RULES FOR BUILDING AND CLASSING

STEEL VESSELS 2004

PART 5
SPECIFIC VESSEL TYPES (CHAPTERS 7-10)

American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862

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Rule Change Notice *(2004)*

The effective date of each technical change since 1993 is shown in parenthesis at the end of the subsection/paragraph titles within the text of each Part. Unless a particular date and month are shown, the years in parentheses refer to the following effective dates:

(2000) and after	1 January 2000 (and subsequent years)	*(1996)*	9 May 1996
(1999)	12 May 1999	*(1995)*	15 May 1995
(1998)	13 May 1998	*(1994)*	9 May 1994
(1997)	19 May 1997	*(1993)*	11 May 1993

Listing by Effective Dates of Changes from the 2003 Rules

Notice No. 3 to the 2003 Rules (effective on 1 July 2003), which is incorporated in the 2004 Rules, is summarized below.

EFFECTIVE DATE 1 July 2003
(based on the contract date for construction between builder and Owner)

Part/Para. No.	*Title/Subject*	*Status/Remarks*
5-8-3/7.2	<No title>	To align the Rules with amendments to the International Code for the Construction and Equipment of Ships Carrying Liquefied Gasses in Bulk (IGC Code), per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-3/7.4	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-4/8.3	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-4/10.10	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-5/6.5	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-5/7.3	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-8/2.7	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-9/5.3	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-11/2.4	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-13/3.1	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-14/3.2	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-18/3.3	<No title>	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)
5-8-18/8.9	Additional Operating Requirements	To align the Rules with amendments to the IGC Code, per IMO Res. MSC.103 (73). (Incorporates Notice No. 3)

Part/Para. No.	*Title/Subject*	*Status/Remarks*
5-9-5/7.3	<No title>	To align the Rules with amendments to the International Code for the Construction and Equipment of Ships Carrying Chemical Cargoes in Bulk (IBC Code), per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-8/1.1	<No title>	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-8/1.6	<No title>	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-8/3.2	<No title>	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-8/3.3 (New)	<No title>	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-8/3.5	<No title>	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-14/2.9	<No title>	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-15/3	Carbon Disulphide	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-16/3.3	<No title>	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)
5-9-16/7	Additional Operational Requirements	To align the Rules with amendments to the IBC Code, per IMO Res. MSC.102 (73). (Incorporates Notice No. 3)

EFFECTIVE DATE 1 January 2004

(based on the contract date for construction between builder and Owner)

Part/Para. No.	*Title/Subject*	*Status/Remarks*
5-8-3/7.5 (New)	<No title>	To provide a cross-reference to the new Subsection 5-8-10/3.
5-8-10/3 (New)	Integrated Cargo and Ballast Systems	To incorporate IACS UR M64, requiring independence for emergency shutdowns for control circuits of integrated cargo and ballast systems.
5-9-3/5.4 (New)	<No title>	To provide a cross-reference to the new Subsection 5-9-10/5.
5-9-10/5 (New)	Integrated Cargo and Ballast Systems	To incorporate IACS UR M64, requiring independence for emergency shutdowns for control circuits of integrated cargo and ballast systems.

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PART

5

Specific Vessel Types

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PART 5

CHAPTER 7 Vessels Intended to Carry Passengers

This Chapter is superseded by the separately published ABS *Guide for Building and Classing Passenger Vessels*, 2001. This Guide may be viewed and downloaded from the ABS website "www.eagle.org/rules/downloads.html".

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PART

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

CONTENTS

Note: Text in italics comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3.

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PART

5

CHAPTER 8 Vessels Intended to Carry Liquefied Gases in Bulk

SECTION 1 General (ABS)

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training or national requirements are shown in *Arial Italic*.

1 Classification

1.1 Liquefied Gas Carriers

1.1.1

In accordance with 1-1-3/3, the classification of ✠ **A1 Liquefied Gas Carrier** is to be assigned to vessels designed and specifically fitted for the carriage of liquefied gases and built to the requirements of this Chapter and other relevant sections of the Rules.

1.1.2

These requirements are intended to apply to steel vessels with machinery aft, regardless of their size, including those of less than 500 tons gross tonnage engaged in carriage of liquefied gases having a vapor pressure exceeding 2.8 bar (2.855 kgf/cm^2, 40.61 lbf/in^2) absolute at a temperature of 37.8°C (100°F) and other products, as shown in Section 5-8-19, when carried in bulk.

The requirements relating to the primary container apply only where non-corrosive cargoes are carried. If ballast or corrosive cargoes are carried in the primary container, the scantlings are to be suitably increased or an effective method of corrosion control is to be adopted.

This Chapter applies to the cargo containment system and related systems. The remainder of the vessel is to comply with the hull and machinery requirements of the Rules, except as modified in this Section.

3 Format

This Chapter is based on the technical requirements of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), which are all contained in their entirety and are required for classification.

The term "should be" is to be understood to read as "is to be" or "are to be" and unless otherwise specified, the term "Administration" is to be read as the "Bureau". The numbering system of the technical requirements reproduced herein follow the numbering contained in the IGC Code, except the prefix of the numbering has been modified to reflect Part 5, Chapter 8.

The parts in this Chapter which are classification requirements and not based on the Codes are presented in non-italics "Times New Roman" type style, etc. Under these parts are also interpretations of the Codes with their source such as IMO (International Maritime Organization), IACS (International Association of Classification Societies), etc. and additional Bureau requirements.

The parts of this Chapter which are operational, training or national requirements are presented in italic "Arial" type style, i.e., *operational, training or national requirements*, and are not required for classification, and are shown for information only.

The text contained in this Chapter that comes from the IGC Code is presented in italics "Times New Roman" type style.

5 Submission of Data

The following plans, calculations and information, as appropriate, are to be submitted in addition to those required by Section 1-1-7.

i) Full particulars of the intended cargo or cargoes and its properties, including flashpoint, maximum vapor pressure, minimum and, if necessary, maximum temperature, and loading and carriage procedures.

ii) General arrangement plans of the vessel showing the position of the following:

Cargo containment system, cargo tanks, fuel oil, water ballast and other tanks, and void spaces

Manholes in cargo tanks, opening for tank cleaning, any other opening of the cargo tanks.

Doors and other openings in cargo pump and compressor rooms and other gas dangerous rooms

Ventilation ducts of cargo pump and compressor rooms and other "gas dangerous" spaces

Door, air-locks, manholes, ducts and other openings for "non-gas dangerous" spaces which are, however, adjacent to the cargo area, including rooms inside and under the forecastle deck

Cargo piping, both liquid and gaseous phases, located under and above deck

Vent piping and gas freeing piping and protective devices, such as flame screens, etc., fitted at the outlet end of the vents etc.

Gas dangerous spaces

iii) Plans of the hull structure in way of the cargo tanks, including the installation of attachments, accessories, internal reinforcements, saddles for support and tie-down devices.

iv) Plans of the structure of the cargo containment system, including the installation of attachments, supports and attachment of accessories

For independent pressure cargo tanks, the standard or Code adopted for the construction and design is to be identified. Detailed construction drawings together with design calculations for the pressure boundary, tank support arrangement and analysis for the load distribution. Anti collision, chocking arrangement and design calculations.

v) Distribution of the grades and types of steel proposed for the structures of the hull and of the cargo containment system, including attachments, accessories, etc., together with the calculation of the temperatures on all of the structures which can be affected by the low temperatures of the cargo *vi)* Results of direct calculations of the stresses in the hull and in the cargo containment system

vii) Specifications and plans of the insulation system and calculation of the heat balance

viii) Procedures and calculations of the cooling down, loading and unloading operations

ix) Loading and unloading systems, venting systems, and gas-freeing systems, as well as a schematic diagram of the remote controlled valve system

x) Details and installation of the safety valves and relevant calculations of their relieving capacity

xi) Details and installation of the various monitoring and control systems, including the devices for measuring the level of the cargoes in the tanks and the temperatures in the containment system

xii) Schematic diagram of the ventilation system indicating the vent pipe sizes and height of the openings above the main deck

xiii) Schematic diagram of the refrigeration system together with the calculations concerning the refrigerating capacity

xiv) Details of the electrical equipment installed in the cargo area and of the electrical bonding of the cargo tanks and piping

xv) Where fitted, plans and specifications relative to the use of the cargo as fuel for boilers and internal combustion engines (general installations; schematic diagram of the fuel-gas lines with the indication of all of the valves and safety devices; compressors of the fuel gas and relevant engines; fuel-gas heaters and pressure vessels; installation of the burners of the fuel-gas and of the fuel oil; electrical bonding systems)

xvi) Details of testing procedures of cargo tanks and liquid and vapor systems

xvii) Diagram of inert-gas system or hold-space environmental-control system

xviii) Diagram of gas-detection system

xix) Jettison arrangements, if provided

xx) Schematic-wiring diagrams

xxi) Details of all cargo and vapor handling equipment

xxii) Details of fire extinguishing systems

xxiii) Welding procedure

xxiv) Emergency shutdown arrangements

xxv) Construction details of cargo and booster pumps and compressors including material specification.

xxvi) Hazardous area drawing showing access, openings, vent outlets.

xxvii) Bilge and ballast arrangement for the cargo area.

xxviii) Emergency Towing Arrangement.

7 Still-water Bending-moment Calculations

Still-water bending-moment calculations for the anticipated loaded and ballasted conditions are to be submitted for all liquefied gas carriers.

9 Loading Guidance

Loading guidance is to be as required by 3-2-1/7.

11 Hull Scantlings

The scantlings of the hull structure are to be generally in accordance with Part 5, Chapter 2 and Part 5, Chapter 4, and other applicable sections of the Rules, which may be modified in accordance with the following paragraphs.

11.1 Bulkheads

11.1.1 Transverse Bulkheads

Transverse bulkheads used for ballast or cargo are to comply with Part 5, Chapter 2. Bulkheads not subject to hydrostatic loads are to be in accordance with Section 3-2-9.

11.1.2 Cofferdam Bulkheads

Where a transverse cofferdam is used as a tank, the local stiffener and plate scantlings of transverse bulkheads subject to internal hydrostatic pressure are to be in accordance with Section 3-2-10.

Where a cofferdam is of a cellular-type construction and is used as a tank and not subject to a hydrostatic load on external side, the depth of the internal diaphragm plates, either horizontal or vertical, are to be at least 63 mm/m (0.75 in/ft) of the lesser of the horizontal or vertical unsupported span of the cofferdam bulkhead and is to be of sufficient depth to provide ready access.

11.1.3 Longitudinal Bulkheads

Scantlings of longitudinal bulkheads forming narrow wing tanks are to be in accordance with Part 5, Chapter 2, except that the vertical distance h as used in the equations for supporting members may be measured to a point 1.22 m (4 ft) above the deck at the side. Where the wing-tank-space bulkhead to side-shell plating is of a cellular-type construction, the depth of internal diaphragm plates is to be at least 83 mm/m (1 in/ft) of length and is to be of sufficient depth to provide ready access.

11.1.4 Dynamic Forces from the Cargo

When the cargo containment system is either a membrane or semi-membrane system, the transverse bulkheads are also to be designed to withstand the dynamic forces from the cargo.

The scantlings of the bulkheads are to be not less than as modified below:

The value of h used in the various equations is to be as derived from 5-8-4/3.2.

The plating is to be determined from Section 3-2-10.

Each of the stiffeners in association with the plate to which it is attached is not to have a section modulus less than required by 5-8-4/5.1.3(c).

11.3 Reduction in Plate Thickness

The thickness of the tank bulkhead plating described in 5-8-1/11.1.2 and 5-8-1/11.1.3 may be reduced by 10%, but not more than 1.5 mm (0.06 in.) where the space on one side is intended to be dry at all times.

11.5 Thickness of Double Side Transverses

The thickness of double side transverses in wing tanks or cofferdams of a cellular-type construction is to be equal to or greater than obtained from the following equation:

$t = 0.036L + 4.7$ mm

$t = 0.00043L + 0.18$ in.

t = thickness, in mm (in.)

L = length of vessel, as defined in 3-1-1/3.1, in m (ft)

11.7 Double Bottom

Double bottoms, where fitted, are to be in accordance with Section 3-2-4 . The minimum depth of the double bottom is to be in compliance with the survivability requirements of Section 5-8-2. Double bottoms are to be designed to withstand the dynamic forces from the cargo containment system.

11.9 Shell Plating

The bottom and side shell plating is to be in accordance with Section 3-2-2.

11.11 Deck Plating

Upper decks are to be in accordance with Section 3-2-3. Where the deck is of the two-plate cellular-type construction, special consideration may be given to plate thickness.

11.13 Arrangement

Tanks forward of the collision bulkhead are not to be arranged for the carriage of oil or other liquid substances that are flammable.

11.15 Hull Structure in Way of Tanks

The hull structure in way of primary containers, the foundations, chocks, keys and sway braces is to be of sufficient strength to support the containment system when subjected to design loadings.

11.17 Steering Gear

The steering gear is to be in accordance with Section 4-3-4 with the modification that the steering gear is to be arranged so that after a single failure in its piping system or one of the power units, the defect can be isolated so that this steering capability can be maintained or regained in 45 seconds or less.

13 Access *(1998)*

Satisfactory arrangements are to be provided to safeguard the crew in reaching all parts used in the necessary work of the ship. See Section 3-2-17/3.

15 Changes to Codes

Changes to IGC/IBC Codes, other than those of operational nature, will become ABS Rule requirements as of the effective date of the particular change to the Code.

17 Special Construction Requirements

17.1 Material

In addition to the material requirements indicated in Section 5-8-6, hull structural material is to be in accordance with Section 3-1-2 and Part 2, Chapter 1 and Part 2, Chapter 2.

17.3 Low Temperature Cargo

For all liquefied gas carriers where low temperature cargo is carried, the grade of material for the strength deck stringer, sheer strake and bilge strake outside 0.4*L* amidships is to be the same as would be required within 0.4*L* amidships for that particular thickness. The strakes of this material are to extend beyond the ends of spaces containing low temperature cargo.

17.5 Cold Deformation

Materials subjected to cold deformation or strain are to be dealt with as may be required to maintain the specific impact properties. For formed material, see 2-4-1/3.13.

17.7 Welding

Welding details are to be in accordance with Part 2, Chapter 4. Details of all joints subject to impact testing are to be indicated on the plans; preliminary tests are to be made to ascertain that the Charpy V-notch impact properties of the various types of butt welds to be used are equal to the requirements noted in Section 5-8-6.

19 Service Test

All primary containers for low-temperature cargoes, the insulation and the cargo-handling equipment are to be tested under service conditions prior to final action in regard to classification. The primary containers are to be filled to the normal-capacity level with cargo at the minimum service temperature.

Final acceptance of the insulating arrangements is subject to confirmation of their effectiveness under operating conditions. If the service tests or subsequent operation are not satisfactory, changes in the insulating arrangements may be required.

21 Test Agenda

The agenda for the tests required by this section is to be submitted for review. The tests are to be witnessed by a Surveyor and a complete report of the results is to be submitted for consideration prior to final approval of the primary container, non-structural secondary barrier and the adjacent hull structure. In addition, for hydrostatic testing of pressure vessel type cargo tanks, see 4-4-1/7.11.

23 Installation of Cargo Tanks

23.1 Access around Tanks

Pressure containers for liquefied gas are to be arranged in the holds so as to provide adequate clearance around the tanks to provide access for inspection. Where more than one tank is installed, the distance between such tanks and between the tanks and the vessel's structure is to be adequate to permit access for inspection and maintenance of all tank surfaces and hull structure. Also see 5-8-3/5.

23.3 Horizontal Pressure Tanks

Foundations for horizontal tanks are to generally have supports fitted at only two locations so as to prevent absorbing hull deflections. Where due to the design three or more supports are fitted, the calculations required by 5-8-4/4.6.3.2 are to include the effects of vertical deflections imposed upon the tank through the tank/hull girder interaction for all contemplated loading conditions. In addition to the foundation, chocks are to be fitted to prevent shifting, but these chocks need not be in contact with the tank shell.

25 Surveys

See Sections 7-3-2 and 7-6-2 for survey requirements for vessels in service intended to carry liquefied gases.

27 Initial Testing

27.1 Primary Barriers

All integral and independent tanks (other than pressure vessels complying with Part 4, Chapter 4) are to be hydropneumatically or hydrostatically tested to approximate the design stresses and so that the pressure at the top of the tank corresponds to the maximum allowable relief valve setting (MARVS). Techniques for testing of membrane tanks are to be submitted for approval. Also see Section 3-7-1.

27.3 Ballast or Fuel Oil Tanks

Requirements for testing are contained in Section 3-7-1.

29 International Certificate of Fitness

When the vessel is issued an International Certificate of Fitness for The Carriage of Liquefied Gases In Bulk by the Country of Registration Administration or its agents other than the Bureau, such certificate will be accepted as evidence of compliance with the following requirements of this section.

5-8-2/2	Freeboard and intact stability
5-8-2/5	Damage assumptions
5-8-2/7	Flooding assumptions
5-8-2/8	Standard of damage
5-8-2/9	Survival requirements
5-8-11/1	Structural fire protection requirements

On all other vessels, the Bureau will review the data and plans for compliance with these requirements.

When authorized by the Country of Registration Administration and upon the request of the Owners of a classed vessel or one intended to be classed, the Bureau will review the plans, data, etc. and survey the vessel for compliance of these Rules and issue The International Certificate of Fitness For The Carriage of Liquefied Gases in Bulk in addition to the classification indicated in 5-8-1/1.

1 Application

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 (140°F), closed cup test, or less nor flammable products listed in Section 5-8-19 should be carried in tanks located within the protective zones described in 5-8-2/6.1.1.

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 5-8-2/6.1.2.

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.

1.4.4

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/PG ship is solely used for cooling, circulation or fuelling purposes.

1.5

Except as provided in 5-8-1/1.7.1, 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.

1.6

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 Section 5-8-19, the Administration 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.*

**"Administration" means "Flag State Administration"*

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:

1.7.1.1 those listed exclusively in Section 5-8-19 of this Code; and

1.7.1.2 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 Section 5-8-19.

1.7.2

When a ship is intended exclusively to carry one or more of the products noted in 5-8-1/1.7.1.2, the requirements of the International Bulk Chemical Code as amended should apply. "Administration" means "Flag State Administration."

2 Hazards

Hazards of gases considered in this Code include fire, toxicity, corrosivity, reactivity, low temperature and pressure.

3 Definitions

Except where expressly provided otherwise, the following definitions apply to the Code. Additional definitions are given in Section 5-8-4.

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.

3.2

" 'A' class divisions" means divisions as defined in regulation II-2/3.3 of the 1983 SOLAS amendments.

3.3.1

"Administration" means the Government of the State whose flag the ship is entitled to fly.

For the purpose of classification the term "Administration", unless otherwise specified, is to be read as the "Bureau". See 5-8-1/3.

3.3.2

"Port Administration" means the appropriate authority of the country in the port of which the ship is loading or unloading.

3.4

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

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 meters.

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.

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.

3.8

"Cargo control room" is a space used in the control of cargo handling operations and complying with the requirements of 5-8-3/4.

3.9

"Cargoes" are products listed in Section 5-8-19 carried in bulk by ships subject to the Code.

3.10

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

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.

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.

3.12 (ABS)

"Contiguous hull structure" means hull structure that includes the inner deck, the inner bottom plating, longitudinal bulkhead plating, transverse bulkhead plating, floors, webs, stringers, and all attached stiffeners.

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.

3.13.1 (ABS)

"Design temperature." see 5-8-4/2.7

3.13.2 (ABS)

"Design vapor pressure." see 5-8-4/2.6

3.14

"Flammable products" are those identified by an "F" in column "f" in the table of Section 5-8-19.

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.

3.15 (ABS)

"Flammable range" means the range between the minimum and maximum concentrations of vapor in air which form a flammable mixture.

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 Section 5-8-19.

3.17

"Gas-dangerous space or zone" is:

3.17.1

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;

3.17.2

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 vapor into the atmosphere of that space;

3.17.3

a cargo containment system and cargo piping;

3.17.4.1

a hold space where cargo is carried in a cargo containment system requiring a secondary barrier;

3.17.4.2

a hold space where cargo is carried in a cargo containment system not requiring a secondary barrier;

3.17.5

a space separated from a hold space described in 5-8-1/3.17.4.1 by a single gastight steel boundary;

3.17.6

a cargo pump room and cargo compressor room;

3.17.7

a zone on the open deck, or semi-enclosed space on the open deck, within 3 m of any cargo tank outlet, gas or vapor outlet, cargo pipe flange or cargo valve or of entrances and ventilation openings to cargo pump rooms and cargo compressor rooms;

3.17.8

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;

3.17.9

a zone within 2.4 m of the outer surface of a cargo containment system where such surface is exposed to the weather;

3.17.10

an enclosed or semi-enclosed space in which pipes containing products are located. A space which contains gas detection equipment complying with 5-8-13/6.5 and a space utilizing boil-off gas as fuel and complying with Section 5-8-16 are not considered gas-dangerous spaces in this context;

3.17.11

a compartment for cargo hoses; or

3.17.12

an enclosed or semi-enclosed space having a direct opening into any gas-dangerous space or zone.

