Maritime Safety Committee by resolution MSC.5(48).

[1] United Nations, *Treaty Series*, vol. 1340, p. 61 (authentic English and Russian texts), and vol. 1341, p. 3 (authentic French and Spanish texts).

2.4. An efficient hand gear shall be provided for recovery of each survival craft and rescue boat. Hand gear handles or wheels shall not be rotated by moving parts of the winch when the survival craft or rescue boat is being lowered or when it is being hoisted by power.

2.5. Where davit arms are recovered by power, safety devices shall be fitted which will automatically cut off the power before the davit arms reach the stops in order to avoid overstressing the falls or davits, unless the motor is designed to prevent such overstressing.

2.6. The speed at which the survival craft or rescue boat is lowered into the water shall be not less than that obtained from the formula:

$$S = 0.4 + (0.02 \times H)$$

where S = speed of lowering in metres per second

and H = height in metres from davit head to the waterline at the lightest seagoing condition.

2.7. The maximum lowering speed shall be established by the Administration having regard to the design of the survival craft or rescue boat, the protection of its occupants from excessive forces, and the strength of the launching arrangements taking into account inertia forces during an emergency stop. Means shall be incorporated in the appliance to ensure that this speed is not exceeded.

2.8. Every rescue boat launching appliance shall be capable of hoisting the rescue boat when loaded with its full rescue boat complement of persons and equipment at a rate of not less than 0.3 m/s.

2.9. Every launching appliance shall be fitted with brakes capable of stopping the descent of the survival craft or rescue boat and holding it securely when loaded with its full complement of persons and equipment; brake pads shall, where necessary, be protected from water and oil.

2.10. Manual brakes shall be so arranged that the brake is always applied unless the operator, or a mechanism activated by the operator, holds the brake control in the "off" position.

3. *Float-free launching*

Where a survival craft requires a launching appliance and is also designed to float free, the float-free release of the survival craft from its stowed position shall be automatic.

4. *Free-fall launching*

Every free-fall launching appliance using an inclined plane shall, in addition to complying with the applicable requirements of paragraph 1, also comply with the following requirements:

.1 The launching appliance shall be so arranged that excessive forces are not experienced by the occupants of the survival craft during launching.

.2 The launching appliance shall be a rigid structure with a ramp angle and length sufficient to ensure that the survival craft effectively clears the ship.

.3 The launching appliance shall be efficiently protected against corrosion and be so constructed as to prevent incendive friction or impact sparking during the launching of the survival craft.

5. *Evacuation-slide launching and embarkation*

Every evacuation-slide launching appliance shall, in addition to complying with the applicable requirements of paragraph 1, also comply with the following requirements:

.1 The evacuation slide shall be capable of being deployed by one person at the embarkation station.

.2 The evacuation slide shall be capable of being used in high winds and in a seaway.

6. *Liferaft launching appliances*

Every liferaft launching appliance shall comply with the requirements of paragraphs 1 and 2, except with regard to use of gravity for turning out the appliance, embarkation in the stowed position and recovery of the loaded liferaft. The launching appliance shall be so arranged as to prevent premature release during lowering and shall release the liferaft when waterborne.

7. *Embarkation ladders*

7.1. Handholds shall be provided to ensure a safe passage from the deck to the head of the ladder and vice versa.

7.2. The steps of the ladder shall be:

.1 Made of hardwood, free from knots or other irregularities, smoothly machined and free from sharp edges and splinters, or of suitable material of equivalent properties;

.2 Provided with an efficient non-slip surface either by longitudinal grooving or by the application of an approved non-slip coating;

.3 Not less than 480 mm long, 115 mm wide and 25 mm in depth, excluding any non-slip surface or coating;

.4 Equally spaced not less than 300 mm or more than 380 mm apart and secured in such a manner that they will remain horizontal.

7.3. The side ropes of the ladder shall consist of two uncovered manila ropes not less than 65 mm in circumference on each side. Each rope shall be continuous with no joints below the top step. Other materials may be used provided the dimensions, breaking strain, weathering, stretching and gripping properties are at least equivalent to those of manila rope. All rope ends shall be secured to prevent unravelling.

SECTION VII. OTHER LIFE-SAVING APPLIANCES

Regulation 49. LINE-THROWING APPLIANCES

1. Every line-throwing appliance shall:

.1 Be capable of throwing a line with reasonable accuracy;

.2 Include not less than four projectiles each capable of carrying the line at least 230 m in calm weather;

.3 Include not less than four lines each having a breaking strength of not less than 2 kN;

.4 Have brief instructions or diagrams clearly illustrating the use of the line-throwing appliance.

2. The rocket, in the case of a pistol fired rocket, or the assembly, in the case of an integral rocket and line, shall be contained in a water-resistant casing. In addition, in the case of a pistol-fired rocket, the line and rockets together with the means of ignition shall be stowed in a container which provides protection from the weather.

Regulation 50. GENERAL EMERGENCY ALARM SYSTEM

The general emergency alarm system shall be capable of sounding the general emergency alarm signal consisting of seven or more short blasts followed by one long blast on the ship's whistle or siren and additionally on an electrically operated bell or klaxon or other equivalent warning system, which shall be powered from the ship's main supply and the emergency source of electrical power required by regulation II-1/42 or II-1/43, as appropriate. The system shall be capable of operation from the navigating bridge and, except for the ship's whistle, also from other strategic points. The system shall be audible throughout all the accommodation and normal crew working spaces.

SECTION VIII. MISCELLANEOUS

Regulation 51. TRAINING MANUAL

The training manual, which may comprise several volumes, shall contain instructions and information, in easily understood terms illustrated wherever possible, on the life-saving appliances provided in the ship and on the best methods of survival. Any part of such information may be provided in the form of audio-visual aids in lieu of the manual. The following shall be explained in detail:

.1 Donning of lifejackets and immersion suits, as appropriate;
.2 Muster at the assigned stations;
.3 Boarding, launching, and clearing the survival craft and rescue boats;
.4 Method of launching from within the survival craft;
.5 Release from launching appliances;
.6 Methods and use of devices for protection in launching areas, where appropriate;
.7 Illumination in launching areas;
.8 Use of all survival equipment;
.9 Use of all detection equipment;
.10 With the assistance of illustrations, the use of radio life-saving appliances;
.11 Use of drogues;
.12 Use of engine and accessories;
.13 Recovery of survival craft and rescue boats including stowage and securing;
.14 Hazards of exposure and the need for warm clothing;
.15 Best use of the survival craft facilities in order to survive;
.16 Methods of retrieval, including the use of helicopter rescue gear (slings, baskets, stretchers), breeches-buoy and shore life-saving apparatus and ship's line-throwing apparatus;
.17 All other functions contained in the muster list and emergency instructions;
.18 Instructions for emergency repair of the life-saving appliances.

Regulation 52. INSTRUCTIONS FOR ON-BOARD MAINTENANCE

Instructions for on-board maintenance of life-saving appliances shall be easily understood, illustrated wherever possible, and, as appropriate, shall include the following for each appliance:

.1 A checklist for use when carrying out the inspections required by regulation 19.7;
.2 Maintenance and repair instructions;
.3 Schedule of periodic maintenance;
.4 Diagram of lubrication points with the recommended lubricants;
.5 List of replaceable parts;
.6 List of sources of spare parts;
.7 Log for records of inspections and maintenance.

Regulation 53. MUSTER LIST AND EMERGENCY INSTRUCTIONS

1. The muster list shall specify details of the general emergency alarm signal prescribed by regulation 50 and also action to be taken by crew and passengers when this alarm is sounded. The muster list shall also specify how the order to abandon ship will be given.

2. The muster list shall show the duties assigned to the different members of the crew including:

.1 Closing of the watertight doors, fire doors, valves, scuppers, sidescuttles, skylights, portholes and other similar openings in the ship;

.2 Equipping of the survival craft and other life-saving appliances;

.3 Preparation and launching of survival craft;

.4 General preparations of other life-saving appliances;

.5 Muster of passengers;

.6 Use of communication equipment;

.7 Manning of fire parties assigned to deal with fires;

.8 Special duties assigned in respect of the use of fire-fighting equipment and installations.

3. The muster list shall specify which officers are assigned to ensure that life-saving and fire appliances are maintained in good condition and are ready for immediate use.

4. The muster list shall specify substitutes for key persons who may become disabled, taking into account that different emergencies may call for different actions.

5. The muster list shall show the duties assigned to members of the crew in relation to passengers in case of emergency. These duties shall include:

.1 Warning the passengers;

.2 Seeing that they are suitably clad and have donned their lifejackets correctly;

.3 Assembling passengers at muster stations;

.4 Keeping order in the passageways and on the stairways and generally controlling the movements of the passengers;

.5 Ensuring that a supply of blankets is taken to the survival craft.

6. The muster list shall be prepared before the ship proceeds to sea. After the muster list has been prepared, if any change takes place in the crew which necessitates an alteration in the muster list, the master shall either revise the list or prepare a new list.

7. The format of the muster list used on passenger ships shall be approved.

PART 4

CHAPTER IV. RADIOTELEGRAPHY AND RADIOTELEPHONY

Regulation 2. TERMS AND DEFINITIONS

The following new sub-paragraph is added:

"(i) 'Emergency position-indicating radio beacon' means a station in the mobile service the emissions of which are intended to facilitate search and rescue operations."

The following new regulations are added:

"*Regulation 14-1.* SURVIVAL CRAFT EMERGENCY POSITION-INDICATING RADIO BEACONS

(*a*) Survival craft emergency position-indicating radio beacons required by regulation III/6.2.3 to be carried in survival craft shall provide transmissions to enable aircraft to locate the survival craft and may also provide transmissions for alerting purposes.

(*b*) Survival craft emergency position-indicating radio beacons shall, at least, be capable of transmitting alternately or simultaneously signals complying with the relevant standards and recommended practices of the International Civil Aviation Organization (ICAO) on the frequencies 121.5 MHz and 243.0 MHz.

(*c*) Survival craft emergency position-indicating radio beacons shall:

(i) Be of a highly visible colour, so designed that they can be used by an unskilled person and so constructed that they may be easily tested and maintained. Batteries shall not require replacement at intervals of less than 12 months, taking into account testing arrangements;

(ii) Be watertight, capable of floating and being dropped into the water without damage from a height of at least 20 m;

(iii) Be capable only of manual activation and de-activation;

(iv) Be portable, lightweight, and compact;

(v) Be provided with an indication that signals are being emitted;

(vi) Derive their energy supply from a battery forming an integral part of the device and having sufficient capacity to operate the apparatus for a period of 48 h. The transmission may be intermittent. Determination of the duty cycle should take into account the probability of homing being properly carried out, the need to avoid congestion on the frequencies and the need to comply with the requirements of the International Civil Aviation Organization (ICAO); and

(vii) Be tested and, if necessary, have their source of energy replaced at intervals not exceeding 12 months.

Regulation 14-2. PERIODIC INSPECTION AND TESTING OF EMERGENCY POSITION-INDICATING RADIO BEACONS

Emergency position-indicating radio beacons provided in accordance with regulation III/6.2.3 shall at intervals not exceeding 12 months be inspected, tested and, if necessary, have their source of energy replaced. However, in cases where it appears proper and reasonable, the Administration may extend this period to 17 months.

Regulation 14-3. TWO-WAY RADIOTELEPHONE APPARATUS FOR SURVIVAL CRAFT

(*a*) The apparatus required by regulation III/6.2.4 shall be so designed that it can be used in an emergency by an unskilled person.

(*b*) The apparatus shall be portable and capable of being used for on-board communications.

(*c*) The apparatus shall conform to the requirements laid down in the relevant Radio Regulations for equipment used in the maritime mobile service for on-board communications and shall be capable of operation on those channels specified by the Radio Regulations and as required by the Administration. If the apparatus is operating in the VHF band, precautions shall be taken to prevent the inadvertent selection of VHF channel 16 on equipment capable of being operated on that frequency.

(*d*) The apparatus shall be operated from a battery of adequate capacity to ensure 4 h operation with a duty cycle of 1 : 9.

(*e*) While at sea, the equipment shall be maintained in satisfactory condition, and, whenever necessary, the battery shall be brought to the fully charged condition or replaced."

PART 5

CHAPTER VII. CARRIAGE OF DANGEROUS GOODS

The existing text of chapter VII is replaced by the following:

PART A. CARRIAGE OF DANGEROUS GOODS IN PACKAGED FORM OR IN SOLID FORM IN BULK

Regulation 1. APPLICATION

1. Unless expressly provided otherwise, this part applies to dangerous goods classified under regulation 2 which are carried in packaged form or in solid form in bulk (hereinafter referred to as "dangerous goods"), in all ships to which the present regulations apply and in cargo ships of less than 500 tons gross tonnage.

2. The provisions of this part do not apply to ships' stores and equipment.

3. The carriage of dangerous goods is prohibited except in accordance with the provisions of this part.

4. To supplement the provisions of this part, each Contracting Government shall issue, or cause to be issued, detailed instructions on safe packaging and stowage of dangerous goods which shall include the precautions necessary in relation to other cargo.*

Regulation 2. CLASSIFICATION

Dangerous goods shall be divided into the following classes:

Class 1. Explosives

Class 2. Gases: compressed, liquefied or dissolved under pressure

Class 3. Flammable** liquids

Class 4.1. Flammable** solids

Class 4.2. Substances liable to spontaneous combustion

Class 4.3. Substances which, in contact with water, emit flammable gases

Class 5.1. Oxidizing substances

Class 5.2. Organic peroxides

Class 6.1. Poisonous (toxic) substances

Class 6.2. Infectious substances

Class 7. Radioactive materials

Class 8. Corrosives

Class 9. Miscellaneous dangerous substances, that is any other substance which experience has shown, or may show, to be of such a dangerous character that the provisions of this part shall apply to it.

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* Reference is made to the International Maritime Dangerous Goods Code (IMDG Code) adopted by the Organization by resolution A.81(IV),[1] and to the relevant sections and the related parts of Appendix B of the Code of Safe Practice for Solid Bulk Cargoes (BC Code) adopted by the Organization by resolution A.434(XI),[2] as have been or may be amended by the Maritime Safety Committee.

[1] *Resolutions and Other Decisions, Intergovernmental Maritime Consultative Organization Assembly, Fourth Session, 15-28 September 1965*, p. 18.

[2] *Ibid., Eleventh Session, 5-15 November 1979*, p. 156.

** "Flammable" has the same meaning as "inflammable".

Regulation 3. PACKAGING

1. The packaging of dangerous goods shall be:

.1 Well made and in good condition;

.2 Of such a character that any interior surface with which the contents may come in contact is not dangerously affected by the substance being conveyed; and

.3 Capable of withstanding the ordinary risks of handling and carriage by sea.

2. Where the use of absorbent or cushioning material is customary in the packaging of liquids in receptacles, that material shall be:

.1 Capable of minimizing the dangers to which the liquid may give rise;

.2 So disposed as to prevent movement and ensure that the receptacle remains surrounded; and

.3 Where reasonably possible, of sufficient quantity to absorb the liquid in the event of breakage of the receptacle.

3. Receptacles containing dangerous liquids shall have an ullage at the filling temperature sufficient to allow for the highest temperature during the course of normal carriage.

4. Cylinders or receptacles for gases under pressure shall be adequately constructed, tested, maintained and correctly filled.

5. Empty uncleaned receptacles which have been used previously for the carriage of dangerous goods shall be subject to the provisions of this part for filled receptacles, unless adequate measures have been taken to nullify any hazard.

Regulation 4. MARKING, LABELLING AND PLACARDING

1. Packages containing dangerous goods shall be durably marked with the correct technical name; trade names alone shall not be used.

2. Packages containing dangerous goods shall be provided with distinctive labels or stencils of the labels, or placards, as appropriate, so as to make clear the dangerous properties of the goods contained therein.

3. The method of marking the correct technical name and of affixing labels or applying stencils of labels, or of affixing placards on packages containing dangerous goods, shall be such that this information will still be identifiable on packages surviving at least three months' immersion in the sea. In considering suitable marking, labelling and placarding methods, account shall be taken of the durability of the materials used and of the surface of the package.

4. Packages containing dangerous goods shall be so marked and labelled except that:

.1 Packages containing dangerous goods of a low degree of hazard or packed in limited quantities*; or

.2 When special circumstances permit, packages that are stowed and handled in units that are identified by labels or placards*;

may be exempted from labelling requirements.

Regulation 5. DOCUMENTS

1. In all documents relating to the carriage of dangerous goods by sea where the goods are named, the correct technical name of the goods shall be used (trade names alone shall not be used) and the correct description given in accordance with the classification set out in regulation 2.

* Reference is made to the specific exemptions provided for in the International Maritime Dangerous Goods Code (IMDG Code).

2. The shipping documents prepared by the shipper shall include, or be accompanied by, a signed certificate or declaration that the shipment offered for carriage is properly packaged and marked, labelled or placarded, as appropriate, and in proper condition for carriage.

3. Each ship carrying dangerous goods shall have a special list or manifest setting forth, in accordance with the classification set out in regulation 2, the dangerous goods on board and the location thereof. A detailed stowage plan which identifies by class and sets out the location of all dangerous goods on board may be used in place of such special list or manifest.

Regulation 6. STOWAGE REQUIREMENTS

1. Dangerous goods shall be stowed safely and appropriately in accordance with the nature of the goods. Incompatible goods shall be segregated from one another.

2. Explosives (except ammunition) which present a serious risk shall be stowed in a magazine which shall be kept securely closed while at sea. Such explosives shall be segregated from detonators. Electrical apparatus and cables in any compartment in which explosives are carried shall be so designed and used as to minimize the risk of fire or explosion.

3. Dangerous goods in packaged form which give off dangerous vapours shall be stowed in a mechanically ventilated space or on deck. Dangerous goods in solid form in bulk which give off dangerous vapours shall be stowed in a well ventilated space.

4. In ships carrying flammable liquids or gases, special precautions shall be taken where necessary against fire or explosion.

5. Substances which are liable to spontaneous heating or combustion shall not be carried unless adequate precautions have been taken to minimize the likelihood of the outbreak of fire.

Regulation 7. EXPLOSIVES IN PASSENGER SHIPS

1. In passenger ships the following explosives only may be carried:

.1 Safety cartridges and safety fuses;

.2 Small quantities of explosives not exceeding 10 kg total net mass;

.3 Distress signals for use in ships or aircraft, if the total mass of such signals does not exceed 1,000 kg;

.4 Except in ships carrying unberthed passengers, fireworks which are unlikely to explode violently.

2. Notwithstanding the provisions of paragraph 1, additional quantities or types of explosives may be carried in passenger ships in which special safety measures approved by the Administration are taken.

PART B. CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING DANGEROUS LIQUID CHEMICALS IN BULK

Regulation 8. DEFINITIONS

For the purpose of this part, unless expressly provided otherwise:

1. "International Bulk Chemical Code" means the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted by the Maritime Safety Committee of the Organization by resolution MSC.4(48), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the Annex other than chapter I.

2. "Chemical tanker" means a cargo ship constructed or adapted and used for the carriage in bulk of any liquid product listed in chapter 17 of the International Bulk Chemical Code.

3. For the purpose of regulation 9, "ship constructed" means a ship the keel of which is laid or which is at a similar stage of construction.

4. "At a similar stage of construction" means the stage at which:

.1 Construction identifiable with a specific ship begins; and

.2 Assembly of that ship has commenced comprising at least 50 tonnes or 1% of the estimated mass of all structural material, whichever is less.

Regulation 9. APPLICATION TO CHEMICAL TANKERS

1. Unless expressly provided otherwise, this part applies to chemical tankers constructed on or after 1 July 1986 including those of less than 500 tons gross tonnage. Such tankers shall comply with the requirements of this part in addition to any other applicable requirements of the present regulations.

2. Any chemical tanker, irrespective of the date of construction, which undergoes repairs, alterations, modifications and outfitting related thereto shall continue to comply with at least the requirements previously applicable to the ship. Such a ship, if constructed before 1 July 1986, shall, as a rule, comply with the requirements for a ship constructed on or after that date to at least the same extent as before undergoing such repairs, alterations, modifications or outfitting. Repairs, alterations and modifications of a major character, and outfitting related thereto, shall meet the requirements for a ship constructed on or after 1 July 1986 in so far as the Administration deems reasonable and practicable.

3. A ship, irrespective of the date of construction, which is converted to a chemical tanker shall be treated as a chemical tanker constructed on the date on which such conversion commenced.

Regulation 10. REQUIREMENTS FOR CHEMICAL TANKERS

1. A chemical tanker shall comply with the requirements of the International Bulk Chemical Code and shall, in addition to the requirements of regulations I/8, I/9, and I/10, as applicable, be surveyed and certified as provided for in that Code. For the purpose of this regulation, the requirements of the Code shall be treated as mandatory.

2. A chemical tanker holding a certificate issued pursuant to the provisions of paragraph 1 shall be subject to the control established in regulation I/19. For this purpose such certificate shall be treated as a certificate issued under Regulation I/12 and I/13.

PART C. CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK

Regulation 11. DEFINITIONS

For the purpose of this part, unless expressly provided otherwise:

1. "International Gas Carrier Code" means the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk as adopted by the Maritime Safety Committee of the Organization by resolution MSC.5(48), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the Annex other than chapter I.

2. "Gas carrier" means a cargo ship constructed or adapted and used for the carriage in bulk of any liquefied gas or other product listed in chapter 19 of the International Gas Carrier Code.

3. For the purpose of regulation 12, "ship constructed" means a ship the keel of which is laid or which is at a similar stage of construction.

4. "At a similar stage of construction" means the stage at which:

.1 Construction identifiable with a specific ship begins; and

.2 Assembly of that ship has commenced comprising at least 50 tonnes or 1% of the estimated mass of all structural material, whichever is less.

Regulation 12. APPLICATION TO GAS CARRIERS

1. Unless expressly provided otherwise, this part applies to gas carriers constructed on or after 1 July 1986 including those of less than 500 tons gross tonnage. Such gas carriers shall comply with the requirements of this part in addition to any other applicable requirements of the present regulations.

2. Any gas carrier, irrespective of the date of construction, which undergoes repairs, alterations, modifications and outfitting related thereto shall continue to comply with at least the requirements previously applicable to the ship. Such a ship if constructed before 1 July 1986 shall, as a rule, comply with the requirements for a ship constructed on or after that date to at least the same extent as before undergoing such repairs, alterations, modifications or outfitting. Repairs, alterations and modifications of a major character, and outfitting related thereto, shall meet the requirements for a ship constructed on or after 1 July 1986 in so far as the Administration deems reasonable and practicable.

3. A ship, irrespective of the date of construction, which is converted to a gas carrier shall be treated as a gas carrier constructed on the date on which such conversion commenced.

Regulation 13. REQUIREMENTS FOR GAS CARRIERS

1. A gas carrier shall comply with the requirements of the International Gas Carrier Code and shall, in addition to the requirements of regulations I/8, I/9 and I/10, as applicable, be surveyed and certified as provided for in that Code. For the purpose of this regulation, the requirements of the Code shall be treated as mandatory.

2. A gas carrier holding a certificate issued pursuant to the provisions of paragraph 1 shall be subject to the control established in regulation I/19. For this purpose such certificate shall be treated as a certificate issued under regulation I/12 or I/13.

RESOLUTION MSC.4(48)[1]
adopted on 17 June 1983

ADOPTION OF THE INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING DANGEROUS CHEMICALS IN BULK (IBC CODE)

The Maritime Safety Committee,

Recalling resolution A.490 (XII) by which the Assembly authorized it to adopt the revised Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk when harmonized with the Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk as adopted by resolution A.328(IX),

Noting resolution MSC.6(48) by which it adopts, *inter alia*, amendments to chapter VII of the International Convention for the Safety of Life at Sea, 1974 (1974 SOLAS Convention), to

[1] Resolution published for information by the Secretariat of the United Nations.

make the provisions of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) mandatory under that Convention,

Having considered the text of the proposed IBC Code:

1. Adopts the IBC Code, the text of which is given in the Annex to the present resolution;

2. Notes that under part B of chapter VII of the 1974 SOLAS Convention as amended by resolution MSC.6(48), amendments to the IBC Code shall be adopted, brought into force and take effect in accordance with the provisions of article VIII of that Convention;

3. Further notes that the IBC Code will require amendments to cover pollution prevention aspects prior to the entry into force of Annex II of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto;[1]

4. Requests the Secretary-General to circulate to all Governments concerned amendments to the IBC Code adopted as above which comprise the inclusion in chapter 17 of new products, recommending that, pending the entry into force of those amendments, these new products should be carried by chemical tankers in compliance with the provisions of the amendments;

5. Further requests the Secretary-General to transmit a copy of the present resolution together with the text of the IBC Code to all Members of the Organization and to all Contracting Governments to the 1974 SOLAS Convention which are not Members of the Organization.

ANNEX

INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING DANGEROUS CHEMICALS IN BULK

TABLE OF CONTENTS

[1] United Nations, *Treaty Series*, vol. 1340, p. 61 (authentic English and Russian texts), and vol. 1341, p. 3 (authentic French and Spanish texts).

PREAMBLE

1. The purpose of this Code is to provide an international standard for the safe carriage by sea in bulk of dangerous liquid chemicals listed in chapter 17 of the Code by prescribing the design and construction standards of ships regardless of tonnage involved in such carriage and the equipment they should carry so as to minimize the risk to the ship, to its crew and to the environment, having regard to the nature of the products involved.

2. The basic philosophy is one of ship types related to the hazards of the products covered by the Code. Each of the products may have one or more hazard properties which include flammability, toxicity, corrosivity and reactivity.

3. Throughout the development of the Code it was recognized that it must be based upon sound naval architectural and engineering principles and the best understanding available as to the hazards of the various products covered; furthermore that chemical tanker design technology is not only a complex technology but is rapidly evolving and that the Code should not remain static. Therefore the Organization will periodically review the Code taking into account both experience and technical development.

4. Requirements for new products and their conditions of carriage will be circulated as recommendations, on an interim basis, when adopted by the Maritime Safety Committee of the Organization, prior to the entry into force of the appropriate amendments, under the terms of article VIII of the International Convention for the Safety of Life at Sea, 1974.

5. The Code primarily deals with ship design and equipment. In order to ensure the safe transport of the products, the total system must, however, be appraised. Other important facets of the safe transport of the products, such as training, operation, traffic control and handling in port, are being or will be examined further by the Organization.

6. The development of the Code has been greatly assisted by relevant work of the International Association of Classification Societies (IACS) and of the International Electrotechnical Commission (IEC).

7. Chapter 16 of the Code, dealing with operational requirements of chemical tankers, highlights the regulations in other chapters that are operational in nature and mentions those other important safety features that are peculiar to chemical tanker operation.

8. The layout of the Code is in line with the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) adopted by the Maritime Safety Committee at its forty-eighth session. Gas carriers may also carry in bulk liquid chemicals covered by this Code as dealt with in the IGC Code.

Chapter 1. GENERAL

1.1. *Application*

1.1.1. The Code applies to ships regardless of size, including those of less than 500 tons gross tonnage, engaged in the carriage of bulk cargoes of dangerous liquid chemical 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.

The Code is at present limited to the liquids shown in the summary of minimum requirements in chapter 17. Products that have been reviewed and determined not to come within the scope of the Code are found in chapter 18.

1.1.2. Liquids covered by the Code are those having a vapour pressure not exceeding 2.8 bar at a temperature of 37.8°C.

1.1.3. For a product proposed for carriage in bulk, but not listed in chapter 17 or 18, the Administration and port Administrations involved in such carriage should prescribe the pre-

liminary suitable conditions for the carriage, having regard to the criteria for hazard evaluation of bulk chemicals. The Organization should be notified of the conditions for consideration for inclusion of the product in the Code.

1.1.4. Unless expressly provided otherwise the Code applies to ships the keels of which are laid or which are at a stage at which:

.1 Construction identifiable with the ship begins; and

.2 Assembly has commenced comprising at least 50 tonnes or 1% of the estimated mass of all structural material, whichever is less;

on or after 1 July 1986.

1.1.5. A ship, irrespective of the date of construction, which is converted to a chemical tanker on or after 1 July 1986, should be treated as a chemical tanker constructed on the date on which such conversion commences.

1.1.6. Where reference is made in the Code to a paragraph, all the provisions of the subparagraphs of that designation should apply.

1.2. *Hazards*

Hazards of products covered by the Code include:

1.2.1. Fire hazard defined by flashpoint, boiling point, flammability limits and autoignition temperature of the chemical.

1.2.2. Health hazard defined by:

.1 Irritant or toxic effect on the skin or on the mucous membranes of the eyes, nose, throat and lungs in the gas or vapour state combined with vapour pressure; or

.2 Irritational effects on the skin in the liquid state; or

.3 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: the concentration which is lethal by inhalation to 50% of the test subjects.

1.2.3. Water pollution hazard defined by human toxicity, water solubility, volatility, odour or taste, and relative density.

1.2.4. Air pollution hazard defined by:

.1 Emergency exposure limit (E.E.L.) or LC 50;

.2 Vapour pressure;

.3 Solubility in water;

.4 Relative density of liquid;

.5 Vapour density.

1.2.5. Reactivity hazard defined by reactivity with:

.1 Other products; or

.2 Water; or

.3 The product itself (including polymerization).

1.3 *Definitions*

The following definitions apply unless expressly provided otherwise. (Additional definitions are given in individual chapters.)

1.3.1. 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.

1.3.2.1. Administration means the Government of the State whose flag the ship is entitled to fly.

1.3.2.2. Port Administration means the appropriate authority of the country in the port of which the ship is loading or unloading.

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

1.3.4. 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.

1.3.5. 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 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 forwardmost hold space are excluded from the cargo area.

1.3.6. Cargo pump room is a space containing pumps and their accessories for the handling of products covered by the Code.

1.3.7. 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.

1.3.8. Cargo tank is the envelope designed to contain the cargo.

1.3.9. Chemical tanker is a cargo ship constructed or adapted and used for the carriage in bulk of any liquid product listed in chapter 17.

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

1.3.11. 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.

1.3.12. 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.

1.3.13. Flashpoint is the temperature in degrees Celsius at which a product will give off enough flammable vapour to be ignited. Values given in the Code are "closed cup test" determined by an approved flashpoint apparatus.

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

1.3.15. 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.

1.3.16. 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.

1.3.17. 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.

1.3.18. 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.

1.3.19. 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 1.8 bar gauge.

1.3.20. Organization is the International Maritime Organization (IMO).

1.3.21. 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.

1.3.22. Pump room is a space, located in the cargo area, containing pumps and their accessories for the handling of ballast and oil fuel.

1.3.23. Relative density of liquid is the ratio of the mass of a volume of a product to the mass of an equal volume of fresh water. For a product of limited solubility, the relative density indicates whether it floats on water or sinks.

1.3.24. 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 leakage into the pipe between the two spectacle flanges.

1.3.25. 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.

1.3.26. 1974 SOLAS Convention means the International Convention for the Safety of Life at Sea, 1974.

1.3.27. 1983 SOLAS amendments means the 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).

1.3.28. Vapour density or the relative density of vapour is the ratio of the mass of a volume of vapour or gas (with no air present) to the mass of an equal volume of air at the same pressure and temperature. Vapour density below or above 1 indicates whether the vapour or gas is lighter or heavier than air.

1.3.29. Vapour pressure is the equilibrium pressure of the saturated vapour above the liquid expressed in bars absolute at a specified temperature.

1.3.30. 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.

1.4. *Equivalents*

1.4.1. Where the Code requires that a particular fitting, material, appliance, apparatus, item of equipment or type thereof should be fitted or carried in a ship, or that any particular provision should be made, or any procedure or arrangement should be complied with, the Administration may allow any other fitting, material, appliance, apparatus, item of equipment or type thereof to be fitted or carried, or any other provision, procedure or arrangement to be

made in that ship, if it is satisfied by trial thereof or otherwise that such fitting, material, appliance, apparatus, item of equipment or type thereof or that any particular provision, procedure or arrangement is at least as effective as that required by the Code. However, the Administration may not allow operational methods or procedures to be made an alternative to a particular fitting, material, appliance, apparatus, item of equipment, or type thereof, which are prescribed by the Code, unless such substitution is specifically allowed by the Code.

1.4.2. When the Administration so allows any fitting, material, appliance, apparatus, item of equipment, or type thereof, or provision, procedure, or arrangement, or novel design or application to be substituted thereafter, it should communicate to the Organization the particulars thereof together with a report on the evidence submitted so that the Organization may circulate the same to other Contracting Governments to the 1974 SOLAS Convention for the information of their officers.

1.5. *Surveys and certification*

1.5.1. *Survey procedure*

1.5.1.1. The survey of ships, so far as regards the enforcement of the provisions of the regulations and granting of exemptions therefrom, should be carried out by officers of the Administration. The Administration may, however, entrust the surveys either to surveyors nominated for the purpose or to organizations recognized by it.