3.18

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

3.19

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

3.19 (ABS)

"IMO" means the International Maritime Organization

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.

3.20.1 (ABS)

"Independent tank." see 5-8-4/2.4.1

3.20.2 (ABS)

"Independent tank, type A." see 5-8-4/2.4.2

3.20.3 (ABS)

"Independent tank, type B." see 5-8-4/2.4.3

3.20.4 (ABS)

"Independent tank, type C." see 5-8-4/2.4.4

3.20.5 (ABS)

"International Certificate of Fitness" means an International Certificate of Fitness for Carriage of Liquefied Gases in Bulk issued under the "International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk," adopted by the Maritime Safety Committee of IMO.

3.21

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

3.21.1 (ABS)

"Integral tank." see 5-8-4/2.1

3.21.2 (ABS)

"Internal insulation tanks" see 5-8-4/2.5

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.

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 meters.

3.23 (ABS)

"Liquefied gas" means a cargo having a vapor pressure of 2.8 bars (2.855 kgf/cm^2, 40.61 lbf/in^2) absolute or more at 37.8°C (100°F).

3.24

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

3.24.1

internal combustion machinery used for main propulsion; or

3.24.2

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

3.24.3

any oil-fired boiler or oil fuel unit.

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.

3.26

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

3.26 (ABS)

"Membrane tanks." see 5-8-4/2.2

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.

3.28

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

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.

3.30.1

"Primary barrier" is the inner element designed to contain the cargo when the cargo containment system includes two boundaries.

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 Section 5-8-4.

3.30 (ABS)

"Process pressure vessel" means a pressure vessel that is used in a reliquefaction, cargo heating or other system that processes cargo onboard.

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.

3.31 (ABS)

"Semi-membrane tank" see 5-8-4/2.3.

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:

3.32.1

removing spool pieces or valves and blanking the pipe ends;

3.32.2

arrangement of two spectacle flanges in series with provisions for detecting leakage into the pipe between the two spectacle flanges.

3.33

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

3.33 Interpretation of 5-8-1/3.33 (ABS)

The "service spaces" refer to normal stores for hotel services and other similar spaces. Boatswain stores, lamp lockers and carpenter shops would not be considered a "service space".

3.33.1 (ABS)

"Shut-off valve" means a valve in a cargo liquid or vapor line that fully closes a pipeline and provides nominal metal to metal contact between the valve operating parts, including the disc and gate, and the valve body.

3.34

"1974 SOLAS Convention" means the International Convention for the Safety of Life at Sea, 1974.

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).

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.

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.

3.38

"Toxic products" are those identified by a "T" in column "f" in the table of Section 5-8-19.

3.39

"Vapor pressure" is the equilibrium pressure of the saturated vapor above the liquid expressed in bars absolute at a specified temperature.

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.

4 Equivalents

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.

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.

5 Surveys and certification

5.1 Survey procedure

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.

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:

5.1.2.1 require repairs to a ship; and

5.1.2.2 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.

**Port State authority has the meaning as presented in chapter I, regulation 19 of the 1978 Protocol to the 1974 SOLAS Convention.*

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.*

5.2 Survey requirements

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:

5.2.1.1 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.

5.2.1.2 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.

5.2.1.3 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.

5.2.1.4 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.

5.2.1.5 An additional survey, either general or partial according to the circumstances, should be made when required after an investigation prescribed in 5-8-1/5.3.3, 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.

5.3 Maintenance of conditions after survey

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.

5.3.2

After any survey of the ship under 5-8-1/5.2 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.

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 5-8-1/5.2.1.5 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.

5.4 Issue of certificate

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.

5.4.2

The certificate issued under the provisions of this section should be available on board for inspection at all times.

5.4.3

When a ship is designed and constructed under the provisions of 5-8-1/1.5, International Certificates of Fitness should be issued in accordance with the requirements of this section and with the requirements of the International Bulk Chemical Code (5-9-1/5).

5.5 Issue or endorsement of certificate by another Government

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.

5.6 Duration and validity of the certificate

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.

5.6.2

No extension of the 5-year period of the certificate should be permitted.

5.6.3

The certificate should cease to be valid:

5.6.3.1 if the surveys are not carried out within the period specified by 5-8-1/5.2;

5.6.3.2 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 5-8-1/5.3.1 and 5-8-1/5.3.2. 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.

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PART

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CHAPTER 8 Vessels Intended to Carry Liquefied Gases in Bulk

SECTION 2 Ship Survival Capability and Location of Cargo Tanks

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

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. See Annex 5-8-A1.*

1.2

Ships subject to the Code should be designed to one of the following standards:

1.2.1

A "type 1G ship" is a gas carrier intended to transport products indicated in Section 5-8-19 which require maximum preventive measures to preclude the escape of such cargo.

1.2.2

A "type 2G ship" is a gas carrier intended to transport products indicated in Section 5-8-19 which require significant preventive measures to preclude the escape of such cargo.

1.2.3

A "type 2PG ship" is a gas carrier of 150 m in length or less intended to transport products indicated in Section 5-8-19 which require significant preventive measures to preclude escape of such cargo, and where the products are carried in independent type C tanks designed (see 5-8-4/2.4.4) for a MARVS of at least 7 bar (7.138 kgf/cm^2, 101.526 lbf/in^2) gauge and a cargo containment system design temperature of -55°C (-67°F) or above. Note that a ship of this description but over 150 m (492 ft) in length is to be considered a type 2G ship.

1.2.4

A "type 3G" ship is a gas carrier intended to carry products indicated in Section 5-8-19 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.

1.3

The ship type required for individual products is indicated in column "c" in the table of Section 5-8-19.

1.4

If a ship is intended to carry more than one product listed in Section 5-8-19 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 Freeboard and intact stability

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

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.

2.3

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 center 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.

2.4

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.

2.5

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.

2.5 Interpretation of 5-8-2/2.5 (ABS)

Loading guidance meeting requirements of 5-8-1/9(ABS) will comply with 5-8-2/2.5 for loading information booklet.

3 Shipside discharges below the freeboard deck

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:

3.1.1

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

3.1.2

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.

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.

3.3

The automatic non-return valves referred to in 5-8-2/3.1.1 and 5-8-2/3.1.2 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 5-8-2/9.

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.

• *The cargo content of small independent purge tanks on deck need not be taken into account when assessing the ballast condition.*

5 Damage assumptions

5.1

The assumed maximum extent of damage should be:

5.1.1	*Side damage:*		
5.1.1.1	*Longitudinal extent:*	$^1/_3L^{2/3}$ *or 14.5 m (47.57 ft), whichever is less*	
5.1.1.2	*Transverse extent: measured inboard from the ship's side at right angles to the centerline at the level of the summer load line*	*B/5 or 11.5 m (37.73 ft), whichever is less*	
5.1.1.3	*Vertical extent: from the moulded line of the bottom shell plating at centerline*	*Upwards without limit*	
5.1.2	*Bottom damage:*	*For 0.3L from the forward perpendicular of the ship*	*Any other part of the ship*
5.1.2.1	*Longitudinal extent:*	$^1/_3L^{2/3}$ *or 14.5 m (47.57 ft), whichever is less*	$^1/_3L^{2/3}$ *or 5 m (16.4 ft), whichever is less*
5.1.2.2	*Transverse extent:*	*B/6 or 10 m (32.8 ft), whichever is less*	*B/6 or 5 m (16.4 ft), whichever is less*
5.1.2.3	*Vertical extent:*	*B/15 or 2 m (6.56 ft), whichever is less, measured from the moulded line of the bottom shell plating at centerline (see 5-8-2/6.3).*	*B/15 or 2 m (6.56 ft), whichever is less, measured from the moulded line of the bottom shell plating at centerline (see 5-8-2/6.3).*

5.2 Other damage

5.2.1

If any damage of a lesser extent than the maximum damage specified in 5-8-2/5.1 would result in a more severe condition, such damage should be assumed.

5.2.2

Local side damage anywhere in the cargo area extending inboard 760 mm (30 in.) measured normal to the hull shell should be considered and transverse bulkheads should be assumed damaged when also required by the applicable subparagraphs of 5-8-2/8.1.

6 Location of cargo tanks

6.1

Cargo tanks should be located at the following distances inboard:

6.1.1

Type 1G ships: from the side shell plating not less than the transverse extent of damage specified in 5-8-2/5.1.1.2 and from the moulded line of the bottom shell plating at centerline not less than the vertical extent of damage specified in 5-8-2/5.1.2.3 and nowhere less than 760 mm (30 in.) from the shell plating.

6.1.2

Types 2G/2PG and 3G ships: from the moulded line of the bottom shell plating at centerline not less than the vertical extent of damage specified in 5-8-2/5.1.2.3 and nowhere less than 760 mm (30 in.) from the shell plating.

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 5-8-2/Figure 1). For internal insulation tanks the extent of damage should be measured to the supporting tank plating.

6.2 Interpretation of 5-8-2/6.2 (ABS)

Where the cargo tanks are located within the extent of damage assumed in 5-8-2/5, the stability is to be investigated, assuming the cargo tanks are damaged and also with the cargo tanks undamaged (5-8-2/5.2). Deck cargo tanks are to be located not less than 760 mm (30 in.) inboard from the side shell.

6.3

Except for type 1G ships, suction wells installed in cargo tanks may protrude into the vertical extent of bottom damage specified in 5-8-2/5.1.2.3 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 (14 in.), whichever is less. Where there is no double bottom, the protrusion below the upper limit of bottom damage should not exceed 350 mm (14 in.). Suction wells installed in accordance with this paragraph may be ignored in determining the compartments affected by damage.

7 Flooding assumptions

7.1

The requirements of 5-8-2/9 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.

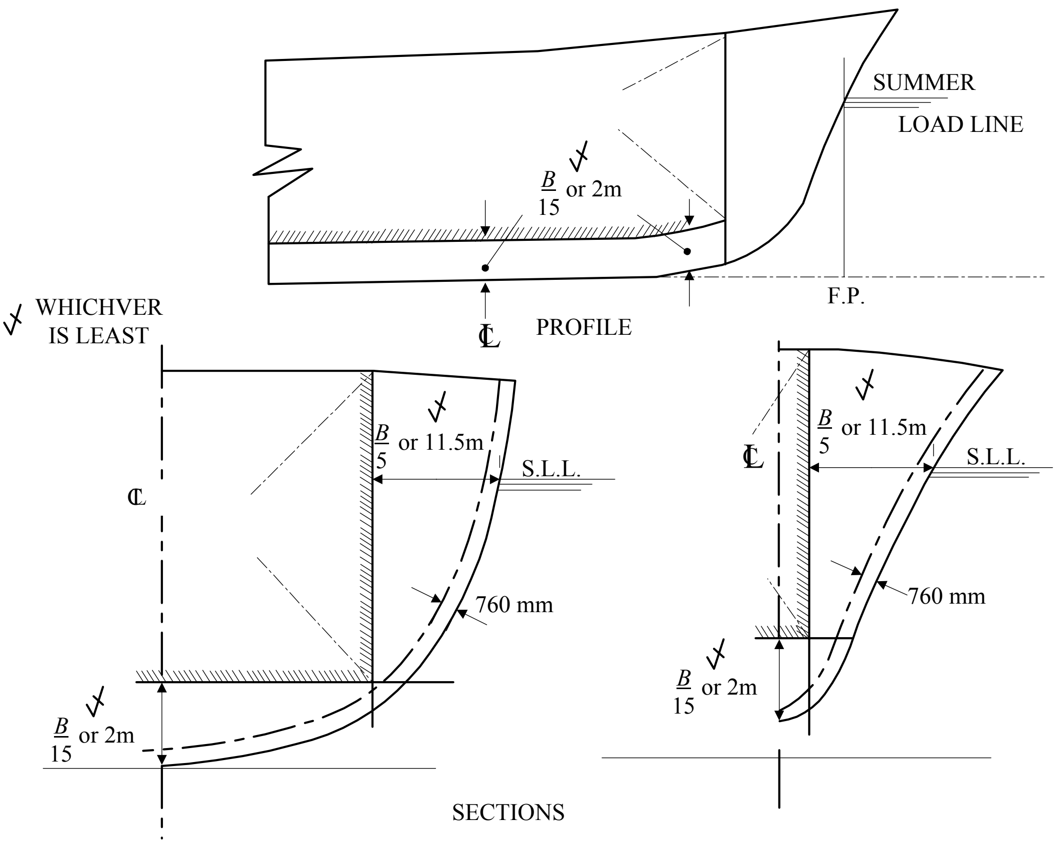
7.2

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.*

FIGURE 1
Tank location requirements as set out in 5-8-2/6



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.

7.4

Where the damage between transverse watertight bulkheads is envisaged as specified in 5-8-2/8.1.4, 5-8-2/8.1.5 and 5-8-2/8.1.6, transverse bulkheads should be spaced at least at a distance equal to the longitudinal extent of damage specified in 5-8-2/5.1.1.1 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 non-existent for the purpose of determining flooded compartments. Further, any portion of a transverse bulkhead bounding side compartments or double bottom compartments should be assumed damaged if the watertight bulkhead boundaries are within the extent of vertical or horizontal penetration required by 5-8-2/5. Also, any transverse bulkhead should be assumed damaged if it contains a step or recess of more than 3 m (9ft-10 in.) 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.

7.5

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

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 5-8-2/9.1 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.

7.7

If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in 5-8-2/5, arrangements should be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

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:

7.8.1

they are separated from the damaged space by watertight divisions and the requirements of 5-8-2/9.1.1 in respect of these intact spaces are complied with; and

7.8.2

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 5-8-2/9.2.1; however the immersion of any other openings capable of being closed weathertight may be permitted.

8 Standard of damage

8.1

Ships should be capable of surviving the damage indicated in 5-8-2/5 with the flooding assumptions in 5-8-2/7 to the extent determined by the ship's type according to the following standards:

8.1.1

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

8.1.2

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

8.1.3

A type 2G ship of 150 m (492 ft) 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;

8.1.4

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 5-8-2/5.1.1.1;

8.1.5

A type 3G ship of 125 m (410 ft) 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 5-8-2/5.1.1.1;

8.1.6

A type 3G ship less than 125 m (410 ft) 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 5-8-2/5.1.1.1 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.

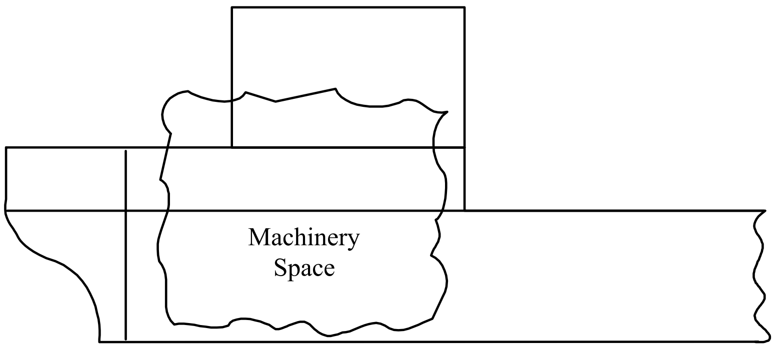
8.1 Interpretation of 5-8-2/7.8 and 5-8-2/8.1 (IMO)

The longitudinal extent of damage to superstructure in the instance of side damage to a machinery space aft under 5-8-2/8.1 should be the same as the longitudinal extent of the side damage to the machinery space (see 5-8-2/Figure 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 5-8-2/8.1.3, 5-8-2/8.1.4, and 5-8-2/8.1.6, 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 for the Carriage of Liquefied Gases in Bulk.

FIGURE 2
Longitudinal extent of damage to superstructure
(5-8-2/7.8 and 5-8-2/8.1)



9 Survival requirements

Ships subject to the Code should be capable of surviving the assumed damage specified in 5-8-2/5 to the standard provided in 5-8-2/8 in a condition of stable equilibrium and should satisfy the following criteria.

9.1 In any stage of flooding

9.1.1

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;

9.1.2

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

9.1.3

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 5-8-2/9.2.1.

9.2 At final equilibrium after flooding

9.2.1

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 (3.937 in.) 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 5-8-2/9.1.1 and other openings capable of being closed weathertight may be permitted; and

9.2.2

the emergency source of power should be capable of operating.

9.2.1 Interpretation of 5-8-2/9.2.1 (IMO)

The 20° range may be measured from any angle commencing between the position equilibrium and the angle of 25° (or 30° if no deck immersion occurs).

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PART

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **3 Ship Arrangements**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Segregation of the cargo area

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.

1.1 Interpretation of 5-8-3/1.1 (ABS)

Bow thrusters, if fitted, may be located forward of the hold spaces.

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 5-8-3/1.1 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.

1.3

Where cargo is carried in a cargo containment system requiring a secondary barrier, segregation of hold spaces from spaces referred to in 5-8-3/1.1 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.

1.4

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

1.4.1

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

1.4.2

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

1.5

Any piping system which may contain cargo or cargo vapor should:

1.5.1

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

1.5.2

except as provided in Section 5-8-16, 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;

1.5.3

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;

1.5.4

except for bow or stern loading and unloading arrangements in accordance with 5-8-3/8 and emergency cargo jettisoning piping systems in accordance with 5-8-3/1.6, and except in accordance with Section 5-8-16, be located in the cargo area above the open deck; and

1.5.5

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 5-8-2/6.1.

1.6

Any emergency cargo jettisoning piping system should comply with 5-8-3/1.5 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.

1.7

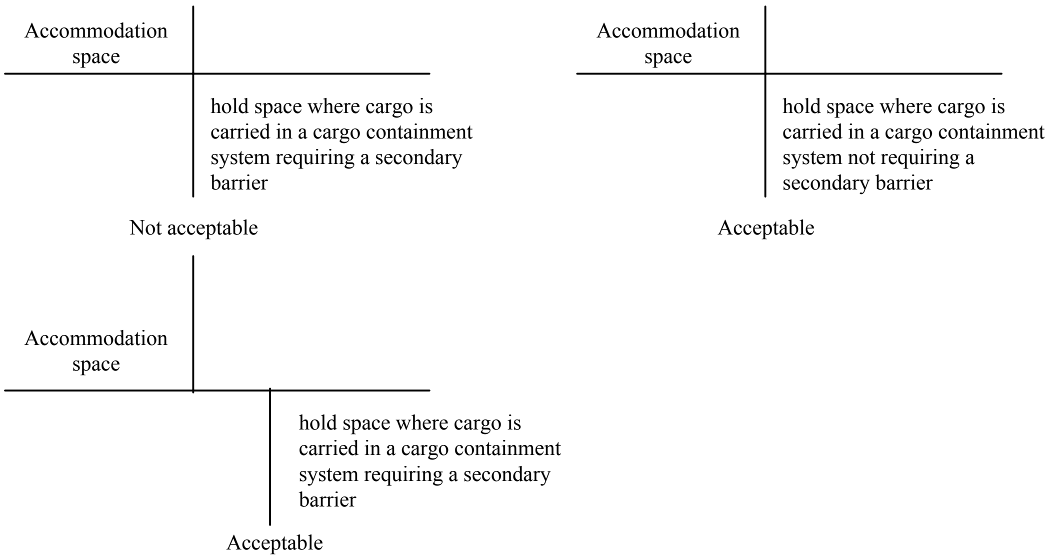
Arrangements should be made for sealing the weather decks in way of openings for cargo containment systems.

2 Accommodation, service and machinery spaces and control stations *(1 Oct. 1994)*

2.1

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

2.1. Interpretation of 5-8-3/2.1 (ABS)



2.2

In order to guard against the danger of hazardous vapors, 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.

2.2 Interpretation of 5-8-3/2.2 (IMO)

Compliance with other relevant paragraphs of the Code and in particular with paragraphs 5-8-3/2.4, 5-8-3/8, 5-8-8/2.10 and 5-8-12/1.6, where applicable, would also ensure compliance with this paragraph.

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 5-8-3/6.1 when accommodation spaces are aft.

2.4

Entrances, air inlets and openings to accommodation spaces, service spaces, machinery spaces and control stations should not face the cargo area. They should be located on the end bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse or on both at a distance of at least 4% of the length (L) of the ship but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area. This distance, however, need not exceed 5 m. Windows and sidescuttles facing the cargo area and on the sides of the superstructures or deckhouses 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 vapor 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.

2.4 Interpretation of 5-8-3/2.4 (IMO)

Air outlets are subject to the same requirements as air inlets and air intakes. This interpretation also applies to paragraphs 5-8-3/2.2, 5-8-3/8.4 and 5-8-8/2.10.

2.5

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

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 should be operated from inside the space.

2.6 Interpretation of 5-8-3/2.6 (IACS)

2.6.1

The requirement for fitting air intakes and openings with closing devices operable from inside the space in ships intended to carry toxic products should apply to spaces which are used for the ships' radio and main navigating equipment, cabins, mess rooms, toilets, hospitals, galleys, etc., but should not apply to spaces not normally manned such as deck stores, forecastle stores, engine room casings, steering gear compartments, workshops. The requirement also does not apply to cargo control rooms located within the cargo area.

2.6.2

When internal closing is required, this should include both ventilation intakes and outlets.

2.6.3

The closing devices should give a reasonable degree of gas tightness. Ordinary steel fire-flaps without gaskets/seals should normally not be considered satisfactory.

3 Cargo pump rooms and cargo compressor rooms

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 11-2/58 of the 1983 SOLAS amendments.

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 5-8-1/3.6 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.

3.1.3

Where the limits of the cargo area are extended by 5-8-3/3.1.2, 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.

3.1.3 Interpretation of 5-8-3/3.1.2 and 5-8-3/3.1.3 (IMO)

When cargo pump-rooms and compressor rooms are permitted to be fitted at the after end of the aftermost hold space, the bulkhead which separates the cargo pump-rooms and 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. The same condition should also be satisfied when cargo pump-rooms and compressor rooms, fitted within the cargo area, have a bulkhead in common with accommodation and service spaces, control stations and machinery spaces of category A.

3.2

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

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.

4 Cargo control rooms

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:

4.1.1 *the cargo control room is a gas-safe space; and*

4.1.2.1 if the entrance complies with 5-8-3/2.4, the control room may have access to the spaces described above;

4.1.2.2 if the entrance does not comply with 5-8-3/2.4, 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.

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 5-8-13/6.5.

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.

5 Access to spaces in the cargo area

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 5-8-3/5.2, 5-8-4/7.7 or 5-8-4/10.16 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.

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.

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:

5.3.1 *Access should be provided:*

5.3.1.1 to cargo tanks direct from the open deck;

5.3.1.2 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

5.3.1.3 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.

5.3.2

The dimensions referred to in 5-8-3/5.3.1.2 and 5-8-3/5.3.1.3 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.

5.3.3

The requirements of 5-8-3/5.3.1.2 and 5-8-3/5.3.1.3 do not apply to spaces described in 5-8-1/3.17.5. Such spaces should be provided only with direct or indirect access from the open weather deck, not including an enclosed gas-safe space.

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 5-8-3/6.

5 Interpretation of 5-8-3/5 (IACS)

5.1 (IACS)

Designated passageways below and above cargo tanks should have at least the cross sections as required by 5-8-3/5.3.1.3

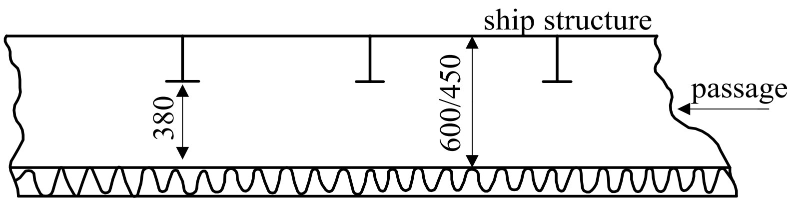
5.2 (IACS)

For the purpose of 5-8-3/5.1 or 5-8-3/5.2, the following should apply:

5.2.1 (IACS)

Where the surveyor requires to pass between the surface to be inspected, flat or curved, and structural elements such as deck beams, stiffeners, frames, girders etc., the distance between that surface and the free edge of the structural elements should be at least 380 mm. The distance between the surface to be inspected and the surface to which the above structural elements are fitted, e.g., deck, bulkhead or shell, should be at least 450 mm in case of a curved tank surface (e.g., in case of type C-tank) or 600 mm in case of a flat tank surface (e.g., in case of type A-tank). (See 5-8-3/Figure 1)

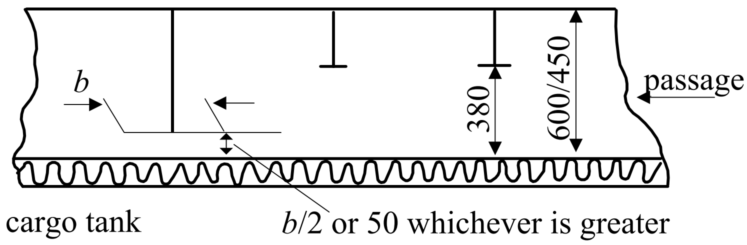
FIGURE 1



5.2.2 (IACS)

Where the surveyor does not require to pass between the surface to be inspected and any part of the structure, for visibility reasons, the distance between the free edge of that structural element and the surface to be inspected should be at least 50 mm or half the breadth of the structure’s face plate, whichever is the larger. (See 5-8-3/Figure 2)

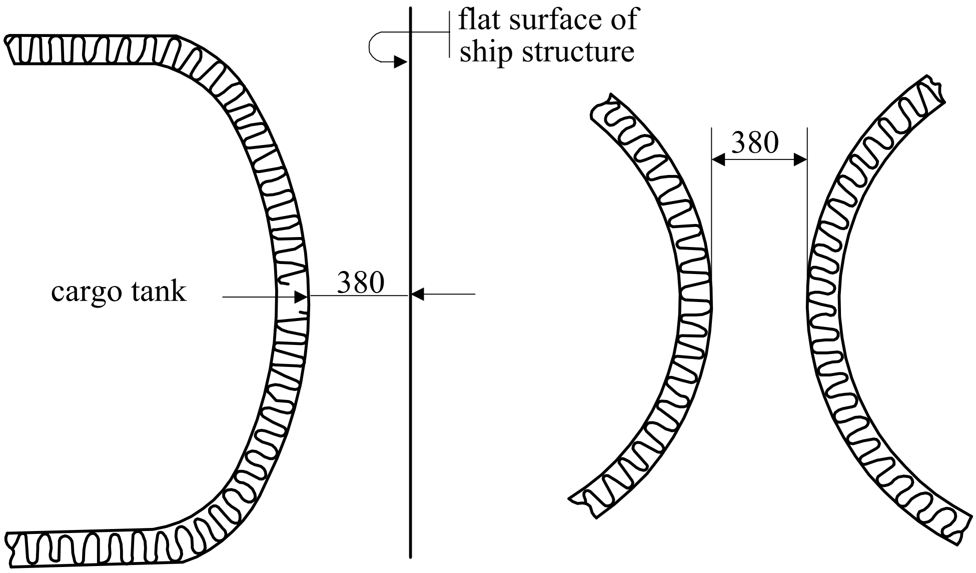
FIGURE 2



5.2.3 (IACS)

If, for inspection of a curved surface, the surveyor requires to pass between that surface and another surface, flat or curved, to which no structural elements are fitted, the distance between both surfaces should be at least 380 mm. (See 5-8-3/Figure 3) Where the surveyor does not require to pass between that curved surface and another surface, a smaller distance than 380 mm may be accepted, taking into account the shape of the curved surface.

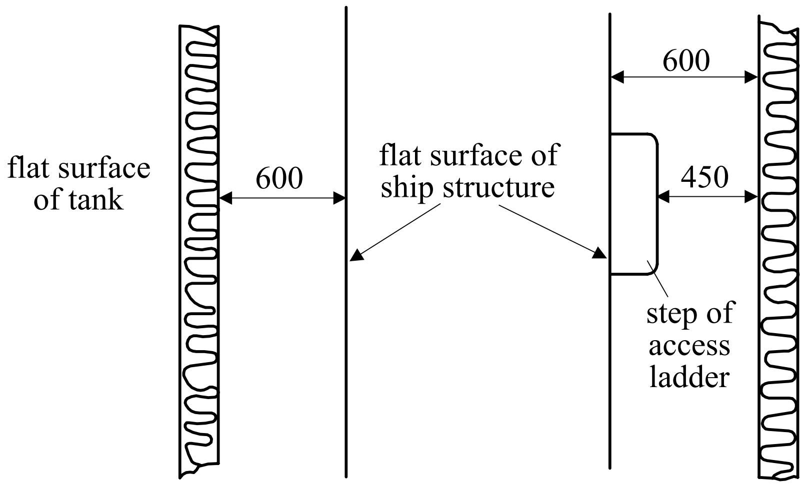
FIGURE 3



5.2.4 (IACS)

If, for inspection of an approximately flat surface, the surveyor requires to pass between two approximately flat and approximately parallel surfaces to which no structural elements are fitted, the distance between those surfaces should be at least 600 mm. (See 5-8-3/Figure 4)

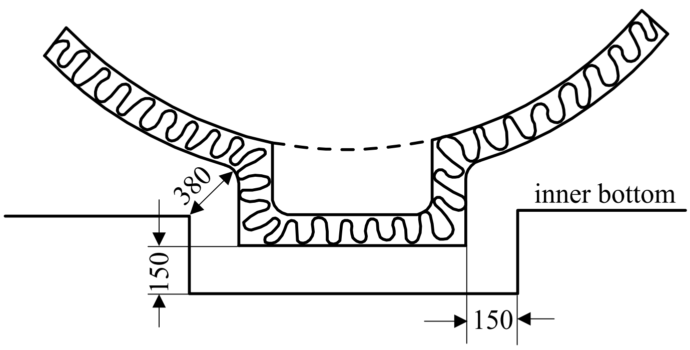
FIGURE 4



5.2.5 (IACS)

The minimum distances between a cargo tank sump and adjacent double bottom structure in way of a suction wells should not be less than shown in 5-8-3/Figure 5. If there is no suction well, the distance between the cargo tank sump and the inner bottom should not be less than 50 mm.

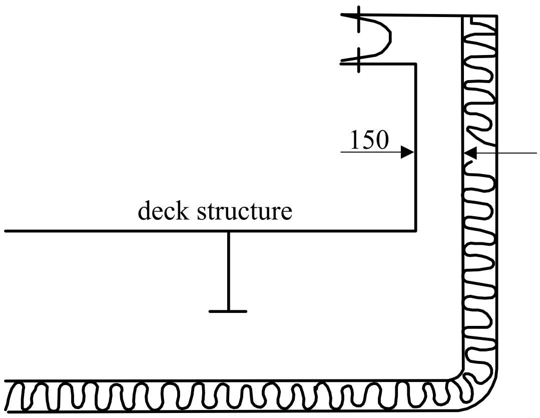
FIGURE 5



5.2.6 (IACS)

The distance between a cargo tank dome and deck structures should not be less than 150 mm. (See 5-8-3/Figure 6)

FIGURE 6



5.2.7 (IACS)

If necessary for inspection, fixed or portable staging should be installed. This staging should not impair the distances required under 5-8-3/5.2.1(IACS) to 5-8-3/5.2.4(IACS).

5.2.8 (IACS)

If fixed or portable ventilation ducting has to be fitted in compliance with 5-8-12/2, such ducting should not impair the distances required under 5-8-3/5.2.1(IACS) to 5-8-3/5.2.4(IACS).

5.3 (IACS)

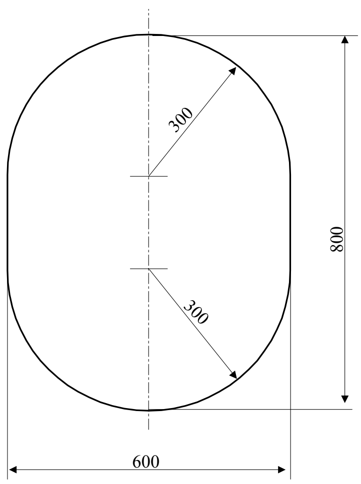
For the purpose of subparagraphs 5-8-3/5.3.1.2 and 5-8-3/5.3.1.3, the following should apply:

5.3.1 (IACS)

The term "minimum clear opening of not less than 600 × 600 mm" means that such openings may have corner radii up to 100 mm maximum.

5.3.2 (IACS)

The term "minimum clear opening of not less than 600 × 800 mm" also includes an opening of the following size:



5.3.3 (IACS)

Circular access openings in type-C cargo tanks should have diameters of not less than 600 mm.

6 *Air-locks*

6.1

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

6.2

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

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.

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 5-8-10/2.5.4). Electrical equipment which is not of the certified safe type for maneuvering, anchoring and mooring equipment as well as the emergency fire pumps should not be located in spaces to be protected by air-locks.

6.4 Interpretation of 5-8-3/6.3 and 5-8-3/6.4 (IMO)

The following means are considered acceptable alternatives to differential pressure sensing devices in spaces having a ventilation rate not less than 30 air changes per hour:

6.4.1 monitoring of current or power in the electrical supply to the ventilation motors; or

6.4.2 air flow sensors in the ventilation ducts.

In spaces where the ventilation rate is less than 30 air changes per hour and where one of the above alternatives is fitted, in addition to the alarms required by 5-8-3/6.3, the arrangements should be made to de-energize electrical equipment which is not of the certified safe type if more than one air lock door is moved from the closed position.

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.

6.6

The air-lock space should be monitored for cargo vapor.

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.

7 Bilge, ballast and fuel oil arrangements *(1 July 2003)*

Paragraph 5-8-3/7.2.2 applies to ships constructed on or after 1 July 2002.

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.

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.

7.2 *(1 July 2003)*

7.2.1

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

7.2.2

Arrangements referred to in 5-8-3/7.2.1 should be provided with a removable spool piece.

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 5-8-4/9.7.2.

7.4 *(1 July 2003)*

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

7.5 (ABS/IACS) *(2004)*

For integrated cargo and ballast system arrangements, see 5-8-10/3.

8 Bow or stern loading and unloading arrangements

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.

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 requiring a type 1G ship. Bow or stern loading and unloading lines should not be used for the transfer of toxic products as specified in 5-8-1/3.38 unless specifically approved by the Administration.

8.2

Portable arrangements should not be permitted.

8.3

In addition to the requirements of Section 5-8-5 the following provisions apply to cargo piping and related piping equipment:

8.3.1

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.

8.3.2

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.

8.3.3

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.

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 superstructure or deckhouse facing the cargo shore connection location of the bow or stern loading and unloading arrangements. This distance, however, need not exceed 5 m. Sidescuttles facing the shore connection location and on the sides of the superstructure or deckhouse within the distance mentioned above 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 of deckhouse side should be kept closed. Where in the case of small ships, compliance with 5-8-3/2.4 and this paragraph is not possible, the Administration may approve relaxations from the above requirements.

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.

8.6

Electrical equipment within a zone of 3 m from the cargo shore connection location should be in accordance with Section 5-8-10.

8.7

Fire-fighting arrangements for the bow or stern loading and unloading areas should be in accordance with 5-8-11/3.1.3 and 5-8-11/4.7.

8.8

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

9 Temperature of Steam or Heating Media within the Cargo Area (IACS/ABS) *(1999)*

The maximum temperature of steam or heating media within the cargo area is to take into consideration the temperature class (i.e., auto-ignition temperature) of the cargoes being carried.

PART

5

CHAPTER 8 Vessels Intended to Carry Liquefied Gases in Bulk

SECTION 4 Cargo Containment

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

Administrations should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this chapter.

1.2

In addition to the definitions in 5-8-1/3, the definitions given in this Chapter apply throughout the Code.

2 Definitions

2.1 Integral tanks

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.

2.1.2

The design vapor pressure P_o as defined in 5-8-4/2.6 should not normally exceed 0.25 bar. If, however, the hull scantlings are increased accordingly, P_o may be increased to a higher value but less than 0.7 bar.

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.

2.2 Membrane tanks

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.

2.2.2

The design vapor pressure P_o 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_o may be increased to a higher value but less than 0.7 bar.

2.2.3

The definition of membrane tanks does not exclude designs such as those in which nonmetallic membranes are used or in which membranes are included or incorporated in insulation. Such designs require, however, special consideration by the Administration. In any case the thickness of the membranes should normally not exceed 1.0 mm.

2.3 Semi-membrane tanks

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.

2.3.2

The design vapor pressure P_o 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_o may be increased to a higher value but less than 0.7 bar.

2.4 Independent tanks

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 5-8-4/2.4.2 to 5-8-4/2.4.4.

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 vapor pressure P_o should be less than 0.7 bar.

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 vapor pressure P_o should be less than 0.7 bar.

2.4.4

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

$$P_o = 2 + AC(\rho_r)^{1.5} \text{ (bar)}$$

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 aluminum alloy (5083-0)

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

h; 0.75*b; 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.

2.4.4 Interpretation of 5-8-4/2.4.4 (IACS)

2.4.4.1 (IACS) If the carriage of products not covered by the Code• is intended, it should be verified that the double amplitude of the primary membrane stress $\Delta\sigma_m$ created by the maximum dynamic pressure differential $\Delta\sigma$ does not exceed the allowable double amplitude of the dynamic membrane stress $\Delta\sigma_A$, as specified in 5-8-4/2.4.4 i.e.:

$$\Delta\sigma_m \leq \Delta\sigma_A$$

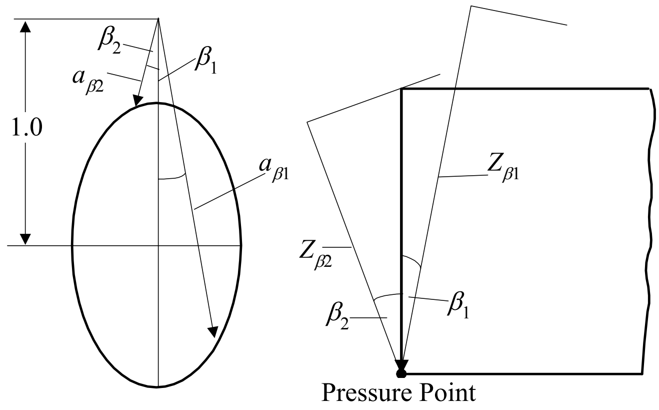
2.4.4.2 (IACS) The allowable dynamic membrane stress $\Delta\sigma_A$ of 55 N/mm² (5.61 kgf/mm², 7977 lbf/in²) is applicable to ferritic-perlitic, martensitic, and austenitic steel.

2.4.4.3 (IACS) The dynamic pressure differential $\Delta\rho$ should be calculated as follows:

$$\Delta\rho = \frac{\rho}{1.02 \cdot 10^4} (a_{\beta 1} Z_{\beta 1} - a_{\beta 2} Z_{\beta 2}) \text{ (bar)}$$

where ρ, a_β, Z_β are as defined in 5-8-4/3.2.2, see also sketches below. $a_{\beta 1}$ and $Z_{\beta 1}$ are the a_β- and Z_β-values giving the maximum liquid pressure $hgd_{\max}$, as defined in 5-8-4/3.2.

In order to evaluate the maximum pressure differential $\Delta\rho$, pressure differentials should be evaluated over the full range of the acceleration ellipse, as shown in the sketches given below.



Note:

- The outlined procedure is only applicable to products having a relative density exceeding 1.0.

2.5 Internal insulation tanks

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.

2.5.2

The two categories of internal insulation tanks are:

2.5.2.1 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.

2.5.2.2 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.

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 5-8-4/7.

2.5.4

The design vapor pressure P_o should not normally exceed 0.25 bar. If, however, the cargo containment system is designed for a higher vapor 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 vapor 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.

2.6 Design vapor pressure

2.6.1

The design vapor pressure P_o is the maximum gauge pressure at the top of the tank which has been used in the design of the tank.

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 vapor 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.

2.6.3

In all cases, including 5-8-4/2.6.2, P_o should not be less than MARVS.

2.6.4

Subject to special consideration by the Administration and to the limitations given in 5-8-4/2.1 to 5-8-4/2.5 for the various tank types, a vapor pressure higher than P_o may be accepted in harbor conditions, where dynamic loads are reduced.

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.

3 Design loads

3.1 General

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.

3.1.2

Account should be taken of the loads corresponding to the pressure test referred to in 5-8-4/10.

3.1.3

Account should be taken of an increase of vapor pressure in harbor conditions referred to in 5-8-4/2.6.4.

3.1.4

The tanks should be designed for the most unfavorable static heel angle within the range 0° to 30° without exceeding allowable stresses given in 5-8-4/5.1.

3.2 Internal pressure *(1 Oct. 1994)*

3.2.1

The internal pressure P_{eq} in bars gauge resulting from the design vapor pressure P_o and the liquid pressure P_{gd} defined in 5-8-4/3.2.2, but not including effects of liquid sloshing, should be calculated as follows:

$$P_{eq} = P_o + (P_{gd})_{\max} \qquad (bar)$$

Equivalent calculation procedures may be applied.