1.5.1.2. The Administration nominating surveyors or recognizing organizations to conduct surveys should, as a minimum, empower any nominated surveyor or recognized organization to:

.1 Require repairs to a ship; and

.2 Carry out surveys if requested by the port State authority* concerned.

The Administration should notify the Organization of the specific responsibilities and conditions of the authority delegated to nominated surveyors or recognized organizations for circulation to the Contracting Governments.

1.5.1.3. When a nominated surveyor or recognized organization determines that the condition of the ship or its equipment does not correspond substantially with the particulars of the certificate or is such that the ship is not fit to proceed to sea without danger to the ship, or persons on board, such surveyor or organization should immediately ensure that corrective action is taken and should in due course notify the Administration. If such corrective action is not taken the relevant certificate should be withdrawn and the Administration should be notified immediately; and, if the ship is in a port of another Contracting Government, the port State authority concerned should also be notified immediately.

1.5.1.4. In every case, the Administration should guarantee the completeness and efficiency of the survey, and should undertake to ensure the necessary arrangements to satisfy this obligation.

1.5.2. *Survey requirements*

1.5.2.1. The structure, equipment, fittings, arrangements and material (other than items in respect of which a Cargo Ship Safety Construction Certificate, Cargo Ship Safety Equipment Certificate and Cargo Ship Safety Radiotelegraphy Certificate or Cargo Ship Safety Radiotelephony Certificate are issued) of a chemical tanker should be subjected to the following surveys:

.1 An initial survey before the ship is put in service or before the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk is issued for the first time, which should include a complete examination of its structure, equipment, fittings, arrangements and material in so far as the ship is covered by the Code. This survey should be such as to

* Port State authority has the meaning as presented in chapter I, regulation 19 of the 1978 Protocol to the 1974 SOLAS Convention.

ensure that the structure, equipment, fittings, arrangements and material fully comply with the applicable provisions of the Code.

.2 A periodical survey at intervals specified by the Administration, but not exceeding 5 years which should be such as to ensure that the structure, equipment, fittings, arrangements and material comply with the applicable provisions of the Code.

.3 A minimum of one intermediate survey during the period of validity of the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk. In cases where only one such intermediate survey is carried out in any one certificate validity period, it should be held not before 6 months prior to, nor later than 6 months after, the half-way date of the certificate's period of validity. Intermediate surveys should be such as to ensure that the safety equipment, and other equipment, and associated pump and piping systems comply with the applicable provisions of the Code and are in good working order. Such surveys should be endorsed on the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk.

.4 A mandatory annual survey within 3 months before or after the anniversary date of the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk which should include a general examination to ensure that the structure, equipment, fittings, arrangements and materials remain in all respects satisfactory for the service for which the ship is intended. Such a survey should be endorsed in the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk.

.5 An additional survey, either general or partial according to the circumstances, should be made when required after an investigation prescribed in 1.5.3.3, or whenever any important repairs or renewals are made. Such a survey should ensure that the necessary repairs or renewals have been effectively made, that the material and workmanship of such repairs or renewals are satisfactory; and that the ship is fit to proceed to sea without danger to the ship or persons on board.

1.5.3. *Maintenance of conditions after survey*

1.5.3.1. The condition of the ship and its equipment should be maintained to conform with the provisions of the Code to ensure that the ship will remain fit to proceed to sea without danger to the ship or persons on board.

1.5.3.2. After any survey of the ship under 1.5.2 has been completed, no change should be made in the structure, equipment, fittings, arrangements and material covered by the survey, without the sanction of the Administration, except by direct replacement.

1.5.3.3. Whenever an accident occurs to a ship or a defect is discovered, either of which affects the safety of the ship or the efficiency or completeness of its lifesaving appliances or other equipment, the master or owner of the ship should report at the earliest opportunity to the Administration, the nominated surveyor or recognized organization responsible for issuing the relevant certificate, who should cause investigations to be initiated to determine whether a survey, as required by 1.5.2.5, is necessary. If the ship is in a port of another Contracting Government, the master or owner should also report immediately to the port State authority concerned and the nominated surveyor or recognized organization should ascertain that such a report has been made.

1.5.4. *Issue of International Certificate of Fitness*

1.5.4.1. A certificate called an International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk, the model form of which is set out in the appendix, should be issued after an initial or periodical survey to a chemical tanker which complies with the relevant requirements of the Code.

1.5.4.2. The certificate issued under provisions of this section should be available on board for inspection at all times.

1.5.5. *Issue or endorsement of International Certificate of Fitness by another Government*

1.5.5.1. A Contracting Government may, at the request of the Government of another State, cause a ship entitled to fly the flag of the other State to be surveyed and, if satisfied that the requirements of the Code are complied with, issue or authorize the issue of the certificate to the ship, and, where appropriate, endorse or authorize the endorsement of the certificate on board the ship in accordance with the Code. Any certificate so issued should contain a statement to the effect that it has been issued at the request of the Government of the State whose flag the ship is entitled to fly.

1.5.6. *Duration and validity of the International Certificate of Fitness*

1.5.6.1. An International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk should be issued for a period specified by the Administration which should not exceed 5 years from the date of the initial survey or the periodical survey.

1.5.6.2. No extension of the 5 year period of the certificate should be permitted.

1.5.6.3. The certificate should cease to be valid:

.1 If the surveys are not carried out within the period specified by 1.5.2;

.2 Upon transfer of the ship to the flag of another State. A new certificate should only be issued when the Government issuing the new certificate is fully satisfied that the ship is in compliance with the requirements of 1.5.3.1 and 1.5.3.2. Where a transfer occurs between Contracting Governments, the Government of the State whose flag the ship was formerly entitled to fly should, if requested within 12 months after the transfer has taken place, as soon as possible transmit to the Administration copies of the certificates carried by the ship before the transfer and, if available, copies of the relevant survey reports.

Chapter 2. SHIP SURVIVAL CAPABILITY* AND LOCATION OF CARGO TANKS

2.1. *General*

2.1.1. Ships subject to the Code 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.

2.1.2. Ships subject to the Code should be designed to one of the following standards:

.1 A type 1 ship is a chemical tanker intended to transport chapter 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 chapter 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 chapter 17 products with sufficiently severe environmental and safety hazards which require a moderate degree of containment to increase survival capability in a damaged condition.

* Reference is made to the Guidelines for the Uniform Application of the Survival Requirements of the Bulk Chemical Code and the Gas Carrier Code.

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 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.

2.1.3. The ship type required for individual products is indicated in column "c" in the table of chapter 17.

2.1.4. If a ship is intended to carry more than one product listed in chapter 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.

2.2. *Freeboard and intact stability*

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

2.2.2. The stability of the ship in all seagoing conditions should be to a standard which is acceptable to the Administration.

2.2.3. 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 Administration.

2.2.4. 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.

2.2.5. 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.

2.3. *Shipside discharges below the freeboard deck*

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.

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

[1] United Nations, *Treaty Series*, vol. 640, p. 133.

2.3.3. The automatic non-return valves referred to in 2.3.1.1 and 2.3.1.2 should be of a type acceptable to the Administration 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 2.9.

2.4. *Conditions of loading*

Damage survival capability should be investigated on the basis of loading information submitted to the Administration for all anticipated conditions of loading and variations in draught and trim. Ballast conditions where the chemical tanker is not carrying products covered by the Code, or is carrying only residues of such products, need not be considered.

2.5. *Damage assumptions*

2.5.1. The assumed maximum extent of damage should be:

.1	Side damage:		
.1.1	Longitudinal extent:	$1/3L^{2/3}$ or 14.5 m, whichever is less	
.1.2	Transverse extent: Measured inboard from the ship's side at right angles to the centreline at the level of the summer load line	B/5 or 11.5 m, whichever is less	
.1.3	Vertical extent: From the moulded line of the bottom shell plating at centreline	upwards without limit	
.2	Bottom damage:		
		For 0.3L from the forward perpendicular of the ship	Any other part of the ship
.2.1	Longitudinal extent:	$1/3L^{2/3}$ or 14.5 m, whichever is less	$1/3L^{2/3}$ or 5 m, whichever is less
.2.2	Transverse extent:	B/6 or 10 m, whichever is less	B/6 or 5 m, whichever is less
.2.3	Vertical extent:	B/15 or 6 m, whichever is less measured from the moulded line of the bottom shell plating at centreline (see 2.6.2).	B/15 or 6 m, whichever is less measured from the moulded line of the bottom shell plating at centreline (see 2.6.2).

2.5.2. Other damage:

.1 If any damage of a lesser extent than the maximum damage specified in 2.5.1 would result in a more severe condition, such damage should be considered.

.2 For type 1 and type 2 ships, 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 additionally assumed damaged when also required by the applicable subparagraphs of 2.8.1.

2.6. *Location of cargo tanks*

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 2.5.1.1.2 and from the moulded line of the bottom shell plating at centreline not less than the vertical extent of damage specified in 2.5.1.2.3 and nowhere less than 760 mm from the shell plating.

.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 2.5.1.2.3 and nowhere less than 760 mm from the shell plating.

.3 Type 3 ships: no requirement.

2.6.2. Except for type 1 ships, suction wells installed in cargo tanks may protrude into the vertical extent of bottom damage specified in 2.5.1.2.3 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.

2.7. *Flooding assumptions*

2.7.1. The requirements of 2.9 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.

2.7.2. 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*

* The permeability of partially filled compartments should be consistent with the amount of liquid carried in the compartment.

2.7.3. 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.

2.7.4. Every watertight division within the maximum extent of damage defined in 2.5.1 and considered to have sustained damage in positions given in 2.8.1 should be assumed to be penetrated. Where damage less than the maximum is being considered in accordance with 2.5.2, only watertight divisions or combinations of watertight divisions within the envelope of such lesser damage should be assumed to be penetrated.

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

2.7.6. 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 2.9 and sufficient residual stability should be maintained during all stages where equalization is used. Spaces which are linked by ducts of large cross-sectional [areas] may be considered to be common.

2.7.7. If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in 2.5, arrangements should be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

2.7.8. 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 2.9.3 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 2.9; however the immersion of any other openings capable of being closed weathertight may be permitted.

2.8. *Standard of damage*

2.8.1. Ships should be capable of surviving the damage indicated in 2.5 with the flooding assumptions in 2.7 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 125m 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 Administration.

2.8.2. In the case of small type 2 and type 3 ships which do not comply in all respects with the appropriate requirements of 2.8.1.3 and 2.8.1.6, special dispensations may only be considered by the Administration 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 referred to in 1.5.4.

2.9. *Survival requirements*

2.9.1. Ships subject to the Code should be capable of surviving the assumed damage specified in 2.5 to the standard provided in 2.8 in a condition of stable equilibrium and should satisfy the following criteria.

2.9.2. 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 Administration. However, it should never be significantly less than that required by 2.9.3.

2.9.3. 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 2.9.2.1 and other openings capable of being closed weathertight may be permitted; and

.2 The emergency source of power should be capable of operating.

Chapter 3. SHIP ARRANGEMENTS

3.1. *Cargo segregation*

3.1.1. Unless expressly provided otherwise, tanks containing cargo or residues of cargo subject to the Code 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.

3.1.2. Cargoes which react in a hazardous manner with other cargoes 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.

3.1.3. Cargo piping should not pass through any accommodation, service or machinery space other than cargo pump rooms or pump rooms.

3.1.4. Cargoes subject to the Code should not be carried in either the fore or aft peak tank.

3.2. *Accommodation, service and machinery spaces and control stations*

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 regulation II-2/56 of the 1983 SOLAS amendments and no cargo or slop tank should be aft of the forward end of any accommodation.

3.2.2. 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.

3.2.3. 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 deckhouse 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 permitted by the Administration. 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 wheelhouse 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 superstructures 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.

3.3. *Cargo pump rooms*

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.

3.3.2. Permanent arrangements should be made for hoisting an injured person with a rescue line while avoiding any projecting obstacles.

3.3.3. Guard railings should be installed on all ladders and platforms.

3.3.4. Normal access ladders should not be fitted vertical and should incorporate platforms at suitable intervals.*

3.3.5. 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 on-shore reception facilities.

3.3.6. Pump discharge pressure gauges should be provided outside the cargo pump room.

3.3.7. 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.

3.4. *Access to spaces in the cargo area*

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.

3.4.2. 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.

3.4.3. 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.

3.4.4. Smaller dimensions may be approved by the Administration in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Administration.

3.5. *Bilge and ballast arrangements*

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

* Reference is made to the Recommendation on Safe Access to and Working in Large Tanks (resolution A.272(VIII))[1] as amended by resolution A 330(IX).[2]

[1] *Resolutions and Other Decisions, Intergovernmental Maritime Consultative Organization Assembly, Eighth Session, 13-23 November 1973*, p. 92.

[2] *Ibid., Ninth Session, 3-14 November 1975*, p. 192.

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.

3.5.2. 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.

3.5.3. 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 where such spaces are separated from tanks containing cargo or residues of cargo by a double bulkhead.

3.6. *Pump and pipeline identification*

Provisions should be made for the distinctive marking of pumps, valves and pipelines to identify the service and tanks which they serve.

3.7. *Bow or stern loading and unloading arrangements*

3.7.1. Subject to the approval of the Administration, cargo piping may be fitted to permit bow or stern loading and unloading. Portable arrangements should not be permitted.

3.7.2. 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 15.12.1, unless specifically approved by the Administration.

3.7.3. In addition to 5.1, 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 Administration.

.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.

3.7.4. 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 (nonopening) 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 3.2.3 and this paragraph is not possible, the Administration may approve relaxations from the above requirements.

3.7.5. Air pipes and other openings to enclosed spaces not listed in 3.7.4 should be shielded from any spray which may come from a burst hose or connection.

3.7.6. Escape routes should not terminate within the coamings required by 3.7.7 or within a distance of 3 m beyond the coamings.

3.7.7. Continuous coamings of suitable height should be fitted to keep any spills on deck and away from the accommodation and service areas.

3.7.8. Electrical equipment within the coamings required by 3.7.7 or within a distance of 3 m beyond the coamings should be in accordance with the requirements of chapter 10.

3.7.9. Fire-fighting arrangements for the bow or stern loading and unloading areas should be in accordance with 11.3.16.

3.7.10. 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 shore connection location.

Chapter 4. CARGO CONTAINMENT

4.1. *Definitions*

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.

4.1.2. 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.

4.1.3. Gravity tank means a tank having a design pressure not greater than 0.7 bar 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 the standards of the Administration taking account of the temperature of carriage and relative density of the cargo.

4.1.4. Pressure tank means a tank having a design pressure greater than 0.7 bar 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 the standards of the Administration.

4.2. *Tank type requirements for individual products*

Requirements for both installation and design of tank types for individual products are shown in column "d" in the table of chapter 17.

Chapter 5. CARGO TRANSFER

5.1. *Piping scantlings**

5.1.1. Subject to the conditions stated in 5.1.4 the wall thickness (t) of pipes should not be less than:

$$t = \frac{t_o + b + c}{1 - \frac{a}{100}} \text{ (mm)}$$

* Reference is also made to the published Rules of the Members and Associate Members of the International Association of Classification Societies (IACS).

where: t_o = theoretical thickness

$$t_o = PD/(20\,Ke + P)\ (mm)$$

with

P = design pressure (bar) referred to in 5.1.2

D = outside diameter (mm)

K = allowable stress (N/mm^2) referred to in 5.1.5

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 by the Administration as equivalent to seamless pipes. In other cases the e value is to be determined by the Administration depending on the manufacturing process and testing procedure.

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:

$$b = \frac{Dt_o}{2.5r}\ (mm)$$

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 (%).

5.1.2. The design pressure P in the formula for t_o in 5.1.1 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.

5.1.3. 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.

5.1.4. The design pressure should not be less than 10 bar gauge except for open-ended lines where it should be not less than 5 bar gauge.

5.1.5. For pipes, the allowable stress to be considered in the formula for t_o in 5.1.1 is the lower of the following values:

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

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.

5.1.6.1. The minimum wall thickness should be in accordance with Recognized Standards.*

* Recognized Standards for the purpose of this chapter are standards laid down and maintained by a classification society recognized by the Administration.

5.1.6.2. 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 5.1.1 or, if this is impracticable or would cause excessive local stresses, these loads should be reduced, protected against or eliminated by other design methods.

5.1.6.3. Flanges, valves and other fittings should be to a standard acceptable to the Administration, taking into account the design pressure defined under 5.1.2.

5.1.6.4. For flanges not complying with a standard the dimensions of flanges and associated bolts should be to the satisfaction of the Administration.

5.2. *Piping fabrication and joining details*

5.2.1. The requirements of this section apply to piping inside and outside the cargo tanks. However, the Administration may accept relaxations from these requirements for open-ended piping and for piping inside cargo tanks except for cargo piping serving other cargo tanks.

5.2.2. 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 Administration.

5.2.3. 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 satisfactory to the Administration 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 acceptable to the Administration should only be used for accessory lines and instrumentation lines with external diameters of 25 mm or less.

5.2.4. Expansion of piping should normally be allowed for by the provision of expansion loops or bends in the piping system.

.1 Bellows may be specially considered by the Administration in each case.

.2 Slip joints should not be used.

5.2.5. Welding, post weld heat treatment and non-destructive testing should be performed in accordance with Recognized Standards.

5.3. *Flange connections*

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.

5.3.2. Flanges should comply with standards acceptable to the Administration as to their type, manufacture and test.

5.4. *Test requirements for piping*

5.4.1. The test requirements of this section apply to piping inside and outside cargo tanks. However, the Administration may accept relaxations from these requirements for piping inside cargo tanks and open-ended piping.

5.4.2. 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.

5.4.3. After assembly on board, each cargo piping system should be tested for leaks to a pressure depending on the method applied.

5.5. *Piping arrangements*

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 2.6) 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.

5.5.2. 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. 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. The Administration may, however, accept a totally enclosed hydraulically operated valve located outside the cargo tank, 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.

5.5.3. 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.

5.5.4. Cargo piping installed in pipe tunnels should also comply with the requirements of 5.5.1 and 5.5.2. 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.

5.5.5. 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.

5.6. *Cargo transfer control systems*

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.

5.6.2. The controls necessary during transfer or transport of cargoes covered by the Code other than in cargo pump rooms which have been dealt with elsewhere in the Code should not be located below the weather deck.

5.6.3. For certain products additional cargo transfer control requirements are shown in column "*m*" in the table of chapter 17.

5.7. *Ship's cargo hoses*

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

5.7.2. 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.

5.7.3. Each new type of cargo hose, complete with end fittings, should be prototype tested to a pressure not less than 5 times its specified maximum working pressure. The hose temperature during this prototype test should be the intended 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 10 bar gauge.

Chapter 6. MATERIALS OF CONSTRUCTION

6.1. *General*

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 to the satisfaction of the Administration. Steel is assumed to be the normal material of construction.

6.1.2. 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.

6.2. *Special requirements for materials*

6.2.1. For certain products special requirements apply in respect of materials indicated by symbols in column "k" in the table of chapter 17, as stipulated in 6.2.2, 6.2.3 and 6.2.4.

6.2.2. The following materials of construction should not be used for tanks, pipelines, valves, fittings and other equipment, which may come into contact with the products or their vapour where referred to in column "k" in the table of chapter 17:

N1 Aluminium, copper, copper alloys, zinc, galvanized steel and mercury.

N2 Copper, copper alloys, zinc and galvanized steel.

N3 Aluminium, magnesium, zinc, galvanized steel and lithium.

N4 Copper and copper-bearing alloys.

N5 Aluminium, copper and alloys of either.

N6 Copper, silver, mercury, magnesium and other acetylide-forming metals and their alloys.

N7 Copper and copper-bearing alloys with greater than 1% copper.

N8 Aluminium, zinc, galvanized steel and mercury.

6.2.3. Materials normally used in electrical apparatus, such as copper, aluminium and insulation, should as far as practicable be protected, e.g. by encapsulation, to prevent contact with vapours of products where referred to by Z in column "k" in the table of chapter 17.

6.2.4. The following materials of construction which may come into contact with certain products or their vapour should be used for tanks, pipelines, valves, fittings and other equipment, where referred to in column "k" in the table of chapter 17 as follows:

Y1 Steel covered with a suitable protective lining or coating, aluminium or stainless steel.

Y2 Aluminium or stainless steel for product concentrations of 98% or more.

Y3 Special acid-resistant stainless steel for product concentrations of less than 98%.

Y4 Solid austenitic stainless steel.

Y5 Steel covered with suitable protective lining or coating or stainless steel.

6.2.5. Materials of construction having a melting point below 925° C, e.g. aluminium and its alloys, should not be used for external piping involved in cargo handling operations on ships intended for the carriage of products with flashpoints not exceeding 60° C (closed cup test) unless so specified in column "k" in the table of chapter 17. Short lengths of external pipes connected to cargo tanks may be permitted by the Administration if they are provided with fire-resistant insulation.

Chapter 7. CARGO TEMPERATURE CONTROL

7.1. *General*

7.1.1. When provided, any cargo heating or cooling systems should be constructed, fitted and tested to the satisfaction of the Administration. Materials used in the construction of temperature control systems should be suitable for use with the product intended to be carried.

7.1.2. 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 15.13.6.)

7.1.3. Heating or cooling systems should be provided with valves to isolate the system for each tank and to allow manual regulation of flow.

7.1.4. 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.

7.1.5. 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 "h" in the table of chapter 17.

.2 A restricted temperature measuring device is subject to the definition for a restricted gauging device in 13.1.1.2, 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 13.1.1.3, 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 16.6.)

7.1.6. When products for which 15.12, 15.12.1 or 15.12.3 are listed in column "m" in the table of chapter 17 are being heated or cooled, the heating or cooling medium should operate in a circuit:

.1 Which is independent of other ships' 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.

7.2. *Additional requirements*

For certain products, additional requirements contained in chapter 15 are shown in column "m" in the table of chapter 17.

Chapter 8. CARGO TANK VENT SYSTEMS

8.1. *General*

8.1.1. All cargo tanks should be provided with a venting system appropriate to the cargo being carried. Tank vent 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, any spaces containing sources of ignition. They should also be designed to minimize possible spraying on to the decks. Vent outlets should be arranged to prevent entrance of water into the cargo tanks and, at the same time, should direct the vapour discharge upwards in the form of unimpeded jets.

8.1.2. Provision should be made to ensure that the liquid head in any tank does not exceed the test head of that 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 15.19.

8.1.3. For a tank equipped with closed or restricted gauging, the vent system should be sized, allowing for flame screens if fitted, to permit loading at the design rate without overpressurizing the tank. Specifically, under conditions in which a saturated cargo vapour is discharged through the venting system at the maximum anticipated loading rate, the pressure differential between the cargo tank vapour space and the atmosphere should not exceed 0.2 bar or, for independent tanks, the maximum working pressure of the tank.

8.1.4. Any flame screens fitted to the discharge openings of vent systems should be easily accessible and removable for cleaning.

8.1.5. Suitable provision should be made for drainage of vent lines.

8.1.6. 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 the Code, should be similarly lined or coated, or constructed of corrosion-resistant material.

8.2. *Types of tank vent systems**

8.2.1. Open tank venting system means a system which offers no restriction except for friction losses and flame screens if fitted, to the free flow of cargo vapours to and from the cargo tanks during normal operations and should only be used for those cargoes having a flashpoint above 60° C (closed cup test) and not offering a significant inhalation health hazard. 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. However, in no case should shutoff valves be fitted either to the individual vents or to the header.

8.2.2. Controlled tank venting system means a system in which pressure/vacuum relief valves are fitted to each tank to limit the pressure or vacuum in the tank to be used for cargoes other than those for which open venting is permitted. A controlled venting system may consist of individual vents from each tank, or such individual vents, on the pressure side only, as may

* Attention is drawn to regulation II-2/59 of the 1983 amendments to the 1974 SOLAS Convention.

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/vacuum relief valves but provision may be made for bypassing the pressure/vacuum relief valves under certain operating conditions.

.1 The heights of vent outlets should not be less than 4 m above the weather deck or above the fore and aft gangway if fitted within 4 m of the gangway.

.2 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 Administration directing the vapour-air mixture upwards in an unimpeded jet with an exit velocity of at least 30 m/s are fitted.

.3 The vent outlets should also be arranged at a distance of at least 10 m from the nearest air intake or openings to accommodation, service and machinery spaces and ignition sources. Flammable vapour outlets should be provided with readily renewable and effective flame screens or safety heads of an approved type. Due attention should be paid in the design of pressure/vacuum valves, 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.

8.2.3. Reference in 8.2.1 and 8.2.2 to the use of shutoff valves in the vent lines should be interpreted to extend to all other means of stoppage, including spectacle blanks and blank flanges.

8.3. *Venting requirements for individual products*

Venting requirements for individual products are shown in column "e" and additional requirements in column "m" in the table of chapter 17.

Chapter 9. ENVIRONMENTAL CONTROL

9.1. *General*

9.1.1. Vapour spaces within cargo tanks and, in some cases, spaces surrounding cargo tanks may require to have specially controlled atmospheres.

9.1.2. 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 chapter 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.

9.1.3. 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 0.07 bar 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.

9.1.4. 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 9.1.3. Where drying 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.

9.2. *Environmental control requirements for individual products*

The required types of environmental control for certain products are shown in column "f" in the table of chapter 17.

Chapter 10. ELECTRICAL INSTALLATIONS

10.1. *General*

10.1.1. The provisions of this chapter 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.

10.1.2.1. Electrical installations should be such as to minimize the risk of fire and explosion from flammable products. Electrical installations complying with this chapter should not be considered a source of ignition for the purposes of 8.2.2.3, having regard to 10.1.4.

10.1.2.2. 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.

10.1.3. The Administration should take appropriate steps to ensure uniformity in the implementation and the application of the provisions of this chapter in respect of electrical installations.*

10.1.4. Electrical equipment and wiring should not be installed in the hazardous locations referred to in 10.2, unless essential for operational purposes, when the exceptions listed in 10.2.3 are permitted.

10.1.5. Where electrical equipment is installed in hazardous locations, as permitted in this chapter, it should be to the satisfaction of the Administration and certified by the relevant authorities recognized by the Administration for operation in the flammable atmosphere concerned, as indicated in column "g" in the table of chapter 17.

10.1.6. Absence of information on temperature class and apparatus group in column "g" in the table of chapter 17 means that data are not currently available, and this should not be confused with the non-flammable (NF) notation describing some substances. For guidance, indication is given if the flashpoint of a substance is in excess of 60° C (closed cup test). In the case of heated cargo, carriage conditions might need to be established and the requirements of 10.2.2 applied.

10.2. *Hazardous locations and types of equipment and wiring*

10.2.1. The restrictions in this section do not preclude the use of intrinsically safe systems and circuits in all hazardous locations including cargo piping. It is particularly recom-

* Reference is made to the Recommendations published by the International Electrotechnical Commission and in particular to Publication 92-502.

mended that intrinsically safe systems and circuits are used for measurement, monitoring, control and communication purposes.

10.2.2. Cargoes with a flashpoint exceeding 60° C (closed cup test):

.1 Cargo tanks and cargo piping are the only hazardous locations for such cargoes which have no qualification in column "m" in the table of chapter 17. Submerged cargo pump motors and their associated cables may, in exceptional circumstances for a specific cargo or for a clearly defined range of cargoes, be permitted by the Administration, due consideration having been given to the chemical and physical characteristics of the products. Arrangements should be made to prevent the energizing of motors and cables in flammable gas air mixtures and to de-energize the motors and cables in the event of low liquid level. Such a shutdown should be indicated by an alarm at the cargo control station.

.2 Where electrical equipment is located in a cargo pump room, due consideration should be given to the use of types of apparatus which ensure the absence of arcs or sparks and hot spots during normal operation, or which are of a certified safe type.

.3 Where the cargo is heated to within 15° C of its flashpoint value, the cargo pump room should be considered as a hazardous area as well as areas within 3 m of openings from tanks where the cargo is so heated, and within 3 m of the entrance or ventilation openings to cargo pump rooms. Electrical equipment installed within these locations should be of a certified safe type.

.4 Where the cargo is heated above its flashpoint value, the requirements of 10.2.3 are applicable.

10.2.3. For cargoes with a flashpoint not exceeding 60° C (closed cup test) without qualification in column "m" in the table of chapter 17, the hazardous locations are given below. In addition to intrinsically safe systems and circuits, the only electrical installations permitted in hazardous locations are the following:

.1 Cargo tanks and cargo piping: No additional electrical equipment is permitted.

.2 Void spaces adjacent to, above or below integral tanks:

.2.1 Through runs of cables. Such cables should be installed in heavy gauge steel pipes with gastight joints. Expansion bends should not be fitted in such spaces.

.2.2 Electrical depth sounding or log devices and impressed current cathodic protection system anodes or electrodes. These devices should be housed in gastight enclosures; associated cables should be protected as referred to in 10.2.3.2.1.

.3 Hold spaces containing independent cargo tanks:

.3.1 Through runs of cables without any additional protection.

.3.2 Lighting fittings with pressurized enclosure or of the flameproof type. The lighting system should be divided between at least two branch circuits. All switches and protective devices should interrupt all poles or phases and should be located in a non-hazardous location.

.3.3 Electrical depth sounding or log devices and impressed current cathodic protection system anodes or electrodes. These devices should be housed in gastight enclosures.

.4 Cargo pump rooms and pump rooms in the cargo area:

.4.1 Lighting fittings with pressurized enclosures or of the flameproof type. The lighting system should be divided between at least two branch circuits. All switches and all protective devices should interrupt all poles or phases and should be located in a non-hazardous location.

.4.2 Electrical motors for driving cargo pumps and any associated auxiliary pumps should be separated from these spaces by a gastight bulkhead or deck. Flexible couplings, or other means of maintaining alignment, should be fitted to the shafts between the driven equipment and its motors, and in addition, glands should be provided to the satisfaction of the Administration where the shafts pass through the

bulkhead or deck. Such electrical motors should be located in a compartment having positive pressure ventilation.

.4.3 Flameproof general alarm audible indicator.

.5 Zones on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo pipe flange, cargo valve or entrance and ventilation opening to cargo pump rooms; cargo area on open deck over all cargo tanks and cargo tank holds, including all ballast tanks and cofferdams within the cargo area, to the full width of the ship, plus 3 m fore and aft and up to a height of 2.4 m above the deck:

.5.1 Equipment of a certified safe type, adequate for open deck use;

.5.2 Through runs of cables.

.6 Enclosed or semi-enclosed spaces in which pipes containing cargoes are located; enclosed or semi-enclosed spaces immediately above cargo tanks (e.g. between decks) or having bulkheads above and in line with cargo tank bulkheads; enclosed or semi-enclosed spaces immediately above cargo pump rooms or above vertical cofferdams adjoining cargo tanks, unless separated by a gastight deck and suitably ventilated; and compartments for cargo hoses:

.6.1 Lighting fittings of a certified safe type. The lighting system should be divided between at least two branch circuits. All switches and protective devices should interrupt all poles or phases and should be located in a non-hazardous location.

.6.2 Through runs of cables.

.7 Enclosed or semi-enclosed spaces having a direct opening into any hazardous location referred to above should have electrical installations complying with the requirements for the space or zone into which the opening leads.

10.3. *Bonding*

Independent cargo tanks should be electrically bonded to the hull. All gasketed cargo pipe joints and hose connections should be electrically bonded.

10.4. *Electrical requirements for individual products*

Electrical requirements for individual products are shown in column "g" in the table of chapter 17.

Chapter 11. FIRE PROTECTION AND FIRE EXTINCTION

11.1. *Application*

11.1.1. The requirements for tankers in chapter II-2 of the 1983 SOLAS amendments should apply to ships covered by the Code, irrespective of tonnage, including ships of less than 500 tons gross tonnage, except that:

.1 Regulations 60, 61, 62 and 63 should not apply;

.2 Regulation 56.2, i.e. the requirements for location of the main cargo control station, need not apply;

.3 Regulation 4, as applicable to cargo ships, and regulation 7 should apply as they would apply to tankers of 2,000 tons gross tonnage and over;

.4 The provisions of 11.3 should apply in lieu of regulation 61; and

.5 The provisions of 11.2 should apply in lieu of regulation 63.

11.1.2. Notwithstanding the provisions of 11.1.1, ships engaged solely in the carriage of caustic potash solution, phosphoric acid or sodium hydroxide solution need not comply with part D of chapter II-2 of the 1983 SOLAS amendments, provided that they comply with part C of that chapter, except that regulation 53 need not apply to such ships and 11.2 and 11.3 hereunder need not apply.

11.2. *Cargo pump rooms*

11.2.1. The cargo pump room of any ship should be provided with a fixed fire-extinguishing system as follows:

.1 A carbon dioxide system as specified in regulation II-2/5.1 and .2 of the1983 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 requirement, 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 A halogenated hydrocarbon system as specified in regulation II-2/5.1 and .3 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 requirement, an extinguishing system should be provided which would be suitable for machinery spaces but utilizing the following minimum design quantities based on the gross volume of the cargo pump room:

Halon 1301	7%
Halon 1211	5.5%
Halon 2402	0.3 kg/m^3

11.2.2. 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 Administration.

11.2.3. A fire-extinguishing system consisting of either a fixed pressure waterspray system or a high-expansion foam system could be provided for a cargo pump room if it can be demonstrated to the Administration that cargoes will be carried which are not suited to extinguishment by carbon dioxide or halogenated hydrocarbons. The International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk should reflect this conditional requirement.

11.3. *Cargo area**

11.3.1. Every ship should be provided with a fixed deck foam system in accordance with the requirements of 11.3.2 to 11.3.12.

11.3.2. 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 Administration should be provided. Basic protein foams should not be used.

11.3.3. 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.

11.3.4. 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.

* Reference is made to MSC/Circ. 314 which provides guidance for calculating the capacity of foam systems for chemical tankers and may be used in applying the requirements for extinguishing media of the Code.

11.3.5. 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 Administration.

11.3.6. 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 11.3.5.1, 11.3.5.2 and 11.3.5.3.

11.3.7. 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 11.3.5.1 or 11.3.5.2 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 Administration.

11.3.8. 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.

11.3.9. 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.

11.3.10. 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.

11.3.11. 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.

11.3.12. 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.

11.3.13. Ships which are dedicated to the carriage of a restricted number of cargoes should be protected by alternative provisions to the satisfaction of the Administration when they are just as effective for the products concerned as the deck foam system required for the generality of flammable cargoes.

11.3.14. Suitable portable fire-extinguishing equipment for the products to be carried should be provided and kept in good operating order.

11.3.15. Where flammable cargoes are to be carried all sources of ignition should be excluded from hazardous locations referred to in 10.2.

11.3.16. Ships fitted with bow or stern loading and unloading arrangements should be provided with one additional foam monitor meeting the requirements of 11.3.7 and one additional applicator meeting the requirements of 11.3.10. 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.

11.4. *Special requirements*

Fire-extinguishing media considered to be suitable for certain products are listed for information in column "j" in the table of chapter 17.

Chapter 12. MECHANICAL VENTILATION IN THE CARGO AREA

For ships to which the Code applies, the requirements of this chapter replace the requirements of regulation II-2/59.3 of the 1983 SOLAS amendments.

12.1. *Spaces normally entered during cargo handling operations*

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.

12.1.2. 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.

12.1.3. 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 15.17.

12.1.4. 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.

12.1.5. 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.

12.1.6. Ventilation intakes should be so arranged as to minimize the possibility of recycling hazardous vapours from any ventilation discharge opening.

12.1.7. Ventilation ducts should not be led through accommodation, service and machinery spaces or other similar spaces.

12.1.8. 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 chapter 10 should be of nonsparking construction defined as:

.1 Impellers and 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.

12.1.9. Sufficient spare parts should be carried for each type of fan on board, required by this chapter.

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

12.2. *Pump rooms and other enclosed spaces normally entered*

Pump rooms and other enclosed spaces normally entered, which are not covered by 12.1.1, should be fitted with mechanical ventilation systems, capable of being controlled from outside such spaces and complying with the requirements of 12.1.3, 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.

12.3. *Spaces not normally entered*

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 eight 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 12.1.8.

Chapter 13. INSTRUMENTATION

13.1. *Gauging*

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.

13.1.2. Gauging devices should be independent of the equipment required under 15.19.

13.1.3. Open gauging and restricted gauging should be allowed only where:

.1 Open venting is allowed by the Code; or

.2 Means are provided for relieving tank pressure before the gauge is operated.

13.1.4. Types of gauging for individual products are shown in column "h" in the table of chapter 17.

13.2. *Vapour detection*

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.

13.2.2. Vapour detection instruments may be portable or fixed. If a fixed system is installed, at least one portable instrument should be provided.

13.2.3. When toxic vapour detection equipment is not available for some products which require such detection, as indicated in column "i" in the table of chapter 17, the Administration 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 Administration 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 14.2.4 and 16.4.2.2.

13.2.4. Vapour detection requirements for individual products are shown in column "i" in the table of chapter 17.

Chapter 14. PERSONNEL PROTECTION

14.1. *Protective equipment*

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.

14.1.2. 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 Administration 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.

14.1.3. Protective equipment should be used in any operation which may entail danger to personnel.

14.2. *Safety equipment*

14.2.1. Ships carrying cargoes for which 15.12, 15.12.1 or 15.12.3 is listed in column "m" in the table of chapter 17 should 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 should be in addition to that required by regulation II-2/17 of the 1983 SOLAS amendments.

14.2.2. 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 tight-fitting goggles;

.3 Fireproof lifeline with belt resistant to the cargoes carried; and

.4 Explosion-proof lamp.

14.2.3. For the safety equipment required in 14.2.1, 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 regulation II-2/17 of the 1983 SOLAS amendments.

14.2.4. A cargo pump room of ships carrying cargoes which are subject to the requirements of 15.18 or cargoes for which in column "i" in the table of chapter 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 14.2.1. 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.

14.2.5. At least one set of safety equipment as required by 14.2.2 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.

14.2.6. 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.

14.2.7. A stretcher which is suitable for hoisting an injured person up from spaces such as the cargo pump room should be placed in a readily accessible location.

14.2.8. Ships intended for the carriage of certain cargoes should 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 should be accepted only when one filter is suitable for all designated cargoes that the ship is certified to carry;

.2 Self-contained breathing apparatus should have normally at least a duration of service of 15 min;

.3 Emergency escape respiratory protection should not be used for firefighting or cargo handling purposes and should be marked to that effect.

Individual cargoes to which the provisions of this paragraph apply are indicated in column "l" in the table of chapter 17.

14.2.9. The ship should have on board medical first-aid equipment including oxygen resuscitation equipment and antidotes for cargoes carried.

14.2.10. 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.

Chapter 15. SPECIAL REQUIREMENTS

The provisions of this chapter are applicable where specific reference is made in column "m" in the table of chapter 17. These requirements are additional to the general requirements of the Code.

15.1. *Acetone cyanohydrin*

Acetone cyanohydrin should be stabilized with an inorganic acid to prevent decomposition. A certificate of stabilization should be provided by the manufacturer, and kept on board, specifying:

.1 Name and amount of stabilizer added;

.2 Date stabilizer was added and duration of effectiveness;

.3 Any temperature limitations qualifying the stabilizer's effective lifetime;

.4 The action to be taken should the length of voyage exceed the effective lifetime of the stabilizer.

15.2. *Ammonium nitrate solution, 93% or less*

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.

15.2.2. 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.

15.2.3. Except where expressly approved by the Administration, 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 Administration.

15.2.4. 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.

15.2.5. 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.

15.2.6. 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.

15.2.7. Cargo pumps should be of the centrifugal deepwell type or of the centrifugal type with water flushed seals.

15.2.8. Vent piping should be fitted with approved weatherhoods to prevent clogging. Such weatherhoods should be accessible for inspection and cleaning.

15.2.9. 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.

15.3. *Carbon disulphide*

15.3.1. 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.

15.3.2. All openings should be in the top of the tank, above the deck.

15.3.3. Loading lines should terminate near the bottom of the tank.

15.3.4. A standard ullage opening should be provided for emergency sounding.

15.3.5. Cargo piping and vent lines should be independent of piping and vent lines used for other cargo.

15.3.6. 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.

15.3.7. 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.

15.3.8. Water or inert gas displacement may be used for discharging cargo, provided the cargo system is designed for the expected pressure and temperature.

15.3.9. Safety relief valves should be of stainless steel construction.

15.3.10. Because of its low ignition temperature and close clearances required to arrest its flame propagation, only intrinsically safe systems and circuits are permitted in the hazardous locations described in 10.2.3.

15.4. *Diethyl ether*

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 nonsparking construction. Mechanical ventilation equipment should not be located in the void spaces surrounding the cargo tanks.

15.4.2. Pressure relief valve settings should not be less than 0.2 bar gauge for gravity tanks.

15.4.3. Inert gas displacement may be used for discharging cargo from pressure tanks provided the cargo system is designed for the expected pressure.

15.4.4. In view of the fire hazard, provision should be made to avoid any ignition source or heat generation or both in the cargo area.

15.4.5. 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.

15.4.6. Provision should be made to maintain the inert gas pad in the cargo tank during loading, unloading and transit.

15.5. *Hydrogen peroxide solutions over 60% but not over 70%*

15.5.1. Hydrogen peroxide solutions should be carried in dedicated ships only and no other cargoes should be carried.

15.5.2. Cargo tanks and associated equipment should be either pure aluminium (99.5%) or solid stainless steel (304L, 316, 316L or 316Ti), 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.

15.5.3. Pump rooms should not be used for cargo transfer operations.

15.5.4. Cargo tanks should be separated by cofferdams from oil fuel tanks or any other space containing flammable or combustible materials.

15.5.5. Tanks intended for the carriage of hydrogen peroxide should not be used for seawater ballast.

15.5.6. 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.

15.5.7. 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.

15.5.8. 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.

15.5.9. 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.

15.5.10. 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:

.1 The product should be diluted from the original concentration to 35% by weight within 5 min of the spill.

.2 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 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.

15.5.11. Hydrogen peroxide solutions should be stabilized to prevent decomposition. A certificate of stabilization should be provided by the manufacturer, and kept on board, specifying:

.1 Name and amount of stabilizer added;

.2 Date stabilizer was added and duration of effectiveness;

.3 Any temperature limitations qualifying the stabilizer's effective lifetime;

.4 The action to be taken should the length of voyage exceed the effective lifetime of the stabilizer.

15.5.12. 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 peroxide. He should certify to the master that the cargo has been loaded in a stable condition.

15.5.13. 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 non-flammable coveralls, suitable gloves, boots and eye protection.

15.6. *Motor fuel anti-knock compounds (containing lead alkyls)*

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 manufacture of motor fuel anti-knock compounds containing lead alkyls.

15.6.2. If a cargo pump room is located on deck level according to 15.18, the ventilation arrangements should be in compliance with 15.17.

15.6.3. Entry into cargo tanks used for the transportation of these cargoes is not permitted unless approved by the Administration.

15.6.4. 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.

15.7. *Phosphorus, yellow or white*

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.

15.7.2. 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.

15.7.3. Tanks should be so designed as to minimize the interfacial area between the liquid phosphorus and its water pad.

15.7.4. 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.

15.7.5. All openings should be at the top of cargo tanks, and fittings and joints attached thereto should be of materials resistant to phosphorus pentoxide.

15.7.6. Phosphorus should be loaded at a temperature not exceeding 60° C.

15.7.7. Tank heating arrangements should be external to tanks 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.

15.7.8. A water drench system acceptable to the Administration should be installed in all void spaces surrounding the tanks. The system should operate automatically in the event of an escape of phosphorus.

15.7.9. Void spaces referred to in 15.7.8 should be provided with effective means of mechanical ventilation which should be capable of being sealed off quickly in an emergency.

15.7.10. 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.

15.7.11. 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.

15.7.12. Ship-to-shore loading and discharge connections should be of a type approved by the Administration.

15.8. *Propylene oxide*

15.8.1. Propylene oxide transported under the provisions of this section should be acetylene-free.

15.8.2. Unless cargo tanks are properly cleaned, propylene oxide should not be carried in tanks which have contained as one of the three previous cargoes any product 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. chloroacetic);

.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.

15.8.3. Before carrying propylene oxide, 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. Particular care should be taken in the case of ammonia in tanks made of steel other than stainless steel.

15.8.4. 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 propylene oxide.

15.8.5. Tanks should be entered and inspected prior to each initial loading of propylene oxide to ensure freedom from contamination, heavy rust deposits and visible structural defects. When cargo tanks are in continuous propylene oxide service, such inspections should be performed at intervals of not more than 2 years.

15.8.6. Tanks for the carriage of propylene oxide should be of steel or stainless steel construction. Suitable tank coatings may be accepted as such by the Administration and noted on the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk.

15.8.7. Tanks which have contained propylene oxide may be used for other cargoes after thorough cleaning of tanks and associated pipework systems by washing or purging.

15.8.8. All valves, flanges, fittings and accessory equipment should be of a type suitable for use with propylene oxide and should be constructed of steel or stainless steel or other material acceptable to the Administration. The chemical composition of all material used should be submitted to the Administration for approval prior to fabrication. Discs or disc faces, seats and other wearing parts of valves should be made of stainless steel containing not less than 11% chromium.

15.8.9. Gaskets should be constructed of materials which do not react with, dissolve in, or lower the autoignition temperature of propylene oxide 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 by the Administration.

15.8.10. Insulation and packing, if used, should be of a material which does not react with, dissolve in, or lower the autoignition temperature of propylene oxide.

15.8.11. The following materials are generally found unsatisfactory for gaskets, packing and similar uses in propylene oxide containment systems and would require testing before being approved by the Administration:

.1 Neoprene or natural rubber, if it comes into contact with propylene oxide;

.2 Asbestos, or binders used with asbestos;

.3 Materials containing oxides of magnesium, such as mineral wools.

15.8.12. Threaded joints should not be permitted in the cargo liquid and vapour lines.

15.8.13. Filling and discharge piping should extend to within 100 mm of the bottom of the tank or any sump pit.

15.8.14. The containment system for a tank containing propylene oxide should have a valved vapour return connection.

15.8.15. Propylene oxide 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 propylene oxide containment system should be independent of all other containment systems.

15.8.16. During discharging operations, the pressure in the cargo tank should be maintained above 0.07 bar gauge.

15.8.17. Tanks carrying propylene oxide should be vented independently of tanks carrying other products. Facilities should be provided for sampling the tank contents without opening the tank to atmosphere.

15.8.18. 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 propylene oxide does not heat significantly if the discharge line from the pump is shut off or otherwise blocked.

15.8.19. Cargo hoses used for transfer of propylene oxide should be marked "FOR PROPYLENE OXIDE TRANSFER ONLY".

15.8.20. Cargo tanks, void spaces and other enclosed spaces, adjacent to an integral gravity cargo tank, should either contain a compatible cargo (those cargoes specified in 15.8.2 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 propylene oxide and oxygen. Portable sampling equipment is satisfactory. The oxygen content of these spaces should be maintained below 2%.

15.8.21. In no case should air be allowed to enter the cargo pump or piping system while propylene oxide is contained within the system.

15.8.22. 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.

15.8.23. Propylene oxide may be carried in pressure tanks or in independent or integral gravity tanks. Tanks should be designed for the maximum pressure expected to be encountered during loading, conveying and discharging cargo.

15.8.24. Cargo tanks with a design pressure less than 0.6 bar gauge should have a cooling system to maintain the propylene oxide below the reference temperature. Reference temperature (R) means, in the case of propylene oxide, the temperature corresponding to the vapour pressure of the propylene oxide at the set pressure of the pressure relief valve.

15.8.25. The refrigeration requirement for tanks with a design pressure less than 0.6 bar gauge may be waived by the Administration if the ship is operating in restricted areas or in 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.

15.8.26. 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 (R).

15.8.27. An alternative arrangement may consist of three cooling plants, any two of which should be sufficient to maintain the liquid temperature below the reference temperature (R).

15.8.28. Cooling media which are separated from propylene oxide by a single wall only should be nonreactive with the propylene oxide.

15.8.29. Cooling systems requiring compression of propylene oxide should not be used.

15.8.30. Pressure relief valve settings should not be less than 0.2 bar gauge, or greater than 7.0 bar gauge, for pressure tanks.

15.8.31. The piping system for tanks to be loaded with propylene oxide should be separate (as defined in 1.3.24) from piping systems for all other tanks, including empty tanks. If the

piping system for the tanks to be loaded is not independent (as defined in 1.3.15), 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.

15.8.32. Propylene oxide may be transported only in accordance with cargo handling plans that have been approved by the Administration. 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.

15.8.33. Before each loading of propylene oxide, certification verifying that the required piping separation has been achieved should be obtained from a responsible person acceptable to the port Administration and should be 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.

15.8.34.1. No cargo tanks should be more than 98% liquid full at the reference temperature (R).

15.8.34.2. 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 vapor pressure of the cargo at the set pressure of the pressure relief valve.

15.8.34.3. 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 Administration. A copy of the list should be permanently kept on board by the master.

15.8.35. 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 bar 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.

15.8.36. 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.

15.8.37. 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. 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.

15.8.38. A remotely operated, controlled closing-rate shutoff valve should be provided at each cargo hose connection used during cargo transfer.

15.9. *Sodium chlorate solution, 50% or less*

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.

15.9.2. 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.

15.10. *Sulphur liquid*

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.

15.10.2. 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.

15.10.3. Ventilation systems should be so designed and arranged as to preclude depositing of sulphur within the system.

15.10.4. 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.

15.10.5. Connections should be provided to permit sampling and analysing of vapour in void spaces.

15.10.6. Cargo temperature controls should be provided to ensure that the temperature of the sulphur does not exceed 155° C.

15.11. *Acids*

15.11.1. The ship's shell plating should not form any boundaries of tanks containing mineral acids.

15.11.2. Proposals for lining steel tanks and related piping systems with corrosion-resistant materials may be considered by the Administration. The elasticity of the lining should not be less than that of the supporting boundary plating.

15.11.3. 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.

15.11.4. 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.

15.11.5. Because of the danger of evolution of hydrogen when these substances are being carried, the electrical arrangements should comply with 10.2.3.1, 10.2.3.2, 10.2.3.3. 10.2.3.4, 10.2.3.6 and 10.2.3.7. 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.

15.11.6. Substances subjected to the requirements of this section should be segregated from oil fuel tanks, in addition to the segregation requirements in 3.1.1.

15.11.7. Provision should be made for suitable apparatus to detect leakage of cargo into adjacent spaces.

15.11.8. The cargo pump room bilge pumping and drainage arrangements should be of corrosion-resistant materials.

15.12. *Toxic products*

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 Administration, directing the vapour-air mixture upwards in an unimpeded jet with an exit velocity of at least 30 m/s, are fitted.

15.12.2. Tank venting systems should be provided with a connection for a vapour return line to the shore installation.

15.12.3. 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 3.7.2.)

15.12.4. Cargo tank relief valve settings should be a minimum of 0.2 bar gauge.

15.13. *Cargoes inhibited against self-reaction*

15.13.1. Certain cargoes, with a reference in column "m" in the table of chapter 17, by the nature of their chemical make-up tend to polymerize under certain conditions of temperature, exposure to air or contact with a catalyst. Mitigation of this tendency is carried out by introducing small amounts of chemical inhibitors into the liquid cargo or controlling the cargo tank environment.

15.13.2. 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.

15.13.3. Care should be taken to ensure that these cargoes are sufficiently inhibited to prevent polymerization at all times during the voyage. Ships carrying such cargoes should be provided with a certificate of inhibition from the manufacturer, and kept during the voyage, specifying:

.1 Name and amount of inhibitor added;

.2 Date inhibitor was added and duration of effectiveness;

.3 Any temperature limitations qualifying the inhibitor's effective lifetime;

.4 The action to be taken should the length of voyage exceed the effective lifetime of the inhibitor.

15.13.4. Ships using the exclusion of air as the method of preventing self-reaction of the cargo should comply with 9.1.3.

15.13.5. 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.

15.13.6. 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.

15.14. *Cargoes with a vapour pressure greater than 1.013 bar absolute at 37.8° C*

15.14.1. For a cargo referenced in column "m" in the table of chapter 17 to this section, a mechanical refrigeration system should be provided unless the cargo system is designed to with-

stand 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.

15.14.2. A mechanical refrigeration system should maintain the liquid temperature below the boiling temperature at the cargo tank design pressure.

15.14.3. When ships operate in restricted areas and at restricted times of the year, or on voyages of limited duration, the Administration 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.

15.14.4. Connections should be provided for returning expelled gases to shore during loading.

15.14.5. Each tank should be provided with a pressure gauge which indicates the pressure in the vapour space above the cargo.

15.14.6. Where the cargo needs to be cooled, the thermometers should be provided at the top and bottom of each tank.

15.14.7.1. No cargo tanks should be more than 98% liquid full at the reference temperature (R).

15.14.7.2. 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.

15.14.7.3. 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 Administration. A copy of the list should be permanently kept on board by the master.

15.15. *Cargoes with low ignition temperature and wide flammability range*

For ships carrying such cargoes, the distance requirements of 10.2.3.5 should be increased to at least 4.5 m.

15.16. *Cargo contamination*

15.16.1. Where column "m" in the table of chapter 17 refers to this section, alkaline or acidic materials, such as caustic soda or sulphuric acid, should not be allowed to contaminate the cargo.

15.16.2. Where column "m" in the table of chapter 17 refers to this section, 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 chapter 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 be separate 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.

15.17. *Increased ventilation requirements*

For certain products, the ventilation system as described in 12.1.3 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.

15.18. *Special cargo pump room requirements*

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 Administration may give special consideration to cargo pump rooms below deck.

15.19. *Overflow control*

15.19.1. The provisions of this section are applicable where specific reference is made in column "m" in the table of chapter 17, and are in addition to the requirements for gauging devices.

15.19.2. In the event of a power failure on any system essential for safe loading, an alarm should be given to the operators concerned.

15.19.3. Loading operations should be terminated at once in the event of any system essential for safe loading becoming inoperative.

15.19.4. Level alarms should be capable of being tested prior to loading.

15.19.5. The high-level alarm system required under 15.19.6 should be independent of the overflow control system required by 15.19.7 and should be independent of the equipment required by 13.1.

15.19.6. Cargo tanks should be fitted with a visual and audible high-level alarm which complies with 15.19.1 to 15.19.5 and which indicates when the liquid level in the cargo tank approaches the normal full condition.

15.19.7. A tank overflow control system required by this section 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 Administration and the port Administrations concerned.

15.19.8. The loading rate (LR) of the tank should not exceed:

$$LR = \frac{3600\,U}{t}\ (m^3/h)$$

where U = ullage volume (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.

Chapter 16. OPERATIONAL REQUIREMENTS*

16.1. *Maximum allowable quantity of cargo per tank*

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.

16.1.2. 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.

16.1.3. 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.

16.2. *Cargo information*

16.2.1. A copy of this Code, or national regulations incorporating the provisions of this Code, should be on board every ship covered by this Code.

16.2.2. Any cargo offered for bulk shipment should be indicated in the shipping documents by the correct technical name. Where the cargo is a mixture, an analysis indicating the dangerous components contributing significantly to the total hazard of the product should be provided, or a complete analysis if this is available. Such an analysis should be certified by the manufacturer or by an independent expert acceptable to the Administration.

16.2.3. 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 Counter-measures 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 15.1, 15.5.11 or 15.13.3, the cargo should be refused if the certificate required by these paragraphs is not supplied.

16.2.4. If sufficient information necessary for the safe transportation of the cargo is not available, the cargo should be refused.

16.2.5. Cargoes which evolve highly toxic imperceptible vapours should not be transported unless perceptible additives are introduced into the cargo.

16.3. *Personnel training***

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.

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* Attention is also drawn to the operation guidelines contained in the ICS Tanker Safety Guide (Chemicals).

** Reference is made to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978[1] and in particular to the "Mandatory minimum requirements for the training and qualifications of masters, officers and ratings of chemical tankers" — regulation V/2, chapter V of the Annex to that Convention and to resolution 11 of the International Conference on Training and Certification of Seafarers, 1978.

[1] United Nations, *Treaty Series*, vol. 1361, p. 2 (authentic Chinese and English texts), and vol. 1362, p. 2 (authentic French, Russian and Spanish texts).

16.3.2. Personnel involved in cargo operations should be adequately trained in handling procedures.

16.3.3. 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.

16.4. *Opening of and entry into cargo tanks*

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.

16.4.2. 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.

16.4.3. 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.

16.5. *Stowage of cargo samples*

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 Administration.

16.5.2. 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.

16.5.3. Samples which react with each other dangerously should not be stowed close to each other.

16.5.4. Samples should not be retained on board longer than necessary.

16.6. *Cargoes not to be exposed to excessive heat*

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 7.1.5.4).

16.6.2. Heating coils in tanks carrying this product should be blanked off or secured by equivalent means.

16.6.3. Heat-sensitive products should not be carried in deck tanks which are not insulated.

16.7. *Additional operational requirements*

The code contains additional operational requirements in:

3.1.1	15.3.8	15.8.28
3.1.2.1	15.4.6	15.8.29
3.1.2.2	15.5	15.8.31
3.1.4	15.6.1	15.8.32
3.5.2	15.6.3	15.8.33
3.7.4	15.6.4	15.8.34.1
7.1.2	15.7.1	15.8.34.2
7.1.6.3	15.7.6	15.8.34.3
9.1.4	15.7.11	15.8.35
9.2	15.8.1	15.8.36
11.3.2	15.8.2	15.8.37
11.4	15.8.3	15.9
12.1.2	15.8.4	15.10.1
12.2	15.8.5	15.11.4
13.2.1	15.8.7	15.11.6
13.2.2	15.8.15	15.12.3.1
13.2.3	15.8.16	15.13
13.2.4	15.8.17	15.14.7.1
Ch.14	15.8.19	15.14.7.2
15.1	15.8.20	15.14.7.3
15.3.1	15.8.21	15.16
15.3.7	15.8.22	15.19.8

Chapter 17. SUMMARY OF MINIMUM REQUIREMENTS

Explanatory notes

Product name (column a)	The product names are not always identical with those given in the Bulk Chemical Code, as amended (adopted by resolution A.212 (VII)). (For explanation see index of chemicals.)
UN number (column b)	The number relating to each product shown in the recommendations proposed by the United Nations Committee of Experts on the Transport of Dangerous Goods. UN numbers, where available, are given for information only.
Ship type (column c)	1 = ship type 1 (2.1.1) 2 = ship type 2 (2.1.2) 3 = ship type 3 (2.1.2)
Tank type (column d)	1 = independent tank (4.1.1) 2 = integral tank (4.1.2) G = gravity tank (4.1.3) P = pressure tank (4.1.4)
Tank vents (column e)	Open: open venting Cont: controlled venting SR: safety relief valve

Tank environmental control* (column f)	Inert: inerting (9.1.2.1) Pad: liquid or gas (9.1.2.2) Dry: drying (9.1.2.3) Vent: natural or forced (9.1.2.4)
Electrical equipment (column g)	T1 to T6: temperature classes** 11A, 11B or 11C: apparatus groups** NF: nonflammable product (10.1.6) Yes: flashpoint exceeding 60°C (closed cup test) (10.1.6)
Gauging (column h)	O: open gauging (13.1.1.1) R: restricted gauging (13.1.1.2) C: closed gauging (13.1.1.3) I: indirect gauging (13.1.1.3)
Vapour detection* (column i)	F: flammable vapours T: toxic vapours
Fire protection (column j)	A: alcohol-resistant 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 Code
Materials of construction (column k)	N: see 6.2.2 Z: see 6.2.3 Y: see 6.2.4. A blank indicates no special guidance given for materials of construction
Respiratory and eye protection* (column l)	E: see 14.2.8

* "No" indicates nil requirements.

** Temperature classes and apparatus groups as defined in International Electrotechnical Commission Publication 79 (Part 1, Appendix D, Parts 4, 8 and 12). A blank indicates that data are currently not available.

a Product name	b UN number	c Ship type	d Tank type	e Tank vents	f Tank environmental control	g Electrical Equipment: Class	Group	Flash-point >60° C	h Gauging	i Vapour detection	j Fire protection	k Materials of construction	l Respiratory and eye protection	m Special requirements
Acetic acid	2789	3	2G	Cont.	No	T1	11A	No	R	F	A	Y1,Z	E	15.11.2 to 15.11.4, 15.11.6 to 15.11.8
Acetic anhydride	1715	2	2G	Cont.	No	T2	11A	No	R	F-T	A	Y1	E	15.11.2 to 15.11.4, 15.11.6 to 15.11.8
Acetone cyanohydrin	1541	2	2G	Cont.	No	T1	11A	Yes	C	T	A	Y1	E	15.1, 15.12, 15.17, 15.18, 15.19, 16.6
Acetonitrile	1648	2	2G	Cont.	No	T2	11A	No	R	F-T	A		No	15.12
Acrylamide solution, 50% or less		2	2G	Open	No		NF		C	No	No		No	15.12.3, 15.13, 15.16.1, 15.19.6, 16.6.1
Acrylic acid	2218	3	2G	Cont.	No	T2	11A	No	R	F-T	A	Y1	No	15.13, 16.6.1
Acrylonitrile	1093	2	2G	Cont.	No	T1	11B	No	C	F-T	A	N3,Z	E	15.12, 15.13, 15.17, 15.19
Adiponitrile	2205	3	2G	Cont.	No		11B	Yes	R	T	A		No	
Alkyl benzene sulphonic acid	2584 2586	3	2G	Open	No			Yes	O	No	B		No	
Allyl alcohol	1098	2	2G	Cont.	No	T2	11B	No	C	F-T	A		E	15.12, 15.17, 15.19
Allyl chloride	1100	2	2G	Cont.	No	T2	11A	No	C	F-T	A		E	15.12, 15.17, 15.19
2-(2-Aminoethoxy)-ethanol		3	2G	Open	No			Yes	O	No	A,C,D	N2	No	15.19.6
Aminoethylethanolamine		3	2G	Open	No	T2	11A	Yes	O	No	A	N1	No	
N-Aminoethylpiperazine	2815	3	2G	Cont.	No			Yes	R	T	A,C,D	N2	No	15.19.6
Ammonia aqueous, 28% or less	2672	3	2G	Cont.	No		NF		R	T	C	N4	E[a]	
Ammonium nitrate solution, 93% or less	2426	2	1G	Open	No		NF		O	No	No	Y4	No	15.2, 15.11.4, 15.11.6, 15.18, 15.19.6
Aniline	1547	2	2G	Cont.	No	T1	11A	Yes	C	T	A		No	15.12, 15.17, 15.19
Benzene and mixtures having 10% benzene content or more	1114	3	2G	Cont.	No	T1	11A	No	R	F-T	B		No	15.12.1, 15.17