3.2.2

The internal liquid pressures are those created by the resulting acceleration of the center of gravity of the cargo due to the motions of the ship referred to in 5-8-4/3.4.1. The value of internal liquid pressure P_{gd} resulting from combined effects of gravity and dynamic accelerations should be calculated as follows:

$$P_{gd} = a_\beta Z_\beta \frac{\rho}{1.02 \cdot 10^4} \qquad (bar)$$

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 5-8-4/Figure 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 5-8-4/Figure 2).*

Tank domes considered to be part of the accepted total tank volume should be taken into account when determining Z_β unless the total volume of tank domes V_d does not exceed the following value:

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

where:

V_t = *tank volume without any domes*

FL = *filling limit according to Section 5-8-15*

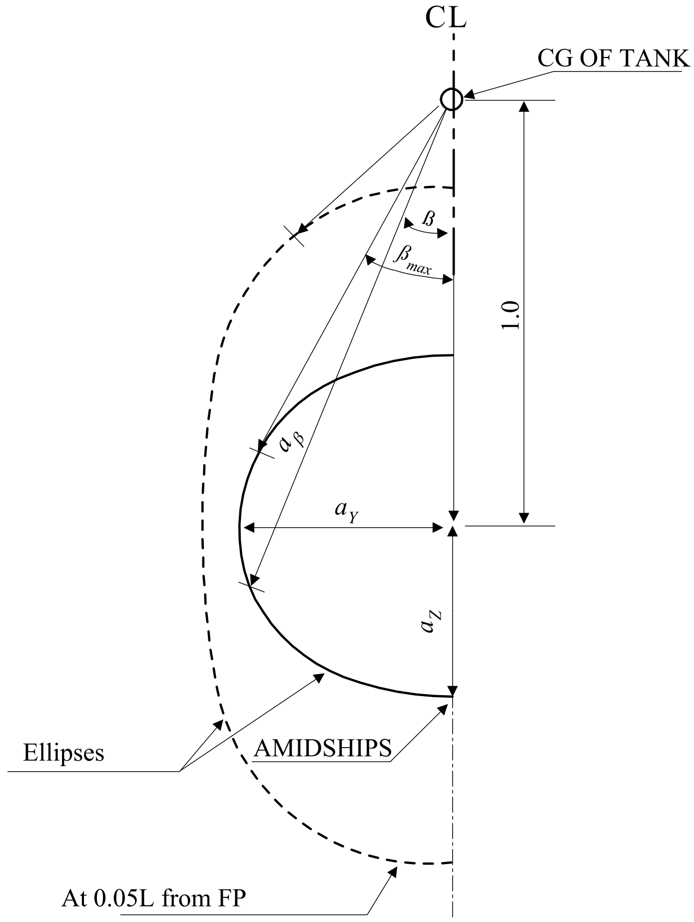
ρ = *maximum cargo density (kg/m^3) at the design temperature.*

The direction which gives the maximum value $(P_{gd})_{max}$ *of* P_{gd} *should be considered. Where acceleration components in three directions need to be considered, an ellipsoid should be used instead of the ellipse in 5-8-4/Figure 1. The above formula applies only to full tanks. (Also see 5-8-4/Figure 2a)*

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.

FIGURE 1
Acceleration ellipse



a_β = resulting acceleration (static and dynamic) in arbitrary direction β
a_Y = transverse component of acceleration
a_Z = vertical component of acceleration

3.4 Dynamic loads due to ship motions

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.

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 5-8-4/12.

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.

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 5-8-4/Figure 3.

3.4.5

Ships for restricted service may be given special consideration.

3.4.6

The accelerations acting on tanks are estimated at their center 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.*

3.5 Sloshing loads

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 5-8-4/3.4.6 should be considered.

FIGURE 2
Determination of internal pressure heads

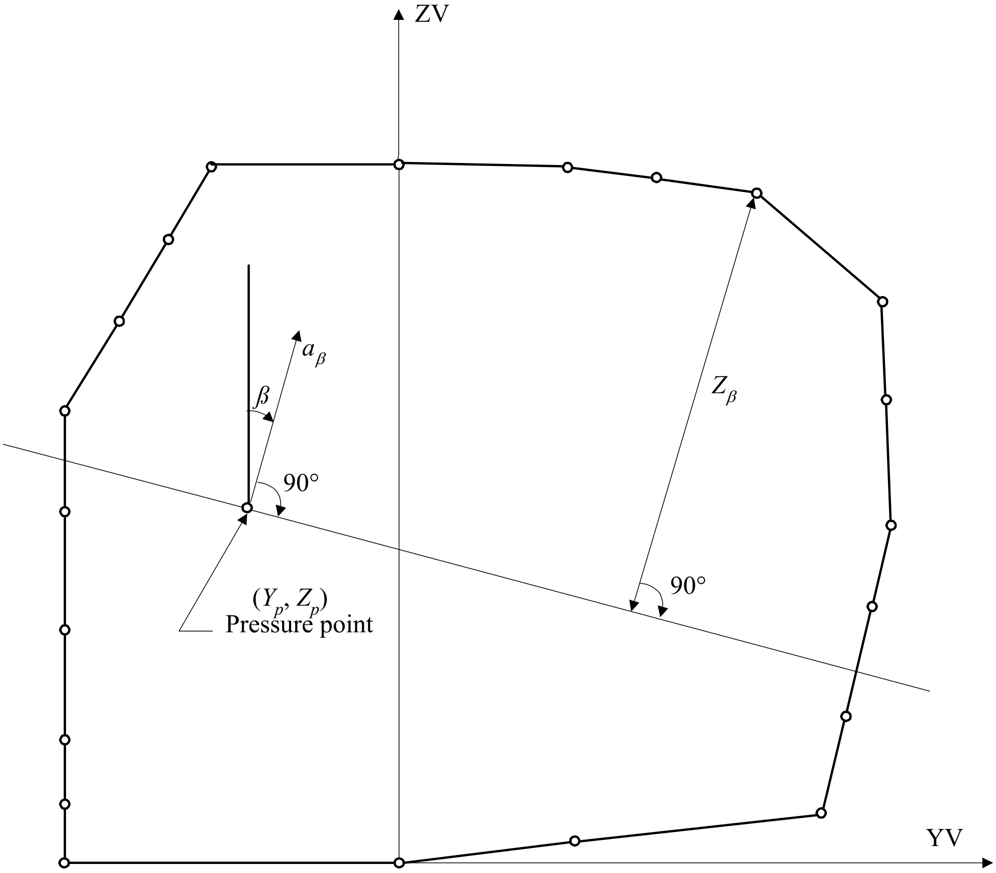
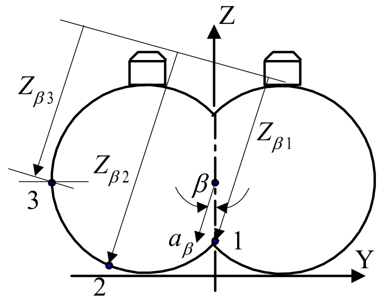
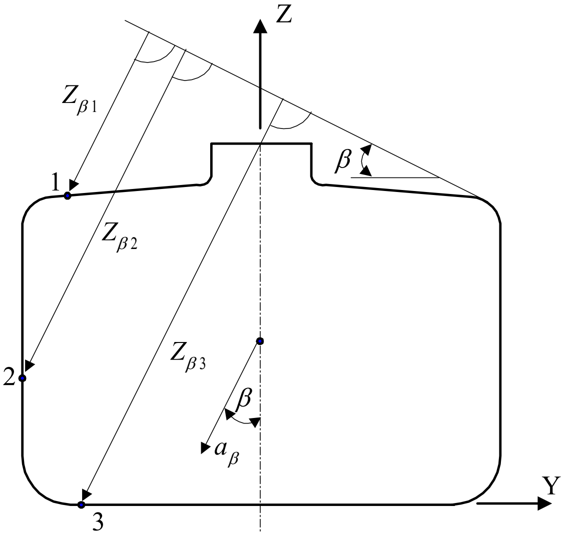


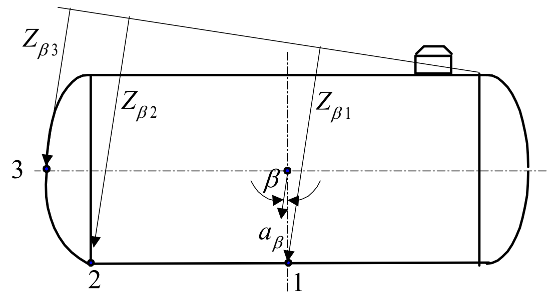
FIGURE 2a (ABS)



Bilobe Tank



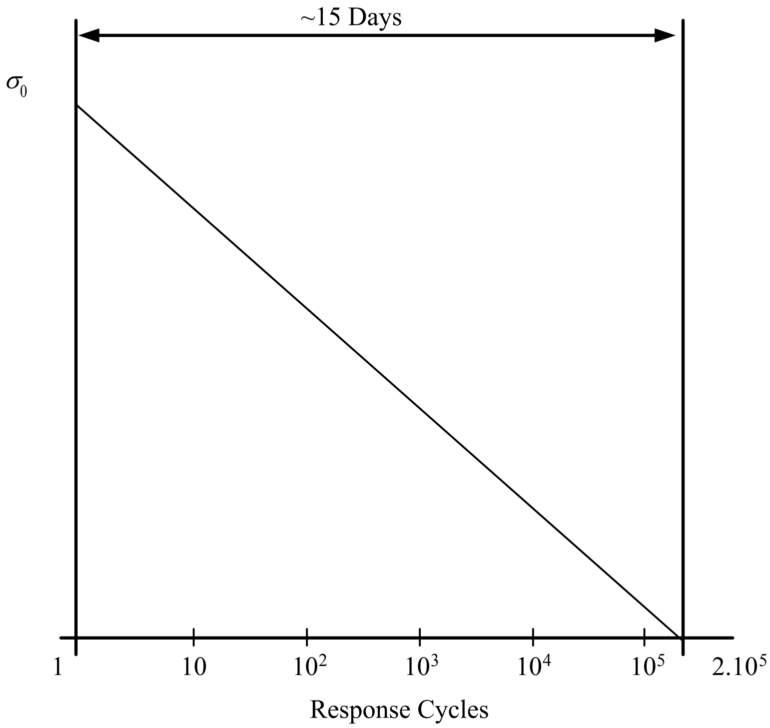
Independent tank, Type A or B



Cylindrical tank
Independent tank, Type C

Note: 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.

FIGURE 3
Simplified load distribution



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

Note: Response cycles scale is logarithmic, the value of 2.10^5 is given as an example of estimate

3.5.2

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

3.5 Interpretation of 5-8-4/3.5 (ABS)

Where loading conditions are proposed including one or more partially filled tanks, calculations or model test are required to show that the resulting loads and pressures are within acceptable limits for the scantlings of the tanks.

3.6 Thermal loads

3.6.1

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

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.

3.7 Loads on supports

The loads on supports are covered by 5-8-4/6.

4 Structural analyses

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 5-8-4/3.2, but the resulting scantlings should not be less than normally required by such standards.

4.1 Interpretation of 5-8-4/4.1 (ABS)

Integral tanks are to be designed and constructed in accordance with the requirements of these Rules. The scantlings of the tank boundary plating and stiffening are to be not less than required by Part 5, Chapter 2, using the heads given in that Section, or as derived from 5-8-4/3.2, whichever is the greater. See also 5-8-4/2.1.2.

4.2 Membrane tanks

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.

4.2.2

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 aging is not liable to prevent the materials from carrying out their intended function.

4.2.3

For the purpose of the test referred to in 5-8-4/4.2.2, 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.

4.2.4

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.

4.2.5

A structural analysis of the hull should be to the satisfaction of the Administration, taking into account the internal pressure as indicated in 5-8-4/3.2. 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 5-8-4/3.2. The allowable stress for the membrane, membrane-supporting material and insulation should be determined in each particular case.

4.2 Interpretation of 5-8-4/4.2 (ABS)

A structural analysis of the hull structure supporting the membrane tank is required using direct calculation procedures which are to be agreed to with the Bureau at an early stage in the design.

The scantlings of the inner hull are not to be less than required by Part 5, Chapter 2 for the maximum head which could be imposed.

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 5-8-4/3.2.

4.3 Interpretation of 5-8-4/4.3 (ABS)

The procedure indicated in 5-8-4/4.2(ABS) is generally to be followed.

4.4 Type A independent tanks

4.4.1

A structural analysis should be performed to the satisfaction of the Administration taking into account the internal pressure as indicated in 5-8-4/3.2. 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 5-8-4/3.2 and any corrosion allowance required by 5-8-4/5.2.

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 5-8-4/3 as far as applicable, and the ship deflection in way of supports.

4.5 Type B independent tanks

For tanks of this type the following applies:

4.5.1

The effects of all dynamic and static loads should be used to determine the suitability of the structure with respect to:

plastic deformation

buckling

fatigue failure

crack propagation.

Statistical wave load analysis in accordance with 5-8-4/3.4, finite element analysis or similar methods and fracture mechanics analysis or an equivalent approach, should be carried out.

4.5.2

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.

4.5.3

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.

4.5.4

A buckling analysis should consider the maximum construction tolerances.

4.5.5

Where deemed necessary by the Administration, model tests may be required to determine stress concentration factors and fatigue life of structural elements.

4.5.6

The cumulative effect of the fatigue load should comply with:

$$\sum \frac{n_i}{N_i} + \frac{10^3}{N_j} \le C_w$$

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.*

4.6 Type C independent tanks

4.6.1

Scantlings based on internal pressure should be calculated as follows:

4.6.1.1 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.

4.6.1.2 The design liquid pressure defined in 5-8-4/3.2 should be taken into account in the above calculations.

4.6.1.3 The welded joint efficiency factor to be used in the calculation according to 5-8-4/4.6.1.1 should be 0.95 when the inspection and the non-destructive testing referred to in 5-8-4/10.9 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 5-8-4/10.9.2.2 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.

4.6.2

Buckling criteria should be as follows:

4.6.2.1 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.

4.6.2.2 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* $P_4 = 0$.

4.6.3

Stress analysis in respect of static and dynamic loads should be performed as follows:

4.6.3.1 Pressure vessel scantlings should be determined in accordance with 5-8-4/4.6.1 and 5-8-4/4.6.2.

4.6.3.2 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 5-8-4/3 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.

4.6.3.3 If required by the Administration, secondary stresses and thermal stresses should be specially considered.

4.6.3 Interpretation of 5-8-4/4.6.3 (ABS)

"Special cases" where fatigue analysis may be required by the Bureau include, but are not limited to, novel designs and designs where cyclic loading is determined to be a factor by the design code used.

4.6.4

For pressure vessels, the thickness calculated according to 5-8-4/4.6.1 or the thickness required by 5-8-4/4.6.2 plus the corrosion allowance, if any, should be considered as a minimum without any negative tolerance.

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 aluminum alloys.

4.7 Internal insulation tanks

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 5-8-4/3.4, finite element analysis or similar methods and fracture mechanics analysis or an equivalent approach should be carried out.

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 structure 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 5-8-4/3.2. 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.

4.7.2.2 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.

4.7.2.3 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 5-8-4/3.2. Tanks constructed of plane surfaces should at least comply with Recognized Standards for deep tanks.

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.

4.7.4.1 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.

4.7.4.2 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).*

4.7.4.3 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.

4.7.4.4 Combined tension and fatigue tests should be carried out to evaluate crack behavior 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.

4.7.5

The effects of fatigue loading should be determined in accordance with 5-8-4/4.5.6 or by an equivalent method.

4.7.6

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

5 Allowable stresses and corrosion allowances (Also See Annex 5-8-A2)

5.1 Allowable stresses

5.1.1

For integral tanks, allowable stresses should normally be those given for hull structure in Recognized Standards.

5.1.2

For membrane tanks, reference is made to the requirements of 5-8-4/4.2.5.

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 aluminum alloys, where R_m and R_e are defined in 5-8-4/5.1.7. However, if detailed calculations are carried out for the primary members, the equivalent stress σ_c as defined in 5-8-4/5.1.8 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.

5.1.3 Interpretation of 5-8-4/5.1.3 (ABS)

The scantlings of independent tanks, type A, are not to be less than that required by Section 3-2-10 (except 3-2-10/5), as modified below:

5.1.3(a) Head. The value of "h" used in the various equations is to be derived from 5-8-4/3.2.

5.1.3(b) Plating.

i) Steel

The plating thickness is to be determined from 3-2-10/3.1 where Y is the specified minimum yield stress at room temperature. If the stress-strain curve does not show a defined yield stress, the 0.2% proof stress (offset method) applies.

Where the cargo is non-corrosive, the thickness obtained may be reduced by the corrosion allowance (CA) indicated in 5-8-4/5.1.3(e)(ABS) below.

ii) Aluminum Alloy

The plating thickness is to be obtained from the following equation:

$$t_a = [t_s - CA]\left(\frac{E_s}{E_a}\right)^{\frac{1}{3}}$$

where

t_a = required thickness of aluminum, in mm (in.)

t_s = required thickness of steel from Section 3-2-10 with $Q = 1.0$

CA = if cargo is non-corrosive, the value of the corrosion allowance is indicated in 5-8-4/5.1.3(e)(ABS) below.

E_s = Modulus of Elasticity of steel

E_a = Modulus of Elasticity of aluminum

5.1.3(c) Stiffeners. Each of the stiffeners in steel or aluminum alloy in association with the plating to which it is attached is not to have a section modulus less than that required by the following equation

$$SM_R = SM\,K_1K_2/\sigma_a$$

where

SM_R = required section modulus of material proposed, in cm^3 (in^3)

SM = required section modulus from 3-2-10/3.3 using $c = 1.0$ and ℓ is the distance, in meters (feet), between supports.

σ_a = allowable stress not exceeding the lower of $R_m/2.66$ or $R_e/1.33$ for steel or aluminum alloy, respectively and R_m and R_e, as defined in 5-8-4/5.1.7.

K_1 = 0.9 for non-corrosive cargoes 1.0 for corrosive cargoes.

K_2 = 108 N/mm^2 (11.0 kgf/mm^2, 15680 psi)

5.1.3(d) Corrugated Bulkheads. Corrugated bulkheads are not to be used for primary barriers.

5.1.3(e) Corrosion Allowance. Where the cargo is non-corrosive, the thickness of plating may be reduced by 3 mm (0.125 in.), except that where the thickness of plating as determined by 3-2-10/3.1 is less than 12.5 mm (0.50 in.), the reduction is not to be greater than 20%. In no case is the thickness of plating to be less than 6.5 mm (0.25 in.).

5.1.3(f) Webs and Girders. Webs and girders in steel and aluminum alloy in association with the plating to which it is attached are not to have a section modulus less than that required by the following equation:

$$SM_R = SM\, K_1 K_3 / \sigma_a$$

where SM_R, SM, K_1 and σ_a are defined in 5-8-4/5.1.3(c) above

K_3 = 124 N/mm^2 (12.6 kgf/mm^2, 17920 psi)

5.1.3(g) Buckling. For higher strength materials and aluminum alloys, calculations are to be submitted to show adequate provision to resist buckling.

5.1.3(h) Fatigue Strength. Proportions and scantlings of structural members where deemed necessary may have to be investigated to improve the fatigue strength especially in higher strength material and aluminum alloys.

5.1.4

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

$$\sigma_m \leq f$$

$$\sigma_L \leq 1.5f$$

$$\sigma_b \leq 1.5F$$

$$\sigma_L + \sigma_b \leq 1.5F$$

$$\sigma_m + \sigma_b \leq 1.5F$$

where

σ_m = *equivalent primary general membrane stress*

σ_L = *equivalent primary local membrane stress*

σ_b = *equivalent primary bending stress*

f = *the lesser of* $\dfrac{R_m}{A}$ *or* $\dfrac{R_e}{B}$

F = *the lesser of* $\dfrac{R_m}{C}$ *or* $\dfrac{R_e}{D}$

with R_m and R_e as defined in 5-8-4/5.1.7. With regard to the stresses σ_m, σ_L and σ_b see also the definition of stress categories in 5-8-4/13. 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:

where

	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*

5.1.5

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

5.1.5 Interpretation of 5-8-4/5.1.5 (ABS)

For independent tanks, type B, primarily constructed of plane surfaces, the equivalent stress, σ_e, in members using a F.E.M. analysis are not to exceed the values of the lower of R_e/E or R_m/F for the materials indicated in the following table and R_m and R_e as defined in 5-8-4/5.1.7 and σ_e as defined in 5-8-4/5.1.8.

Member	*Factor*	*Nickel steels and Carbon-manganese steels*	*Austenitic Steels*	*Aluminum Alloys*
PLATING	*E*	1.00	1.00	1.00
	F	2.00	2.00	2.00
STIFFENERS	*E*	1.33	1.25	1.33
	F	2.00	2.50	2.50
WEB, GIRDERS, STRINGER	*E*	1.33	1.25	1.33
	F	2.00	2.50	2.50

5.1.6

For type C independent tanks the maximum allowable membrane stress to be used in calculation according to 5-8-4/4.6.1.1 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 5-8-4/5.1.7.

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 5-8-1/5, and should have at least the minimum values indicated in the table in 5-8-4/5.1.4.*

5.1.7

For the purpose of 5-8-4/5.1.3, 5-8-4/5.1.4 and 5-8-4/5.1.6 the following apply:

5.1.7.1

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 aluminum alloys the respective values of R_e or R_m in annealed conditions should be used.

5.1.7.2 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.

5.1.8

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

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

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.*

5.1.9

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

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

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

$$\tau_{xy} = \tau_{xy.st} \pm \sqrt{\sum (\tau_{xy.dyn})^2}$$

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.

5.1.10

For internal insulation tanks, reference is made to the requirement of 5-8-4/4.7.2.

5.1.11

Allowable stresses for materials other than those covered by Section 5-8-6 should be subject to approval by the Administration in each case.