Benzenesulphonyl chloride	2225	3	2G	Cont.	No			Yes	R	T	B,D	N1	No	15.19.6
Benzyl chloride	1738	2	2G	Cont.	No	T1	11A	Yes	C	Y	B		E	15.12, 15.13, 15.17, 15.19
n-Butyl acrylate	2348	2	2G	Cont.	No	T2	11B	No	R	F-T	A		No	15.13, 16.6.1, 16.6.2
Butylamine (all isomers)	1125 1214	2	2G	Cont.	No			No	R	F-T	A	N1	E	15.12, 15.17, 15.19.6
n-Butyl ether	1149	3	2G	Cont.	Inert	T4	11B	No	R	F-T	A,D		No	15.4.6, 15.12
Butyl/Decyl/Cetyl-Eicosyl methacrylate mixture		3	2G	Cont.	No				R	No	A,C,D		No	15.13, 16.6.1, 16.6.2
Butyl methacrylate	2227	3	2G	Cont.	No		11A	No	R	F-T	A,D		No	15.13, 16.6.1, 16.6.2
n-Butyraldehyde	1129	3	2G	Cont.	No	T3	11A	No	O	F-T	A		No	15.16.1
Camphor oil	1130	3	2G	Cont.	No		11A	No	O	F	B		No	
Carbolic oil		2	2G	Cont.	No			Yes	C	F-T	A		No	15.12, 15.9
Carbon disulphide	1131	2	1G	Cont.	Pad+Inert	T5	11C	No	C	F-T	C		E	15.3, 15.12, 15.15, 15.19
Carbon tetrachloride	1846	3	2G	Cont.	No		NF		C	T	No	Z	E	15.12, 15.17, 15.19.6
Cashew nut shell oil (untreated)		3	2G	Cont.	No			Yes	R	T	B		No	
Caustic potash solution	1814	3	2G	Open	No		NF		O	No	No	N8	No	
Cetyl-Eicosyl methacrylate mixture		3	2G	Open	No			Yes	O	No	A,C,D		No	15.13, 16.6.1, 16.6.2
Chlorobenzene	1134	3	2G	Cont.	No	T1	11A	No	R	F-T	B		No	
Chloroform	1888	3	2G	Cont.	No		NF		R	T	No		E	15.12
Chlorohydrins, crude		2	2G	Cont.	No		11A	No	C	F-T	A		No	15.12, 15.19
2- or 3-Chloropropionic acid	2511	3	2G	Open	No			Yes	O	No	A	Y1	No	15.11.2 to 15.11.4, 15.11.6 to 15.11.8
Chlorosulphonic acid	1754	1	2G	Cont.	No		NF		C	T	No		E	15.11.2 to 15.11.8, 15.12, 15.16.2, 15.19
(*o*-, *m*-, *p*-) Chlorotoluenes	2238	3	2G	Cont.	No			No	R	F-T	B,C		No	
Coal tar naphtha	2553	3	2G	Cont.	No	T3	11A	No	R	F-T	A,D		No	
Creosote		3	2G	Open	No	T2	11A	Yes	O	No	B,D		No	15.19.6
Cresols, mixed isomers	2076	3	2G	Open	No	T1	11A	Yes	O	No	B		No	

a Product name	b UN number	c Ship type	d Tank type	e Tank vents	f Tank environmental control	g Electrical Equipment			h Gauging	i Vapour detection	j Fire protection	k Materials of construction	l Respiratory and eye protection	m Special requirements
						Class	Group	Flash-point >60° C						
Crotonaldehyde	1143	2	2G	Cont.	No	T3	11B	No	R	F-T	A		E	15.12, 15.16.1, 15.17
Cyclohexanone	1915	3	2G	Cont.	No	T2	11A	No	R	F-T	A	N5	No	
Cyclohexylamine	2357	3	2G	Cont.	No	T3	11A	No	R	F-T	A,D	N1	No	
Decyl acrylate		3	2G	Open	No	T3	11A	Yes	O	No	A,C,D	N2	No	15.13, 16.6.1, 16.6.2
Dibutylamine	2248	3	2G	Cont.	No	T2	11A	No	R	F-T	B,D	N4	No	
o-Dichlorobenzene	1591	3	2G	Cont.	No	T1	11A	Yes	R	T	B,D	N5	No	
1,1-Dichloroethane	2362	3	2G	Cont.	No	T2	11A	No	R	F-T	B		E	
Dichloroethyl ether	1916	2	2G	Cont.	No	T2	11A	No	R	F-T	A	N5	No	
2,2-Dichloroisopropyl ether	2490	2	2G	Cont.	No			Yes	R	T	B,C,D	N5	No	15.12, 15.17, 15.19
2,4-Dichlorophenol	2021	3	2G	Cont.	Dry			Yes	R	T	B,C,D	N1	No	15.19.6
1,2-Dichloropropane	1279	2	2G	Cont.	No	T1	11A	No	R	F-T	B	Z	No	15.12
1,3-Dichloropropane		2	2G	Cont.	No	T1	11A	No	R	F-T	B		No	15.12
Dichloropropene/Dichloropropane mixtures		2	2G	Cont.	No			No	C	F-T	B,C,D		E	15.12, 15.17, 15.18, 15.19
1,3-Dichloropropene	2047	2	2G	Cont.	No	T2	11A	No	C	F-T	B		E	15.12, 15.17, 15.18, 15.19
2,2 Dichloropropionic acid		3	2G	Cont.	Dry			Yes	R	No	A	Y5	No	15.11.2, 15.11.4, 15.11.6, 15.11.8
Diethanolamine		3	2G	Open	No	T1	11A	Yes	O	No	A	N2	No	
Diethylamine	1154	3	2G	Cont.	No	T2	11A	No	R	F-T	A	N1	E	15.12
Diethylenetriamine	2079	3	2G	Open	No	T2	11A	Yes	O	No	A	N2	No	
Diethylethanolamine	2686	3	2G	Cont.	No	T2	11A	No	R	F-T	A,D	N1	No	
Diethyl ether	1155	2	1G	Cont.	Inert	T4	11B	No	C	F-T	A	N7	E	15.4, 15.14, 15.15, 15.19
Di-(2-ethylhexyl) phosphoric acid	1902	3	2G	Open	No			Yes	O	No	B,C,D	N2	No	
Diethyl sulphate	1594	2	2G	Cont.	No			Yes	C	T	A,D	N3	No	15.19.6
Diisobutylamine	2361	2	2G	Cont.	No			No	R	F-T	B,D	N1	No	15.12.3, 15.19.6
Diisopropanolamine		3	2G	Open	No	T2	11A	Yes	O	No	A	N2	No	

Diisopropylamine	1158	2	2G	Cont.	No	T2	11A	No	C	F-T	A	N2	E	15.12, 15.19
Dimethylamine aqueous, 45% or less	1160	3	2G	Cont.	No	T2	11A	No	R	F-T	C,D	N1	E	15.12
Dimethylamine aqueous greater than 45% but not greater than 55%	1160	2	2G	Cont.	No			No	C	F-T	A,C,D	N1	E	15.12, 15.17, 15.19
Dimethylamine aqueous greater than 55% but not greater than 65%	1160	2	2G	Cont.	No			No	C	F-T	A,C,D	N1	E	15.12, 15.14, 15.17, 15.19
N,N-Dimethylcyclohexylamine	2264	2	2G	Cont.	No			No	R	F-T	A,C	N1	No	15.12, 15.17, 15.19.6
Dimethylethanolamine	2051	3	2G	Cont.	No	T3	11A	No	R	F-T	A,D	N2	No	
Dimethylformamide	2265	3	2G	Cont.	No	T2	11A	No	R	F-T	A,D		No	
1,4-Dioxane	1165	2	2G	Cont.	No	T4	11B	No	C	F-T	A		No	15.12, 15.19
Diphenylmethane diisocyanate	2489	2	2G	Cont.	Dry			No[b]	C	T[b]	C[c],D	N5	No	15.12, 15.16.2, 15.17, 15.19.6
Di-*n*-propylamine	2383	3	2G	Cont.	No			No	R	F-T	A	N2	No	15.12.3, 15.19.6
Dodecyl diphenyl oxide disulphonate solution		3	2G	Open	No		NF		O	No	No		No	
Dodecyl methacrylate		3	2G	Open	No			Yes	O	No	A,C		No	15.13
Dodecyl-Pentadecyl methacrylate mixture		3	2G	Open	No			Yes	O	No	A,C,D		No	15.13, 16.6.1, 16.6.2
Epichlorohydrin	2023	2	2G	Cont.	No		11B	No	C	F-T	A		E	15.12, 15.17, 15.19
Ethyl acrylate	1917	2	2G	Cont.	No	T2	11B	No	R	F-T	A		E	15.13, 16.6.1, 16.6.2
N-Ethylbutylamine		3	2G	Cont.	No			No	R	F-T	A	N1	No	15.12.3, 15.19.6
N-Ethylcyclohexylamine		3	2G	Cont.	No			No	R	F-T	A,C	N1	No	15.19.6
Ethylene chlorohydrin	1135	2	2G	Cont.	No	T2	11A	No	C	F-T	D		E	15.12, 15.17, 15.19
Ethylene cyanohydrin		3	2G	Open	No		11B	Yes	O	No	A		No	
Ethylenediamine	1604	2	2G	Cont.	No	T2	11A	No	R	F-T	A	N2	No	
Ethylene dibromide	1605	2	2G	Cont.	No		NF		C	T	No		E	15.12, 15.19.6
Ethylene dichloride	1184	2	2G	Cont.	No	T2	11A	No	R	F-T	B	N4	No	15.19
2-Ethylhexyl acrylate		3	2G	Open	No	T3	11B	Yes	O	No	A		No	15.13, 16.6.1, 16.6.2
2-Ethylhexylamine	2276	2	2G	Cont.	No			No	R	F-T	A	N2	No	15.12
Ethylidene norbornene		3	2G	Cont.	No			No	R	F-T	B,C,D	N4	No	15.12.1, 15.16.1, 15.19.6

a Product name	b UN number	c Ship type	d Tank type	e Tank vents	f Tank environmental control	g Electrical Equipment: Class	g Electrical Equipment: Group	g Electrical Equipment: Flash-point >60° C	h Gauging	i Vapour detection	j Fire protection	k Materials of construction	l Respiratory and eye protection	m Special requirements
Ethyl methacrylate	2277	3	2G	Cont.	No		11A	No	R	F-T	B,D		No	15.13, 16.6.1, 16.6.2
2-Ethyl-3-propylacrolein		3	2G	Cont.	No		11A	No	R	F-T	A		No	
Formaldehyde solutions, 45% or less	1198[d]	3	2G	Cont.	No	T2	11B	No	R	F-T	A		E[e]	15.16.1
Formic acid	1779	3	2G	Cont.	No	T1	11A	No	R	T	A	Y2/Y3	E	15.11.2 to 15.11.4, 15.11.6 to 15.11.8
Furfural	1199	3	2G	Cont.	No	T2	11B	No	R	F-T	A		No	15.16.1
Glutaraldehyde solutions, 50% or less		3	2G	Open	No		NF		O	No	No		No	15.16.1
Hexamethylenediamine solutions	1783	3	2G	Cont.	No			Yes	R	T	A	N2	No	15.19.6
Hexamethyleneimine	2493	2	2G	Cont.	No			No	R	F-T	A,C	N1	No	
Hydrochloric acid	1789	3	1G	Cont.	No		NF		R	T	No		E[f]	15.11
Hydrogen peroxide solutions over 60% but not over 70%		2	2G	Cont.	No		NF		C	No	No		No	15.5, 15.19.6
2-Hydroxyethyl acrylate		2	2G	Cont.	No			Yes	C	T	A		No	15.12, 15.13, 15.19.6, 16.6.1, 16.6.2
Isobutyl acrylate	2527	2	2G	Cont.	No	T2	11B	No	R	F-T	A		No	15.13, 16.6.1, 16.6.2
Isobutyraldehyde	2045	3	2G	Cont.	No	T3	11A	No	O	F-T	A		No	15.16.1
Isophorone diamine	2289	3	2G	Cont.	No			Yes	R	T	A	N2	No	
Isophorone diisocyanate	2290	3	2G	Cont.	Dry			Yes	C	T	C[c],D	N5	No	15.12, 15.16.2, 15.17, 15.19.6
Isoprene	1218	3	2G	Cont.	No	T3	11B	No	R	F	B		No	15.13, 15.14, 16.6.1, 16.6.2
Isopropylamine	1221	2	2G	Cont.	No	T2	11A	No	C	F-T	C,D	N2	E	15.12, 15.14, 15.19
Isopropyl ether	1159	3	2G	Cont.	Inert			No	R	F	A		No	15.4.6, 15.13.3, 15.19.6
Isovaleraldehyde	2058	3	2G	Cont.	Inert	T3	11B	No	R	F-T	A		No	15.4.6, 15.16.1
Maleic anhydride	2215	3	2G	Cont.	No			Yes	R	No	A[g],C		No	
Mesityl oxide	1229	3	2G	Cont.	No	T2	11B	No	R	F-T	A		No	15.19.6

Methacrylic acid	2531	3	2G	Cont.	No			Yes	R	T	A	Y1	No	15.13, 16.6.1
Methyl acrylate	1919	2	2G	Cont.	No	T1	11B	No	R	F-T	B		E	15.13, 16.61, 16.6.2
Methylamine solutions, 42% or less	1235	2	2G	Cont.	No				C	F-T	A,C,D	N1	E	15.12, 15.17, 15.19
2-Methyl-6-ethyl aniline		3	2G	Open	No			Yes	O	No	B,C,D		No	
Methylene chloride	1593	3	2G	Cont.	No	T1	11A	Yes	R	T	No		No	
2-Methyl-5-ethylpyridine	2300	3	2G	Open	No		11A	Yes	O	No	D	N4	No	
Methyl formate	1243	2	2G	Cont.	No			No	R	F-T	A		E	15.12, 15.14, 15.19
2-Methyl-2-hydroxy-3-butyne		3	2G	Cont.	No			No	R	F-T	A,C,D	N6	No	15.19.6
Methyl methacrylate	1247	2	2G	Cont.	No	T2	11A	No	R	F-T	B		No	15.13, 16.6.1, 16.6.2
2-Methylpyridine	2313	2	2G	Cont.	No			No	C	F	A,C	N4	No	15.12.3, 15.19.6
a-Methylstyrene	2303	3	2G	Cont.	No	T1	11B	No	R	F-T	D		No	15.13, 16.6.1, 16.6.2
Monoethanolamine	2491	3	2G	Open	No	T2	11A	Yes	O	F-T	A	N2	No	
Monoethylamine		2	1G	Cont.	No	T2	11A	No	C	F-T	C,D	N2	E	15.12, 15.14
Monoethylamine solutions, 72% or less	2270	2	2G	Cont.	No			No	C	F-T	A,C	N1	E	15.2, 15.14, 15.17, 15.19
Monoisopropanolamine		3	2G	Open	No	T2	11A	Yes	O	F-T	A	N2	No	
Mononitrobenzene	1662	2	2G	Cont.	No	T1	11A	Yes	C	T	D		No	15.12, 15.17, 15.18, 15.19
Morpholine	2054	3	2G	Cont.	No	T2	11A	No	R	F	A	N2,Z	No	
Motor fuel anti-knock compounds	1649	2	1G	Cont.	No	T4	11A	No	C	F-T	B,C		E	15.6, 15.12, 15.18, 15.19
Naphthalene, molten	2304	3	2G	Cont.	No	T1	11A	Yes	R	No	A,D		No	
Nitric acid, 70% and over	2031 2032[h]	2	2G	Cont.	No		NF		C	T	No		E	15.11, 15.19
Nitric acid, less than 70%	2031	2	2G	Cont.	No		NF		R	T	No		E	15.11 15.19
o-Nitrochlorobenzene	1578	2	2G	Cont.	No			Yes	C	T	B,C,D		No	15.12, 15.17, 15.18, 15.19
o-Nitrophenol, molten	1663	2	2G	Cont.	No			Yes	C	T	A,C,D		No	15.12, 15.19.6
1- or 2-Nitropropane	2608	3	2G	Cont.	No	T2	11B	No	R	F-T	A		No	
(*o*- and *p*-) Nitrotoluene	1664	2	2G	Cont.	No		11B	Yes	C	T	B		No	15.12, 15.17, 15.19
Oleum	1831	2	2G	Cont.	No		NF		C	T	No		E	15.11.2 to 15.11.8, 15.12.1, 15.16.2, 15.17, 15.19
Paraldehyde	1264	3	2G	Cont.	No	T3	11B	No	R	F	A		No	

a Product name	*b* UN number	*c* Ship type	*d* Tank type	*e* Tank vents	*f* Tank environmental control	*g* Electrical Equipment			*h* Gauging	*i* Vapour detection	*j* Fire protection	*k* Materials of construction	*l* Respiratory and eye protection	*m* Special requirements
						Class	Group	Flash-point >60° C						
Pentachloroethane	1669	3	2G	Cont.	No		NF		R	T	No		No	15.12, 15.17
1,3-Pentadiene		3	2G	Cont.	No			No	R	F-T	B		No	15.13, 16.6
Phenol	2312	2	2G	Cont.	No	T1	11A	Yes	C	T	A		No	15.12, 15.19
Phosphoric acid	1805	3	2G	Open	No		NF		O	No	No		No	15.11.1 to 15.11.4, 15.11.6 to 15.11.8
Phosphorus, yellow or white	2447	1	1G	Cont.	Pad + (vent or Inert)			No[k]	C	No	C		E	15.7, 15.19
Phthalic anhydride	2214 2734[i]	3	2G	Cont.	No	T1	11A	Yes	R	No	D		No	
Polyethylene polyamines	2735	3	2G	Open	No			Yes	O	No	A	N2	No	
Polymethylene polyphenyl isocyanate	2206[i] 2207	2	2G	Cont.	Dry			No[b]	C	T[b]	C[c],D	N5	No	15.12, 15.16.2, 15.19.6
n-Propanolamine		3	2G	Open	No			Yes	O	No	A,D	N2	No	
β-Propiolactone		2	2G	Cont.	No		11A	Yes	R	T	A		No	
Propionaldehyde	1275	3	2G	Cont.	No			No	R	F-T	A		E	15.16.1, 15.17
Propionic Acid	1848	3	2G	Cont.	No	T1	11A	No	R	F	A	Y1	E	15.11.2 to 15.11.4, 15.11.6 to 15.11.8
Propionic anhydride	2496	3	2G	Cont.	No	T2	11A	Yes	R	T	A	Y1	No	
Propionitrile	2404	2	1G	Cont.	No	T1	11B	No	C	F-T	A,D		E	15.12, 15.17, 15.18, 15.19
n-Propylamine	1277	2	2G	Cont.	Inert	T2	11A	No	C	F-T	C,D	N2	E	15.12, 15.19
Propylene oxide	1280	2	2G	Cont.	Inert	T2	11B	No	C	F-T	A,C	Z	No	15.8, 15.12.1, 15.14, 15.15, 15.19
Pyridine	1282	3	2G	Cont.	No	T1	11A	No	R	F	A	N4	No	
Sodium borohydride, 15% or less/Sodium hydroxide solution		3	2G	Open	No		NF		O	No	No	N1	No	
Sodium chlorate solutions, 50% or less		3	2G	Open	No		NF		O	No	No		No	15.9, 15.16.1, 15.19.6

Sodium dichromate solution, 70% or less		2	2G	Open	No		NF		C	No	No	N2	No	15.12.3, 15.19
Sodium hydrosulphide solution, 45% or less		3	2G	Cont.	Vent or pad (gas)		NF		R	T	No		No	15.16.1
Sodium hydroxide solution	1824	3	2G	Open	No		NF		O	No	No	N8	No	
Sodium hypochlorite solution, 15% or less		3	2G	Cont.	No		NF		R	No	No	N5	No	15.16.1
Sodium-2-mercaptobenzothiazol solution		3	2G	Open	No		NF		O	No	No	N1	No	
Styrene monomer	2055	3	2G	Cont.	No	T1	11A	No	O	F	B	N4,Z	No	15.13, 16.6.1, 16.6.2
Sulphur, liquid	2448	3	1G	Open	Vent or pad (gas)		T3	Yes[l]	O	F-T	No		No	15.10
Sulphuric acid	1830	3	2G	Open	No		NF		O	No	No		No	15.11., 15.16.2
Sulphuric acid, spent	1832	3	2G	Open	No		NF		O	No	No		No	15.11, 15.16.2
Tetrachloroethane	1702	3	2G	Cont.	No		NF		R	T	No		No	15.12, 15.17
Tetraethylenepentamine	2320	3	2G	Open	No			Yes	O	No	A	N1	No	
Tetrahydrofuran	2056	3	2G	Cont.	No	T3	11B	No	R	F-T	A,D		No	
Toluenediamine	1709	2	2G	Cont.	No			Yes	C	T	B,C,D	N1	E	15.12, 15.17, 15.19
Toluene diisocyanate	2078	2	2G	Cont.	Dry	T1	11A	Yes	C	F-T	C[c],D	N4	E	15.12, 15.16.2, 15.17, 15.19
o-Toluidine	1708	2	2G	Cont.	No			Yes	C	T	A,C		No	15.12, 15.17, 15.19
1,2,4-Trichlorobenzene	2321	3	2G	Cont.	No			Yes	R	T	C		No	15.19.6
1,1,2-Trichloroethane		3	2G	Cont.	No		NF		R	T	No		No	15.12.1
Trichloroethylene	1710	3	2G	Cont.	No	T2	11A	Yes	R	T	No		No	15.12, 15.16.1, 15.17
1,2,3-Trichloropropane		2	2G	Cont.	No			Yes	C	T	B,C,D		No	15.12, 15.17, 15.19
Triethanolamine		3	2G	Open	No		11A	Yes	O	No	A	N1	No	
Triethylamine	1296	2	2G	Cont.	No	T2	11A	No	R	F-T	B	N2	E	15.12
Triethylenetetramine	2259	3	2G	Open	No	T2	11A	Yes	O	No	A	N1	No	
Trimethylacetic acid		3	2G	Cont.	No			Yes	R	No	A,C	Y1	No	15.11.2 to 15.11.8
Trimethylhexamethylene diamine (2,2,4- and 2,4,4- isomers)	2327	3	2G	Open	No			Yes	O	No	A,C	N1	No	15.19.6

a Product name	*b* UN number	*c* Ship type	*d* Tank type	*e* Tank vents	*f* Tank environmental control	*g* Electrical Equipment			*h* Gauging	*i* Vapour detection	*j* Fire protection	*k* Materials of construction	*l* Respiratory and eye protection	*m* Special requirements
						Class	Group	Flash-point >60° C						
Trimethylhexamethylene diisocyanate (2,2,4- and 2,4,4-isomers)	2328	2	2G	Cont.	Dry			Yes	C	T	A,C[c]		No	15.12, 15.16.2, 15.17, 15.19.2
Trimethyl phosphite	2329	3	2G	Cont.	No			No	R	F-T	A,D		No	15.12.1, 15.16.2, 15.19.6
Tritolyl phosphate, containing 1% or more ortho-isomer	2574[j]	2	2G	Cont.	No	T2	11A	Yes	C	No	B		No	15.12.3, 15.19
Urea, ammonium solution, containing aqua ammonia		3	2G	Cont.	No		NF		R	T	A	N4	No	
n-Valeraldehyde	2058	3	2G	Cont.	Inert	T3	11B	No	R	F-T	A		No	15.4.6, 15.16.1
Vinyl acetate	1301	3	2G	Cont.	No	T2	11A	No	O	F	A		No	15.13, 16.6.1, 16.6.2
Vinyl ethyl ether	1302	2	1G	Cont.	Inert	T3	11B	No	C	F-T	A	N6	E	15.4, 15.13, 15.14, 15.19, 16.6.1, 16.6.2
Vinylidene chloride	1303	2	2G	Cont.	Inert	T2	11A	No	R	F-T	B	N5	E	15.13, 15.14, 16.6.1, 16.6.2
Vinyl neodecanoate		3	2G	Open	No			Yes	O	No	B		No	15.13, 15.16.1, 16.6.1, 16.6.2
Vinyl toluene	2618	3	2G	Cont.	No		11A	No	R	F	D	N1	No	15.13, 16.6.1, 16.6.2
Xylenols	2261	3	2G	Open	No		11A	Yes	O	No	B		No	

[a] Applies to ammonia, aqueous, 28% or less, but not below 10%.

[b] If the product to be carried contains flammable solvents such that the flashpoint does not exceed 60° C, then special electrical systems and a flammable vapour detector should be provided.

[c] Although water is suitable for extinguishing open-air fires involving chemicals to which this footnote applies, water should not be allowed to contaminate closed tanks containing these chemicals because of the risk of hazardous gas generation.

[d] UN number 1198 only applies if flashpoint is below 60° C.

[e] Applies to formaldehyde solutions, 45% or less, but not below 5%.

[f] Applies to hydrochloric acid not below 10%.

[g] Dry chemical cannot be used because of the possibility of an explosion.

[h] UN number 2032 assigned to red fuming nitric acid.

[i] UN number depends on boiling point of substance.

[j] UN number assigned to this substance containing more than 3% of ortho-isomer.

[k] 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° C.

[l] Sulphur, liquid, has a flashpoint above 60° C, however electrical equipment should be certified safe for the gases evolved.

Chapter 18. LIST OF CHEMICALS TO WHICH THE CODE DOES NOT APPLY*

1. The following are products which are not considered to come within the scope of the Code. This list may be used as a guide in considering bulk carriage of products whose hazards have not yet been evaluated.

2. Although the products listed in this chapter fall outside the scope of the Code, the attention of Administrations is drawn to the fact that some safety precautions may be needed for their safe transportation. Accordingly Administrations should prescribe appropriate safety requirements.

3. The products listed below may be subject to reconsideration upon the coming into force of the International Convention for the Prevention of Pollution from Ships, 1973/78.

Chapter 18	*UN number*
Acetone	1090
Amylacetate, commercial	1104
n-Amyl acetate	1104
sec-Amyl acetate	1104
n-Amyl alcohol	1105
sec-Amyl alcohol	1105
tert-Amyl alcohol	1105
Amyl alcohol, primary	1105
tert-Amylenes	—
Benzyl alcohol	—
n-Butyl acetate	1123
sec-Butyl acetate	1123
n-Butyl alcohol	1120
sec-Butyl alcohol	1120
tert-Butyl alcohol	1120
Butyl benzyl phthalate	—
Butylene glycol	—
γ-Butyrolactone	—
Calcium alkyl salicylate	—
Cumene	1918
Cyclohexane	1145
Cyclohexanol	—
p-Cymene	2046
n-Decyl alcohol	—
Diacetone alcohol	1148
Dibutyl phthalate	—
Dicyclopentadiene	2048
Diethylbenzene	2049
Diethylene glycol	—
Diethylene glycol diethyl ether	—
Diethylene glycol monobutyl ether	—
Diethylene glycol monobutyl ether acetate.	—
Diethylene glycol monoethyl ether	—
Diethylene glycol monoethyl ether acetate.	—
Diethylene glycol monomethyl ether	—
Diethylene glycol monomethyl ether acetate	—
Diisobutylene	2050
Diisobutyl ketone	1157
Diisobutyl phthalate	—
Diisooctyl phthalate	—
2,2-Dimethyloctanoic acid	—
Dioctyl phthalate	—
Dipentene	2052
Diphenyl ether	—
Dipropylene glycol	—
Dipropylene glycol monomethyl ether	—
Dodecyl alcohol	—
Dodecylbenzene	—
Dodecylphenol	—
2-Ethoxyethanol	1171
2-Ethoxyethyl acetate	1172
Ethyl acetate	1173
Ethyl acetoacetate	—
Ethyl alcohol	1170
Ethylbenzene	1175
Ethylcyclohexane	—
Ethylene carbonate	—
Ethylene glycol	—
Ethylene glycol methyl butyl ether	—
Ethylene glycol monobutyl ether	2369
Ethylene glycol monobutyl ether acetate.	—
Ethylene glycol monomethyl ether	1188
Ethylene glycol monomethyl ether acetate	1189
Ethylene glycol monophenyl ether	—
2-Ethylhexanoic acid	—
Formamide	—
Furfuryl alcohol	2874
Glycerine	—
n-Heptane	1206
Heptanol, all isomers	—
Heptene, mixed isomers	2278
n-Hexane	1208
Hexan-1-ol	2282
1-Hexene	2370
Hexylene glycol	—
Isoamyl acetate	1104
Isoamyl alcohol	1105
Isobutyl acetate	1213
Isobutyl alcohol	1212

* The product names are not always identical with the names given in the various editions of the Bulk Chemical Code (resolution A.212 (VII)).

Chapter 18	*UN number*
Isobutyl formate	2393
Isodecyl alcohol	—
Isopentane	1265
Isopentene	2371
Isophorone	—
Isopropyl acetate	1220
Isopropyl alcohol	1219
Lactic acid	—
Latex	—
Methyl acetate	1231
Methyl alcohol	1230
Methylamyl acetate	1233
Methylamyl alcohol	2053
Methyl amyl ketone	1110
Methyl *tert*-butyl ether	2398
Methyl ethyl ketone	1193
Methyl isobutyl ketone	1245
2-Methyl-1-pentene	—
N-Methyl-2-pyrrolidone	—
Molasses	—
Naphtha solvent	1256
Nonane	1920
Nonyl alcohol	—
Nonylphenol	—
Octane	1262
Octanol, all isomers	—
Paraffin wax	—
n-Pentane	1265
n-Pentene	1108
Petrolatum	—
Petroleum naphtha	1255

Chapter 18	*UN number*
Perchloroethylene	1897
Pinene	2368
Polypropylene glycols	—
n-Propyl acetate	1276
n-Propyl alcohol	1274
Propylene glycol	—
Propylene glycol monoethyl ether	—
Propylene glycol monomethyl ether	—
Propylene tetramer	2850
Propylene trimer	2057
Sulpholane	—
Tall oil	—
Tetrahydronaphthalene	—
Toluene	1294
Tributyl phosphate	—
1,1,1-Trichloroethane	2831
Tridecanol	—
Triethylbenzene	—
Triethylene glycol	—
Triisopropanolamine	—
1,2,4-Trimethylbenzene	—
Tripropylene glycol	—
Tripropylene glycol monomethyl ether	—
Tritolyl phosphate (?1% ortho-isomer)	—
Trixylenyl phosphate	—
Turpentine	1299
Urea, ammonium nitrate solutions	—
Urea, ammonium phosphate solutions	—
White spirit	1300
Wines	—
Xylenes	1307

Chapter 19. REQUIREMENTS FOR SHIPS ENGAGED IN THE INCINERATION AT SEA OF LIQUID CHEMICAL WASTE

19.1. *General*

19.1.1. Chapters 1 to 16 apply to incinerator ships, as relevant, and as supplemented or modified by the provisions of this chapter.

19.1.2. Information on the composition and the hazards of the waste to be incinerated should be made available to the Administration or port Administration, or both, as appropriate, which may prohibit carriage of those wastes deemed to be too hazardous to be carried in bulk.*

19.1.3. The following additional definitions apply:

.1 Incinerator space is a gastight space containing solely the incinerator and its associated auxiliaries.

.2 Incinerator blower space is a space containing the blowers which supply combustion air to the incinerator burners.

* The environmental aspects of incineration and dumping of wastes are regulated by the Dumping Convention. In general, for incineration of waste, a permit from the appropriate authority of the Contracting Party to the Convention, where the loading port is situated, is required. Where the loading port is situated in a State not being a Contracting Party to the Convention, the Administration should issue a permit.

.3 Dumping Convention means the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter at Sea, 1972.[1]

.4 Cargo area is that part of the ship defined by 1.3.5, excluding incinerators and chemical waste piping leading to the incinerators.

19.1.4. During the periodical and intermediate surveys required under 1.5.2.1.2 and .3, all cargo tanks and the cargo piping system should be inspected for corrosion and the remaining thickness of material should be determined. Where severely corrosive wastes have been carried, inspections of cargo tanks and the cargo piping system for corrosion should be held annually and the remaining thickness of materials determined during those inspections.

19.2. *Ship survival capability and location of cargo tanks*

19.2.1. Ships subject to this chapter should comply with type 2 ship standards and with the requirements for location of cargo tanks in type 2 ships.

19.2.2. Waste mixtures containing substances which would require a type 1 ship standard may be carried in type 2 ships if solely for the purpose of incineration.

19.3. *Ship arrangements*

19.3.1. Liquid chemical wastes should not be stowed adjacent to oil fuel tanks except those tanks containing oil fuel to be used exclusively for incineration.

19.3.2. Tanks and pumps, other than those described in 19.3.3, which may contain liquids and which are to be used for the incineration process or for washing cargo pipes and cargo tanks may be located adjacent to cargo tanks and should be located within the cargo area. The provisions of 3.1 should apply to such tanks and equipment to the same extent as they apply to cargo tanks.

19.3.3. Where necessary, oil fuel tanks and fuel pumps directly feeding the incinerator burners during the process of pre-heating or supporting incineration may be located outside the cargo area provided the oil fuel used has a flashpoint above 60° C (closed cup test). (See also 19.5.3.)

19.3.4. Liquids which have been used for cleaning cargo pipes and cargo tanks as well as for pumproom drainage should be stored in a slop tank in the cargo area, for disposal in conformity with the technical guidelines annexed to the Dumping Convention. A cargo tank may be used as a slop tank. Pumps used for handling contaminated cleaning fluids should be located in the cargo area.

19.3.5. Where necessary, compliance with 3.2.1 need not be required in so far as accommodation spaces, service spaces, control stations and machinery spaces other than those of category A may be permitted forward of the cargo area, subject to an equivalent standard of safety and appropriate fire-extinguishing arrangements being provided to the satisfaction of the Administration.

19.3.6. If accommodation spaces, service spaces, control stations or machinery spaces other than those of category A are located forward of the cargo area in accordance with 19.3.5, the requirements of 3.2.3 should be applied by analogy; i.e. the specified distances should be measured from the after end of a house located forward of the cargo area.

19.3.7. The incinerator should be located outside the external perimeter of the cargo area. Alternative arrangements may, however, be considered by the Administration, provided an equivalent degree of safety is achieved.

19.3.8. The effect which combustion gases may have on adequate vision from the navigating bridge, on air intakes and openings into accommodation, service and machinery spaces, and on deck working areas and passageways should be considered.

[1] United Nations, *Treaty Series*, vol. 1046, p. 120.

19.3.9. Access to the incinerator space should be from the open deck. However, the incinerator control room and incinerator blower space may have direct access to the incinerator space provided that these spaces have an additional access from the open deck. Access openings of the incinerator space should be fitted with self-closing gastight doors.

19.4. *Cargo containment and incinerator standards*

19.4.1. Integral gravity tanks may be used for hazardous wastes.

19.4.2. The incinerator including burners should be designed and constructed to safety standards acceptable to the Administration*. For materials of construction the provisions of 6.1 apply.

19.4.3. The steel structure of the incinerator including supports and other fixtures should be designed for the most unfavourable static angle of heel within the range of 0° to 30°, taking into account the dynamic loads due to the ship's motion.

19.4.4. Suitable bricklining and insulation should be provided to ensure that any temperature rise will not impair the strength of the incinerator structure or the functioning of the associated auxiliaries and instruments and will not adversely affect personnel safety.

19.4.5. Means should be provided for measuring the temperature on the outside furnace surfaces. Means for alarms should be provided to indicate when the temperature approved by the Administration is exceeded and the process of incineration has to be stopped.

19.5. *Cargo transfer*

19.5.1. The requirements of 5.1 apply, except that cargo piping should as far as practicable be fitted in the cargo area and that cargo piping leading to the incinerator should:

.1 Be fitted at least 760 mm inboard;

.2 If outside the cargo area, be on the open deck;

.3 Be clearly marked; and

.4 Be so designed as to allow draining and purging.

19.5.2. Arrangements of the cargo piping and controls should be such as to preclude the discharge overboard of wastes intended to be incinerated during normal cargo handling operations.

19.5.3. Oil fuel and cargo piping systems may be connected in front of the burners, provided that three-way cocks are installed and the oil fuel pipes are fitted with two screw-down non-return valves inside the incinerator space.

19.5.4. Remote shutdown devices to cut out the supply of waste and fuel for incineration should be fitted at the control station and on the navigating bridge. Shutoff valves should be located in the cargo area. Where shutoff valves are remotely controlled, provision for local manual operation should be made, or a separate manually operated valve should be fitted.

19.5.5. Flanges of the loading manifold connections should be provided with shields, which may be portable, to guard against the danger of the cargo being sprayed. Drip trays should also be provided.

19.6. *Materials of construction*

19.6.1. Section 6.2—special requirements for materials—is replaced by the following:

.1 Aluminium, copper, copper alloys, zinc, galvanized steel or mercury should not be used for cargo tanks, pipelines, valves, fittings and other equipment which may come into contact with the liquid wastes or their vapour.

.2 Materials of construction having a melting point below 925°C; e.g. aluminium and its alloys, should not be used for external piping involved in cargo handling operations on

* The standards set out by the Dumping Convention for the control of incineration of wastes and other matter at sea should also be observed.

ships intended for the carriage of wastes with a flashpoint not exceeding 60° C (closed cup test). Short lengths of external pipes connected to cargo tanks may be permitted by the Administration if they are provided with fire-resistant insulation.

.3 In determining the scantlings of the cargo system the corrosivity of the waste should be taken into account.

19.7. *Tank vent systems*

19.7.1. The provisions for controlled venting systems—chapter 8 and section 15.12 apply, except 8.2.1 and 15.12.3.

19.8. *Cargo tank environmental control*

19.8.1. When the recirculating drop line does not terminate near the bottom of the cargo tank, the tank should be inerted whenever wastes having a flashpoint not exceeding 60° C (closed cup test) are being recirculated to it.

19.8.2. When washing machines using liquids having a flashpoint not exceeding 60° C (closed cup test) are employed, the cargo tank should be inerted.

19.8.3. The oxygen content of the atmosphere in an inerted tank should not exceed 8% by volume in any part of the tank.

19.8.4. An audible and visual alarm should be provided to indicate when the pressure in the vapour space of an inerted cargo tank is less than 0.07 bar gauge.

19.9. *Electrical installation*

19.9.1. In incinerator spaces, incinerator blower spaces, and adjacent spaces having direct access thereto, the lighting systems, telephone and public address systems and general alarm systems should be of the certified safe type.

19.9.2. All other electrical installations which are fitted in the spaces referred to in 19.9.1 should be of the certified safe type unless the following conditions are complied with:

.1 It is assured that the spaces are adequately ventilated prior to activating installations not of a certified safe type. Interlocks should be provided between fans and the switch gear of such installations to ensure compliance with this requirement.

.2 Installations not of a certified safe type should be automatically switched off in case of loss of the pressure required by 19.11.2.1 and 19.11.3.1. A reasonable time delay may be permitted by the Administration before these installations are switched off.

.3 Installations not of a certified safe type should comply as a minimum with IP 55* or equivalent protection.

19.10. *Fire protection and fire extinguishing*

19.10.1. The incinerator space should be provided with a fixed foam fire-extinguishing system complying with regulation II-2/8 or II-2/9 of the 1983 SOLAS amendments. This system may be connected to the deck foam fire-extinguishing system.

19.11. *Mechanical ventilation in the cargo area and in the incinerator location*

19.11.1. For cargo pump rooms the provisions of 15.17—increased ventilation requirements—apply.

19.11.2. The ventilation system of the incinerator space should be permanent, normally of the positive pressure type and independent of all other air supply systems.

.1 The air pressure should always be positive to the pressure within the furnace (see also 19.9.2.2).

* Reference is made to the Recommendations published by the International Electrotechnical Commission and in particular to Publication 44.

.2 A minimum capacity of 45 changes of air per hour should be provided based upon the total volume of the incinerator space.

Consideration should be given to venting requirements during maintenance of burners.

19.11.3. The ventilation system of the incinerator blower space should be permanent, normally of the positive pressure type and independent of other air supply systems.

.1 The air pressure should always be positive to the pressure within the furnace (see also 19.9.2.2).

.2 A minimum capacity of 20 changes of air per hour should be provided based upon the total volume of the incinerator blower space.

19.12. *Instrumentation and overflow control*

19.12.1. Closed gauging devices described in 13.1.1.3 should be fitted and overflow control systems required in 15.19 should be provided.

19.12.2. Vapour detection instruments for toxic and flammable products described in 13.2 should be fitted.

19.13. *Personnel protection*

19.13.1. The safety equipment described in 14.2, including respiratory and eye protection for every person on board described in 14.2.8, should be provided.

APPENDIX. MODEL FORM OF INTERNATIONAL CERTIFICATE OF FITNESS FOR THE CARRIAGE OF DANGEROUS CHEMICALS IN BULK

INTERNATIONAL CERTIFICATE OF FITNESS FOR THE CARRIAGE OF DANGEROUS CHEMICALS IN BULK

(OFFICIAL SEAL)

ISSUED UNDER THE PROVISIONS OF THE

INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING DANGEROUS CHEMICALS IN BULK

(resolution MSC.4 (48))

under the authority of the Government of .....
(full official designation of country)

by .....
(full official designation of the competent person or organization recognized by the Administration)

Name of ship	*Distinctive number or letters*	*Port of registry*	*Gross tonnage*	*Ship type (Code paragraph 2.1.2)*[1]

Date on which keel was laid or on which the ship was at a similar stage of construction or (in the case of a converted ship) date on which conversion to chemical tanker was commenced:

.....

The Certificate should be drawn up in the official language of the issuing country. If the language used is neither English nor French, the text should include a translation into one of these languages.

The ship also complies fully with the following amendments to the Code: .....

The ship is exempted from compliance with the following provisions of the Code: .....

This is to certify:

1. .1 That the ship has been surveyed in accordance with the provisions of section 1.5 of the Code;

.2 That the survey showed that the construction and equipment of the ship complied with the relevant provisions of the Code;

*.3 That the ship is an incinerator ship complying also with the supplementary and modified requirements of chapter 19;

2. That the ship is suitable for the carriage in bulk of the following products, provided that all relevant operational provisions of the Code are observed.[2]

Products	Conditions of carriage (tank numbers etc.)

* Continued on attachment 1, additional signed and dated sheets.
Tank numbers referred to in this list are identified on attachment 2, signed and dated tank plan.
For incinerator ships enter "liquid chemical waste" in lieu of individual products.

3. That, in accordance with *1.4 and *2.8.2, the provisions of the Code are modified in respect of the ship in the following manner:

* Delete as appropriate.

4. That the ship must be loaded:

*.1 In accordance with the loading conditions provided in the approved loading manual, stamped and dated ..... and signed by a responsible officer of the Administration, or of an organization recognized by the Administration;

*.2 In accordance with the loading limitations appended to this Certificate.

Where it is required to load the ship other than in accordance with the above instruction, then the necessary calculations to justify the proposed loading conditions should be communicated to the certifying Administration who may authorize in writing the adoption of the proposed loading condition.**

This certificate is valid until .....

Issued at ....19....
(place of issue of certificate)

The undersigned declares that he is duly authorized by the said Government to issue this Certificate.

.....
(signature of official issuing the certificate and/or seal of issuing authority)

Notes on completion of Certificate

[1] "Ship type". Any entry under this column must relate to all relevant recommendations, e.g. an entry "type 2" should mean type 2 in all respects prescribed by the Code.

[2] Paragraph 2. Only products listed in chapter 17 of the Code, or which have been evaluated by the Administration in accordance with 1.1.3 of the Code, should be listed. In respect of the latter "new" products, any special requirements provisionally prescribed should be noted. It should be noted that for incinerator ships "liquid chemical waste" is to be entered in lieu of the individual product names.

ENDORSEMENT FOR MANDATORY ANNUAL SURVEYS

This is to certify that at a mandatory annual survey required by 1.5.2.1.4 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, the ship was found to comply with the relevant provisions of the Code.

Signed: .....
(signature of authorized official)

Place: .....

Date: .....

(seal or stamp of the Authority, as appropriate)

* Delete as appropriate.

** Instead of being incorporated in the Certificate, this text may be appended to the Certificate if duly signed and stamped.

Signed: .....
(*signature of authorized official*)
Place: .....
Date: .....
(seal or stamp of the Authority, as appropriate)

Signed: .....
(*signature of authorized official*)
Place: .....
Date: .....
(seal or stamp of the Authority, as appropriate)

Signed: .....
(*signature of authorized official*)
Place: .....
Date: .....
(seal or stamp of the Authority, as appropriate)

NOTE. An intermediate survey may take the place of a mandatory annual survey where the relevant provisions of 1.5.2.1.3 and 1.5.2.1.4 are complied with.

ENDORSEMENT FOR INTERMEDIATE SURVEYS

This is to certify that at an intermediate survey required by 1.5.2.1.3 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, the ship was found to comply with the relevant provisions of the Code.

Signed: .....
(*signature of authorized official*)
Place: .....
Date: .....
(seal or stamp of the Authority, as appropriate)

Signed: .....
(*signature of authorized official*)
Place: .....
Date: .....
(seal or stamp of the Authority, as appropriate)

Attachment 1 to the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk

Continued list of products to those specified in section 3, and their conditions of carriage

Products	Conditions of carriage (tank numbers, etc.)

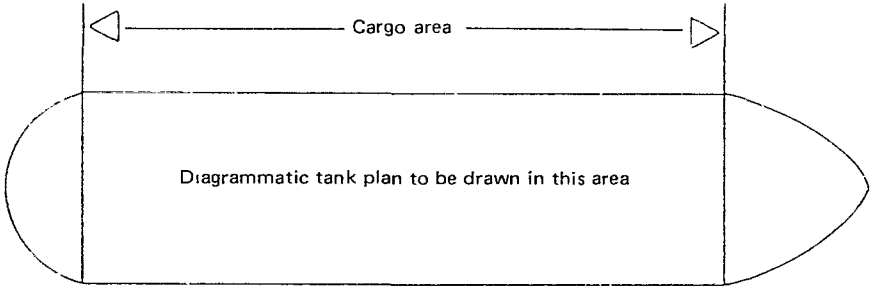
Date .....
(as for certificate)

.....
(signature of official issuing the certificate and/or seal of issuing authority)

Attachment 2 to the International Certificate of Fitness for the Carriage of Dangerous Chemicals

TANK PLAN (SPECIMEN)

Name of ship: .....
Distinctive number or letters: .....



Date .....
(as for certificate)

.....
(signature of official issuing the certificate and/or seal of issuing authority)

RESOLUTION MSC.5(48)[1]
adopted 17 June 1983

ADOPTION OF THE INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK (IGC CODE)

The Maritime Safety Committee,

Recalling resolution A.328(IX) by which the Assembly authorized the Maritime Safety Committee to amend the Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk as may be necessary,

Noting resolution MSC.6(48) by which it adopts, *inter alia*, amendments to chapter VII of the International Convention for the Safety of Life at Sea, 1974 (1974 SOLAS Convention), to make the provisions of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) mandatory under that Convention,

[1] Resolution published for information by the Secretariat of the United Nations.

Having considered the text of the proposed IGC Code:

1. Adopts the IGC Code, the text of which is given in the Annex to the present resolution;

2. Notes that under part C of chapter VII of the 1974 SOLAS Convention as amended by resolution MSC.6(48), amendments to the IGC Code shall be adopted, brought into force and take effect in accordance with the provisions of article VIII of that Convention;

3. Requests the Secretary-General to circulate to all Governments concerned amendments to the IGC Code adopted as above which comprise the inclusion in chapter 19 of new products, recommending that, pending the entry into force of those amendments, these new products should be carried by gas carriers in compliance with the provisions of the amendments;

4. Further requests the Secretary-General to transmit a copy of the present resolution together with the text of the IGC Code to all Members of the Organization and to all Contracting Governments to the 1974 SOLAS Convention which are not Members of the Organization.

ANNEX

INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK

TABLE OF CONTENTS

PREAMBLE

1. The purpose of this Code is to provide an international standard for the safe carriage by sea in bulk of liquefied gases and certain other substances listed in chapter 19 of the Code, by prescribing the design and construction standards of ships involved in such carriage and the equipment they should carry so as to minimize the risk to the ship, to its crew and to the environment, having regard to the nature of the products involved.

2. The basic philosophy is one of ship types related to the hazards of the products covered by the Code. Each of the products may have one or more hazard properties which include flammability, toxicity, corrosivity and reactivity. A further possible hazard may arise due to the products being transported under cryogenic or pressure conditions.

3. Severe collisions or strandings could lead to cargo tank damage and result in uncontrolled release of the product. Such release could result in evaporation and dispersion of the product and, in some cases, could cause brittle fracture of the ship's hull. The requirements in the Code are intended to minimize this risk as far as is practicable, based upon present knowledge and technology.

4. Throughout the development of the Code it was recognized that it must be based upon sound naval architectural and engineering principles and the best understanding available as to the hazards of the various products covered; furthermore that gas carrier design technology is not only a complex technology but is rapidly evolving and that the Code should not remain static. Therefore the Organization will periodically review the Code taking into account both experience and future development.

5. Requirements for new products and their conditions of carriage will be circulated as recommendations, on an interim basis, when adopted by the Maritime Safety Committee of the Organization, prior to the entry into force of the appropriate amendments, under the terms of article VIII of the International Convention for the Safety of Life at Sea, 1974.

6. The Code primarily deals with ship design and equipment. In order to ensure the safe transport of the products the total system must, however, be appraised. Other important facets of the safe transport of the products, such as training, operation, traffic control and handling in port, are being or will be examined further by the Organization.

7. The development of the Code has been greatly assisted by the work of the International Association of Classification Societies (IACS) and full account his been taken of the IACS Unified Requirements for Liquefied Gas Tankers in chapters 4, 5 and 6.

8. The development of chapter 10 has been greatly assisted by the relevant work of the International Electrotechnical Commission (IEC).

9. Chapter 18 of the Code dealing with operation of liquefied gas carriers highlights the regulations in other chapters that are operational in nature and mentions those other important safety features that are peculiar to gas carrier operation.

10. The layout of the Code is in line with the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) adopted by the Maritime Safety Committee at its forty-eighth session.

Chapter 1. GENERAL

1.1. *Application*

1.1.1. The Code applies to ships regardless of their size, including those of less than 500 tons gross tonnage, engaged in carriage of liquefied gases having a vapour pressure exceeding 2.8 bar absolute at a temperature of 37.8°C, and other products as shown in chapter 19, when carried in bulk.

1.1.2. Unless expressly provided otherwise, the Code applies to ships the keels of which are laid or which are at a stage at which:

.1 Construction identifiable with the ship begins; and

.2 Assembly of that ship has commenced comprising at least 50 tonnes or 1% of the estimated mass of all structural material, whichever is less;

on or after 1 July 1986.

1.1.3. A ship, irrespective of the date of construction, which is converted to a gas carrier on or after 1 July 1986 should be treated as a gas carrier constructed on the date on which such conversion commences.

1.1.4.1. When cargo tanks contain products for which the Code requires a type 1G ship, neither flammable liquids having a flashpoint of 60°C (closed cup test) or less nor flammable products listed in chapter 19 should be carried in tanks located within the protective zones described in 2.6.1.1.

1.1.4.2. Similarly, when cargo tanks contain products for which the Code requires a type 2G/2PG ship, the above-mentioned flammable liquids should not be carried in tanks located within the protective zones described in 2.6.1.2.

1.1.4.3. In each case the restriction applies to the protective zones within the longitudinal extent of the hold spaces for the cargo tanks loaded with products for which the Code requires a type 1G or 2G/2PG ship.

1.1.4.4. The above-mentioned flammable liquids and products may be carried within these protective zones when the quantity retained in the cargo tanks of products for which the Code requires a type 1G or 2G/2PG ship is solely used for cooling, circulation or fuelling purposes.

1.1.5. Except as provided in 1.1.7.1, when it is intended to carry products covered by this Code and products covered by the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted by the Maritime Safety Committee under the authority of the Assembly of the Organization conferred by resolution A.490(XII), as may be amended by the Organization (IBC Code), the ship should comply with the requirements of both Codes appropriate to the products carried.

1.1.6. Where it is proposed to carry products which may be considered to come within the scope of the Code but are not at present designated in chapter 19, the Administrations and the port Administrations involved in such carriage should establish preliminary suitable conditions of carriage based on the principles of the Code and notify the Organization of such conditions.

1.1.7.1. The requirements of this Code should take precedence when a ship is designed and constructed for the carriage of the following products:

.1 Those listed exclusively in chapter 19 of this Code; and

.2 One or more of the products which are listed both in this Code and in the International Bulk Chemical Code. These products are marked with an asterisk (*) in column "a" in the table of chapter 19.

1.1.7.2. When a ship is intended exclusively to carry one or more of the products noted in 1.1.7.1.2, the requirements of the International Bulk Chemical Code as amended should apply.

1.1.8. Compliance of the ship with the requirements of the International Gas Carrier Code should be shown in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk provided for in 1.5. Compliance with the amendments to the Code, as appropriate, should also be indicated in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

1.2. *Hazards*

Hazards of gases considered in this Code include fire, toxicity, corrosivity, reactivity, low temperature and pressure.

1.3. *Definitions*

Except where expressly provided otherwise, the following definitions apply to the Code. Additional definitions are given in chapter 4.

1.3.1. "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.

1.3.2. "'A' class divisions" means divisions as defined in regulation II-2/3.3 of the 1983 SOLAS amendments.

1.3.3.1. "Administration" means the Government of the State whose flag the ship is entitled to fly.

1.3.3.2. "Port Administration" means the appropriate authority of the country in the port of which the ship is loading or unloading.

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

1.3.5. "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.

1.3.6. "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.

1.3.7. "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.

1.3.8. "Cargo control room" is a space used in the control of cargo handling operations and complying with the requirements of 3.4.

1.3.9. "Cargoes" are products listed in chapter 19 carried in bulk by ships subject to the Code.

1.3.10. "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.

1.3.11. "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.

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

1.3.13. "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.

1.3.14. "Flammable products" are those identified by an "F" in column "f" in the table of chapter 19.

1.3.15. "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.

1.3.16. "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 chapter 19.

1.3.17. "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;

.4.1 A hold space where cargo is carried in a cargo containment system requiring a secondary barrier;

.4.2 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 .4.1 by a single gas-tight 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 13.6.5 and a space utilizing boil-off gas as fuel and complying with chapter 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.

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

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

1.3.20. "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.

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

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

1.3.23. "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.

1.3.24. "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.

1.3.25. "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.

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

1.3.27. "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 1.8 bar gauge.

1.3.28. "Organization" is the International Maritime Organization (IMO).

1.3.29. "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.

1.3.30.1. "Primary barrier" is the inner element designed to contain the cargo when the cargo containment system includes two boundaries.

1.3.30.2. "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 chapter 4.

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

1.3.32. "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 leakage into the pipe between the two spectacle flanges.

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

1.3.34. "1974 SOLAS Convention" means the International Convention for the Safety of Life at Sea, 1974.

1.3.35. "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).

1.3.36. "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.

1.3.37. "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.

1.3.38. "Toxic products" are those identified by a "T" in column "f" in the table of chapter 19.

1.3.39. "Vapour pressure" is the equilibrium pressure of the saturated vapour above the liquid expressed in bars absolute at a specified temperature.

1.3.40. "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.

1.4. *Equivalents*

1.4.1. Where the Code requires that a particular fitting, material, appliance, apparatus, item of equipment or type thereof should be fitted or carried in a ship, or that any particular provision should be made, or any procedure or arrangement should be complied with, the Administration may allow any other fitting, material, appliance, apparatus, item of equipment or type thereof to be fitted or carried, or any other provision, procedure or arrangement to be made in that ship, if it is satisfied by trial thereof or otherwise that such fitting, material, appliance, apparatus, item of equipment or type thereof or that any particular provision, procedure or arrangement is at least as effective as that required by the Code. However, the Administration may not allow operational methods or procedures to be made an alternative to a particular fitting, material, appliance, apparatus, item of equipment, or type thereof which is prescribed by the Code.

1.4.2. When the Administration so allows any fitting, material, appliance, apparatus, item of equipment, or type thereof, or provision, procedure or arrangement to be substituted, it should communicate to the Organization the particulars thereof together with a report on the evidence submitted, so that the Organization may circulate the same to other Contracting Governments to the 1974 SOLAS Convention for the information of their officers.

1.5. *Surveys and certification*

1.5.1. *Survey procedure*

1.5.1.1. The survey of ships, so far as regards the enforcement of the provisions of the regulations and the granting of exemptions therefrom, should be carried out by officers of the Administration. The Administration may, however, entrust the surveys either to surveyors nominated for the purpose or to organizations recognized by it.

1.5.1.2. The Administration nominating surveyors or recognizing organizations to conduct surveys should, as a minimum, empower any nominated surveyor or recognized organization to:

.1 Require repairs to a ship; and

.2 Carry out surveys if requested by the port State authority* concerned.

The Administration should notify the Organization of the specific responsibilities and conditions of the authority delegated to nominated surveyors or recognized organizations for circulation to the Contracting Governments.

1.5.1.3. When a nominated surveyor or recognized organization determines that the condition of the ship or its equipment does not correspond substantially with the particulars of the certificate or is such that the ship is not fit to proceed to sea without danger to the ship, or persons on board, such surveyor or organization should immediately ensure that corrective action is taken and should in due course notify the Administration. If such corrective action is not taken the relevant certificate should be withdrawn and the Administration should be notified immediately; and, if the ship is in a port of another Contracting Government, the port State authority concerned should also be notified immediately.

1.5.1.4. In every case, the Administration should guarantee the completeness and efficiency of the survey, and should undertake to ensure the necessary arrangements to satisfy this obligation.

* Port State authority has the meaning as presented in chapter I, regulation 19 of the 1978 Protocol[1] to the 1974 SOLAS Convention.

[1] United Nations, *Treaty Series*, vol. 1226, p. 213.

1.5.2. *Survey requirements*

1.5.2.1. The structure, equipment, fittings, arrangements and material (other than items in respect of which a Cargo Ship Safety Construction Certificate, Cargo Ship Safety Equipment Certificate and Cargo Ship Safety Radiotelegraphy Certificate or Cargo Ship Safety Radiotelephony Certificate is issued) of a gas carrier should be subjected to the following surveys:

.1 An initial survey before the ship is put in service or before the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk is issued for the first time, which should include a complete examination of its structure, equipment, fittings, arrangements and material in so far as the ship is covered by the Code. This survey should be such as to ensure that the structure, equipment, fittings, arrangements and material fully comply with the applicable provisions of the Code.

.2 A periodical survey at intervals specified by the Administration, but not exceeding 5 years which should be such as to ensure that the structure, equipment, fittings, arrangements and material comply with the applicable provisions of the Code.

.3 A minimum of one intermediate survey during the period of validity of the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk. In cases where only one such intermediate survey is carried out in any one certificate validity period, it should be held not before 6 months prior to, nor later than 6 months after, the half-way date of the certificate's period of validity. Intermediate surveys should be such as to ensure that the safety equipment, and other equipment, and associated pump and piping systems comply with the applicable provisions of the Code and are in good working order. Such surveys should be endorsed on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

.4 A mandatory annual survey within 3 months before or after the anniversary date of the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk which should include a general examination to ensure that the structure, equipment, fittings, arrangements and materials remain in all respects satisfactory for the service for which the ship is intended. Such a survey should be endorsed in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

.5 An additional survey, either general or partial according to the circumstances, should be made when required after an investigation prescribed in 1.5.3.3, or whenever any important repairs or renewals are made. Such a survey should ensure that the necessary repairs or renewals have been effectively made, that the material and workmanship of such repairs or renewals are satisfactory; and that the ship is fit to proceed to sea without danger to the ship or persons on board.

1.5.3. *Maintenance of conditions after survey*

1.5.3.1. The condition of the ship and its equipment should be maintained to conform with the provisions of the Code to ensure that the ship will remain fit to proceed to sea without danger to the ship or persons on board.

1.5.3.2. After any survey of the ship under 1.5.2 has been completed, no change should be made in the structure, equipment, fittings, arrangements and material covered by the survey, without the sanction of the Administration, except by direct replacement.

1.5.3.3. Whenever an accident occurs to a ship or a defect is discovered, either of which affects the safety of the ship or the efficiency or completeness of its life-saving appliances or other equipment, the master or owner of the ship should report at the earliest opportunity to the Administration, the nominated surveyor or recognized organization responsible for issuing the relevant certificate, who should cause investigations to be initiated to determine whether a survey, as required by 1.5.2.5, is necessary. If the ship is in a port of another Contracting Government, the master or owner should also report immediately to the port State authority con-

cerned and the nominated surveyor or recognized organization should ascertain that such a report has been made.

1.5.4. *Issue of certificate*

1.5.4.1. A certificate called an International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk, the model form of which is set out in the appendix, should be issued after an initial or periodical survey to a gas carrier which complies with the relevant requirements of the Code.

1.5.4.2. The certificate issued under the provisions of this section should be available on board for inspection at all times.

1.5.4.3. When a ship is designed and constructed under the provisions of 1.1.5, International Certificates of Fitness should be issued in accordance with the requirements of this section and with the requirements of section 1.5 of the International Bulk Chemical Code.

1.5.5. *Issue or endorsement of certificate by another Government*

1.5.5.1. A Contracting Government may, at the request of another Government, cause a ship entitled to fly the flag of the other State to be surveyed and, if satisfied that the requirements of the Code are complied with, issue or authorize the issue of the certificate to the ship, and, where appropriate, endorse or authorize the endorsement of the certificate on board the ship in accordance with the Code. Any certificate so issued should contain a statement to the effect that it has been issued at the request of the Government of the State whose flag the ship is entitled to fly.

1.5.6. *Duration and validity of the certificate*

1.5.6.1. An International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk should be issued for a period specified by the Administration which should not exceed 5 years from the date of the initial survey or the periodical survey.

1.5.6.2. No extension of the 5 year period of the certificate should be permitted.

1.5.6.3. The certificate should cease to be valid:

.1 If the surveys are not carried out within the period specified by 1.5.2;

.2 Upon transfer of the ship to the flag of another State. A new certificate should only be issued when the Government issuing the new certificate is fully satisfied that the ship is in compliance with the requirements of 1.5.3.1 and 1.5.3.2. Where a transfer occurs between Contracting Governments, the Government of the State whose flag the ship was formerly entitled to fly should, if requested within 12 months after the transfer has taken place, as soon as possible transmit to the Administration copies of the certificates carried by the ship before the transfer and, if available, copies of the relevant survey reports.

Chapter 2. SHIP SURVIVAL CAPABILITY* AND LOCATION OF CARGO TANKS

2.1. *General*

2.1.1. Ships subject to the Code 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.

* Reference is made to the Guidelines for Uniform Application of the Survival Requirements of the Bulk Chemical Code and the Gas Carrier Code.

2.1.2. Ships subject to the Code should be designed to one of the following standards:

.1 A type of 1G ship is a gas carrrier intended to transport products indicated in chapter 19 which require maximum preventive measures to preclude the escape of such cargo.

.2 A type 2G ship is a gas carrier intended to transport products indicated in chapter 19 which require significant preventive measures to preclude the escape of such cargo.

.3 A type 2PG ship is a gas carrier of 150 m in length or less intended to transport products indicated in chapter 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 4.2.4.4) for a MARVS of at least 7 bar 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 2G ship.

.4 A type 3G ship is a gas carrier intended to carry products indicated in chapter 19 which require moderate preventive measures to preclude the escape of such cargo.

Thus a type 1G ship is a gas carrier intended for the transportation of products considered to present the greatest overall hazard and types 2G/2PG and type 3G for products of progressively lesser hazards. Accordingly, a type 1G 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.

2.1.3. The ship type required for individual products is indicated in column "c" in the table of chapter 19.

2.1.4. If a ship is intended to carry more than one product listed in chapter 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.

2.2. *Freeboard and intact stability*

2.2.1. Ships subject to the Code 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 Code.

2.2.2. 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 Administration.

2.2.3. 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 Administration.

2.2.4. 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.

2.2.5. 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.

2.3. *Shipside discharges below the freeboard deck*

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 0.01L, two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination under service conditions.

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

2.3.3. The automatic non-return valves referred to in 2.3.1.1 and 2.3.1.2 should be of a type acceptable to the Administration 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 2.9.

2.4. *Conditions of loading*

Damage survival capability should be investigated on the basis of loading information submitted to the Administration 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.

2.5. *Damage assumptions*

2.5.1. The assumed maximum extent of damage should be:

.1	Side damage:	
.1.1	Longitudinal extent:	$1/3L^{2/3}$ or 14.5 m, whichever is less
.1.2	Transverse extent: measured inboard from the ship's side at right angles to the centreline at the level of the summer load line	B/5 or 11.5 m, whichever is less
.1.3	Vertical extent: from the moulded line of the bottom shell plating at centreline	Upwards without limit
.2	Bottom damage: For 0.3L from the forward perpendicular of the ship	Any other part of the ship
.2.1	Longitudinal extent: $1/3L^{2/3}$ or 14.5 m, whichever is less	$1/3L^{2/3}$ or 5 m, whichever is less
.2.2	Transverse extent: B/6 or 10 m, whichever is less	B/6 or 5 m, whichever is less
.2.3	Vertical extent: B/15 or 2 m, whichever is less measured from the moulded line of the bottom shell plating at centreline (see 2.6.3)	B/15 or 2 m, whichever is less measured from the moulded line of the bottom shell plating at centreline (see 2.6.3)

2.5.2. *Other damage:*

.1 If any damage of a lesser extent than the maximum damage specified in 2.5.1 would result in a more severe condition, such damage should be assumed.

* The cargo content of small independent purge tanks on deck need not be taken into account when assessing the ballast condition.

.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 2.8.1.

2.6. *Location of cargo tanks*

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

.1 Type 1G ships: from the side shell plating not less than the transverse extent of damage specified in 2.5.1.1.2 and from the moulded line of the bottom shell plating at centreline not less than the vertical extent of damage specified in 2.5.1.2.3 and nowhere less than 760 mm from the shell plating.

.2 Types 2G/2PG and 3G ships: from the moulded line of the bottom shell plating at centreline not less than the vertical extent of damage specified in 2.5.1.2.3 and nowhere less than 760 mm from the shell plating.

2.6.2. 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 figure 2.1). For internal insulation tanks the extent of damage should be measured to the supporting tank plating.

2.6.3. Except for type 1G ships, suction wells installed in cargo tanks may protrude into the vertical extent of bottom damage specified in 2.5.1.2.3 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.

2.7. *Flooding assumptions*

2.7.1. The requirements of 2.9 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.

2.7.2. 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*

* The permeability of partially filled compartments should be consistent with the amount of liquid carried in the compartment.

2.7.3. 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.

2.7.4. Where the damage between transverse watertight bulkheads is envisaged as specified in 2.8.1.4, .5, and .6, transverse bulkheads should be spaced at least at a distance equal to the longitudinal extent of damage specified in 2.5.1.1.1 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 nonexistent 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 2.5.

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.

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

2.7.6. 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 2.9.1 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.

2.7.7. If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in 2.5, arrangements should be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

2.7.8. 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 2.9.1.2.1 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 2.9.1; however the immersion of any other openings capable of being closed weathertight may be permitted.

2.8. *Standard of damage*

2.8.1. Ships should be capable of surviving the damage indicated in 2.5 with the flooding assumptions in 2.7 to the extent determined by the ship's type according to the following standards:

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

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

.3 A type 2G 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 2PG 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 2.5.1.1.1;

.5 A type 3G 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 2.5.1.1.1;

.6 A type 3G 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 2.5.1.1.1 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 Administration.

2.8.2. In the case of small type 2G/2PG and 3G ships which do not comply in all respects with the appropriate requirements of 2.8.1.3, .4, and .6, special dispensations may only be considered by the Administration 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 referred to in 1.5.4.

2.9. *Survival requirements*

Ships subject to the Code should be capable of surviving the assumed damage specified in 2.5 to the standard provided in 2.8 in a condition of stable equilibrium and should satisfy the following criteria.