5.1.12

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

5.1 Interpretation of 5-8-4/5.1 (Permissible Stress in way of Supports of Type C Cargo Tanks) (IACS)

5.1.1

With reference to 5-8-4/5.1, the following criterion for the allowable stresses in way of supports of type C-cargo tanks made of carbon manganese steel may be used:

$$\sigma_e = \sqrt{(\sigma_n + \sigma_b)^2 + 3\tau^2} \le \sigma_a$$

where

σ_e = equivalent stress (N/mm^2)

σ_n = normal stress in the circumferential direction of the stiffening ring (N/mm^2)

σ_b = bending stress in the circumferential direction of the stiffening ring (N/mm^2)

τ = shear stress in the stiffening ring (N/mm^2)

σ_a = allowable stress (N/mm^2), to be taken as the smaller of the values: 0.57 R_m or 0.85 R_e

R_m and R_e, as defined in 5-8-4/5.1.7.1.

Equivalent stress values σ_e should be calculated over the full extent of the stiffening ring by a procedure acceptable to the Classification Society, for a sufficient number of load cases, as defined in 5-8-4/6.2 and 5-8-4/6.3.

5.1.2

The following assumptions should be made for the stiffening rings:

5.1.2(a) The stiffening ring should be considered as a circumferential beam formed by web, face plate, doubler plate, if any, and associated shell plating.

The effective width of the associated plating should be taken as:

i) For cylindrical shells: an effective width (mm) not greater than $0.78\sqrt{rt}$ on each side of the web. A doubler plate, if any, may be included within that distance.

where:

r = means radius of the cylindrical shell (mm)

t = shell thickness (mm).

ii) For longitudinal bulkheads (in the case of lobe tanks): the effective width should be determined according to established standards. A value of $20t_b$ on each side of the web may be taken as a guidance value.

where:

t_b = bulkhead thickness (mm).

5.1.2(b) The stiffening ring should be loaded with circumferential forces, on each side of the ring, due to the shear stress, determined by the bi-dimensional shear flow theory from the shear force of the tank.

5.1.3

The following factors should be taken into account:

5.1.3(a) Elasticity of support material (intermediate layer of wood or similar material)

5.1.3(b) Change in contact surface between tank and support, and of the relevant reactions, due to:

thermal shrinkage of tank

elastic deformations of tank and support material.

The final distribution of the reaction forces at the supports should not show any tensile forces.

5.1.4

The bucking strength of the stiffening rings should be examined.

5.2 Corrosion allowances

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.

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 vapor 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 5-8-4/4.6 should be increased as appropriate.

6 Supports

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.

6.2

The tanks with supports should also be designed for a static angle of heel of 30° without exceeding allowable stresses given in 5-8-4/5.1.

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 5-8-4/Figure 1. The half axes of the "acceleration ellipse" should be determined according to 5-8-4/3.4.2.

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.

6.5

The loads mentioned in 5-8-4/6.2 and 5-8-4/6.4 need not be combined with each other or with wave-induced loads.

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 5-8-4/6.3.

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.

6 Interpretation of 5-8-4/6 (ABS)

A design analysis substantiating the above criteria is to be submitted.

7 Secondary barrier

7.1

Where the cargo temperature at atmospheric pressure is below -10°C, a secondary barrier should be provided when required by 5-8-4/7.3 to act as a temporary containment for any envisaged leakage of liquid cargo through the primary barrier.

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:

7.2.1

the hull material should be suitable for the cargo temperature at atmospheric pressure as required by 5-8-4/9.2; and

7.2.2

the design should be such that this temperature will not result in unacceptable hull stresses.

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 5-8-4/2 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 5-8-4/2.1.3.*

[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*

7.4

The secondary barrier should be so designed that:

7.4.1

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 5-8-4/3.4.4;

7.4.2

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 5-8-4/8.2; and

7.4.3

the mechanism of failure for the primary barrier does not also cause the failure of the secondary barrier and vice versa.

7.5

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

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 5-8-4/3.4.4 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 adjacent to cargo tanks should be protected against liquid cargo.

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.

7.7

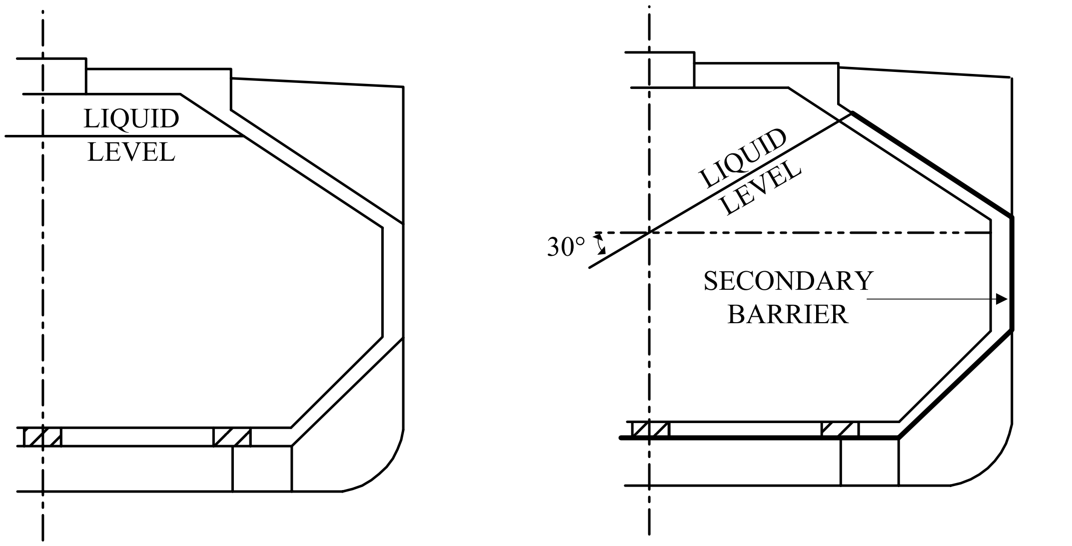
The secondary barrier should be capable of being periodically checked for its effectiveness, by means of a pressure/vacuum test, a visual inspection or another suitable method acceptable to the Administration. The method should be submitted to the Administration for approval.

7 Interpretation of 5-8-4/7 (ABS)

Extent of complete secondary barrier

The extent of the complete secondary barrier is to be not less than that obtained assuming the cargo tank is breached at a static angle of heel of 30° and there is an equalization of liquid in the hold space. See 5-8-4/Figure 4.

FIGURE 4



INTACT CARGO TANK

BREACHED CARGO TANK
WITH STATIC ANGLE OF HEEL OF 30°

8 Insulation (Also see Annex 5-8-A2)

8.1 *(1 Oct. 1994)*

Where a product is carried at a temperature below -10°C suitable insulation should be provided to ensure that the temperature of the hull structure does not fall below the minimum allowable design temperature given in Section 5-8-6 for the grade of steel concerned, as detailed in 5-8-4/9, 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 provided for in 5-8-1/29.

8.2

Where a complete or partial secondary barrier is required, calculations should be made with the assumptions in 5-8-4/8.1 to check that the temperature of the hull structure does not fall below the minimum allowable design temperature given in Section 5-8-6 for the grade of steel concerned, as detailed in 5-8-4/9. The complete or partial secondary barrier should be assumed to be at the cargo temperature at atmospheric pressure.

8.3 *(1 July 2003)*

Calculations required by 5-8-4/8.1 and 5-8-4/8.2 should be made assuming still air and still water, and except as permitted by 5-8-4/8.4, no credit should be given for means of heating. In the case referred to in 5-8-4/8.2, the cooling effect of the rising boil-off vapor from the leaked cargo should be considered in the heat transmission studies. For structural members connecting inner and outer hulls, the mean temperature may be taken for determining the steel grade.

8.4

In all cases referred to in 5-8-4/8.1 and 5-8-4/8.2 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:

8.4.1

sufficient heat should be available to maintain the hull structure above the minimum allowable temperature in the conditions referred to in 5-8-4/8.1 and 5-8-4/8.2;

8.4.2

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;

8.4.3

the heating system should be considered as an essential auxiliary; and

8.4.4

the design and construction of the heating system should be to the satisfaction of the Administration.

8.4 Interpretation of 5-8-4/8.4 (ABS)

Where the cargo is carried in a containment system requiring a secondary barrier, the hull heating system is to be contained solely within the cargo area or the drain returns from the hull heating coils in the wing tanks, cofferdams, and double bottom are to be led to a degassing tank. The degassing tank is to be located in the cargo area, where possible, and the vent outlets are to be located in a safe position and fitted with a flame screen.

8.5

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

9 Materials (Also see Annex 5-8-A2)

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 5-8-6/Table 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.

9.2

Hull material forming the secondary barrier should be in accordance with 5-8-6/Table 2. Metallic materials used in secondary barriers not forming part of the hull structure should be in accordance with 5-8-6/Tables 2 or 3 as applicable. Insulation materials forming a secondary barrier should comply with the requirements of 5-8-4/9.7. Where the secondary barrier is formed by the deck or side shell plating, the material grade required by 5-8-6/Table 2 should be carried into the adjacent deck or side shell plating, where applicable, to a suitable extent.

9.3

Materials used in the construction of cargo tanks should be in accordance with 5-8-6/Table 1, 5-8-6/Table 2, or 5-8-6/Table 3.

9.4

Materials other than those referred to in 5-8-4/9.1, 5-8-4/9.2 and 5-8-4/9.3 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 5-8-6/Table 5 for temperatures as determined by 5-8-4/8. This includes inner bottom plating, longitudinal bulkhead plating, transverse bulkhead plating, floors, webs, stringers and all attached stiffening members.

9.4 Interpretation of 5-8-4/8 and 5-8-4/9 (ABS)

9.4.1 Shell and Deck Plating

The material quality of the shell and deck plating is to be in accordance with 5-8-1/17(ABS), unless the calculated temperature is below -5°C (14°F) due to the effect of the low temperature of the cargo, assuming an ambient still sea water and still air temperature of 0°C (32°F) and 5°C (41°F), respectively. Where calculated temperature of the shell and deck plating is less than -5°C (14°F), the material quality is not to be less than that required by 5-8-6/Table 5.

The secondary barriers are assumed to be at the temperature of the cargo for these temperature studies. Where secondary barriers are not required, the cargo tanks are to be assumed to be at the temperature of the cargo for these temperature studies.

Some countries of registration may require lower ambient temperatures than those mentioned above. Also see Annex 5-8-A2.

9.4.2 Contiguous Hull Structure

Contiguous hull materials (not forming part of the secondary barriers) subject to reduced temperature due to the cargo are to be in accordance with 5-8-6/Table 5 using the calculated temperature indicated in 5-8-4/9.4.1(ABS) above.

Heating, meeting the requirements of 5-8-4/8.4*,* may be used in the above mentioned temperature calculations. If lower ambient temperatures are used in the temperature calculations, the longitudinal contiguous hull structures are also to meet the material of 5-8-6/Table 5 without heating and with ambient still sea water and still air temperature of 0°C (32°F) and 5°C (41°F), respectively. Also see Annex 5-8-A2.

9.5

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

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 vapor and mechanical damage.

9.7

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:

9.7.1.1 compatibility with the cargo

9.7.1.2 solubility in the cargo

9.7.1.3 absorption of the cargo

9.7.1.4 shrinkage

9.7.1.5 aging .

9.7.1.6 closed cell content

9.7.1.7 density

9.7.1.8 mechanical properties

9.7.1.9 thermal expansion

9.7.1.10 abrasion

9.7.1.11 cohesion

9.7.1.12 thermal conductivity

9.7.1.13 resistance to vibrations

9.7.1.14 resistance to fire and flame spread.

9.7.2

In addition to meeting the above requirements, insulation materials which form part of the cargo containment as defined in 5-8-4/2.5 should be tested for the following properties after simulation of aging and thermal cycling to ensure that they are adequate for the intended service:

9.7.2.1 bonding (adhesive and cohesive strength)

9.7.2.2 resistance to cargo pressure

9.7.2.3 fatigue and crack propagation properties

9.7.2.4 compatibility with cargo constituents and any other agent expected to be in contact with the insulation in normal service

9.7.2.5 where applicable the influence of presence of water and water pressure on the insulation properties should be taken into account

9.7.2.6 gas de-absorbing.

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.

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.

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 cargo containment system.

10 Construction and testing

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.

10.1.2

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

10.1.2.1 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.

10.1.2.2 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.

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 5-8-6/3.7.

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 program.

10.4

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

10.5

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 program.

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.

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.

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.

10.8

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.

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 5-8-4/10.10.1.

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.

10.8.4

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

10.9

For type C independent tanks, inspection and non-destructive testing should be as follows:

10.9.1 Manufacture and workmanship (1 Oct. 1994)

The tolerances relating to manufacture and workmanship such as out-of-roundness, local deviations from the true form, welded joints alignment and tapering of plates having different thicknesses, should comply with standards acceptable to the Administration. The tolerances should also be related to the buckling analysis referred to in 5-8-4/4.6.2.

10.9.2 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:

10.9.2.1 Total non-destructive testing referred to in 5-8-4/4.6.1.3:

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 of reinforcement rings around holes, nozzles, etc.

10.9.2.2 Partial non-destructive testing referred to in 5-8-4/4.6.1.3:

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.

10.10

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

10.10.1

For type A independent tanks, this test should be so performed that the stresses approximate, as far 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.

10.10.2

For type B independent tanks, the test should be performed as required in 5-8-4/10.10.1 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.

10.10.3

Type C independent tanks should be tested as follows:

10.10.3.1 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 $1.5P_o$*, 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 5-8-4/2.6. 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.*

10.10.3.2 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.

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

10.10.3.4 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 5-8-4/10.10.3.1, 5-8-4/10.10.3.2 and 5-8-4/10.10.3.3.

10.10.3.5 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 5-8-4/10.10.3.1 should be fully complied with.

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

10.10.3.7 (1 July 2003) Pneumatic testing of pressure vessels other than cargo tanks should only 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.

10.11

All tanks should be subjected to a tightness test which may be performed in combination with the pressure test referred to in 5-8-4/10.10 or separately.

10.12

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

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.

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.

10.15

Heating arrangements, if fitted in accordance with 5-8-4/8.4, should be tested for required heat output and heat distribution.

10.16

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

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.

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 raisers.

11 Stress relieving for type C independent tanks

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.

11.2 *(1 Oct. 1994)*

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:

11.2.1

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.

11.2.2

The mechanical stress relieving process should preferably be carried out during the hydrostatic pressure test required by paragraph 5-8-4/10.10.3 by applying a higher pressure than the test pressure required by 5-8-4/10.10.3.1. The pressurizing medium should be water.

11.2.3

For the water temperature paragraph 5-8-4/10.10.3.2 applies.

11.2.4

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

11.2.5

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

11.2.6

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

equivalent general primary membrane stress: $0.9 \cdot R_e$

equivalent stress composed of primary bending stress plus membrane stress: $1.35 \cdot R_e$

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

11.2.7

Strain measurements will normally be required to prove these limits for at least the first tank of a series of identical tanks built consecutively.

The location of strain gauges should be included in the mechanical stress relieving procedure to be submitted in accordance with 5-8-4/11.2.14.

11.2.8

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

11.2.9

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

11.2.10

Steels which have a ratio of yield stress to ultimate tensile strength greater than 0.8 should generally not be mechanically stress relieved.

If, however, the yield stress is raised by a method giving high ductility of the steel, slightly higher ratios may be accepted upon consideration in each case.

11.2.11

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

11.2.12

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

11.2.13

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

11.2.14

The procedure for mechanical stress relieving should be submitted beforehand to the Administration for approval.

11.3 (ABS)

See 2-4-2/17 for post-weld heat treatment requirements in all other cases and for materials other than those mentioned above.

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 5-8-4/3.4.6

$$a_z = \pm\, a_o \sqrt{1 + \left(5.3 - \frac{45}{L_o}\right)^2 \left(\frac{x}{L_o} + 0.05\right)^2 \left(\frac{0.6}{C_B}\right)^{1.5}}$$

Transverse acceleration as defined in 5-8-4/3.4.6

$$a_y = \pm\, a_o \sqrt{0.6 + 2.5\left(\frac{x}{L_o} + 0.05\right)^2 + K\left(1 + 0.6K\frac{z}{B}\right)^2}$$

Longitudinal acceleration as defined in 5-8-4/3.4.6

$$a_x = \pm\, a_o \sqrt{0.06 + A^2 - 0.25A}$$

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

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

13 Stress categories

For the purpose of stress evaluation referred to in 5-8-4/5.1.4, stress categories are defined in this section.

13.1

Normal stress is the component of stress normal to the plane of reference.

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.

13.3

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

13.4

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

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.

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.

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:

$$S_1 \leq 0.5\sqrt{Rt}$$

and

$$S_2 \geq 2.5\sqrt{Rt}$$

where

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

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.*

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.

PART

5

CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **5 Process Pressure Vessels and Liquid, Vapor, and Pressure Piping Systems**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

Administrations should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this chapter.

1.2

The requirements for type C independent tanks in Section 5-8-4 may also apply to process pressure vessels if required by the Administration. If so required the term "pressure vessels" as used in Section 5-8-4 covers both type C independent tanks and process pressure vessels.

2 Cargo and process piping

2.1 General

2.1.1

The requirements of 5-8-5/2 to 5-8-5/5 apply to product and process piping including vapor piping and vent lines of safety valves or similar piping. Instrument piping not containing cargo is exempt from these requirements.

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.

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.

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.

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.

2.1.6

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

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.

2.2 Scantlings based on internal pressure

2.2.1

Subject to the conditions stated in 5-8-5/2.4, the wall thickness of pipes should not be less than:

$$t = \frac{t_o + b + c}{1 - \dfrac{a}{100}} \text{ (mm)}$$

where

t_o = *theoretical thickness*

t_o = $PD/(20\,Ke + P)$ *(mm)*

with:

P = *design pressure (bar) referred to in 5-8-5/2.3*

D = *outside diameter (mm)*

K = *allowable stress (N/mm^2) referred to in 5-8-5/2.4*

e = *efficiency factor equal to 1.0 for seamless pipes and for longitudinally or spirally welded pipes, delivered by approved manufacturers of welded pipes, which are considered equivalent to seamless pipes when nondestructive testing on welds is carried out in accordance with*

Recognized Standards. In other cases an efficiency factor of less than 1.0, in accordance with recognized standards, may be required depending on the manufacturing process.

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

$$b = \frac{Dt_o}{2.5r} \qquad (mm)$$

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 (%).*

2.2.1 (IACS) *(1998)*

An efficiency factor, e, of less than 1.0 may be required depending on the manufacturing process.

2.3 Design pressure

2.3.1

The design pressure P in the formula for t_o in 5-8-5/2.2.1 is the maximum gauge pressure to which the system may be subjected in service:

2.3.2

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

2.3.2.1 for vapor piping systems or components which may be separated from their relief valves and which may contain some liquid: the saturated vapor pressure at 45°C, or higher or lower if agreed upon by the Administration (see 5-8-4/2.6.2);

2.3.2.2 for systems or components which may be separated from their relief valves and which contain only vapor at all times: the superheated vapor pressure at 45°C or higher or lower if agreed upon by the Administration (see 5-8-4/2.6.2), assuming an initial condition of saturated vapor in the system at the system operating pressure and temperature; or

2.3.2.3 the MARVS of the cargo tanks and cargo processing systems; or

2.3.2.4 the pressure setting of the associated pump or compressor discharge relief valve; or

2.3.2.5 the maximum total discharge or loading head of the cargo piping system; or

2.3.2.6 the relief valve setting on a pipeline system.

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.

2.4 Permissible stresses

2.4.1

For pipes, the permissible stress to be considered in the formula for t in 5-8-5/2.2.1 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 5-8-1/29 and have values of at least $A = 2.7$ *and* $B = 1.8$.

2.4.2

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

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 5-8-5/2.2, or, if this is impracticable or would cause excessive local stresses, these loads should be reduced, protected against or eliminated by other design methods.

2.4.4

Flanges, valves and other fittings should comply with recognized standards, taking into account the design pressure defined in 5-8-5/2.3. For bellows expansion joints used in vapor service, a lower minimum design pressure may be accepted.

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.

2.4.5 (ABS)

Design calculations, materials, dimensions and gasket data are to be submitted for non-standard flanges.

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.

2.6 Materials

2.6.1

The choice and testing of materials used in piping systems should comply with the requirements of Section 5-8-6 taking into account the minimum design temperature. However, some relaxation may be permitted in the quality of material of open-ended vent piping, provided the temperature of the cargo at the pressure relief valve setting is -55°C or greater and provided no liquid discharge to the vent piping can occur. Similar relaxations may be permitted under the same temperature conditions to open-ended piping inside cargo tanks, excluding discharge piping and all piping inside membrane and semi-membrane tanks.

2.6.2

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.

3 Type tests on piping components

3.1

Each type of piping component should be subject to type tests.

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.

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:

3.2.2.1 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.

3.2.2.2 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.

3.2.2.3 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.

3.2.2.4 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.

3.2.2.5 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.

4 Piping fabrication and joining details

4.1

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

4.2

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

4.2.1

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.

4.2.2

Slip-on welded joints with sleeves and related welding, having dimensions in accordance with recognized standards, should only be used for open-ended lines with external diameter of 50 mm or less and design temperatures not lower than -55°C.

4.2.3

Screwed couplings complying with recognized standards should only be used for accessory lines and instrumentation lines with external diameters of 25 mm or less.

4.3

4.3.1

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

4.3.2

Flanges should comply with recognized standards as to their type, manufacture and test. In particular, for all piping except open ended, the following restrictions apply:

4.3.2.1 For design temperatures lower than -55°C, only welded neck flanges should be used.

4.3.2.2 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.

4.4

Piping connections, other than those mentioned in 5-8-5/4.2 and 5-8-5/4.3, may be accepted by the Administration in each case.

4.5

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

4.5.1

If necessary, bellows should be protected against icing.

4.5.2

Slip joints should not be used except within the cargo tanks.

4.6 Welding, post-weld heat treatment and nondestructive testing (1 Oct. 1994)

4.6.1

Welding should be carried out in accordance with 5-8-6/3.

4.6.2

Post-weld heat treatment 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.

4.6.3

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:

4.6.3.1 100% radiographic inspection of butt welded joints for piping systems with design temperatures lower than -10°C and with inside diameters of more than 75 mm or wall thicknesses greater than 10 mm.

When such butt welded joints of piping sections are made by automatic welding procedures in the pipe fabrication shop, upon special approval by the Administration, the extent of radiographic inspection may be progressively reduced but in no case to less than 10% of each joint. If defects are revealed the extent of examination should be increased to 100% and should include inspection of previously accepted welds. This special approval can only be granted if well-documented quality assurance procedures and records are available to enable the Administration to assess the ability of the manufacturer to produce satisfactory welds consistently.

4.6.3.2 For other butt welded joints of pipes not covered by 5-8-5/4.6.3.1, 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 Testing of piping

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.

5.2

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 hydro-statically 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.

5.3

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.

5.4

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

6 Cargo system valving requirements

6.1

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

6.1.1

For cargo tanks with a MARVS not exceeding 0.7 bar gauge, all liquid and vapor 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 vapor 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 5-8-5/6.3 and should comply with the requirements of 5-8-5/6.4.

6.1.2

For cargo tanks with a MARVS exceeding 0.7 bar gauge, all liquid and vapor 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 5-8-5/6.4, is capable of local manual operation and provides full closure of the line.

6.1.3

Cargo pumps and compressors should be arranged to shutdown automatically if the emergency shutdown valves required by 5-8-5/6.1.1 and 5-8-5/6.1.2 are closed by the emergency shutdown system required by 5-8-5/6.4.

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.

6.2 Interpretation of 5-8-5/6.2 (IMO)

The requirements of 5-8-5/6.2, providing relaxations for cargo tanks referred to in 5-8-5/6.1.2, should not apply to cargo tank connections for gauging or measuring devices of cargo tanks referred to in 5-8-5/6.1.1.

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.

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 5-8-13/1.3 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.

6.5 (1 July 2003)

The closure time of 30 s for the emergency shutdown valve referred to in 5-8-5/6.4 should be measured from the time of manual or automatic initiation to final closure. This is called the total shutdown time and is made up of a signal response time and a valve closure time. The valve closure time should be such as to avoid surge pressure in the pipelines. Such valves should close in a manner so as to cut off the flows smoothly.

6.6

Excess flow valves should close automatically at the rated closing flow of vapor 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.

7 Ship's cargo hoses

7.1

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

7.2

Hoses subject to tank pressure, or the discharge pressure of pumps or vapor 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.

7.3 *(1 July 2003)*

For cargo hoses installed on board ships on or after 1 July 2002, each new type of cargo hose, complete with end-fittings, should be prototype-tested at a normal ambient temperature with 200 pressure cycles from zero to at least twice the specified maximum working pressure. After this cycle pressure test has been carried out, the prototype test should demonstrate a bursting pressure of at least 5 times its specified maximum working pressure at the extreme service temperature. Hoses used for prototype testing should not be used for cargo service. Thereafter, before being placed in service, each new length of cargo hose produced should be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure but not more than two-fifths of its bursting pressure. The hose should be stenciled or otherwise marked with the date of testing, its specified maximum working pressure and, if used in services other than the ambient temperature services, its maximum and minimum service temperature, as applicable. The specified maximum working pressure should not be less than 10 bar (145 psi) gauge.

8 Cargo transfer methods

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.

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.

9 Vapor return connections

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

PART

5

CHAPTER **8** **Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **6** **Materials of Construction**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

Administrations should take appropriate steps to ensure uniformity in the implementation and application of the provisions of this chapter.

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 5-8-6/2 and 5-8-6/Table 1 to 5-8-6/Table 5. The requirements for weldments are given in 5-8-6/3.

1.3

The manufacture, testing, inspection and documentation should be in accordance with Recognized Standards and the specific requirements given in this Code.

1.3 Interpretation of 5-8-5/1.3 (ABS)

Testing of plating, rolled sections, pipes process pressure vessels, valves, forgings, castings.

Test and Test Data

Witness Test. The designation (W) indicates that the Surveyor is to witness the testing unless the plant and product is approved under the Bureau's Quality Assurance Program.

Manufacturer's Data. The designation (M) indicates that test data is to be provided by the manufacturer without verification by a Surveyor of the procedures used or the results obtained.

Cargo Tanks. (Types A, B and C) & Process Pressure Vessels

A.	Plating	W	
B.	Rolled Sections	W	
C.	Castings & forgings	W	
D.	Membrane	W	(Tension test only)
Secondary Barriers (Metallic)			
a.	Membrane	W	(Tension test only)
b.	Plates and Rolled sections	W	
Cargo and vapor piping			
A.	Design Temperature at or below -18°C (0°F)	W	
B.	Design Temperatures above -18°C (0°F) and pressure 10.3 bar (10.5 kgf/cm^2, 150 psi) or below	M	
C.	Pressure above 10.3 bar (10.5 kgf/cm^2, 150 psi)	W	
Valves, castings and forgings in cargo and vapor piping systems		M	

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 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 energy average of three specimens*
10 × 10 mm	*E*
10 × 7.5 mm	$^5/_6$ *E*
10 × 5.0 mm	$^2/_3$ *E*

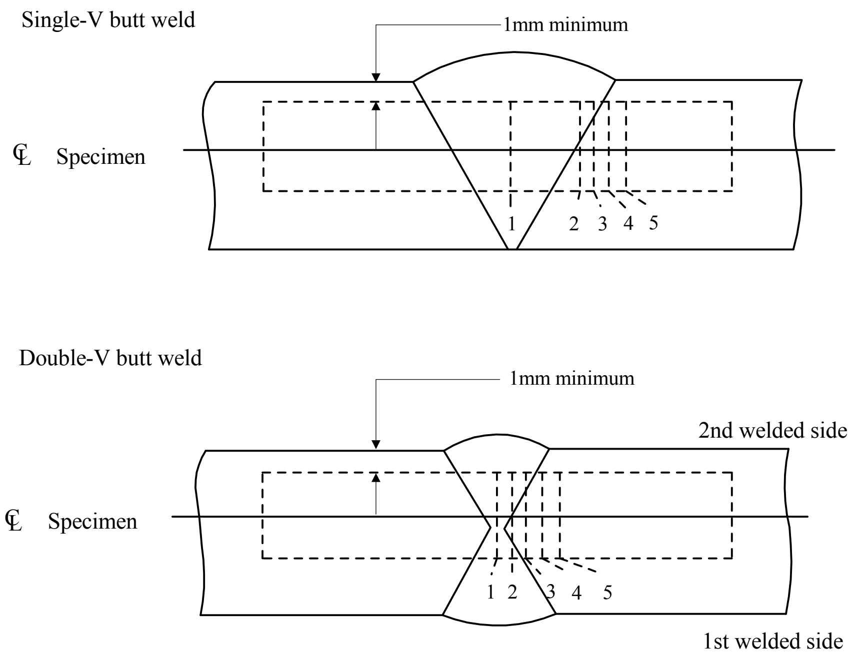
Where E = the energy values (J) specified in 5-8-6/Table 1 to 5-8-6/Table 4.

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

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 center of the thickness and the length of the notch perpendicular to the surface (see 5-8-6/Figure 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.*

FIGURE 1
Orientation of weld test specimen



Notch location:
1 Center 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 of Charpy specimens possible for the material thickness should be machined with the center of the specimens located as near as practicable to a point midway between the surface and the center of the thickness. In all cases, the distance from the surface of the material to the edge of the specimen should be approximately one (1) mm or greater. In addition for double-V butt welds, specimens should be machined closer to the surface of the second welded side.

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.

1.6

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

1.7

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

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 treatment condition in accordance with 5-8-6/3. In cases where a post-weld heat treatment is applied, the test requirements may be modified at the discretion of the Administration.

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.

2 Material requirements

The requirements for materials of construction are shown in the tables as follows:

Table 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 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 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 4: *Pipes (seamless and welded), forgings and castings for cargo and process piping for design temperatures below 0°C and down to -165°C.*

Table 5: *Plates and sections for hull structures required by 5-8-4/9.1 and 5-8-4/9.4.*

TABLE 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 approved by the Administration		
Normalized, or quenched and tempered [2]		
TENSION 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

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 2

PLATES, SECTIONS AND FORGINGS [1] FOR CARGO TANKS, SECONDARY BARRIERS AND PROCESS PRESSRUE VESSELS FOR DESIGN TEMPERATURES BELOW 0°C AND DOWN TO -55°C					
Maximum thickness 25mm [2]					
CHEMICAL COMPOSITION AND HEAT TREATMENT					
CARBON – MANGANESE STEEL			*Fully killed*	*Aluminum 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]					
TENSION AND TOUGHNESS (IMPACT) TEST REQUIREMENTS (1 OCT. 94)					
PLATES	*Each "piece" to be tested*				
SECTIONS AND FORGINGS	*Batch test*				
CHARPY V-NOTCH TEST	*Test temperatures 5°C below the design temperature or -20°C whichever is lower*				
PLATES	*Transverse test piece. 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 –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 that 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 the thermally stressed 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 5-8-6/Table 3 may be necessary

TABLE 2 (ABS) Requirements for Design Temperatures Below 0°C (32°F) and Down to -55°C (-67°F) *(1995)*

Note: Supplementary to 5-8-6/Table 2

Tension Test Tensile Strength	400 – 490 N/mm^2 (41 – 50 kgf/mm^2, 58,000 – 71,000 psi)	490 – 620 N/mm^2 (50 – 63 kgf/mm^2, 71,000 – 90,000 psi)
Yield Strength (2) Min.	235 N/mm^2 (24 kgf/mm^2, 34,000 psi)	355 N/mm^2 (36 kgf/mm^2, 51,000 psi)
Elongation (%) in		
200 mm (8 in.) or	21	19
50 mm (2 in.) or	24	22
5.65 $\sqrt{A}$	22	20
A = Cross Sectional area of Specimen in mm^2 (in^2)		
Marking (see 2-1-4/9 and Note 2)	AB/V-OXX	AB/VH-OXX
Impact Test (Charpy V-notch)		
Frequency: Plates – See 5-8-6/Table 2	Sections – each 15 tons of each heat	
Heat Treatment: See 5-8-6/Table 2 and Note 1 for 5-8-6/Table 2 (ABS)		

Notes:

1. Control Rolled (for sections only) or Thermo-Mechanical Controlled Process may also be considered as an alternative to normalizing or quenching and tempering.
2. For materials which exhibit a definite yield point exceeding 80% of the tensile strength, a letter "Y" is to be added at the end of the marking thus AB/V-OXXY or ABVH-OXXY.

TABLE 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 25mm [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	*Aluminum alloys; such as type 5083 annealed*	*Not required*
-165	*Austenitic Fe-Ni alloy (36% nickel) Heat treatment as agreed*	*Not required*
TENSION 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 aluminum 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 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. (°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).*	See Notes 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*
	Aluminum alloys such as type 5083 annealed		*Not required*

TENSION 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.*

9(ABS) Impact tests are not required by ABS for austenitic stainless steels.

TABLE 5

PLATES AND SECTIONS FOR HULL STRUCTURES REQUIRED BY 5-8-4/9.1 *AND* 5-8-4/9.4							
Minimum design temperature of hull structure (°C)	*Maximum thickness (mm) for steel grades in accordance with* 5-8-6/*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 5-8-6/Table 2 except that the thickness limitation given in 5-8-6/Table 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* 5-8-4/9.4.

2 *For the purpose of* 5-8-4/9.1.

3(ABS) For rolled and built up sections, the web thickness may be used to determine the grade of material (ABS).

2 Interpretation of 5-8-6/1 and 5-8-6/2 (ABS)

2.1 Definitions (ABS)

2.1.1 Piece

The term *piece* is understood to mean the rolled product from a single slab, billet or ingot if this is rolled directly into plates, sections or bars.

2.1.2 Batch

A number of similar pieces presented as a group for acceptance tests.

2.2 Test Samples (ABS)

2.2.1

All material in a batch presented for acceptance tests is to be of the same product form e.g., plates, flats, sections, etc. from the same cast and in the same condition of supply.

2.2.2

The test samples are to be fully representative of the material and, where appropriate, are not to be cut from the material until heat treatment has been completed.

2.2.3

The test specimens are not to be separately heat treated in any way.

2.2.4

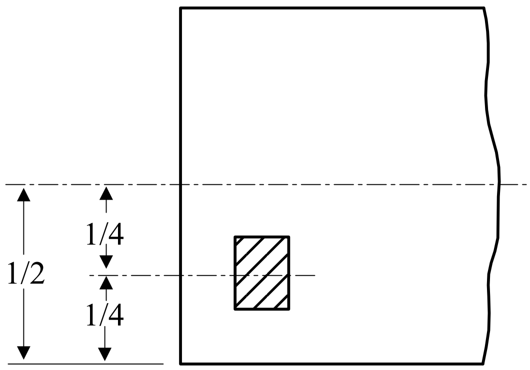
Unless otherwise agreed the test samples are to be taken from the following positions:

2.2.4(a) Plates and flats with a width ≥ 600 mm. The test samples are to be taken from one end at a position approximately midway between the axis in the direction of rolling and the edge of the rolled product [see 5-8-6/Figure 1(ABS)]. Unless otherwise agreed the tension test specimens are to be prepared with their longitudinal axes transverse to the final direction of rolling.

2.2.4(b) Flats with a width < 600 mm, bulb flats and other sections. The test samples are to be taken from one end at a position approximately one-third from the outer edge [see 5-8-6/Figure 2(ABS), 5-8-6/Figure 3(ABS) and 5-8-6/Figure 4(ABS)] or in the case of small sections, as near as possible to this position. In the case of channels, beams or bulb angles, the test samples may alternatively be taken from a position approximately one quarter of the width from the web centerline or axis [see 5-8-6/Figure 3(ABS)]. The tension test specimens may be prepared with their longitudinal axes either parallel or transverse to the final direction of rolling.

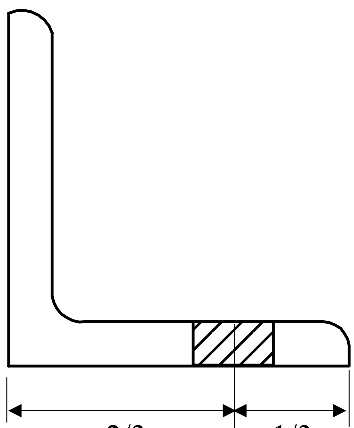
2.2.4(c) Bars and other similar products. The test samples are to be taken so that the longitudinal axes of the test specimens are parallel to the direction of rolling.

FIGURE 1 (ABS)



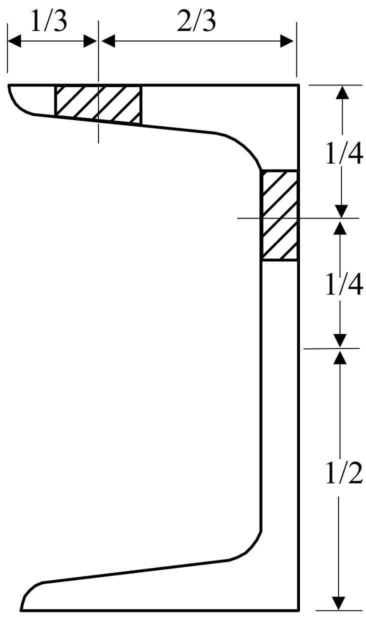
Plates and flats

FIGURE 2 (ABS)



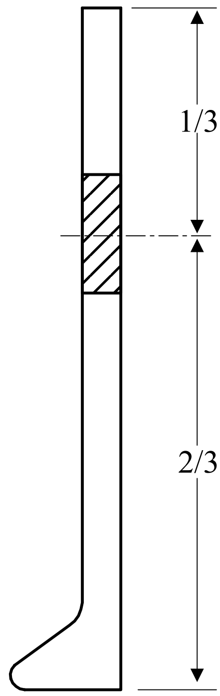
Angles

FIGURE 3 (ABS)



Channel and beams

FIGURE 4 (ABS)



Bulb flats

3 Welding and non-destructive testing

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 aluminum alloy weldments may be omitted and other tests may be specially required for any material.

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 tension and Charpy V-notch impact tests should be in accordance with Recognized Standards. The chemical composition of the deposited weld metal should be recorded for information and approval.

3.3 Welding procedure tests for cargo tanks and process pressure vessels

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.

3.3.2

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

3.3.2.1 Cross-weld tension tests.

3.3.2.2 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.

3.3.2.3 One set of three Charpy V-notch impacts, generally at each of the following locations, as shown in 5-8-6/Figure 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.

3.3.2.4 Macrosection, microsection and hardness survey may also be required by the Administration.

3.4 Test requirements

3.4.1 Tension 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.

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.

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 5-8-6/1.4.1. 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 5-8-6/1.4.1. 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.

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 5-8-6/3.3. Unless otherwise specially agreed with the Administration, the test requirements should be in accordance with 5-8-6/3.4.

3.6 Production weld tests

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 5-8-6/3.6.2, 5-8-6/3.6.3 and 5-8-6/3.6.4, may be required for cargo tanks or secondary barriers at the discretion of the Administration.

3.6.2

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

3.6.2.1 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 center 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 center of the weld.

3.6.2.2 The test requirements are the same as the applicable test requirements listed in 5-8-6/3.4 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.

3.6.3

In addition to those tests listed in 5-8-6/3.6.2.1 for Type C independent tanks and process pressure vessels, transverse weld tension tests are required. The test requirements are listed in 5-8-6/3.4 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.

3.6.4

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

3.7 Non-destructive testing

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.

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.

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.

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.

3.7.2

Inspection of type C independent tanks and process pressure vessels should be carried out in accordance with 5-8-4/10.9.

3.7.3

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

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 5-8-4/4.7. The schedule for inspection and non-destructive testing should be to the satisfaction of the Administration.

3.7.5

Inspection of piping should be carried out in accordance with the requirements of Section 5-8-5.

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.

PART

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **7 Cargo Pressure/Temperature Control**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General (Also see Annex 5-8-A2)

1.1

Unless the entire cargo system is designed to withstand the full gauge vapor 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:

1.1.1

a system which regulates the pressure in the cargo tanks by the use of mechanical refrigeration;

1.1.2

a system whereby the boil-off vapors are utilized as fuel for shipboard use or waste heat system subject to the provisions of Section 5-8-16. This system may be used at all times, including while in port and while maneuvering, provided that a means of disposing of excess energy is provided, such as a steam dump system, that is satisfactory to the Administration;

1.1.3

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;

1.1.4

other systems acceptable to the Administration;

1.1.5

in addition to the above means, the Administration may permit certain cargoes to be controlled by venting cargo vapors to the atmosphere at sea. This may be also permitted in port with the permission of the port Administration.

1.2

The systems required by 5-8-7/1.1 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.

1.3

For certain highly dangerous cargoes specified in Section 5-8-17, the cargo containment system should be capable of withstanding the full vapor pressure of the cargo under conditions of the upper ambient design temperatures irrespective of any system provided for dealing with boil-off gas.

2 Refrigeration systems

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.

2.2.1

Where two or more refrigerated cargoes which may react chemically in a dangerous manner are carried simultaneously, special consideration should be given to the refrigeration systems to avoid the possibility of mixing cargoes. For the carriage of such cargoes, separate refrigeration systems, each complete with a stand-by unit as specified in 5-8-7/2.1, 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.

2.2.2

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

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.

2.4

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

2.4.1

a direct system where evaporated cargo is compressed, condensed and returned to cargo tanks. For certain cargoes specified in Section 5-8-17 this system should not be used;

2.4.2

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

2.4.3

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 Section 5-8-17 this system should not be used.

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.

2 Cargo-refrigeration System (ABS)

Where the vessel is equipped with a refrigerating system for cooling cargo or with a reliquefaction plant for treating boil-off gas, the arrangements will be specially considered. In general, such equipment is to comply with the requirements of Part 6, Chapter 2 and this Section.