2.9.1. 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 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;

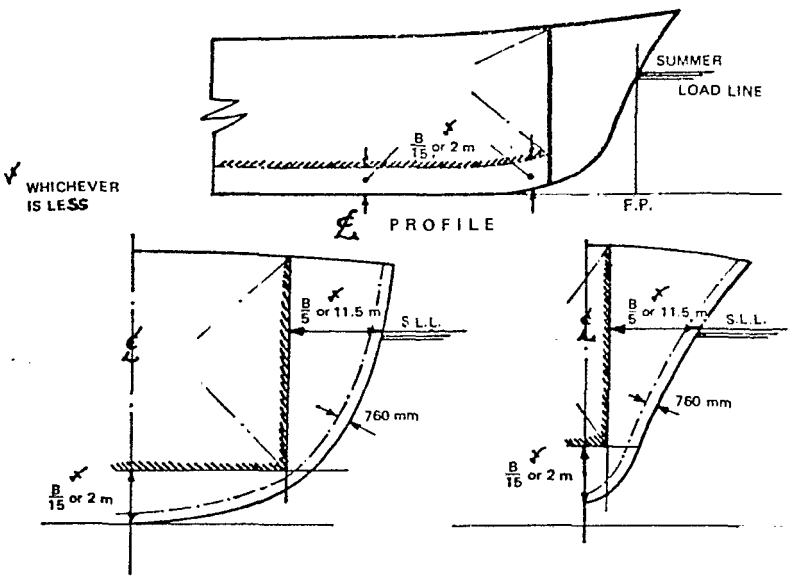
.2 The maximum angle of heel due to unsymmetrical flooding should not exceed 30°; and

.3 The residual stability during intermediate stages of flooding should be to the satisfaction of the Administration. However, it should never be significantly less than that required by 2.9.2.1.

2.9.2. 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 2.9.1.1 and other openings capable of being closed weathertight may be permitted; and

.2 The emergency source of power should be capable of operating.



SECTIONS

FIGURE 2.1. TANK LOCATION REQUIREMENTS AS SET OUT IN 2.6.

Chapter 3. SHIP ARRANGEMENTS

3.1. *Segregation of the cargo area*

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 Administration for the safety or navigation of the ship.

3.1.2. Where cargo is carried in a cargo containment system not requiring a secondary barrier, segregation of hold spaces from spaces referred to in 3.1.1 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.

3.1.3. Where cargo is carried in a cargo containment system requiring a secondary barrier, segregation of hold spaces from spaces referred to in 3.1.1 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.

3.1.4. 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.

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

.1 Be segregated from other piping systems, except where interconnections 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 chapter 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 trunkway 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 3.8 and emergency cargo jettisoning piping systems in accordance with 3.1.6, and except in accordance with chapter 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 2.6.1.

3.1.6. Any emergency cargo jettisoning piping system should comply with 3.1.5 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.

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

3.2. *Accommodation, service and machinery spaces and control stations*

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.

3.2.2. 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.

3.2.3. 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 3.6.1 when accommodation spaces are aft.

3.2.4. Entrances, air inlets and openings to accommodation spaces, service 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 house or on both 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 area. This distance, however, need not exceed 5 m. Windows and sidescuttles facing the cargo area and on the sides of the houses 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 Administration may approve relaxations from the above requirements.

3.2.5. Sidescuttles in the shell below the uppermost continuous deck and in the first tier of the superstructure are to be of the fixed (non-opening) type.

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

3.3. *Cargo pump rooms and cargo compressor rooms*

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 Administration. Cargo compressor rooms should be treated as cargo pump rooms for the purpose of fire protection according to regulation II-2/58 of the 1983 SOLAS amendments.

3.3.1.2. 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 1.3.6 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.

3.3.1.3. Where the limits of the cargo area are extended by 3.3.1.2, 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.

3.3.2. 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.

3.3.3. 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.

3.4. *Cargo control rooms*

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

.2.1 If the entrance complies with 3.2.4, the control room may have access to the spaces described above;

.2.2 If the entrance does not comply with 3.2.4, 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.

3.4.2. 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 13.6.5.

3.4.3. 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.

3.5. *Access to spaces in the cargo area*

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 3.5.2, 4.7.7 or 4.10.16 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.

3.5.2. 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.

3.5.3. 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:

.1.1 To cargo tanks direct from the open deck;

.1.2 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

.1.3 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 3.5.3.1.2 and .1.3 may be decreased if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Administration.

.3 The requirements of 3.5.3.1.2 and .1.3 do not apply to spaces described in 1.3.17.5. Such spaces should be provided only with direct or indirect access from the open weather deck, not including an enclosed gas-safe space.

3.5.4. 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 3.6.

3.6. *Air-locks*

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 gas-tight spaced at least 1.5 m but not more than 2.5 m apart.

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

3.6.3. 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.

3.6.4. 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 10.2.5.4). Electrical equipment which is not of the certified safe type for manœuvring, anchoring and mooring equipment as well as the emergency fire pumps should not be located in spaces to be protected by air-locks.

3.6.5. 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.

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

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

3.7. *Bilge, ballast and fuel oil arrangements*

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.

3.7.1.2. 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.

3.7.2. The interbarrier space 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 leakage to the cargo tanks.

3.7.3. 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 4.9.7.2.

3.7.4. Ballast spaces, fuel oil tanks and gas-safe spaces may be connected to pumps in the machinery spaces. Duct keels may be connected to pumps in the machinery spaces, provided the connections are led directly to the pumps and the discharge from the pumps led 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.

3.8. *Bow or stern loading and unloading arrangements*

3.8.1. Subject to the approval of the Administration and to the requirements of this section, cargo piping may be arranged to permit bow or stern loading and unloading.

3.8.1.1. 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 requir-

ing a type 1G ship. Bow or stern loading and unloading lines should not be used for the transfer of toxic products as specified in 1.3.38 unless specifically approved by the Administration.

3.8.2. Portable arrangements should not be permitted.

3.8.3. In addition to the requirements of chapter 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.

3.8.4. 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 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 3.2.4 and this paragraph is not possible, the Administration may approve relaxations from the above requirements.

3.8.5. 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.

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

3.8.7. Fire-fighting arrangements for the bow or stern loading and unloading areas should be in accordance with 11.3.1.3 and 11.4.7.

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

Chapter 4. CARGO CONTAINMENT

4.1. *General*

4.1.1. Administrations should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this chapter*.

4.1.2. In addition to the definitions in 1.3, the definitions given in this chapter apply throughout the Code.

* Reference is made to the published Rules of members and associate members of the International Association of Classification Societies and in particular to IACS Unified Requirements Nos. G1 and G2.

4.2. *Definitions*

4.2.1. *Integral tanks*

4.2.1.1. 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.

4.2.1.2. The design vapour pressure P_0 as defined in 4.2.6 should not normally exceed 0.25 bar. If, however, the hull scantlings are increased accordingly, P_0 may be increased to a higher value but less than 0.7 bar.

4.2.1.3. 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 Administration subject to special consideration.

4.2.2. *Membrane tanks*

4.2.2.1. 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.

4.2.2.2. The design vapour pressure P_0 should not normally exceed 0.25 bar. 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 0.7 bar.

4.2.2.3. The definition of membrane tanks does not exclude designs such as those in which non-metallic membranes are used or in which membranes are included or incorporated in insulation. Such designs require, however, special consideration by the Administration. In any case the thickness of the membranes should normally not exceed 10 mm.

4.2.3. *Semi-membrane tanks*

4.2.3.1. 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.

4.2.3.2. The design vapour pressure P_0 should not normally exceed 0.25 bar. 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 0.7 bar.

4.2.4. *Independent tanks*

4.2.4.1. 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 4.2.4.2 to 4.2.4.4.

4.2.4.2. Type A independent tanks are tanks which are designed primarily using Recognized Standards* of classical ship-structural analysis procedures. Where such tanks are primarily constructed of plane surfaces (gravity tanks), the design vapour pressure P_0 should be less than 0.7 bar.

4.2.4.3. 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 0.7 bar.

* Recognized Standards for the purpose of chapters 4, 5 and 6 are standards laid down and maintained by a classification society recognized by the Administration.

4.2.4.4. 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:

$$P_o = 2 + AC(\rho_r)^{1.5} \quad \text{(bar)}$$

where: $A = 0.0185\left(\frac{\sigma_m}{\Delta\sigma_A}\right)^2$

with

σ_m = design primary membrane stress

$\Delta\sigma_A$ = allowable dynamic membrane stress (double amplitude at probability level $Q = 10^{-8}$)
55 N/mm² for ferritic/martensitic steel
25 N/mm² 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 ($\rho_r = 1$ for fresh water) at the design temperature.

However, the Administration 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.

4.2.5. *Internal insulation tanks*

4.2.5.1. 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.

4.2.5.2. The two categories of internal insulation tanks are:

.1 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.

.2 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 term "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.

4.2.5.3. 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 4.4.7.

4.2.5.4. The design vapour pressure P_o should not normally exceed 0.25 bar. If, however, the cargo containment system is designed for a higher vapour pressure, P_o may be increased to such higher value, but not exceeding 0.7 bar if the internal insulation tanks are supported by the inner hull structure. However, a design vapour pressure of more than 0.7 bar may be accepted by the Administration provided the internal insulation tanks are supported by suitable independent tank structures.

4.2.6. *Design vapour pressure*

4.2.6.1. The design vapour pressure P_o is the maximum gauge pressure at the top of the tank which has been used in the design of the tank.

4.2.6.2. For cargo tanks where there is no temperature control and where the pressure of the cargo is dictated only by the ambient temperature, P_o 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 Administration 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 ambient temperature.

4.2.6.3. In all cases, including 4.2.6.2, P_o should not be less than MARVS.

4.2.6.4. Subject to special consideration by the Administration and to the limitations given in 4.2.1 to 4.2.5 for the various tank types, a vapour pressure higher than P_o may be accepted in harbour conditions, where dynamic loads are reduced.

4.2.7. *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 Administration should be made to ensure that the tank or cargo temperature cannot be lowered below the design temperature.

4.3. *Design loads*

4.3.1. *General*

4.3.1.1. 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 attachments.

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

4.3.1.2. Account should be taken of the loads corresponding to the pressure test referred to in 4.10.

4.3.1.3. Account should be taken of an increase of vapour pressure in harbour conditions referred to in 4.2.6.4.

4.3.1.4. The tanks should be designed for the most unfavourable static heel angle within the range 0° to 30° without exceeding allowable stresses given in 4.5.1.

4.3.2. *Internal pressure*

4.3.2.1. The internal pressure head h_{eq} in bars gauge resulting from the design vapour pressure P_o and the liquid pressure h_{gd} defined in 4.3.2.2, but not including effects of liquid sloshing, should be calculated as follows:

$$h_{eq} = P_o + (h_{gd})_{max} \qquad \text{(bar)}$$

Equivalent calculation procedures may be applied.

4.3.2.2. 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 4.3.4.1. The value

of internal pressure head h_{gd} resulting from combined effects of gravity and dynamic accelerations should be calculated as follows:

$$h_{gd} = a_\beta Z_\beta \frac{\rho}{1.02 \times 10^4} \quad \text{(bar)}$$

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 figure 4.1).

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 figure 4.2). Small tank domes not considered to be part of the accepted total volume of the cargo tank need not be considered when determining Z_β.

ρ = maximum cargo density (kg/m^3) at the design temperature.

The direction which gives the maximum value (h_{gd}) of h_{gd} should be considered. Where acceleration in three directions needs to be considered, an ellipsoid should be used instead of the ellipse in figure 4.1. The above formula applies only to full tanks.

4.3.3. *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.

4.3.4. *Dynamic loads due to ship motions*

4.3.4.1. 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.

4.3.4.2. For design against plastic deformation and buckling the dynamic loads should be taken as the most probable largest loads the ship will encounter during its operating life (normally taken to correspond to a probability level of 10^{-8}). Guidance formulae for acceleration components are given in 4.12.

4.3.4.3. 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 Administration.

4.3.4.4. 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 figure 4.3.

4.3.4.5. Ships for restricted service may be given special consideration.

4.3.4.6. 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.

4.3.5. *Sloshing loads*

4.3.5.1. When partial filling is contemplated, the risk of significant loads due to sloshing induced by any of the ship motions referred to in 4.3.4.6 should be considered.

4.3.5.2. When risk of significant sloshing-induced loads is found to be present, special tests and calculations should be required.

4.3.6. *Thermal loads*

4.3.6.1. Transient thermal loads during cooling down periods should be considered for tanks intended for cargo temperatures below −55°C.

4.3.6.2. Stationary thermal loads should be considered for tanks where design supporting arrangement and operating temperature may give rise to significant thermal stresses.

4.3.7. *Loads on supports*

The loads on supports are covered by 4.6.

4.4. *Structural analyses*

4.4.1. *Integral tanks*

The structural analysis of integral tanks should be in accordance with Recognized Standards. The tank boundary scantlings should meet at least the requirements for deep tanks taking into account the internal pressure as indicated in 4.3.2, but the resulting scantlings should not be less than normally required by such standards.

4.4.2. *Membrane tanks*

4.4.2.1. 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.

4.4.2.2. 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.

4.4.2.3. For the purpose of the test referred to in 4.4.2.2, 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.

4.4.2.4. 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.

4.4.2.5. A structural analysis of the hull should be to the satisfaction of the Administration, taking into account the internal pressure as indicated in 4.3.2. 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 Recognized Standards for deep tanks taking into account the internal pressure as indicated in 4.3.2. The allowable stress for the membrane, membrane-supporting material and insulation should be determined in each particular case.

4.4.3. *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 4.3.2.

4.4.4. *Type A independent tanks*

4.4.4.1. A structural analysis should be performed to the satisfaction of the Administration taking into account the internal pressure as indicated in 4.3.2. The cargo tank plating

thickness should meet at least the requirements of Recognized Standards for deep tanks taking into account the internal pressure as indicated in 4.3.2 and any corrosion allowance required by 4.5.2.

4.4.4.2. For parts such as structure in way of supports not otherwise covered by Recognized Standards, stresses should be determined by direct calculations, taking into account the loads referred to in 4.3 as far as applicable, and the ship deflection in way of supports.

4.4.5. *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 analyses in accordance with 4.3.4, finite element analyses or similar methods and fracture mechanics analyses 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 Administration, 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 Administration 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.

4.4.6. *Type C independent tanks*

4.4.6.1. Scantlings based on internal pressure should be calculated as follows:

.1 The thickness and form of pressure-containing parts of pressure vessels under internal pressure, including flanges, should be determined according to a standard acceptable to the Administration. 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 a standard acceptable to the Administration.

.2 The design liquid pressure defined in 4.3.2 should be taken into account in the above calculations.

.3 The welded joint efficiency factor to be used in the calculation according to 4.4.6.1.1 should be 0.95 when the inspection and the non-destructive testing referred to in 4.10.9 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 Administration may accept partial non-destructive examinations, but not less than those of 4.10.9.2.2 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-mentioned factors should be reduced depending on the specified mechanical properties of the welded joint.

4.4.6.2. Buckling criteria should be as follows:

.1 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 Administration. 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.

.2 The design external pressure P_e used for verifying the buckling of the pressure vessels should not be less than that given by:

$$P_e = P_1 + P_2 + P_3 + P_4 \qquad \text{(bar)}$$

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 0.25 bar.

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 $P_4 = 0$.

4.4.6.3. Stress analysis in respect of static and dynamic loads should be performed as follows:

.1 Pressure vessel scantlings should be determined in accordance with 4.4.6.1 and .2.

.2 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 4.3 should be used, as applicable. Stresses in way of the supports should be to a standard acceptable to the Administration. In special cases a fatigue analysis may be required by the Administration.

.3 If required by the Administration, secondary stresses and thermal stresses should be specially considered.

4.4.6.4. For pressure vessels, the thickness calculated according to 4.4.6.1 or the thickness required by 4.4.6.2 plus the corrosion allowance, if any, should be considered as a minimum without any negative tolerance.

4.4.6.5. 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.

4.4.6.5. 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.

4.4.7. *Internal insulation tanks*

4.4.7.1. 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 4.3.4, finite element analysis or similar methods and fracture mechanics analysis or an equivalent approach should be carried out.

4.4.7.2.1. 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 Administration. 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 4.3.2. 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.

4.4.7.2.2. 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.

4.4.7.2.3. 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 4.3.2. Tanks constructed of plane surfaces should at least comply with Recognized Standards for deep tanks.

4.4.7.3. 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 Administration unless such analysis is available for a similar ship.

4.4.7.4.1. 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.

4.4.7.4.2. 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).

4.4.7.4.3. 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.

4.4.7.4.4. 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.

4.4.7.5. The effects of fatigue loading should be determined in accordance with 4.4.5.6 or by an equivalent method.

4.4.7.6. 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.

4.5. *Allowable stresses and corrosion allowances*

4.5.1. *Allowable stresses*

4.5.1.1. For integral tanks, allowable stresses should normally be those given for hull structure in Recognized Standards.

4.5.1.2. For membrane tanks, reference is made to the requirements of 4.4.2.5.

4.5.1.3. For type A independent tanks primarily constructed of plane surfaces, the stresses for primary and secondary members (stiffeners, web frames, 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 4.5.1.7. However, if detailed calculations are carried out for the primary members, the equivalent stress $_C$ as defined in 4.5.1.8 may be increased over that indicated above to a stress acceptable to the Administration; 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.

4.5.1.4. For type B independent tanks, primarily constructed of bodies of revolution, the allowable stresses should not exceed:

$$\sigma_m \leq f$$
$$\sigma_L \leq 1.5\,f$$
$$\sigma_b \leq 1.5\,F$$
$$\sigma_L + \sigma_b \leq 1.5\,F$$
$$\sigma_m + \sigma_b \leq 1.5\,F$$

where: σ_m = equivalent primary general membrane stress

σ_L = equivalent primary local membrane stress

σ_b = equivalent primary bending stress

f = the lesser of $\frac{R_m}{A}$ or $\frac{R_e}{B}$

F = the lesser of $\frac{R_m}{C}$ or $\frac{R_e}{D}$

with R_m and R_e as defined in 4.5.1.7. With regard to the stresses σ_m, σ_L and σ_b see also the definition of stress categories in 4.13. 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 following minimum values:

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

4.5.1.5. For type B independent tanks, primarily constructed of plane surfaces, the Administration may require compliance with additional or other stress criteria.

4.5.1.6. For type C independent tanks the maximum allowable membrane stress to be used in calculation according to 4.4.6.1.1 should be the lower of:

$$\frac{R_m}{A} \text{ or } \frac{R_e}{B}$$

where: R_m and R_e are as defined in 4.5.1.7.

The values of A and B should be shown on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk provided for in 1.5, and should have at least the minimum values indicated in the table of 4.5.1.4.

4.5.1.7. For the purpose of 4.5.1.3, 4.5.1.4 and 4.5.1.6 the following apply:

.1 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.
R_m = specified minimum tensile strength at room temperature (N/mm^2).
For welded connections in aluminium alloys the respecive values of R_e or R_m in annealed conditions should be used.

.2 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 Administration, 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 provided for in 1.5.

4.5.1.8. 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.

4.5.1.9. 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:

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

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

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

where: $\sigma_{x.st}$, $\sigma_{y.st}$ and $\tau_{xy.st}$ = static stresses
$\sigma_{x.dyn}$, $\sigma_{y.dyn}$ and $\tau_{xy.dyn}$ = dynamic stresses

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

4.5.1.10. For internal insulation tanks, reference is made to the requirement of 4.4.7.2.

4.5.1.11. Allowable stresses for materials other than those covered by chapter 6 should be subject to approval by the Administration in each case.

4.5.1.12. Stresses may be further limited by fatigue analysis, crack propagation analysis and buckling criteria.

4.5.2. *Corrosion allowances*

4.5.2.1. 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 Administration may require a suitable corrosion allowance.

4.5.2.2. 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 scantlings calculated according to 4.4.6 should be increased as appropriate.

4.6. *Supports*

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 variations and hull deflections without undue stressing of the tank and of the hull.

4.6.2. The tanks with supports should also be designed for a static angle of heel of 30° without exceeding allowable stresses given in 4.5.1.

4.6.3. 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 figure 4.1. The half axes of the "acceleration ellipse" should be determined according to 4.3.4.2.

4.6.4. 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.

4.6.5. The loads mentioned in 4.6.2 and 4.6.4 need not be combined with each other or with wave-induced loads.

4.6.6. 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 4.6.3.

4.6.7. 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.

4.7. *Secondary barrier*

4.7.1. Where the cargo temperature at atmospheric pressure is below − 10° C, a secondary barrier should be provided when required by 4.7.3 to act as a temporary containment for any envisaged leakage of liquid cargo through the primary barrier.

4.7.2. 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 4.9.2; and

.2 The design should be such that this temperature will not result in unacceptable hull stresses.

4.7.3. Secondary barriers in relation to tank types should normally be provided in accordance with the following table. For tanks which differ from the basic tank types as defined

in 4.2 the secondary barrier requirements should be decided by the Administration in each case.

Cargo temperature at atmospheric pressure	*– 10° C and above*	*Below – 10° C down to – 55° C*	*Below – 55° C*
Basic tank type	*No secondary barrier required*	*Hull may act as secondary barrier*	*Separate secondary barrier where required*
Integral		Tank type not normally allowed[1]	
Membrane		Complete secondary barrier	
Semi-membrane		Complete secondary barrier[2]	
Independent			
Type A		Complete secondary barrier	
Type B		Partial secondary barrier	
Type C		No secondary barrier required	
Internal insulation			
Type 1		Complete secondary barrier	
Type 2		Complete secondary barrier is incorporated	

[1] A complete secondary barrier should normally be required if cargoes with a temperature at atmospheric pressure below – 10° C are permitted in accordance with 4.2.1.3.

[2] In the case of semi-membrane tanks which comply in all respects with the requirements applicable to type B independent tanks, except for the manner of support, the Administration may, after special consideration, accept a partial secondary barrier.

4.7.4. 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 4.3.4.4;

.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 4.8.2; and

.3 The mechanism of failure for the primary barrier does not also cause the failure of the secondary barrier and vice versa.

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

4.7.6.1. 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 4.3.4.4 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 in way of cargo tanks should be protected against liquid cargo.

4.7.6.2. 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.

4.7.7. 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 Administration. The method should be submitted to the Administration for approval.

4.8. *Insulation*

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 service temperature given in chapter 6 for the grade of steel concerned, as detailed in 4.9, 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 Administration for ships operated in restricted areas. Conversely, lesser values of the ambient temperatures may be fixed by the Administration 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 in Bulk as provided for in 1.5.

4.8.2. Where a complete or partial secondary barrier is required, calculations should be made with the assumptions in 4.8.1 to check that the temperature of the hull structure does not fall below the minimum allowable service temperature given in chapter 6 for the grade of steel concerned, as detailed in 4.9. The complete or partial secondary barrier should be assumed to be at the cargo temperature at atmospheric pressure.

4.8.3. Calculations required by 4.8.1 and 4.8.2 should be made assuming still air and still water, and except as permitted by 4.8.4, no credit should be given for means of heating. In the case referred to in 4.8.2, the cooling effect of the rising boil-off vapour from the leaked cargo should be considered in the heat transmission studies. For members connecting inner and outer hulls, the mean temperature may be taken for determining the steel grade.

4.8.4. In all cases referred to in 4.8.1 and 4.8.2 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 4.8.1 and 4.8.2;

.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 Administration.

4.8.5. 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.

4.9. *Materials*

4.9.1. The shell and deck plating of the ship and all stiffeners attached thereto should be in accordance with Recognized Standards, 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 6.5 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.

4.9.2. Hull material forming the secondary barrier should be in accordance with table 6.2. Metallic materials used in secondary barriers not forming part of the hull structure should be in accordance with table 6.2 or 6.3 as applicable. Insulation materials forming a secondary barrier should comply with the requirements of 4.9.7. Where the secondary barrier is formed by the deck or side shell plating, the material grade required by table 6.2 should be carried into the adjacent deck or side shell plating, where applicable, to a suitable extent.

4.9.3. Materials used in the construction of cargo tanks should be in accordance with table 6.1, 6.2 or 6.3.

4.9.4. Materials other than those referred to in 4.9.1, 4.9.2 and 4.9.3 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 6.5 for temperatures as determined by 4.8. This includes inner bottom plating, longitudinal bulkhead plating, transverse bulkhead plating, floors, webs, stringers and all attached stiffening members.

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

4.9.6. 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.

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

.1 Compatibility with the cargo,
.2 Solubility in the cargo,
.3 Absorption of the cargo,
.4 Shrinkage,
.5 Ageing,
.6 Closed cell content,
.7 Density,
.8 Mechanical properties,
.9 Thermal expansion,
.10 Abrasion,
.11 Cohesion,
.12 Thermal conductivity,
.13 Resistance to vibrations,
.14 Resistance to fire and flame spread.

4.9.7.2. In addition to meeting the above requirements, insulation materials which form part of the cargo containment as defined in 4.2.5 should be tested for the following properties after simulation of ageing and thermal cycling to ensure that they are adequate for the intended service:

.1 Bonding (adhesive and cohesive strength),
.2 Resistance to cargo pressure,
.3 Fatigue and crack propagation properties,
.4 Compatibility with cargo constituents and any other agent expected to be in contact with the insulation in normal service,
.5 Where applicable the influence of presence of water and water pressure on the insulation properties should be taken into account,
.6 Gas de-absorbing.

4.9.7.3. 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.

4.9.8. 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 Administration.

4.9.9. 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 containment system.

4.10. *Construction and testing*

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 Administration 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.

4.10.1.2. Welding joint details for type C independent tanks should be as follows:

.1 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 Administration for very small process pressure vessels. Other edge preparations may be allowed by the Administration depending on the results of the tests carried out at the approval of the welding procedure.

.2 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 Administration. All welds connecting nozzles, domes or other penetrations of the vessel and all welds connecting flanges to the vessel or nozzles should be full penetration welds extending through the entire thickness of the vessel wall or nozzle wall, unless specially approved by the Administration for small nozzle diameters.

4.10.2. Workmanship should be to the satisfaction of the Administration. Inspection and non-destructive testing of welds for tanks other than type C independent tanks should be in accordance with the requirements of 6.3.7.

4.10.3. 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.

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

4.10.5.1. 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.

4.10.5.2. 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 Administration.

4.10.6. Integral tanks should be hydrostatically or hydropneumatically tested to the satisfaction of the Administration. The test in general 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.

4.10.7. 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.

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

4.10.8.2. In ships fitted with internal insulation tanks where independent tanks are the supporting structure, the independent tanks should be tested in accordance with 4.10.10.1.

4.10.8.3. 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 Administration.

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

4.10.9. For type C independent tanks, inspection and non-destructive testing should be as follows:

.1 Manufacture and workmanship: The tolerances relating to manufacture and workmanship such as local out-of-roundness deviations from the true form, welded joints alignment and tapering of plates having different thicknesses, should comply with standards acceptable to the Administration. The tolerances should also be related to the buckling analysis referred to in 4.2.6.2.

.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 Administration, but the controls to be carried out should not be less than the following:

.2.1 Total non-destructive testing referred to in 4.4.6.1.3:

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 Administration. In addition, the Administration may require total ultrasonic testing on welding or reinforcement rings around holes, nozzles, etc.

.2.2 Partial non-destructive testing referred to in 4.4.6.1.3:

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 Administration in each instance.

4.10.10. Each independent tank should be subjected to a 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 4.10.10.1 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:

.3.1 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_o, 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_o is given in 4.2.6. 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.

.3.2 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.

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

.3.4 Where necessary for cargo pressure vessels, and with the specific approval of the Administration, a hydropneumatic test may be carried out under the conditions prescribed in 4.10.10.3.1, .2 and .3.

.3.5 Special consideration may be given by the Administration to the testing of tanks in which higher allowable stresses are used, depending on service temperature. However, the requirements of 4.10.10.3.1 should be fully complied with.

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

.3.7 Pneumatic testing of pressure vessels other than cargo tanks should be considered on an individual case basis by the Administration. 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.

4.10.11. All tanks should be subjected to a tightness test which may be performed in combination with the pressure test referred to in 4.10.10 or separately.

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

4.10.13. 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 Administration for type C independent tanks dependent on their configuration and on the arrangement of their supports and attachments.

4.10.14. 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 Administration.

4.10.15. Heating arrangements, if fitted in accordance with 4.8.4, should be tested for required heat output and heat distribution.

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

4.10.17. 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.

4.10.18. 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 rises.

4.11. *Stress relieving for type C independent tanks*

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 Administration. The soaking temperature and holding time should be to the satisfaction of the Administration.

4.11.2. 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 with the approval of the Administration and 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 plate thicknesses should not exceed those given by a standard acceptable to the Administration.

.3 The performance of a detailed stress analysis to ascertain that the maximum primary membrane stress during the mechanical stress relieving closely approaches, but does not exceed, 90% of the yield stress of the material. Strain measurements during the stress relief pressurization may be required by the Administration for verifying the calculations.

.4 The procedure for mechanical stress relieving should be submitted beforehand to the Administration for approval.

4.12. *Guidance formulae for acceleration components*

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 4.3.4.6

$$a_z = \pm a_o \sqrt{1 + \left(5.3 - \frac{45}{L_o}\right)^2 \left(\frac{x}{L_o} + 0.05\right)^2 \left(\frac{0.6}{C_B}\right)^{1.5}}$$

Transverse acceleration as defined in 4.3.4.6

$$a_y = \pm a_o \sqrt{0.6 + 2.5 \left(\frac{x}{L_o} + 0.05\right)^2 + K\left(1 + 0.6\ K\frac{z}{B}\right)^2}$$

Longitudinal acceleration as defined in 4.3.4.6

$$a_x = \pm a_o \sqrt{0.06 + A^2 - 0.25\ A}$$

with:

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

where: L_o = 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 waterline to the centre of gravity of tank with contents; z is positive above and negative below the waterline.

$$a_o = 0.2\frac{V}{\sqrt{L_o}} + \frac{34 - \frac{600}{L_o}}{L_o}$$

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 = 13GM/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.

4.13. *Stress categories*

For the purpose of stress evaluation referred to in 4.5.1.4, stress categories are defined in this section.

4.13.1. Normal stress is the component of stress normal to the plane of reference.

4.13.2. 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.

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

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

4.13.5. 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.

4.13.6. 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.

4.13.7. 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:

$$S_1 \leq 0.5 \sqrt{Rt} \quad \text{and}$$

$$S_2 \geq 2.5 \sqrt{Rt}$$

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

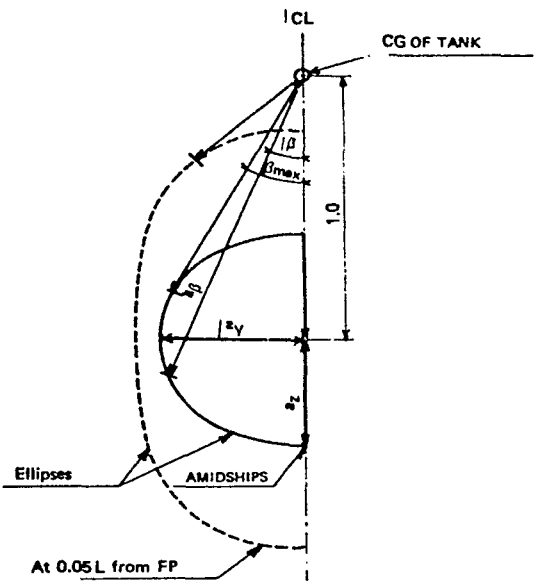
S_2 = distance in the meridional direction to another region where the limits for primary general membrane stress are exceeded

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.

4.13.8. 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.



a_β = resulting acceleration (static and dynamic) in arbitary direction β

a_y = transverse component of acceleration

a_z = vertical component of acceleration

FIGURE 4.1. ACCELERATION ELLIPSE

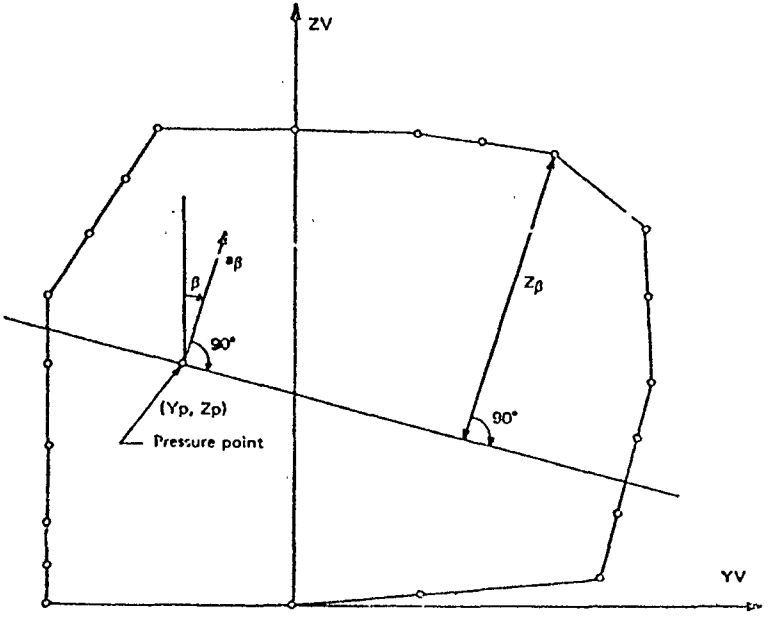
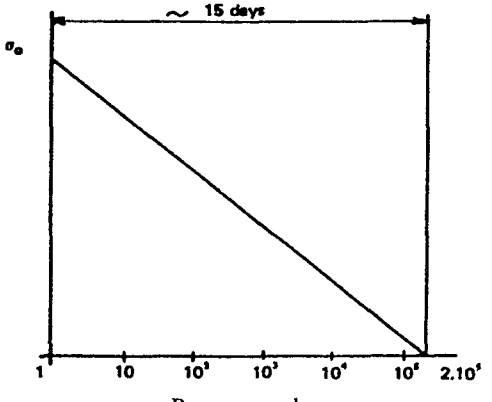


FIGURE 4.2. DETERMINATION OF INTERNAL PRESSURE HEADS



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

Response cycle scale is logarithmic; the value of 2.10^6 is given as an example of estimate.