2 Interpretation of 5-8-7/2 (IACS) Reliquefaction plant of motor-driven LNG-carriers

2.1 Mechanical Refrigeration Fitted as the Primary System for Cargo Pressure Control (IACS)

2.1.1

5-8-7/2 is based on the assumption that 5-8-7/1.1 is being complied with by using means defined in 5-8-7/1.1.1. That is to say, a mechanical refrigeration system is fitted as the primary means of maintaining the cargo tank pressure below MARVS.

2.1.2

5-8-7/2 should apply to refrigeration systems when fitted on LNG carriers, i.e., stand-by capacity will be required as detailed in 5-8-7/2.1. A stand-by LNG/refrigerant heat exchanger need not be provided and the fitted LNG/refrigerant heat exchanger will not be required to have 25% excess capacity over that for normal requirements•. Other heat exchangers utilizing water cooling should have a stand-by or have at least 25 per cent excess capacity.

• The reason for this relaxation is that corrosion and fouling problems are not expected in LNG/refrigerant heat exchangers.

5-8-7/2.1 states that 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 fitted.

For the purpose of complying with the above, a suitable alternative means of pressure/temperature control would be:

1.3.1. Auxiliary boiler(s) capable of burning the boil-off vapors and disposing of the generated steam or an alternative waste heat system acceptable to the Society. Consideration will be given to systems burning only part of the boil-off vapor if it can be shown that MARVS will not be reached within a period of 21 days.

1.3.2 Controlled venting of cargo vapors as specified in 5-8-7/1.1.5 if permitted by the Administrations concerned.

2.2 Mechanical Refrigeration Fitted as the Secondary System for Cargo Pressure Control (IACS)

Where a refrigeration plant is fitted with a means of disposing of excess energy as detailed in the 2nd sentence of 5-8-7/1.1.2, no stand-by unit will be required for the refrigeration plant.

PART

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CHAPTER 8 Vessels Intended to Carry Liquefied Gases in Bulk

SECTION 8 Cargo Tank Vent Systems

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

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 vapor 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 Section 5-8-7 should be independent of the pressure relief valves.

2 Pressure relief systems

2.1

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

2.2

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

2.3

The setting of the pressure relief valves should not be higher than the vapor pressure which has been used in the design of the tank.

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.

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.

2.6

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

2.6.1

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

2.6.2

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.

2.7 (1 July 2003)

The changing of the set pressure under the provisions of 5-8-8/2.6, and the corresponding resetting of the alarms referred to in 5-8-13/4.1 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.

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:

2.8.1

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

2.8.2

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

2.8.3

pressure relief valve capacities such that if one valve is out of service the remaining valves have the combined relieving capacity required by 5-8-8/5. However, this capacity may be provided by the combined capacity of all valves, if a suitably maintained spare valve is carried on board.

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.

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.

2.11

All other cargo vent exits not dealt with in other chapters should be arranged in accordance with 5-8-8/2.9 and 5-8-8/2.10.

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.

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.

2.14

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

2.14 Interpretation of 5-8-8/2.14 (ABS)

Protection screens need not be flame screens.

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.

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 5-8-8/5.

2.17

Pressure relief valves should be positioned on the cargo tank so that they will remain in the vapor phase under conditions of 15° list and 0.015L trim, where L is as defined in 5-8-1/3.23.

3 Additional pressure relieving system for liquid level control

3.1

Where required by 5-8-15/1.4.2, 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 5-8-8/5 should be fitted to each tank. This pressure relieving system should consist of:

3.1.1

one or more relief valves set at a pressure corresponding to the gauge vapor pressure of the cargo at the reference temperature defined in 5-8-15/1.4.2; and

3.1.2

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 5-8-8/3.1.1 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.

Also see 5-8-15/1.4.2 (IMO)

3.2

The total relieving capacity of the additional pressure relieving system at the pressure mentioned in 5-8-8/3.1.1 should not be less than:

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

TABLE 1
Factor *m*

Product	$m = -di/d_{\rho_r}$ *(kJ/kg)*
Ammonia, anhydrous	*3400*
Butadiene	*1800*
Butane	*2000*
Butylene	*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.

where:

Q' = *minimum required rate of discharge of air at standard conditions of 273 K and 1.013 bar.*

$$G' = \frac{12.4}{(L + \rho_r m)D}\sqrt{\frac{Z \cdot T'}{M}}$$

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 5-8-8/Table 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 5-8-8/5.2.

3.3

Compliance with 5-8-8/3.1.1 requires changing of the setting of the relief valves provided for in this section. This should be accomplished in accordance with the provisions of 5-8-8/2.6 and 5-8-8/2.7.

3.4

Relief valves mentioned under 5-8-8/3.1.1 above may be the same as the pressure relief valves mentioned in 5-8-8/2, provided the setting pressure and the relieving capacity are in compliance with the requirements of this section.

3.5

The exhaust of such pressure relief valves may be led to the venting system referred to in 5-8-8/2.9. If separate venting arrangements are fitted these should be in accordance with the requirements of 5-8-8/2.9 to 5-8-8/2.15.

4 Vacuum protection systems

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 vapor return into the cargo tanks, or by operation of a cargo refrigeration system, need no vacuum relief protection.

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 vapor return into the cargo tanks, or by operation of a cargo refrigeration system, or by sending boil-off vapor to the machinery spaces, should be fitted with:

4.2.1

two independent pressure switches to sequentially alarm and subsequently stop all suction of cargo liquid or vapor 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

4.2.2

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

4.2.3

other vacuum relief systems acceptable to the Administration.

4.3

Subject to the requirements of Section 5-8-17, the vacuum relief valves should admit an inert gas, cargo vapor or air to the cargo tank and should be arranged to minimize the possibility of the entrance of water or snow. If cargo vapor is admitted, it should be from a source other than the cargo vapor lines.

4.4

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

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:

5.1

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

5.2

vapors 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*

$$= \frac{12.4}{LD}\sqrt{\frac{Z \cdot T}{M}}$$

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 5-8-8/Table 2; if k is not known, D = 0.606 should be used. The constant D may also be calculated by the following formula:*

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

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 of the hold less its projected area;*

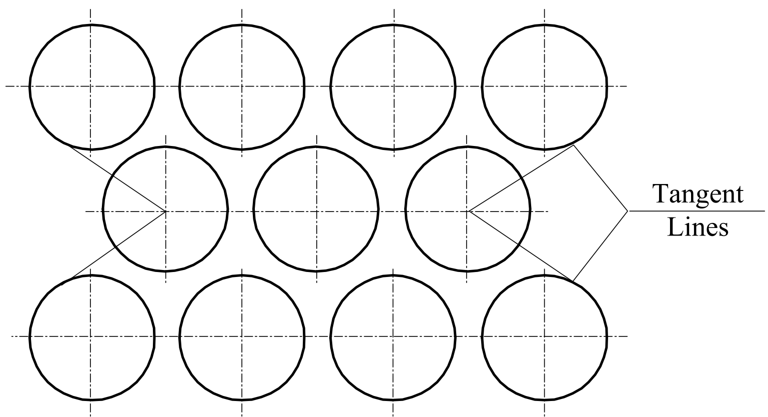
- insulation on the tank structure:

A = *external surface area of the array of pressure vessels excluding insulation, less the projected bottom area shown in 5-8-8/Figure 1.*

TABLE 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	0695	1.98	0.767
1.48	0.698	2.00	0.770
1.50	0.701	2.02	0.772
		2.20	0.792

FIGURE 1



PART

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **9 Environmental Control**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Environmental control within cargo tanks and cargo piping systems

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.

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.

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 vapor or liquid, without permitting a flammable mixture to exist at any time within the cargo tank.

1.4

Piping systems which may contain cargo should be capable of being gas-freed and purged as provided in 5-8-9/1.1 and 5-8-9/1.3.

1.5

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

1 SOLAS Amendments (ABS)

See 5-9-9/1(IMO).

2 Environmental control within the hold spaces (cargo containment systems other than type C independent tanks)

2.1

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

2.2.1

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.

2.2.2

Alternatively, subject to the restrictions specified in Section 5-8-17, the Administration may allow the spaces referred to in 5-8-9/2.2.1 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 vapor 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.

2.3

For non-flammable gases, the spaces referred to in 5-8-9/2.1 and 5-8-9/2.2.1 may be maintained with a suitable dry air or inert atmosphere.

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 5-8-4/9.7.2.

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.

4 Inerting

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.

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.

4.3

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

4.4

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

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.

5 Inert gas production on board

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 Section 5-8-17. 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 Section 5-8-17. Additionally, where inert gas is made by an onboard 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.

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.

5.3 *(1 July 2003)*

Spaces containing inert gas generating plants should have no direct access to accommodation spaces, service spaces or control stations, but may be located in machinery spaces. If such plants are located in machinery spaces or other spaces outside the cargo area, two non-return valves, or equivalent devices should be fitted in the inert gas main in the cargo area as required in 5-8-9/5.2. Inert gas piping should not pass through accommodation spaces, service spaces or control stations. When not in use, the inert gas system should be made separate from the cargo system in the cargo area except for connections to the hold spaces or interbarrier spaces.

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.

5.5 (IACS) *(1999)*

Where a nitrogen generator system is installed, it is to comply with the requirements in 5-1-7/25.41, except 5-1-7/25.41.1; 5-1-7/25.41.2(a) and 5-1-7/25.41.2(c) and where the connections to the cargo tanks, hold spaces or cargo piping are not permanent, the non-return devices required by 5-1-7/25.41.4 may be substituted by non-return valves.

PART

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION 10 Electrical Installations

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

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.

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 Section 5-8-3.

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•.

• *Reference is made to the Recommendations published by the International Electrotechnical Commission and in particular to Publication 92-502.*

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 5-8-10/2 are permitted.

1.5

Where electrical equipment is installed in gas-dangerous spaces or zones as provided in 5-8-10/1.4, 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.

1.6 Cable Installation (ABS)

A grounded distribution or a hull-return system is not to be used. Electric conductors are to be run with a view to avoiding, as far as practicable, gas dangerous spaces and they are not to pass through gas-dangerous spaces, except that certain electrical devices such as echo depth-sounding apparatus, cathodic protection anodes or safe instruments will be specially considered for installation in these spaces complete-details and arrangements are to be submitted.

1.7 Cable Type (ABS)

All cables installed within gas-dangerous spaces and zones are to be moisture-resistant jacketed (impervious-sheathed) and armored or mineral-insulated metal-sheathed and all metallic protective coverings are to be grounded in accordance with 4-8-4/23.

2 Types of equipment

Certified safe type equipment may be fitted in gas-dangerous spaces and zones in accordance with the following provisions:

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 5-8-1/3.17.

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.

2.2.1 Submerged Cargo Pump Motor (ABS)

2.2.1(a) Design. Arrangement and details are to be submitted for approval.

2.2.1(b) Motor Operation. Motors are to be capable of being energized for discharging purposes only when the conditions in 5-8-10/2.2.1(c)(ABS) are satisfied by such means as the use of a pressure cut-out switch with a manual reset.

2.2.1(c) Provision for Safe Environment. Provisions are to be made to exclude air from the tanks at all times by maintaining a positive head with either cargo vapors or inert gas when the tanks contain flammable gases in either liquid or vapor phase

2.2.2 Portable Cargo Pumps (ABS)

Where portable cargo pumps are carried onboard the vessel, in addition to the pumps required by 5-8-5/8.1, for use in cargo discharge in an emergency, they are to comply with the requirements in 5-8-10/2.2.1(ABS). Also, the pump motors should be capable of being isolated from their electrical supply during gas-freeing operations and the arrangements are to be such as to permit the shutdown of the pump motors in the event of low liquid level. The electrical outlets are to be in compliance with 5-8-10/2.5.1(ABS). Cables are to comply with 5-8-10/1.7(ABS). Flexible unarmored cables of the heavy duty type shown to be suitable for use in a low temperature environment may be specially considered upon submission of complete cable construction standards.

2.3 Hold spaces and certain other spaces

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.

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 5-8-1/3.17.5, the following may be installed:

2.3.2.1 through runs of cables;

2.3.2.2 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

2.3.2.3 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 5-8-1/3.17.5:

2.3.2.4 flameproof motors for valve operation for cargo or ballast systems; and

2.3.2.5 flameproof general alarm audible indicators.

2.4 Cargo pump and cargo compressor rooms

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.

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 gastight bulkhead or deck. Such electric motors and associated equipment should be located in a compartment complying with Section 5-8-12.

2.4.3

Where operational or structural requirements are such as to make it impossible to comply with the method described in 5-8-10/2.4.2, motors of the following certified safe types may be installed:

2.4.3.1 increased safety type with flameproof enclosure; and

2.4.3.2 pressurized type.

2.4.4

General alarm audible indicators should have flameproof enclosures.

2.5 Zones on open decks, spaces other than hold spaces

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 vapor 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:

2.5.1.1 certified safe type equipment; and

2.5.1.2 through runs of cables.

2.5.1 Socket-Outlets (IEC 92-502)

Certified safe-type socket-outlets may be considered for supplying portable cargo pumps which are used in emergency circumstances. In such cases, special additional precautions are to be taken such as link connections, or key interlocked changeover switches, to disconnect and earth the cables to socket-outlets when they are not in use; also, a pilot indicator showing when these cables are energized. Such socket-outlets are to be supplied through an isolating transformer separating the circuit from the main supply. See also 5-8-10/1.5.

2.5.2

In enclosed or semi-enclosed spaces in which pipes containing cargoes are located and in compartments for cargo hoses the following may be installed:

2.5.2.1 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

2.5.2.2 through runs of cables.

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.

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 5-8-3/6.4.

3 Integrated Cargo and Ballast Systems (IACS) *(2004)*

3.1 Application

The following requirements are applicable to integrated cargo and ballast systems installed on LNG tankers (i.e., ships constructed primarily to carry liquefied gases in bulk). The integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps (including active control and safety systems but excluding passive components, e.g., piping).

3.3 Functional Requirements

The operation of cargo and/or ballast systems may be necessary, under certain emergency circumstances or during the course of navigation, to enhance the safety of tankers. As such, measures are to be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems.

3.5 Design features

The following design features are to be fitted:

i) the emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems. A single failure in the control system circuits or the emergency stop circuits are not to render the integrated cargo and ballast system inoperative;

ii) manual emergency stops of the cargo pumps are to be arranged in such a way that they do not cause the ballast pump power pack to stop and thus make the ballast pumps inoperable;

iii) the control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

iv) in the event of failure of the automatic or remote control systems, a secondary means of control is to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

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PART

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **11 Fire Protection and Fire Extinction**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Fire safety requirements

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:

1.1.1

regulation 56.6 does not apply;

1.1.2

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;

1.1.3

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	*5-8-11/6*
56.1 and 56.2	*Section 5-8-3*
60, 61, 62	*5-8-11/3 and 5-8-11/4*
63	*5-8-11/5*

1.2

All sources of ignition should be excluded from spaces where flammable vapor may be present except as otherwise provided in Section 5-8-10 and Section 5-8-16.

1.3

The provisions of this section apply in conjunction with Section 5-8-3.

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.

2 Fire water main equipment

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 II-2/4.2.1 and II-2/4.4.1 of the 1983 SOLAS amendments, when the fire pump and fire main are used as part of the water spray system as permitted by 5-8-11/3.3. In addition, the requirements of regulation II-2/4.4.2 of the 1983 SOLAS amendments should be met at a pressure of at least 5.0 bar gauge.

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.

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.

2.4 (1 July 2003)

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

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.

3 Water spray system

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:

3.1.1

exposed cargo tank domes and any exposed parts of cargo tanks;

3.1.2

exposed on-deck storage vessels for flammable or toxic products;

3.1.3

cargo liquid and vapor 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

3.1.4

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.

3.2

The system should be capable of covering all areas mentioned in 5-8-11/3.1 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:

3.2.1

projected horizontal surface multiplied by 10 ℓ/m^2 per minute; or

3.2.2

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 5-8-11/3.1.1 and 5-8-11/3.1.2 should cover the whole of the athwartship tank grouping which includes that area.

3.2 Interpretation of 5-8-11/3.2 (ABS)

The vertical distances between water spray nozzles for protection of vertical surfaces is not to exceed 3.7 m (12 ft).

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 5-8-11/3.1.3 and 5-8-11/3.1.4. 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.

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.

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.

3.6 *(1 Oct. 1994)*

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

4 Dry chemical powder fire-extinguishing systems

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.

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.

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.

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.

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.

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.

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 5-8-11/4.1 to 5-8-11/4.6. 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.

5 Cargo compressor and pump rooms *(1 Oct. 1994)*

5.1

The cargo compressor and pump rooms of any ship should be provided with a carbon dioxide system as specified in regulation II-2/5.1 and .2 of the 1974 SOLAS Convention, as amended. 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 vapor-air mixture. For the purpose of this requirement, an extinguishing system should be provided which would be suitable for machinery spaces. However, the amount of carbon dioxide gas carried should be sufficient to provide a quantity of free gas equal to 45% of the gross volume of the cargo compressor and pump-rooms in all cases.

5.1 Interpretation of 5-8-11/5.1 (IACS)

Since the presence of flames in a room make ineffective electrostatic charges, possibly caused by the discharge of carbon dioxide, the above sentence may be interpreted in the sense that fixed carbon dioxide systems are allowed to be used for smothering fires in gas-dangerous enclosed spaces, provided that:

5.1.1

alarms for the release of carbon dioxide into such spaces are to be of the pneumatic type or electric type.

5.1.1(a) Pneumatically operated alarms. In cases where the periodic testing of such alarms is required, CO_2 operated alarms should not be used owing to the possibility of the generation of static electricity in the CO_2 cloud. Air operated alarms may be used, provided the air supply is clean and dry.

5.1.1(b) Electrically operated alarms. When electrically operated alarms are used, the arrangements are to be such that the electric actuating mechanism is located outside of the space, except where the alarms are certified intrinsically safe.

5.2

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

6 Firemen's outfits

6.1 *(1 Oct. 1994)*

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*
5,000 m^3 and below	*4*
above 5,000 m^3	*5*

6.2

Additional requirements for safety equipment are given in Section 5-8-14.

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.

PART

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CHAPTER **8** **Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **12** **Mechanical Ventilation in the Cargo Area**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

The requirements of this Section 5-8-12 should be substituted for regulation II-2/59.3 of the 1983 SOLAS amendments.

1 Spaces required to be entered during normal cargo handling operations

1.1

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

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 vapors 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.

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 vapors of the products carried.

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.

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.

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.

1.7

Ventilation intakes should be so arranged as to minimize the possibility of recycling hazardous vapors from any ventilation discharge opening.

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 Section 5-8-16.

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 vapor 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:

1.9.1

impellers or housing of nonmetallic construction, due regard being paid to the elimination of static electricity;

1.9.2

impellers and housing of nonferrous materials;

1.9.3

impellers and housing of austenitic stainless steel; and

1.9.4

ferrous impellers and housing with not less than 13 mm design tip clearance.

Any combination of an aluminum 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.

1.9 Interpretation of 5-8-12/1.9 (IACS/ABS) *(1993)*

1.9.1 General

A fan is considered as nonsparking if in both normal and abnormal conditions it is unlikely to produce sparks.

1.9.2 Design Criteria *(1993)*

1.9.2(a) The air gap between the impeller and the casing shall be not less than 10% of the impeller shaft diameter in way of the bearing but not less than 2 mm. It need not be more than 13 mm.

1.9.2(b) Protection screens of not more than 13 mm square mesh are to be fitted in the inlet and outlet of ventilation ducts to prevent the entrance of objects into the fan housing.

1.9.3 Materials

1.9.3(a) Except as indicated in 5-8-12/1.9.3(c)(IACS/ABS) below, the impeller and the housing in way of the impeller are to be made of alloys which are recognized as being spark proof by appropriate test.

1.9.3(b) Electrostatic charges both in the rotating body and the casing are to be prevented by the use of anti-static materials. Furthermore, the installation onboard of the ventilation units is to be such as to ensure the safe bonding to the hull of the units themselves.

1.9.3(c) Tests referred to in 5-8-12/1.9.3(a)(IACS/ABS) above are not required for fans having the following combinations:

i) impellers and/or housings of nonmetallic material, due regard being paid to the elimination of static electricity;

ii) impellers and housings of non-ferrous materials;

iii) impellers of aluminum alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of non-ferrous materials is fitted in way of the impeller;

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

1.9.3(d) The following impellers and housings are considered as sparking and are not permitted:

i) impellers of an aluminum alloy or a magnesium alloy and a ferrous housing, regardless of tip clearance;

ii) housing made of aluminum alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance;

iii) any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

1.9.4 Type Test

Type tests on the finished product are to be carried out using an acceptable national or international standard. The tests need not to be witnessed by the Surveyor for individual fans produced on a production line basis, provided the Surveyor is satisfied from periodic inspections and the manufacturer's quality assurance procedures that the fans are being satisfactorily tested to appropriate standards. See also 1-1-A3/5.3.

1.10

Spare parts should be carried for each type of fan on board referred to in the paragraph.