FIGURE 4.3. SIMPLIFIED LOAD DISTRIBUTION

Chapter 5. PROCESS PRESSURE VESSELS AND LIQUID, VAPOUR, AND PRESSURE PIPING SYSTEMS

5.1. *General*

5.1.1. Administrations should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this chapter.*

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

5.2. *Cargo and process piping*

5.2.1. *General*

5.2.1.1. The requirements of this section 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.

5.2.1.2. 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.

5.2.1.3. 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.

5.2.1.4. 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.

5.2.1.5. 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.

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

5.2.1.7. 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.

5.2.2. *Scantlings based on internal pressure*

5.2.2.1. Subject to the conditions stated in 5.2.4, the wall thickness of pipes should not be less than:

$$t = \frac{t_o + b + c}{1 - \frac{a}{100}} \text{ (mm)}$$

* Reference is made to the published Rules of members and associate members of the International Association of Classification Societies and in particular to IACS Unified Requirement No. G3.

where: t_o = theoretical thickness

$t_o = PD/(20\,Ke + P)$ (mm)

with:

P = design pressure (bar) referred to in 5.2.3

D = outside diameter (mm)

K = allowable stress (N/mm^2) referred to in 5.2.4

e = efficiency factor [equals] 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 value depending on the manufacturing process may be determined by the Administration.

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:

$$b = \frac{Dt_o}{2.5r} \text{ (mm)}$$

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 for thickness (%).

5.2.3. *Design pressure*

5.2.3.1. The design pressure P in the formula for t_o in 5.2.2.1 is the maximum gauge pressure to which the system may be subjected in service.

5.2.3.2. The greater of the following design conditions should be used for piping, piping system and components as appropriate:

.1 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 Administration (see 4.2.6.2);

.2 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 Administration (see 4.2.6.2), assuming an initial condition of saturated vapour in the system at the system operating pressure and temperature; or

.3 The MARVS of the cargo tanks and cargo processing systems; or

.4 The pressure setting of the associated pump or compressor discharge relief valve; or

.5 The maximum total discharge or loading head of the cargo piping system; or

.6 The relief valve setting on a pipeline system.

5.2.3.3. The design pressure should not be less than 10 bar gauge except for open ended lines where it should be not less than 5 bar gauge.

5.2.4. *Permissible stresses*

5.2.4.1. For pipes, the permissible stress to be considered in the formula for t in 5.2.2.1 is the lower of the following values:

$$\frac{R_m}{A} \text{ or } \frac{R_e}{B}$$

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 as provided for in 1.5 and have values of at least A = 2.7 and B = 1.8.

5.2.4.2. The minimum wall thickness should be in accordance with Recognized Standards.

5.2.4.3. 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 5.2.2, or, if this is impracticable or would cause excessive local stresses, these loads should be reduced, protected against or eliminated by other design methods.

5.2.4.4. Flanges, valves and other fittings should be to a standard acceptable to the Administration, taking into account the design pressure defined in 5.2.2. For bellows expansion joints used in vapour service, a lower minimum design pressure may be accepted by the Administration.

5.2.4.5. For flanges not complying with a standard, the dimensions of flanges and related bolts should be to the satisfaction of the Administration.

5.2.5. *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 Administration. For temperatures of above −110 °C, a stress analysis may be required by the Administration 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 Administration.

5.2.6. *Materials*

5.2.6.1. The choice and testing of materials used in piping systems should comply with the requirements of chapter 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.

5.2.6.2. 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.

5.3. *Type tests on piping components*

5.3.1. Each type of piping component should be subject to type tests.

5.3.2.1. Each size and type of valve intended to be used at a working temperature below −55°C should be subjected to a tightness test to the minimum design temperature or lower, and to a pressure not lower than the design pressure of the valve. During the test the satisfactory operation of the valve should be ascertained.

5.3.2.2. The following type tests should be performed on 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:

.1 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.

.2 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 Administration may require the test to be at the minimum design temperature.

.3 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.

.4 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.

.5 The Administration 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 1.0 bar 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.

5.4. *Piping fabrication and joining details*

5.4.1. The requirements of this section apply to piping inside and outside the cargo tanks. However, the Administration may accept relaxations from these requirements for piping inside cargo tanks and open ended piping.

5.4.2. 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 10 bar 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 satisfactory to the Administration, 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 acceptable to the Administration should only be used for accessory lines and instrumentation lines with external diameters of 25 mm or less.

5.4.3.1. Flanges in flange connections should be of the welded neck, slip-on or socket welded type.

5.4.3.2. Flanges should comply with standards acceptable to the Administration as to their type, manufacture and test. In particular, for all piping except open ended, the following restrictions apply:

.1 For design temperatures lower than −55° C, only welded neck flanges should be used.

.2 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.

5.4.4. Piping connections, other than those mentioned in 5.4.2 and .3, may be accepted by the Administration in each case.

5.4.5. 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.

5.4.6. Welding, post-weld heat treatments and non-destructive testing.

.1 Welding should be carried out in accordance with 6.3.

.2 Post-weld heat treatments should be required for all butt welds of pipes made with carbon, carbon-manganese and low alloy steels. The Administration 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:

.3.1 100% radiographic inspection of butt welded joints for piping systems with service temperatures lower than −10° C and with inside diameters of more than 75 mm or wall thicknesses greater than 10 mm.

.3.2 For other butt welded joints of pipes, spot radiographic tests or other non-destructive tests should be carried out at the discretion of the Administration depending upon service, position and materials. In general, at least 10% of butt welded joints of pipes should be radiographed.

5.5. *Testing of piping*

5.5.1. The requirements of this section apply to piping inside and outside the cargo tanks. However, the Administration may accept relaxations from these requirements for piping inside cargo tanks and open ended piping.

5.5.2. 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 Administration for approval.

5.5.3. 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.

5.5.4. 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.

5.6. *Cargo system valving requirements*

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 0.7 bar 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 5.6.3 and should comply with the requirements of 5.6.4.

.2 For cargo tanks with a MARVS exceeding 0.7 bar 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 5.6.4, 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 5.6.1.1 and .2 are closed by the emergency shutdown system required by 5.6.4.

5.6.2. 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.

5.6.3. 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.

5.6.4. 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 13.1.3 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 service 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.

5.6.5. 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.

5.7. *Ship's cargo hoses*

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

5.7.2. 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.

5.7.3. Each new type of cargo hose, complete with end fittings, should be prototype tested to a pressure not less than 5 times its specified maximum working pressure. The hose temperature during this prototype test should be the intended 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 nor more than two fifths 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 or minimum service temperature or both. The specified maximum working pressure should not be less than 10 bar gauge.

5.8. *Cargo transfer methods*

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.

5.8.2. 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.

5.9. *Vapour return connections*

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

Chapter 6. MATERIALS OF CONSTRUCTION

6.1. *General*

6.1.1. Administrations should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this chapter.*

6.1.2. This chapter 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 6.2 and tables 6.1 to 6.5. The requirements for weldments are given in 6.3.

6.1.3. The manufacture, testing, inspection and documentation should be in accordance with Recognized Standards and the specific requirements given in this Code.

6.1.4.1. Acceptance tests should include Charpy V-notch toughness tests unless otherwise specified by the Administration. 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

* Reference is made to the published Rules of members and associate members of the International Association of Classification Societies and in particular to IACS Unified Requirement No. W1.

for specimens smaller than 5.0 mm size should be in accordance with Recognized Standards. Minimum average values for subsized specimens should be:

Charpy V-notch specimen size	*Minimum enery average of three specimens*
10 × 10 mm	E
10 × 7.5 mm	5/6 E
10 × 5.0 mm	2/3 E

where: E = the energy values (J) specified in tables 6.1 to 6.4.

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

6.1.4.2. 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 surface (see figure 6.1). 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 Administration 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.

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

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

6.1.7. Materials with alternative chemical composition or mechanical properties may be accepted by the Administration.

6.1.8. 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 chapter and the weld properties should be determined in the heat treated condition in accordance with 6.3. In cases where a post-weld heat treatment is applied, the test requirements may be modified at the discretion of the Administration.

6.1.9. Where reference is made in this chapter to A, B, D, E, AH, DH and EH hull structural steels, these steel grades are hull structural steels according to Recognized Standards.

6.2. *Material requirements*

The requirements for materials of construction are shown in the tables as follows:

Table 6.1. Plates, pipes (seamless and welded), sections and forgings for cargo tanks and process pressure vessels for design temperatures not lower than 0°C.

Table 6.2. 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 6.3. 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 6.4. Pipes (seamless and welded), forgings and castings for cargo process piping for design temperatures below 0°C and down to −165°C.

Table 6.5. Plates and sections for hull structures required by 4.9.1 and 4.9.4.

TABLE 6.1. 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 Administration
Composition limits to be aproved by the Administration
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 Administration.

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

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

TABLE 6.2. 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:	Batch test
Charpy V-notch test:	Test temperatures 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 Administration.

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

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

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 6.3 may be necessary.

TABLE 6.3. 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, 304L, 316, 316L, 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 Administration.

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

(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 (° C)*
$25 < t \leq 30$	10° below design temperature
$30 < t \leq 35$	15° below design temperature
$35 < t \leq 40$	20° below design temperature

In no case should the test temperature be above that indicated in the table.

The 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.

For 9% Ni, austenitic stainless steels and aluminium alloys, thicknesses greater than 25 mm may be used at the discretion of the Administration.

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

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

(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 Administration, provided that the impact tests are carried out at −196° C.

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

TABLE 6.4. 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. (0° 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, 304L, 316, 316L, 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 Administration.

(2) The requirements for forgings and castings may be subject to special consideration by the Administration.

(3) The requirements for design temperatures below −165° C should be specially agreed with the Administration.

(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 Administration.

(6) A lower design temperature may be specially agreed with the Administration 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 Administration.

TABLE 6.5. PLATES AND SECTIONS FOR HULL STRUCTURES REQUIRED BY 4.9.1 AND 4.9.4

Minimum design temperature of hull structure (° C)	*Maximum thickness (mm) for steel grades in accordance with 6.1.9*						
	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	x	20	25	50	20	40	50
Down to −20	x	x	20	50	x	30	50
Down to −30	x	x	x	40	x	20	40
Below −30	In accordance with table 6.2 except that the thickness limitation given in table 6.2 and in footnote 2 of that table does not apply.						

NOTES

"x" means steel grade not to be used.

(1) For the purpose of 4.9.4

(2) For the purpose of 4.9.1

6.3. *Welding and non-destructive testing*

6.3.1. *General*

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

6.3.2. *Welding consumables*

Welding consumables intended for welding of cargo tanks should be in accordance with Recognized Standards unless otherwise agreed with the Administration. Deposited weld metal tests and butt weld tests should be required for all welding consumables, unless otherwise specially agreed with the Administration. 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.

6.3.3. *Welding procedure tests for cargo tanks and process pressure vessels*

6.3.3.1. 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 Administration. Procedure tests for consumables intended for fillet welding should be in accordance with Recognized Standards. In such cases consumables should be selected which exhibit satisfactory impact properties.

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

.1 Cross-weld tensile tests.

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

.3 One set of three Charpy V-notch impacts, generally at each of the following locations, as shown in figure 6.1:

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.

.4 Macrosection, microsection and hardness survey may also be required by the Administration.

6.3.4. *Test requirements*

6.3.4.1. Tensile tests: Generally, tensile strength should not be less than the specified minimum tensile strength for the appropriate parent materials. The Administration 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.

6.3.4.2. 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 Administration.

6.3.4.3. 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 6.1.4. 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 6.1.4. 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.

6.3.5. *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 6.3.3. Unless otherwise specially agreed with the Administration, the test requirements should be in accordance with 6.3.4.

6.3.6. *Production weld tests*

6.3.6.1. 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 Administration. Tests, other than those specified in 6.3.6.2, .3 and .4, may be required for cargo tanks or secondary barriers at the discretion of the Administration.

6.3.6.2. The production tests for types A and B independent tanks and semi-membrane tanks should include the following tests:

.1 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.

.2 The test requirements are the same as the applicable test requirements listed in 6.3.4 except that impact tests that do not meet the prescribed energy requirements may still be accepted, upon special consideration by the Administration, 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.

6.3.6.3. In addition to those tests listed in 6.3.6.1 for type C independent tanks and process pressure vessels, transverse weld tensile tests are required. The test requirements are listed in 6.3.4 except that impact tests that do not meet the prescribed energy requirements may still be accepted upon special consideration by the Administration, 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.

6.3.6.4. Production tests for integral and membrane tanks should be in accordance with Recognized Standards.

6.3.7. *Non-destructive testing*

6.3.7.1. 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.

6.3.7.1.1. 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.

6.3.7.1.2. 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 Administration.

6.3.7.1.3. All test procedures and acceptance standards should be in accordance with Recognized Standards. The Administration 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 Administration may require ultrasonic testing in addition to normal radiographic inspection.

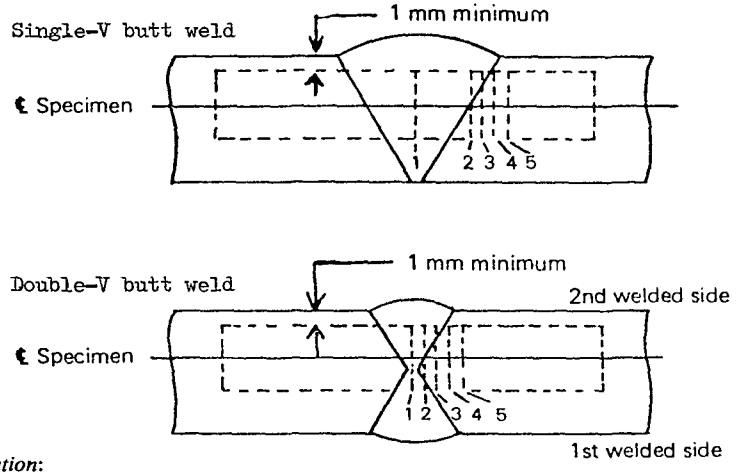
6.3.7.2. Inspection of type C independent tanks and process pressure vessels should be carried out in accordance with 4.10.9.

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

6.3.7.4. 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 4.4.7. The schedule for inspection and non-destructive testing should be to the satisfaction of the Administration.

6.3.7.5. Inspection of piping should be carried out in accordance with the requirements of chapter 5.

6.3.7.6. The secondary barrier should be radiographed as considered necessary by the Administration. 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.



Notch location:

1. Centre of weld
2. On fusion line
3. In HAZ, 1 mm from fusion line
4. In HAZ, 3 mm from fusion line
5. In Haz, 5 mm 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 one mm or greater. In addition for double-V butt welds, specimens should be machined closer to the surface of the second welded side.

FIGURE 6.1. ORIENTATION OF WELD TEST SPECIMEN

Chapter 7. CARGO PRESSURE/TEMPERATURE CONTROL

7.1 *General*

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 section:

.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 chapter 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 Administration;

.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 Administration in each case;

.4 Other systems acceptable to the Administration;

.5 In addition to the above means, the Administration 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.

7.1.2. The systems required by 7.1.1 should be constructed, fitted and tested to the satisfaction of the Administration. 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 Administration.

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

7.2. *Refrigeration systems*

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 Administration, 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.

7.2.2.1. Where two or more refrigerated cargoes which may react chemically in a dangerous manner are carried simultaneously, special considerition 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 7.2.1, 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.

7.2.2.2. 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.

7.2.3. 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.

7.2.4. 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 chapter 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 chapter 17 this system should not be used.

7.2.5. 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.

Chapter 8. CARGO TANK VENT SYSTEMS

8.1. *General*

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 chapter 7 should be independent of the pressure relief valves.

8.2. *Pressure relief systems*

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.

8.2.2. Interbarrier spaces should be provided with pressure relief devices to the satisfaction of the Administration.

8.2.3. 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.

8.2.4. 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.

8.2.5. 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 1.5 bar, ±6% for 1.5 to 3.0 bar, ±3% for 3.0 bar and above. Pressure relief valves should be set and sealed by a competent authority acceptable to the Administration and a record of this action, including the values of set pressure, should be retained aboard the ship.

8.2.6. 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 adjustments should be sealed.

8.2.7. The changing of the set pressure under the provisions of 8.2.6 should be carried out under the supervision of the master in accordance with procedures approved by the Administration 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.

8.2.8. 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 8.5. However, this capacity may be provided by the combined capacity of all valves, if a suitably maintained valve is carried on board.

8.2.9. 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 directed upwards and so arranged as to minimize the possibility of water or snow entering the vent system. The height of vent exits should be not less than B/3 or 6 m, whichever is greater, above the weather deck and 6 m above the working area and the fore and aft gangway.

8.2.10. 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 Administration. 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.

8.2.11. All other cargo vent exits not dealt with in other chapters should be arranged in accordance with 8.2.9 and 8.2.10.

8.2.12. 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.

8.2.13. 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.

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

8.2.15. 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.

8.2.16. The back pressure in the vent lines from the pressure relief valves should be taken into account in determining the flow capacity required by 8.5.

8.2.17. 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 1.3.23.

8.3. *Additional pressure relieving system for liquid level control*

8.3.1. Where required by 15.1.4.2, 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 8.5 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 15.1.4.2; 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 8.3.1.1 to become operable. The fusible elements should be located, 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.

8.3.2. The total relieving capacity of the additional pressure relieving system at the pressure mentioned in 8.3.1.1 should not be less than:

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

where: Q' = minimum required rate of discharge of air at standard conditions of 273 K and 1.013 bar.

$$G' = \frac{12.4}{(L + \rho_r m)D} \sqrt{\frac{Z.T'}{M}}$$

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 2.0 bar the values in table 8.1 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;

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 8.5.2.

8.3.3. Compliance with 8.3.1.1 requires changing of the setting of the relief valves provided for in this section. This should be accomplished in accordance with the provisions of 8.2.6 and 8.2.7.

8.3.4. Relief valves mentioned under 8.3.1.1 above may be the same as the pressure relief valves mentioned in 8.2, provided the setting pressure and the relieving capacity are in compliance with the requirements of this section.

8.3.5. The exhaust of such pressure relief valves may be led to the venting system referred to in 8.2.9. If separate venting arrangements are fitted these should be in accordance with the requirements of 8.2.9 to 8.2.15.

TABLE 8.1. FACTOR M

Product	$m = -di/d_{p_r}$ (kJ/kg)
Ammonia, anhydrous	3400
Butadiene	1800
Butane	2000
Butylenes	1900
Ethane	2100
Ethylene	1500
Methane	2300
Methyl chloride	816
Nitrogen	400
Propane	2000
Propylene	1600
Propylene oxide	1550
Vinyl chloride	900

The values in this table may be used for set pressures not higher than 2.0 bar.

8.4. *Vacuum protection systems*

8.4.1. Cargo tanks designed to withstand a maximum external pressure differential exceeding 0.25 bar 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 relief protection.

8.4.2. Cargo tanks designed to withstand a maximum external pressure differential not exceeding 0.25 bar, 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 Administration.

8.4.3. Subject to the requirements of chapter 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.

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

8.5. *Size of valves*

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:

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

where: Q = minimum required rate of discharge of air at standard conditions of 273 K and 1.013 bar.

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 Administration. (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

$$G' = \frac{12.4}{LD}\sqrt{\frac{Z.T}{M}}$$

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 kJ/kg

D = constant based on relation of specific heats k, shown in table 8.2; if k is not known, D = 0.606 should be used. The constant D may also be calculated by the following formula:

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

Z = compressibility factor of the gas at relieving conditions; if not known, Z = 1.0 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 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 figure 8.1.

TABLE 8.2. CONSTANT D

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

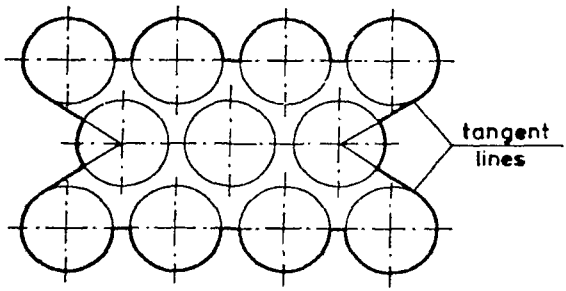


FIGURE 8.1

Chapter 9. ENVIRONMENTAL CONTROL

9.1. *Environmental control within cargo tanks and cargo piping systems*

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.

9.1.2. 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.

9.1.3. 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.

9.1.4. Piping systems which may contain cargo should be capable of being gas-freed and purged as provided in 9.1.1 and 9.1.3.

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

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

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.

9.2.2.1. 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 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.

9.2.2.2. Alternatively, subject to the restrictions specified in chapter 17, the Administration may allow the spaces referred to in 9.2.2.1 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.

9.2.3. For non-flammable gases, the spaces referred to in 9.2.1 and 9.2.2.1 may be maintained with a suitable dry air or inert atmosphere.

9.2.4. 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 4.9.7.2.

9.3. *Environmental control of spaces surrounding type C independent tanks*

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 shipboard inert gas generation system, shipboard storage of inert gas, or dry air provided by suitable air drying equipment.

9.4. *Inerting*

9.4.1. Inerting refers to the process of providing a non-combustible 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.

9.4.2. 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.

9.4.3. Where inert gas is stored at temperatures 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.

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

9.4.5. 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.

9.5. *Inert gas production on board*

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 chapter 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 chapter 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.

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

9.5.3. 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 tank area, two non-return valves or equivalent devices should be fitted in the inert gas main in the cargo area as required in 9.5.2. Inert gas piping should not pass through accommodation spaces, service spaces or control stations.

9.5.4. 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.

Chapter 10. ELECTRICAL INSTALLATIONS

10.1. *General*

10.1.1. The provisions of this chapter 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.

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

10.1.3. Administrations should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this chapter in respect of electrical installations.*

10.1.4. Electrical equipment or wiring should not be installed in gas-dangerous spaces or zones unless essential for operational purposes, when the exceptions listed in 10.2 are permitted.

10.1.5. Where electrical equipment is installed in gas-dangerous spaces or zones as provided in 10.1.4, it should be to the satisfaction of the Administration and approved by the relevant authorities recognized by the Administration for operation in the flammable atmosphere concerned.

10.2. *Types of equipment*

Certified safe type equipment may be fitted in gas-dangerous spaces and zones in accordance with the following provisions:

10.2.1. *Gas-dangerous spaces and zones, general*

Intrinsically safe electrical equipment and wiring may be fitted in all gas-dangerous spaces and zones as defined in 1.3.17.

10.2.2. *Cargo containment systems*

Submerged cargo pump motors and their supply cables may be fitted in cargo containment systems. Arrangements should be made to automatically shut down the motors in the event of low liquid level. This may be accomplished by sensing low pump discharge pressure, low motor current, or low liquid level. This shutdown should be alarmed at the cargo control station. Cargo pump motors should be capable of being isolated from their electrical supply during gas-freeing operations.

10.2.3. *Hold spaces and certain other spaces*

10.2.3.1. In hold spaces where cargo is carried in a cargo containment system requiring a secondary barrier, supply cables for submerged cargo pump motors may be installed.

10.2.3.2. In hold spaces where cargo is carried in a cargo containment system not requiring a secondary barrier and in spaces described in 1.3.17.5, the following may be installed:

.1 Through runs of cables;

.2 Lighting fittings with pressurized enclosures or of the flameproof type. The lighting system should be divided between at least two branch circuits. All switches and protective devices should interrupt all poles or phases and be located in a gas-safe space; and

.3 Electrical depth sounding or log devices and impressed current cathodic protection system anodes or electrodes. These devices should be housed in gas-tight enclosures;

and only in spaces described in 1.3.17.5:

.4 Flameproof motors for valve operation for cargo or ballast systems; and

.5 Flameproof general alarm audible indicators.

10.2.4. *Cargo pump and cargo compressor rooms*

10.2.4.1. Lighting fittings should have pressurized enclosures or should be of the flameproof type. The lighting system should be divided between at least two branch circuits. All switches and protective devices should interrupt all poles or phases and be located in a gas-safe space.

10.2.4.2. Electric motors for driving cargo pumps or cargo compressors should be separated from these spaces by a gastight bulkhead or deck. Flexible couplings or other means of maintaining alignment should be fitted to the shafts between the driven equipment and its motors and, in addition, suitable glands should be provided where the shafts pass through the

* Reference is made to the Recommendations published by the International Electrotechnical Commission and in particular to Publication 92-502.

gastight bulkhead or deck. Such electric motors and associated equipment should be located in a compartment complying with chapter 12.

10.2.4.3. Where operational or structural requirements are such as to make it impossible to comply with the method described in 10.2.4.2, motors of the following certified safe types may be installed:

.1 Increased safety type with flameproof enclosure; and

.2 Pressurized type.

10.2.4.4. General alarm audible indicators should have flameproof enclosures.

10.2.5. *Zones on open decks, spaces other than hold spaces*

10.2.5.1. In zones on open decks or non-enclosed spaces on the open deck, within 3 m of any cargo tank outlet, gas or vapour outlet, cargo pipe flange, cargo valves or entrances and ventilation openings to cargo pump rooms and cargo compressor rooms; in zones on the open deck over the cargo area and 3 m forward and aft of the cargo area on the open deck and up to a height of 2.4 m above the deck; in zones within 2.4 m of the outer surface of a cargo containment system where such surface is exposed to the weather the following may be installed:

.1 Certified safe type equipment; and

.2 Through runs of cables.

10.2.5.2. In enclosed or semi-enclosed spaces in which pipes containing cargo products are located and in compartments for cargo hoses the following may be installed:

.1 Lighting fittings with pressurized enclosures, or of the flameproof type. The lighting system should be divided between at least two branch circuits. All switches and protective devices should interrupt all poles or phases and be located in a gas-safe space; and

.2 Through runs of cables.

10.2.5.3. In enclosed or semi-enclosed spaces having a direct opening into any gas-dangerous space or zone there should be installed electrical installations complying with the requirements for the space or zone to which the opening leads.

10.2.5.4. Electrical equipment within spaces protected by air-locks should be of the certified safe type unless arranged to be de-energized by measures required by 3.6.4.

Chapter 11. FIRE PROTECTION AND FIRE EXTINCTION

11.1. *Fire safety requirements*

11.1.1. The requirements for tankers in chapter II-2 of the 1983 SOLAS amendments should apply to ships covered by the Code, irrespective of tonnage including ships of less than 500 tons gross tonnage, except that:

.1 Regulation 56.4 does not apply;

.2 Regulation 4 as applicable to cargo ships and regulation 7 should apply as they would apply to tankers of 2,000 tons gross tonnage and over;

.3 The following regulations of chapter II-2 of the 1983 SOLAS amendments related to tankers do not apply and are replaced by chapters and sections of the Code as detailed below:

Regulation	*Replaced by*
17	11.6
56.1 and 56.2	Chapter 3
60, 61, 62	11.3 and 11.4
63	11.5

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

11.1.3. The provisions of this section apply in conjunction with chapter 3.

11.1.4. 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 forwardmost hold space should be included in the cargo area.

11.2. *Fire water main equipment*

11.2.1. All ships, irrespective of size, carrying products which are subject to this Code should comply with the requirements of regulations II-2/4 and II-2/7 of the 1983 SOLAS amendments, except that the required fire pump capacity and fire main and water service pipe diameter should not be limited by the provisions of regulations 4.2.1 and 4.4.1 when the fire pump and fire main are used as part of the water spray system as permitted by 11.3.3. In addition, the requirements of regulation 4.4.2 should be met at a pressure of at least 5.0 bar gauge.

11.2.2. 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 regulations II-2/4.5.1 and II-2/4.8 of the 1983 SOLAS amendments, with hose lengths not exceeding 33 m.

11.2.3. 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.

11.2.4. 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 corrosion by seawater, for which purpose galvanized pipe, for example, may be used, and to the effect of fire.

11.2.5. 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.

11.3. Water spray system

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 compressor 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.

11.3.2. The system should be capable of covering all areas mentioned in 11.3.1 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 11.3.1.1 and .2 should cover the whole of the athwartship tank grouping which includes that area.

11.3.3. 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 any one section and to the surfaces specified in 11.3.1.3 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.

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

11.3.5. 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.

11.4. *Dry chemical powder fire-extinguishing systems*

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 for this purpose and satisfactory to the Administration.

11.4.2. 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.

11.4.3. 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 Administration. 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.

11.4.4. 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 Administration. 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.

11.4.5. The capacity of a monitor should be not less than 10 kg/s. 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/s. 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 weather-resistant housing or covers and be readily accessible.

11.4.6. 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 the following requirements:

Capacity of fixed monitors (kg/s) 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.

11.4.7. 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 11.4.1 to 11.4.6. 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.

11.5. *Gas-dangerous enclosed spaces*

11.5.1. Enclosed spaces normally entered where flammable liquid or vapour leakage may occur, such as cargo compressor and pump rooms, should be provided with a fixed installation which is capable of extinguishing a fire within the space. Additionally, this system or another fixed system should be capable of inerting the space following a fire to ensure that the fire does not recur. For purposes of design, the boundaries of the space should be assumed to remain intact. Carbon dioxide and steam smothering systems should be avoided unless due consideration is given to the danger of static electricity.

11.5.2. Provision should be made for closure of ventilation and any other openings into the space and, where necessary, for an audible warning signal to be sounded within the space for the emergency escape of personnel before admission of the inerting/extinguishing medium.

11.6. *Firemen's outfits*

11.6.1. Every ship carrying flammable products should carry firemen's outfits complying with the requirements of regulation II-2/17 of the 1983 SOLAS amendments as follows:

Total cargo capacity	*Number of outfits*
Below 2,000 m^3	2
Between 2,000 m^3 and 5,000 m^3	4
Above 5,000 m^3	5

11.6.2. Additional requirements for safety equipment are given in chapter 14.

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

Chapter 12. MECHANICAL VENTILATION IN THE CARGO AREA

The requirements of this chapter replace regulation II-2/59.3 of the 1983 SOLAS amendments.

12.1. *Spaces required to be entered during normal cargo handling operations*

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 en-

tering the compartment and operating the equipment and a warning notice requiring the use of such ventilation should be placed outside the compartment.

12.1.2. 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.

12.1.3. 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.

12.1.4. 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.

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

12.1.6. 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.

12.1.7. Ventilation intakes should be so arranged as to minimize the possibility of recycling hazardous vapours from any ventilation discharge opening.

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

12.1.9. 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 nonsparking 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.

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

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

12.2. *Spaces not normally entered*

Hold spaces, interbarrier spaces, void spaces, cofferdams, spaces containing cargo piping and other spaces where cargo vapours 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 12.1.9.

Chapter 13. INSTRUMENTATION (GAUGING, GAS DETECTION)

13.1. *General*

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 chapter.

13.1.2. 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 13.6. 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.

13.1.3. 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.

13.1.4. 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 Administration.

13.2. *Level indicators for cargo tanks*

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.

13.2.2. 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 chapter 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.

13.2.3. Sighting ports with a suitable protective cover and situated above the liquid level with an internal scale may be allowed by the Administration as a secondary means of gauging for cargo tanks having a design vapour pressure not higher than 0.7 bar.

13.2.4. 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 Administration for deck tanks, subject to any provisions of chapter 17.

13.3. *Overflow control*

13.3.1. Except as provided in 13.3.2, 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 5.6.4 may be used for this purpose. If another valve is used for this purpose, the same information as referred to in 5.6.4 should be available on board. During loading, whenever the use of these valves may possibly create a potential excess pressure surge in the loading system, the Administration and the port Administration may agree to alternative arrangements such as limiting the loading rate, etc.

13.3.2. 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.

13.3.3. Electrical circuits, if any, of level alarms should be capable of being tested prior to loading.

13.4. *Pressure gauges*

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 13.1.3. 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 8.2.6, high-pressure alarms should be provided for each set pressure.

13.4.2. Each cargo pump discharge line and each liquid and vapour cargo manifold should be provided with at least one pressure gauge.

13.4.3. Local-reading manifold pressure gauges should be provided to indicate the pressure between stop valves and hose connections to the shore.

13.4.4. Hold spaces and interbarrier spaces without open connection to the atmosphere should be provided with pressure gauges.

13.5. *Temperature indicating devices*

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 Administration.

13.5.2. 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.

13.5.3. 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 13.5.3.1 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.

13.5.4. The number and position of temperature indicating devices should be to the satisfaction of the Administration.

13.6. *Gas detection requirements*

13.6.1. Gas detection equipment acceptable to the Administration and suitable for the gases to be carried should be provided in accordance with column "f" in the table of chapter 19.

13.6.2. 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 resulting from compartment purging or ventilation.

13.6.3. Pipe runs from sampling heads should not be led though gas-safe spaces except as permitted by 13.6.5.

13.6.4. Audible and visual alarms from the gas detection equipment, if required by this section, should be located on the navigating bridge, in the control position required by 13.1.3, and at the gas detector readout location.

13.6.5. Gas detection equipment may be located in the control position required by 13.1.3, 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.

13.6.6. 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.

13.6.7. 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 chapter 16; and

.7 Air-locks.

13.6.8. 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 13.6.7.6 sampling should be continuous. Common sampling lines to the detection equipment should not be fitted.

13.6.9. In the case of products which are toxic or both toxic and flammable, the Administration, except when column "h" in the table of chapter 19 refers to 17.9, 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 13.6.7 and at 30 min intervals while they remain therein.

13.6.10. For the spaces listed in 13.6.7, alarms should be activated for flammable products when the vapour concentration reaches 30% of the lower flammable limit.

13.6.11. 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 sampling and detecting 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 Administration in the light of particular cargo containment arrangements. Common sampling lines to the detection equipment should not be fitted.

13.6.12. 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.

13.6.13. Every ship should be provided with at least two sets of portable gas detection equipment acceptable to the Administration and suitable for the products to be carried.

13.6.14. A suitable instrument for the measurement of oxygen levels in inert atmospheres should be provided.

Chapter 14. PERSONNEL PROTECTION

14.1. *Protective equipment*

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.

14.2. *Safety equipment*

14.2.1. Sufficient, but not less than two complete sets of safety equipment in addition to the firemen's outfits required by 11.6.1 each permitting personnel to enter and work in a gas-filled space, should be provided.

14.2.2. 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 ö f free air;

.2 Protective clothing, boots, gloves and tight-fitting goggles;

.3 Steel-cored rescue line with belt; and

.4 Explosion-proof lamp.

14.2.3. An adequate supply of compressed air should be provided and should consist either of:

.1 One set of fully charged air bottles for each breathing apparatus required by 14.2.1;

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 14.2.1; or

.2 Fully charged spare air bottles with a total free air capacity of at least 6,000 ßór each breathing apparatus required by 14.2.1.

14.2.4. Alternatively, the Administration may accept a low-pressure air line system with hose connection suitable for use with the breathing apparatus required by 14.2.1. 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.

14.2.5. Protective equipment required in 14.1 and safety equipment required in 14.2.1 should be kept in suitable, clearly marked lockers located in readily accessible places.

14.2.6. 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.

14.3. *First-aid equipment*

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.

14.3.2. Medical first-aid equipment including oxygen resuscitation equipment and antidotes, if available, for products carried should be provided on board.

14.4. *Personnel protection requirements for individual products*

14.4.1. Provisions of 14.4 are applicable to ships carrying products for which those paragraphs are listed in column "h" in the table of chapter 19.

14.4.2. Respiratory and eye protection suitable for emergency escape purposes should be provided for every person on board subject to the following:

.1.1 Filter type respiratory protection should be accepted, only when one filter is suitable for all designated cargoes that the ship is certified to carry;

.1.2 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.

14.4.3. Suitably marked decontamination showers and an eye wash should be available on deck in convenient locations. The showers and eye wash should be operable in all ambient conditions.

14.4.4. 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 11.6.1 and 14.2.1. At least three spare charged air bottles should be provided for each self-contained air breathing apparatus required in this paragraph.

14.4.5. 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 Administration.

14.4.6. For certain highly dangerous products, cargo control rooms should be of the gas-safe type only.

Chapter 15. FILLING LIMITS FOR CARGO TANKS

15.1. *General*

15.1.1. No cargo tanks should be more than 98% liquid full at the reference temperature, except as permitted by 15.1.3.

15.1.2. The maximum volume to which a cargo tank should be loaded is determined by the following formula:

$$V_L = 0.98\ V \frac{\rho_R}{\rho_L}$$

where: V_L = maximum volume to which the tank may be loaded
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.

15.1.3. The Administration may allow a higher filling limit than the limit of 98% specified in 15.1.1 and 15.1.2 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 specified in 8.2.17 are maintained.

15.1.4. For the purpose of this chapter 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 chapter 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 chapter 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 8.2, an additional pressure relief valve complying with 8.3 should be fitted.

15.2. *Information to be provided to the master*

The maximum allowable tank filling 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 Administration. Pressures at which the pressure relief valves, including those valves required by 8.3, have been set should also be stated on the list. A copy of the list should be permanently kept on board by the master.

Chapter 16. USE OF CARGO AS FUEL

16.1. *General*

16.1.1. Methane (LNG) is the only cargo whose vapour or boil-off gas may be utilized in main propelling machinery spaces and boiler rooms and in such spaces or rooms may be utilized only in boilers, inert gas generators, and combustion engines.

16.1.2. The provisions of this chapter do not preclude the use of vapour or boil-off gas for other services in other locations, such as cargo reliquefaction and inert gas generation, provided that such other services and locations are specially considered by the Administration.

16.2. *Gas fuel supply*

16.2.1. Gas fuel lines should not pass through accommodation spaces, service spaces or control stations. Gas lines may pass through or extend into other spaces provided they fulfil one of the following:

.1 The gas fuel line 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 fuel pressure. Suitable alarms should be provided to indicate a loss of pressure between the pipes; or

.2 The gas fuel lines should be installed in a mechanically exhaust-ventilated pipe or duct. The air space between the outer and inner walls of piping or ducts should be equipped with mechanical 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 inlet should be so arranged that gas or gas-air mixture will not be drawn into the system. The ventilation should always be in operation when there is gas in the supply pipeline. Continuous gas detection should be provided to indicate leaks and to shut down the gas fuel supply to the machinery space in accordance with 16.2.9. The exhaust fan for this duct should be so arranged that the gas fuel supply to the machinery space will be cut off if the required air flow is not established and maintained.

16.2.2. If a gas leak occurs, the gas fuel supply should not be operated until the leak has been found and repaired. Instructions to this effect should be placed in a prominent position in the machinery space.

16.2.3. The double wall piping system or the ventilated duct provided for the gas fuel lines should terminate at the ventilation hood or casing required by 16.2.4.

16.2.4. A ventilation hood or casing should be provided for the areas occupied by flanges, valves, etc., and for the gas fuel piping, which is not enclosed in the double wall piping system or ventilated duct, at gas 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 a duct as specified in 16.2.1.2, 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 16.2.9. The exhaust fan should be so arranged that the gas fuel supply to the machinery space will be cut off if the exhaust ventilation is not functioning so as to produce the required air flow. The 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 hood or casing.

16.2.5. Make-up air for the required ventilation air system and air discharges from the ventilation system shall be taken from and led to a safe location.

16.2.6. 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 other 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 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.

16.2.7. A master gas fuel valve that can be closed from within the machinery space should be provided outside the machinery space. The valve should be so arranged 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.

16.2.8. Provision should be made for inerting and gas-freeing that portion of the gas fuel piping system located in the machinery space.

16.2.9. Gas detection systems provided in accordance with the requirements of 16.2.1 and 16.2.4 should alarm at 30% of the lower flammability limit and shut down the gas fuel supply to the machinery space before the gas concentration reaches 60% of the lower flammability limit.

16.2.10. All details of the gas fuel system should be submitted to the Administration for approval.

Chapter 17. SPECIAL REQUIREMENTS

17.1. *General*

The provisions of this chapter are applicable where reference is made in column "h" in the table of chapter 19. These are requirements additional to the general requirements of the Code.

17.2. *Materials of construction*

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 "h" in the table of chapter 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.

17.3. *Independent tanks*

17.3.1. Products should be carried in independent tanks only.

17.3.2. Products should be carried in type C independent tanks and the provisions of 7.1.3 apply. The design pressure of the cargo tank should take into account any padding pressure or vapour discharge unloading pressure.

17.4. *Refrigeration systems*

17.4.1. Only the indirect system described in 7.2.4.2 should be used.

17.4.2. 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 7.2.4.2 with the condenser inside the cargo tank; or

.2 Using the direct system or combined system described in 7.2.4.1 and .3 respectively, or the indirect system described in 7.2.4.2 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.

17.4.3. If the ship is to carry consecutively products as specified in 17.4.2 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.

17.5. *Deck cargo piping*

One hundred per cent radiography of all butt welded joints in cargo piping exceeding 75 mm in diameter is required.

17.6. *Exclusion of air from vapour spaces*

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.

17.7. *Moisture control*

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.

17.8. *Inhibition*

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 the length of the voyage exceed the effective lifetime of the inhibitors.

17.9. *Permanently installed toxic gas detectors*

17.9.1. Gas sampling lines should not be led into or through gas-safe spaces. Alarms referred to in 13.6.7 should be activated when the vapour concentration reaches the threshold limiting value.

17.9.2. The alternative of using portable equipment in accordance with 13.6.9 should not be permitted.

17.10. *Flame screens on vent outlets*

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 section. 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.

17.11. *Maximum allowable quantity of cargo per tank*

When carrying a cargo referenced to this section, the quantity of the cargo should not exceed 3,000 m^3 in any one tank.

17.12. *Submerged electric cargo pumps*

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.

17.13. *Ammonia*

Because high concentrations of ammonia in confined spaces can be flammable, the provisions of chapter 10 for flammable products should be applied except in zones on the open deck. Liquid ammonia should never be sprayed into a tank containing air as there is a risk of creating a static electrical charge which could cause ignition. To minimize the risk of stress corrosion cracking occurring when ammonia is carried at a temperature above −20° C (vapour pressure 1.9 bar), the oxygen content of the vapour space in pressure vessels and in pipelines made of carbon-manganese steel (and other steels which require special consideration) should be reduced to the minimum practicable before liquid ammonia is introduced. The condensate

system of tanks operating at −33°C may be affected unless they have been thermally stress relieved.

17.14. *Chlorine*

17.14.1. *Cargo containment system*

17.14.1.1. 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.

17.14.1.2. The tank design vapour pressure should not be less than 13.5 bar (see also 7.1.3 and 17.3.2).

17.14.1.3. Parts of tanks protruding above the upper deck should be provided with protection against thermal radiation taking into account total engulfment by fire.

17.14.1.4. 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 1 bar 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 13.5 bar 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.

17.14.1.5. 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.

17.14.1.6. The Administration and the port Administration may require that chlorine is carried in [a] refrigerated state at a specified maximum pressure.

17.14.2. *Cargo piping systems*

17.14.2.1. 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 10.5 bar gauge. Cargo discharge compressors on board ships should not be accepted by the Administration.

17.14.2.2. The design pressure of the cargo piping system should be not less than 21 bar 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.

17.14.2.3. Relief valves of the cargo piping system should discharge to the absorption plant (see also 8.2.16).

17.14.3. *Materials*

17.14.3.1. The cargo tanks and cargo piping systems are to 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.

17.14.3.2. The tanks should be thermally stress relieved. Mechanical stress relief should not be accepted as an equivalent.

17.14.4. *Instrumentation—safety devices*

17.14.4.1. 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.

17.14.4.2. During the gas-freeing of cargo tanks, vapours should not be discharged to the atmosphere.

17.14.4.3. A gas detecting system should be provided capable of monitoring chlorine concentrations of at least 1 ppm by volume. Suction points should be located:

.1 Near the bottom of the cargo hold spaces;

.2 In the pipes from the safety relief valves;

.3 At the outlet from the gas absorbing plant;

.4 At the inlet to the ventilation systems for the accommodation, service and machinery spaces and control stations;

.5 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.

17.14.4.4. Each cargo tank should be fitted with a high-pressure alarm giving an audible alarm at a pressure equal to 10.5 bar gauge.

17.14.5. *Personnel protection*

In addition to the requirements given in chapter 14 the following requirements should be met:

.1 The enclosed space required by 14.4.5 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 remainder of 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 14.4.3 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 17.14.5.1.

17.14.6. *Filling limits for cargo tanks*

17.14.6.1. The requirements of 15.1.4.2 do not apply when it is intended to carry chlorine.

17.14.6.2. The chlorine content of the gas in the vapour space of the cargo tank after loading should be greater than 80% by volume.

17.15. *Diethyl ether and vinyl ethyl ether*

17.15.1. The cargo should be discharged 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.

17.15.2. Inert gas displacement may be used for discharging cargo from type C independent tanks provided the cargo system is designed for the expected pressure.

17.16. *Ethylene oxide*

17.16.1. For the carriage of ethylene oxide the requirements of 17.20 apply, with the additions and modifications as given in this section.

17.16.2. Deck tanks should not be used for the carriage of ethylene oxide.

17.16.3. Stainless steels types 416 and 442 as well as cast iron should not be used in ethylene oxide cargo containment and piping systems.

17.16.4. 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.

17.16.5. Ethylene oxide should be discharged only by deepwell pumps or inert gas displacement. The arrangement of pumps should comply with 17.20.6.3.

17.16.6. Ethylene oxide should be carried refrigerated only and maintained at temperatures of less than 30°C.

17.16.7. Pressure relief valves should be set at a pressure of not less than 5.5 bar gauge. The maximum set pressure should be specially approved by the Administration.

17.16.8. The protective padding of nitrogen gas as required by 17.20.15 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.

17.16.9. Before loading and at all times when the cargo tank contains ethylene oxide liquid or vapour, the cargo tank should be inerted with nitrogen.

17.16.10. The water spray system required by paragraph 17.20.17 and that required by 11.3 should operate automatically in a fire involving the cargo containment system.

17.16.11. A jettisoning arrangement should be provided to allow the emergency discharge of ethylene oxide in the event of uncontrollable self-reaction.

17.17. *Isopropylamine and monoethylamine*

Separate piping systems should be provided as defined in 1.3.32.

17.18. *Methyl acetylene-propadiene mixtures*

17.18.1. Methyl acetylene-propadiene mixtures should be suitably stabilized for transport. Additionally, upper limits of temperature and pressure during the refrigeration should be specified for the mixtures.

17.18.2. Examples of acceptable, stabilized compositions are:

.1 Composition 1

.1.1 Maximum methyl acetylene to propadiene molar ratio of 3 to 1;

.1.2 Maximum combined concentration of methyl acetylene and propadiene of 65 mol per cent;

.1.3 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

.1.4 Maximum combined concentration of propylene and butadiene of 10 mol per cent.

.2 Composition 2

.2.1 Maximum methyl acetylene and propadiene combined concentration of 30 mol per cent;

.2.2 Maximum methyl acetylene concentration of 20 mol per cent;

.2.3 Maximum propadiene concentration of 20 mol per cent;

.2.4 Maximum propylene concentration of 45 mol per cent;

.2.5 Maximum butadiene and butylenes combined concentration of 2 mol per cent;

.2.6 Minimum saturated C_4 hydrocarbon concentration of 4 mol per cent; and

.2.7 Minimum propane concentration of 25 mol per cent.

17.18.3. Other compositions may be accepted provided the stability of the mixture is demonstrated to the satisfaction of the Administration.

17.18.4. A ship carrying methyl acetylene-propadiene mixtures should preferably have an indirect refrigeration system as specified in 7.2.4.2. 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 17.18.2, 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 17.5 bar 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:

.2.1 Two temperature-actuated shutdown switches set to operate at 60° C or less;

.2.2 A pressure-actuated shutdown switch set to operate at 17.5 bar gauge or less; and

.2.3 A safety relief valve set to relieve at 18.0 bar gauge or less.

.3 The relief valve required by 17.18.4.2.3 should vent to a mast meeting the requirements of 8.2.9, 8.2.10, 8.2.13 and 8.2.14 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.

17.18.5. 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 1.3.20) or separate (as defined in 1.3.32) 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.

17.19. *Nitrogen*

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.

17.20. *Propylene oxide and mixtures of ethylene oxide-propylene oxide with ethylene oxide content of not more than 30% by weight*

17.20.1. Products transported under the provisions of this section should be acetylene-free.

17.20.2.1. 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:

.1 Anhydrous ammonia and ammonia solutions;

.2 Amines and amine solutions;

.3 Oxidizing substances (e.g. chlorine).

17.20.2.2. 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.

17.20.2.3. 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.

17.20.2.4. 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.

17.20.2.5. Tanks for the carriage of these products should be of steel or stainless steel construction.

17.20.2.6. 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.

17.20.3.1. 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 or other material acceptable to the Administration. The chemical composition of all material used should be submitted to the Administration for approval prior to fabrication. Discs or disc faces, seats and other wearing parts of valves should be made of stainless steel containing not less than 11% chromium.

17.20.3.2. 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 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 by the Administration.

17.20.3.3. 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.

17.20.3.4. 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 Administration:

.1 Neoprene or natural 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.

17.20.4. Filling and discharge piping should extend to within 100 mm of the bottom of the tank or any sump pit.

17.20.5.1. 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.

17.20.5.2. During discharging operations, the pressure in the cargo tank should be maintained above 0.07 bar gauge.

17.20.5.3. 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.

17.20.6. 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.

17.20.7. Cargo hoses used for transfer of these products should be marked "FOR ALKYLENE OXIDE TRANSFER ONLY".

17.20.8. 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.

17.20.9. 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.

17.20.10. Tanks should be designed for the maximum pressure expected to be encountered during loading, carriage or unloading of cargo.

17.20.11. Tanks for the carriage of propylene oxide with a design vapour pressure of less than 0.6 bar and tanks for the carriage of ethylene oxide-propylene oxide mixtures with a design vapour pressure of less than 1.2 bar should have a cooling system to maintain the cargo below the reference temperature. For reference temperature see 15.1.4.1.

17.20.12. Pressure relief valve settings should not be less than 0.2 bar gauge and for type C independent cargo tanks not greater than 7.0 bar gauge for the carriage of propylene oxide and not greater than 5.3 bar gauge for the carriage of ethylene oxide-propylene oxide mixtures.

17.20.13.1. 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 the product is not independent as defined in 1.3.20 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.

17.20.13.2. The products should be transported only in accordance with cargo handling plans that have been approved by the Administration. 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.

17.20.13.3. Before loading the product, 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.

17.20.14. 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 Administration. A copy of the list should be permanently kept on board by the master.

17.20.15. 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 0.07 bar 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 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.

17.20.16. 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.

17.20.17. 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. 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.

17.21. *Vinyl chloride*

In cases where polymerization of vinyl chloride is prevented by addition of an inhibitor, 17.8 is applicable. In cases where no or insufficient inhibitor has been added, any inert gas used for the purposes of 17.6 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.

Chapter 18. OPERATING REQUIREMENTS

18.1. *Cargo information*

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 inner hull steel temperatures; and

.8 Emergency procedures.

18.1.2. Products required to be inhibited should be refused if the certificate required by 17.8 is not supplied.

18.1.3. A copy of this Code or national regulations incorporating the provisions of this Code should be on board every ship covered by this Code.

18.2. *Compatibility*

18.2.1. The master should ascertain that the quantity and character 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 provided for in 1.5 and in the Loading and Stability Information booklet provided for in 2.2.5 and that products are listed in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk if so required under section 3 of the Certificate.

18.2.2. 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 1.3.32.

18.3. *Personnel training**

18.3.1. Personnel involved in cargo operations should be adequately trained in handling procedures.

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* Reference is made to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978,[1] and in particular to the "Mandatory minimum requirements for the training and qualifications of masters, officers and ratings of liquefied gas tankers"—regulation V/3, chapter V of the Annex to that Convention and to resolution 12 of the International Conference on Training and Certification of Seafarers, 1978.

[1] United Nations, *Treaty Series*, vol. 1361, p. 2 (authentic Chinese and English texts), and vol. 1362, p. 2 (authentic French, Russian and Spanish texts).

18.3.2. 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.

18.3.3. 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 the cargoes carried.

18.4. *Entry into spaces*

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.

18.4.2. 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.

18.4.3.1. 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 de-absorbing characteristics of the insulation material should be taken into account.

18.4.3.2. For internal insulation tanks, repairs should be carried out in accordance with the procedures provided for in paragraph 4.4.7.6.

18.5. *Carriage of cargo at low temperature*

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 material 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.

18.6. *Protective equipment*

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 14.1 during cargo handling.

18.7. *Systems and controls*

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.

18.8. *Cargo transfer operations*

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.

18.8.2. The closing time of the valve referred to in 13.3.1 (i.e. time from shutdown signal initiation to complete valve closure) should not be greater than:

$$\frac{3600\,U}{LR} \quad (s)$$

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 relevant.

18.9. *Additional operating requirements*

Additional operating requirements will be found in the following paragraphs of the Code: 3.8.4, 3.8.5, 7.1.1.5, 8.2.5, 8.2.7, 9.4.2, 12.1.1, 12.1.10, 13.1.4, 14.2.5, 14.2.6, 14.3.1, 15.1, 15.2, 16.2.2, 17.4.2, 17.6, 17.7, 17.12, 17.13, 17.14, 17.15, 17.16, 17.17, 17.18, 17.20.

Chapter 19. SUMMARY OF MINIMUM REQUIREMENTS

Explanatory notes to the summary of minimum requirements

UN Numbers	The UN numbers as listed in the table of chapter 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 13.2.2.1 and .2
	C: Indirect, or closed, as described in 13.2.2.1, .2 and .3
	R: Indirect, closed or restricted, as described in 13.2.2.1, .2, .3 and .4
Refrigerant gases	Non-toxic and non-flammable gases such as:
	Dichlorodifluoromethane (1028)
	Dichloromonofluoromethane (1029)
	Dichlorotetrafluoroethane (1958)
	Monochlorodifluoromethane (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.

a Product name	b UN number	c Ship type	d Independent tank type C required	e Control of vapour space within cargo tanks	f Vapour detection	g Gauging	h Special requirements
Acetaldehyde	1089	2G/2PG	–	Inert	F + T	C	14.4.3, 14.4.4, 17.4.1, 17.6.1
Ammonia, anhydrous	1005	2G/2PG	–	–	T	C	14.4.2, 14.4.3, 14.4.4, 17.2.1, 17.13
Butadiene	1010	2G/2PG	–	–	F	R	17.2.2, 17.4.2, 17.4.3, 17.6, 17.8
Butane	1011	2G/2PG	–	–	F	R	
Butane-propane mixtures	1011/1978	2G/2PG	–	–	F	R	
Butylenes	1012	2G/2PG	–	–	F	R	
Chlorine	1017	1G	Yes	Dry	T	I	14.4, 17.3.2, 17.4.1, 17.5, 17.7, 17.9, 17.14
Diethyl ether*	1155	2G/2PG	–	Inert	F + T	C	14.4.2, 14.4.3, 17.2.6, 17.3.1, 17.6.1, 17.10, 17.11, 17.15
Dimethylamine	1032	2G/2PG	–	–	F + T	C	14.4.2, 14.4.3, 14.4.4, 17.2.1
Ethane	1961	2G	–	–	F	R	
Ethyl chloride	1037	2G/2PG	–	–	F + T	R	
Ethylene	1038	2G	–	–	F	R	
Ethylene oxide	1040	1G	Yes	Inert	F + T	C	14.4.2, 14.4.3, 14.4.4, 14.4.6, 17.2.2, 17.3.2, 17.4.1, 17.5, 17.6.1, 17.16
Ethylene oxide-propylene oxide mixtures with ethylene oxide content of not more than 30% by weight	2983	2G/2PG	–	Inert	F + T	C	14.4.3, 17.3.1, 17.4.1, 17.6.1, 17.10, 17.11, 17.20
Isoprene*	1218	2G/2PG	–	–	F	R	14.4.3, 17.8, 17.10, 17.12
Isopropylamine*	1221	2G/2PG	–	–	F + T	C	14.4.2, 14.4.3, 17.2.4, 17.10, 17.11, 17.12, 17.17
Methane (LNG)	1972	2G	–	–	F	C	
Methyl acetylene-propadiene mixtures	1060	2G/2PG	–	–	F	R	17.18
Methyl bromide	1062	1G	Yes	–	F + T	C	14.4, 17.2.3, 17.3.2, 17.4.1, 17.5, 17.9
Methyl chloride	1063	2G/2PG	–	–	F + T	C	17.2.3
Monoethylamine*	1036	2G/2PG	–	–	F + T	C	14.4.2, 14.4.3, 14.4.4, 17.2.1, 17.3.1, 17.10, 17.11, 17.12, 17.17

a Product name	*b* UN number	*c* Ship type	*d* Independent tank type C required	*e* Control of vapour space within cargo tanks	*f* Vapour detection	*g* Gauging	*h* Special requirements
Nitrogen	2040	3G	–	–	O	C	17.19
Propane	1978	2G/2PG	–	–	F	R	
Propylene	1077	2G/2PG	–	–	F	R	
Propylene oxide*	1280	2G/2PG	–	Inert	F + T	C	14.4.3, 17.3.1, 17.4.1, 17.6.1, 17.10, 17.11, 17.20
Refrigerant gases (see notes)	–	3G	–	–	–	R	
Sulphur dioxide	1079	1G	Yes	Dry	T	C	14.4, 17.3.2, 17.4.1, 17.5, 17.7, 17.9
Vinyl chloride	1086	2G/2PG	–	–	F + T	C	14.4.2, 14.4.3, 17.2.2, 17.2.3, 17.3.1, 17.6, 17.21
Vinyl ethyl ether*	1302	2G/2PG	–	Inert	F + T	C	14.4.2, 14.4.3, 17.2.2, 17.3.1, 17.6.1, 17.8, 17.10, 17.11, 17.15
Vinylidene chloride*	1303	2G/2PG	–	Inert	F + T	R	14.4.2, 14.4.3, 17.2.5, 17.6.1, 17.8, 17.10, 17.11

* This cargo is covered also by the IBC Code.

APPENDIX. MODEL FORM OF INTERNATIONAL CERTIFICATE OF FITNESS FOR THE CARRIAGE OF LIQUEFIED GASES IN BULK

INTERNATIONAL CERTIFICATE OF FITNESS FOR THE CARRIAGE OF LIQUEFIED GASES IN BULK

(OFFICIAL SEAL)

ISSUED UNDER THE PROVISIONS OF THE

INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK

(resolution MSC.5(48))

under the authority of the Government of .....
(full official designation of country)

by .....
(full official designation of the competent person or organization authorized by the Administration)

Name of ship	*Distinctive number or letters*	*Port of registry*	*Cargo capacity (m^3)*	*Ship type (section 2.1 of the Code)*[1]

Date on which keel was laid or on which the ship was at a similar stage of construction or (in the case of a converted ship) date on which conversion to a gas carrier was commenced:

.....

The ship also complies fully with the following amendments to the Code: .....

The ship is exempted from compliance with the following provisions of the Code: .....

This is to certify:

1. .1 That the ship has been surveyed in accordance with the provisions of section 1.5 of the Code;

   .2 That the survey showed that the structure, equipment, fittings, arrangements and materials of the ship and the conditions thereof are in all respects satisfactory and that the ship complies with the relevant provisions of the Code.

[1] The Certificate should be drawn up in the official language of the issuing country. If the language used is neither English nor French, the text should include a translation into one of these languages.

2. That the following design criteria have been used:

.1 Ambient air temperature ..... °C[2]

.2 Ambient water temperature ..... °C[2]

.3

Tank type and number	*Stress factors*[3]				*Materials*[3]	*MARVS*
	A	*B*	*C*	*D*		
Cargo piping						

N.B. Tank numbers referred to in this list are identified on attachment 2, signed and dated tank plan.

.4 Mechanical properties of the cargo tank material were determined at .....°C[4]. .....

3. That the ship is suitable for the carriage in bulk of the following products, provided that all relevant operational provisions of the Code are observed:[5]

Products	*Conditions of carriage (tank numbers, etc.)*

Continued on attachment 1, additional signed and dated sheets.
Tank numbers referred to in this list are identified on attachment 2, signed and dated tank plan.

4. That in accordance with sections 1.4/2.8.2* the provisions of the Code are modified in respect of the ship in the following manner:

* Delete as appropriate.

5. That the ship must be loaded:

*.1 In accordance with the loading conditions provided in the approved loading manual, stamped and dated ..... and signed by a responsible officer of the Administration, or of an organization recognized by the Administration;

*.2 In accordance with the loading limitations appended to this Certificate.

Where it is required to load the ship other than in accordance with the above instruction, then the necessary calculations to justify the proposed loading conditions should be communicated to the certifying Administration who may authorize in writing the adoption of the proposed loading condition.**

This Certificate is valid until .....

Issued at .....
(place of issue of Certificate)

..... 19 ....
(date of issue) *(signature of authorized official issuing the Certificate)*

(seal or stamp of issuing Authority, as appropriate)

Notes on completion of certificate:

(1) "Ship type": Any entry under this column must be related to all relevant recommendations, e.g. an entry "type 2G" should mean type 2G in all respects prescribed by the Code.

(2) Paragraphs 2.1 and 2.2: The ambient temperatures accepted or required by the Administration for the purposes of 4.8.1 of the Code to be inserted.

(3) Paragraph 2.3: Stress factors and materials as accepted or required by the Administration for the purposes of 4.5.1.4 and 4.5.1.6 of the Code to be inserted.

(4) Paragraph 2.4: Temperature accepted by the Administration for the purposes of 4.5.1.7 to be inserted.

(5) Paragraph 3: Only products listed in chapter 19 of the Code or which have been evaluated by the Administration in accordance with paragraph 1.1.6 of the Code should be listed. In respect of the latter "new" products, any special requirements provisionally prescribed should be noted.

ENDORSEMENT FOR MANDATORY ANNUAL SURVEYS

This is to certify that at a mandatory annual survey required by 1.5.2.1.4 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, the ship was found to comply with the relevant provisions of the Code.

Signed: .....
(signature of authorized official)

Place: .....

Date: .....

(seal or stamp of the Authority, as appropriate)

* Delete as appropriate.

** Instead of being incorporated in the Certificate, this text may be appended to the Certificate if duly signed and stamped.

Signed: .....
(*signature of authorized official*)

Place: .....

Date: .....

(seal or stamp of the Authority, as appropriate)

Signed: .....
(*signature of authorized official*)

Place: .....

Date: .....

(seal or stamp of the Authority, as appropriate)

Signed: .....
(*signature of authorized official*)

Place: .....

Date: .....

(seal or stamp of the Authority, as appropriate)

NOTE: An intermediate survey may take the place of a mandatory annual survey where the relevant provisions of 1.5.2.1.3 and 1.5.2.1.4 are complied with.

ENDORSEMENT FOR MANDATORY ANNUAL SURVEYS

This is to certify that at an intermediate survey required by 1.5.2.1.3 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, the ship was found to comply with the relevant provisions of the Code.

Signed: .....
(*signature of authorized official*)

Place: .....

Date: .....

(seal or stamp of the Authority, as appropriate)

Signed: .....
(*signature of authorized official*)

Place: .....

Date: .....

(seal or stamp of the Authority, as appropriate)

Attachment 1 to the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk

Continued list of products to those specified in section 3, and their conditions of carriage

Products	*Conditions of carriage (tank numbers, etc.)*

Date .....
(*as for certificate*)

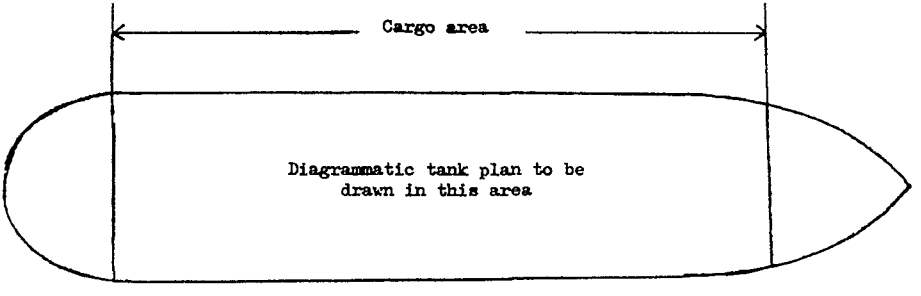
.....
(*signature of official issuing the certificate and/or seal or issuing authority*)

Attachment 2 to the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk

TANK PLAN (SPECIMEN)

Name of ship: .....

Distinctive number or letters: .....



Date ....

(as for certificate) *(signature of official issuing the certificate and/or seal or issuing authority)*

Authentic texts of the Amendments: Chinese, English, French, Russian and Spanish.

Certified statement was registered by the International Maritime Organization on 17 July 1986.

(For the authentic Chinese text, see this volume. For the authentic French and Russian texts, see volume 1432. For the authentic Spanish text, see volume 1433.)