1.11

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

1.11 Interpretation of 5-8-12/1.11 (ABS) *(1993)*

5-8-12/1.11 applies to ventilation systems for which non-sparking fans/ducts are not required by 5-8-12/1.9. For other systems, see 5-8-12/1.9.2(b)(ABS).

2 Spaces not normally entered

Hold spaces, interbarrier spaces, void spaces, cofferdams, spaces containing cargo piping and other spaces where cargo vapors 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.5-8-12/1.9.

2 Interpretation of 5-8-12/2 (IACS)

Sizing pressure relief systems for interbarrier spaces

2.1 General

2.1.1

The formula for determining the relieving capacity given in 5-8-12/2.2(IACS) is developed for interbarrier spaces surrounding independent type A cargo tanks, where the thermal insulation is fitted to the cargo tanks.

2.1.2

The relieving capacity of pressure relief devices of interbarrier spaces surrounding independent type B cargo tanks may be determined on the basis of the method given in 5-8-12/2.2(IACS), however, the leakage rate is to be determined in accordance with 5-8-4/7.6.1.

2.1.3

The relieving capacity of pressure relief devices for interbarrier spaces of membrane and semi-membrane tanks is to be evaluated on the basis of the specific membrane/semi-membrane tank design.

2.1.4

The relieving capacity of pressure relief devices for interbarrier spaces adjacent to integral type cargo tanks may, if applicable, be determined as for type A independent cargo tanks.

2.1.5

Interbarrier space pressure relief devices in the scope of this interpretation are emergency devices for protecting the hull structure from being unduly overstressed in case of a pressure rise in the interbarrier space due to primary barrier failure. Therefore, such devices need not to comply with the requirements of 5-8-8/2.9 and 5-8-8/2.10.

2.2 Size of Pressure Relief Devices

The combined relieving capacity of the pressure relief devices for interbarrier spaces surrounding type A independent cargo tanks where the insulation is fitted to the cargo tanks, may be determined by the following formula:

$$Q_{sa} = 3.4 \cdot A_c \frac{\rho}{\rho_v} \sqrt{h} \quad (\mathrm{m}^3/\mathrm{s})$$

where

Q_{sa} = minimum required discharge rate of air at standard conditions of 273 K and 1.013 bar

A_c = design crack opening area (m^2)

= $\frac{\pi}{4}\,\delta \cdot \ell$ (m^2)

δ = max, crack opening width (m)

δ = 0.2 t (m)

t = thickness of tank bottom plating (m)

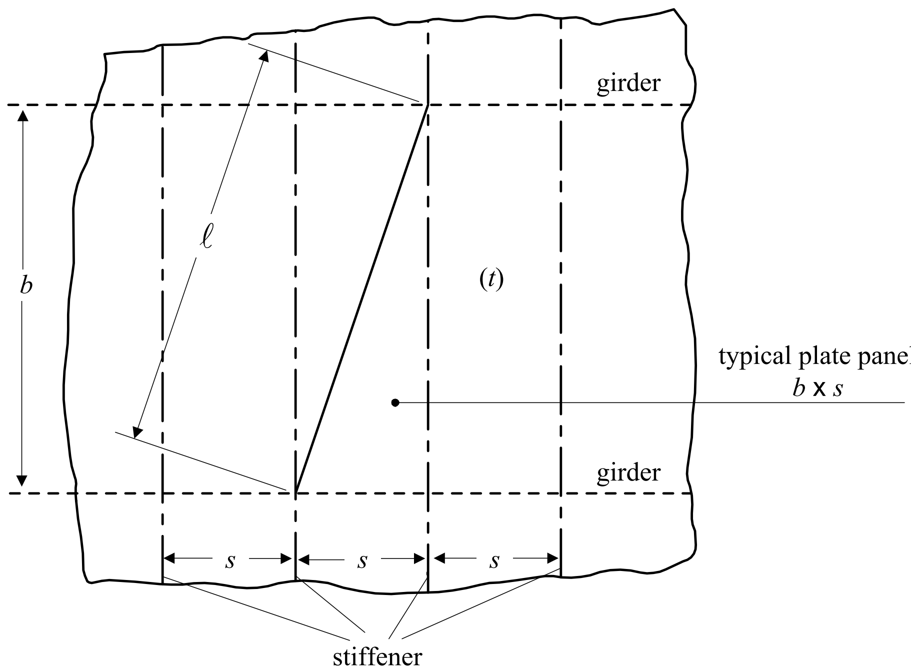
ℓ = design crack length (m) equal to the diagonal of the largest plate panel of the tank bottom, see sketch.

h = max. liquid height above tank bottom plus 10 · MARVS (m)

ρ = density of product liquid phase (kg/m^3) at the set pressure of the interbarrier space relief device

ρ_v = density of product vapor phase (kg/m^3) at the set pressure of the interbarrier space relief device and a temperature of 273 K.

MARVS = max. allowable relief valve setting of the cargo tank (bar)



3 Interpretation of 5-8-12/2 (ABS)

The ventilation system for spaces not normally entered shall have a capacity of not less than eight (8) changes per hour based on the total volume of the space.

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **13 Instrumentation (Gauging, Gas Detection and Cargo Handling Controls)**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

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 vapor piping systems, in cargo refrigerating installations and in the inert gas systems as detailed in this chapter.

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 5-8-13/6. However, the instrumentation need not be capable of locating the area where liquid cargo leaks through the primary barrier of where liquid cargo is in contact with the secondary barrier.

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.

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.

2 *Level indicators for cargo tanks*

2.1

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

2.1 Interpretation of 5-8-13/2.1 (IACS)

In order to assess whether or not only one level gauge is acceptable in relation to the aforesaid sentence, 'any maintenance' means that 'any part' of the level gauge can be overhauled while the cargo tank is in service.

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 Section 5-8-19:

2.2.1

indirect devices, which determine the amount of cargo by means such as weighing or pipe flow meters;

2.2.2

closed devices, which do not penetrate the cargo tank, such as devices using radioisotopes or ultrasonic devices;

2.2.3

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

2.2.4

restricted devices, which penetrate the tank and when in use permit a small quantity of cargo vapor 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.

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 vapor pressure not higher than 0.7 bar.

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 Section 5-8-17.

3 Overflow control

3.1 *(1 July 2003)*

Except as provided in 5-8-13/3.2, 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 5-8-5/6.1 and 5-8-5/6.3 may be used for this purpose. If another valve is used for this purpose, the same information as referred to in 5-8-5/6.4 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 port State authority may agree to alternative arrangements such as limiting the loading rate, etc.

3.1 Interpretation of 5-8-13/3.1 (IMO)

The sensor for automatic closing of the loading valve for overflow control as required in 5-8-13/3.1 may be combined with the liquid level indicators required by 5-8-13/2.1.

3.2

A high liquid level alarm and automatic shutoff of cargo tank filling need not be required when the cargo tank:

3.2.1

is a pressure tank with a volume not more than 200 m^3; or

3.2.2

is designed to withstand the maximum possible pressure during the loading operation and such pressure is below that of the start-to-discharge pressure of the cargo tank relief valve.

3.3

Electrical circuits, if any, of level alarms should be capable of being tested prior to loading.

4 Pressure gauges

4.1

The vapor space of each cargo tank should be provided with a pressure gauge which should incorporate an indicator in the control position required by 5-8-13/1.3. 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 5-8-8/2.6, high-pressure alarms should be provided for each set pressure.

4.2

Each cargo pump discharge line and each liquid and vapor cargo manifold should be provided with at least one pressure gauge.

4.3

Local-reading manifold pressure gauges should be provided to indicate the pressure between stop valves and hose connections to the shore.

4.4

Hold spaces and interbarrier spaces without open connection to the atmosphere should be provided with pressure gauges.

5 Temperature indicating devices

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.

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.

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:

5.3.1

A sufficient number of devices to establish that an unsatisfactory temperature gradient does not occur.

5.3.2

On one tank a number of devices in excess of those required in 5-8-13/5.3.1 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.

5.4

The number and position of temperature indicating devices should be to the satisfaction of the Administration.

6 Gas detection requirements

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 Section 5-8-19.

6.2

In every installation, the positions of fixed sampling heads should be determined with due regard to the density of the vapors of the products intended to be carried and the dilution resulting from compartment purging or ventilation.

6.3

Pipe runs from sampling heads should not be led through gas-safe spaces except as permitted by 5-8-13/6.5.

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 5-8-13/1.3, and at the gas detector readout location.

6.5

Gas detection equipment may be located in the control position required by 5-8-13/1.3, 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:

6.5.1

gas-sampling lines should have shutoff valves or an equivalent arrangement to prevent cross-communication with gas-dangerous spaces; and

6.5.2

exhaust gas from the detector should be discharged to the atmosphere in a safe location.

6.5 (IACS) *(1998)*

For gas monitoring of the cargo area, sampling type gas analyzing units which are not intended for a hazardous location may be located outside cargo areas (e.g., in cargo control room, navigating bridge or engine room) when mounted on the inside of the front bulkhead and subject to compliance with the following:

6.5.1

Sampling lines are not to pass through gas-safe spaces, unless permitted by 5-8-13/6.5.5 (IACS).

6.5.2

The non-safe type gas analyzing unit is to be installed in a safe area and the gas sampling lines are to be fitted with flame arresters. Sample gas is to be led to the atmosphere. The outlets are to be fitted with flame screens and are to be located in a safe location. The area within 3 m (10 ft) of the outlet pipe is to be considered a hazardous location.

6.5.3

Where sampling pipes pass through bulkheads separating safe and dangerous areas, the penetrations are to be of an approved type having fire integrity at least as effective as the bulkhead. A manual isolation valve is to be fitted at each penetration on the gas-safe side.

6.5.4 *(2002)*

The gas detection equipment, including sampling piping, sampling pumps, solenoids, analyzing units, etc., is to be contained in a reasonably gas-tight steel cabinet (e.g., fully enclosed steel cabinet with gasketed door) being monitored by its own sampling point. The entire gas analyzing unit is to be automatically shut down when the gas concentration inside the cabinet reaches 30% of the lower flammability limit.

6.5.5

Where it is impracticable to mount the cabinet on the front bulkhead, sampling pipes are to be of steel or other equivalent material and without any detachable connections, except for the isolating valves at the bulkhead and analyzing units. Runs of sampling pipes within safe space is to be the shortest possible length.

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.

6.7

A permanently installed system of gas detection and audible and visual alarms should be provided for:

6.7.1 *cargo pump rooms;*

6.7.2 *cargo compressor rooms;*

6.7.3 *motor rooms for cargo handling machinery;*

6.7.4 *cargo control rooms unless designated as gas-safe;*

6.7.5 *other enclosed spaces in the cargo area where vapor may accumulate including hold spaces and interbarrier spaces for independent tanks other than type C;*

6.7.6 *ventilation hoods and gas ducts where required by Section 5-8-16; and*

6.7.7 *air-locks.*

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 5-8-13/6.7.6 sampling should be continuous. Common sampling lines to the detection equipment should not be fitted.

6.9

In the case of products which are toxic or both toxic and flammable, the Administration, except when column "i" in the table of Section 5-8-19 refers to 5-8-17/9, 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 5-8-13/6.7 and at 30 minute intervals while they remain therein.

6.10

For the spaces listed in 5-8-13/6.7, alarms should be activated for flammable products when the vapor concentration reaches 30% of the lower flammability limit.

6.11 *(1 Oct. 1994)*

In the case of flammable products, where cargo containment systems other than independent tanks are used, hold spaces and interbarrier spaces should be provided with a permanently installed gas detection system capable of measuring gas concentrations of 0 to 100% by volume. The detection equipment, equipped with audible and visual alarms, should be capable of monitoring from each sampling head location sequentially at intervals not exceeding 30 min. Alarms should be activated when the vapor concentration reaches the equivalent of 30% of the lower flammability 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.

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 hours and in any event before personnel enter the space and at 30 min intervals while they remain therein.

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.

6.14

A suitable instrument for the measurement of oxygen levels in inert atmospheres should be provided.

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CHAPTER 8 Vessels Intended to Carry Liquefied Gases in Bulk

SECTION 14 Personnel Protection

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

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.

2 Safety equipment

2.1

Sufficient, but not less than two complete sets of safety equipment in addition to the firemen's outfits required by 5-8-11/6.1 each permitting personnel to enter and work in a gas-filled space, should be provided.

2.2

One complete set of safety equipment should consist of:

2.2.1 *one self-contained air-breathing apparatus not using stored oxygen, having a capacity of at least 1,200 ℓ of free air;*

2.2.2 *protective clothing, boots, gloves and tight-fitting goggles;*

2.2.3 *steel-cored rescue line with belt; and*

2.2.4 *explosion-proof lamp.*

2.3 *(1 Oct. 1994)*

An adequate supply of compressed air should be provided and should consist either of:

2.3.1

one set of fully charged spare air bottles for each breathing apparatus required by 5-8-14/2.1; 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 5-8-14/2.1; or

2.3.2

fully charged spare air bottles with a total free air capacity of at least 6,000l for each breathing apparatus required by 5-8-14/2.1.

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 5-8-14/2.1. 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 hour 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.

2.5

Protective equipment required in 5-8-14/1 and safety equipment required in 5-8-14/2.1 should be kept in suitable, clearly marked lockers located in readily accessible places.

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.

3 First-aid equipment *(1 Oct. 1994)*

3.1

A stretcher which is suitable for hoisting an injured person from spaces below deck should be kept in a readily accessible location.

3.2 *(1 July 2003)*

The ship should have on board medical first-aid equipment, including oxygen resuscitation equipment and antidotes for cargoes to be carried, based on the guidelines developed by the Organization.•

• *Reference is made to the Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG) which provides advice on the treatment of casualties in accordance with the symptoms exhibited as well as on equipment and antidotes that may be appropriate for treating the casualty.*

4 Personnel protection requirements for individual products

4.1

Provisions of 5-8-14/4 are applicable to ships carrying products for which those paragraphs are listed in column "i" in the table of Section 5-8-19.

4.2 *(1 Oct. 1994)*

Respiratory and eye protection suitable for emergency escape purposes should be provided for every person on board subject to the following:

4.2.1.1 filter type respiratory protection is unacceptable;

4.2.1.2 self-contained breathing apparatus should normally have a duration of service of at least 15 min;

4.2.2

emergency escape respiratory protection should not be used for fire-fighting or cargo handling purposes and should be marked to that effect;

4.2.3

two additional sets of the above respiratory and eye protection should be permanently located in the navigating bridge.

4.3

Suitably marked decontamination showers and an eyewash should be available on deck in convenient locations. The showers and eyewash should be operable in all ambient conditions.

4.4

In ships of 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 5-8-11/6.1 and 5-8-14/2.1. At least three spare charged air bottles should be provided for each self-contained air-breathing apparatus required in this paragraph.*

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.

4.6

For certain highly dangerous products, cargo control rooms should be of the gas-safe type only.

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CHAPTER 8 Vessels Intended to Carry Liquefied Gases in Bulk

SECTION 15 Filling Limits for Cargo Tanks

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

No cargo tanks should be more than 98% liquid full at the reference temperature, except as permitted by 5-8-15/1.3.

1.2

The maximum volume to which a cargo tank may 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.*

1.3

The Administration may allow a higher filling limit than the limit of 98% specified in 5-8-15/1.1 and 5-8-15/1.2 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 vapor pressure of the cargo at the set pressure of the pressure relief valves, provided the conditions specified in 5-8-8/2.17 are maintained.

1.4

For the purpose of Section.5-8-15 only, "reference temperature" means:

1.4.1

the temperature corresponding to the vapor pressure of the cargo at the set pressure of the pressure relief valves when no cargo vapor pressure/temperature control as referred to in Section 5-8-7 is provided;

1.4.2

the temperature of the cargo upon termination of loading, during transport, or at unloading, whichever is the greatest, when a cargo vapor pressure/temperature control as referred to in Section 5-8-7 is provided. If this reference temperature would result in the cargo tank becoming liquid full before the cargo reaches a temperature corresponding to the vapor pressure of the cargo at the set pressure of the relief valves required in 5-8-8/2, an additional pressure relieving system complying with 5-8-8/3 should be fitted.

1.4.2 Interpretation of 5-8-8/3.1 and 5-8-15/1.4.2 (IMO)

The words “to prevent the tank from becoming liquid full” contained in 5-8-8/3.1 and 5-8-15/1.4.2 have the following meaning: At no time during the loading, transport or unloading of the cargo, including fire conditions, will the tank be more than 98% liquid full, except as permitted by 5-8-15/1.3. These requirements, along with those of 5-8-8/2.17, are intended to ensure that the pressure relief valves remain in the vapor phase, since their design and capacity are based on such a condition.

2 Information to be provided to the master

The maximum allowable loading limits for each cargo tank should be indicated for each product which may be carried, for each loading temperature which may be applied and for the applicable maximum reference temperature, on a list to be approved by the Administration. Pressures at which the pressure relief valves, including those valves required by 5-8-8/3, have been set should also be stated on the list. A copy of the list should be permanently kept on board by the master.

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **16 Use of Cargo as Fuel** *(1 Oct. 1994)*

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

Methane (LNG) is the only cargo whose vapor or boil-off gas may be utilized in machinery spaces of Category A and in such spaces may be utilized only in boilers, inert gas generators, combustion engines and gas turbines.

1.2

These provisions do not preclude the use of gas fuels for auxiliary services in other locations provided that such other services and locations are specially considered by the Administration.

1.3 (ABS) *(1998)*

Plans and specifications covering the entire installation with all of the accessories are to be submitted (4-1-1/5) and are to include:

General arrangement

Vapor and gas piping including details of all special valves and fittings

Gas compressors

Gas heaters

Gas storage pressure vessels

Schematic-wiring diagram

Details of all electrical equipment

Electric bonding arrangement

Operating instruction manual

A failure mode and effect analysis (FMEA) examining possible faults affecting the combustion process for internal-combustion engines

2 Arrangement of machinery spaces of category A

2.1

Spaces in which gas fuel is utilized should be fitted with a mechanical ventilation system and should be arranged in such a way as to prevent the formation of dead spaces. Such ventilation should be particularly effective in the vicinity of electrical equipment and machinery or of other equipment and machinery which may generate sparks. Such a ventilation system should be separated from those intended for other spaces.

2.2

Gas detectors should be fitted in these spaces, particularly in the zones where air circulation is reduced. The gas detection system should comply with the requirements of Section 5-8-13.

2.3

Electrical equipment located in the double wall pipe or duct specified in 5-8-16/3.1 should be of the intrinsically safe type.

3 Gas fuel supply

3.1

Gas fuel piping should not pass through accommodation spaces, service spaces or control stations. Gas fuel piping may pass through or extend into other spaces provided they fulfill one of the following:

3.1.1

the gas fuel piping should be a double wall piping system with the gas fuel contained in the inner pipe. The space between the concentric pipes should be pressurized with inert gas at a pressure greater than the gas fuel pressure. Suitable alarms should be provided to indicate a loss of inert gas pressure between the pipes; or

3.1.2

the gas fuel piping should be installed within a ventilated pipe or duct. The air space between the gas fuel piping and inner wall of this pipe or duct should be equipped with mechanical exhaust ventilation having a capacity of at least 30 air changes per hour. The ventilation system should be arranged to maintain a pressure less than the atmospheric pressure. The fan motors should be placed outside the ventilated pipe or duct. The ventilation outlet should be placed in a position where no flammable gas-air mixture may be ignited. The ventilation should always be in operation when there is gas fuel in the piping. Continuous gas detection should be provided to indicate leaks and to shut down the gas fuel supply to the machinery space in accordance with 5-8-16/3.10. The master gas fuel valve required by 5-8-16/3.7 should close automatically if the required air flow is not established and maintained by the exhaust ventilation system.

3.1 (IACS) *(1998)*

Gas fuel piping passing through or extending into machinery spaces or other gas-safe spaces other than accommodation spaces, service spaces and control stations is to comply with the following:

3.1.1

Where the option in 5-8-16/3.1.1 is used, construction and strength of the outer pipes is to be in accordance with 5-8-5/2. The pressure in the space between concentric pipes is to be continuously monitored. An alarm is to be issued and the two automatic valves in the gas fuel line (interlocked gas valves) specified in 5-8-16/3.6 and the master gas fuel valve (master gas valve) specified in 5-8-16/3.7 are to be closed before the pressure drops to below the inner pipe pressure. At the same time, the third interlocked gas valve connected to the vent outlet is to be opened. The inside of the gas fuel supply piping system between the master gas valve and the engine is to be automatically purged with inert gas when the master valve is closed.

3.1.2

Where the option in 5-8-16/3.1.2 is used, the number of flanged joints in protective pipes or ducts is to be minimized. The materials, construction and strength of protection pipes or ducts and mechanical ventilation systems are to be sufficiently durable against bursting and rapid expansion of high pressure gas in the event of gas pipe burst. The air intakes of the mechanical ventilation system are to be provided with non-return devices effective for gas fuel leaks; however, if a gas detector is fitted at the air intakes, the non-return devices can be dispensed with.

3.1.3

Alternative arrangements to those given above may be considered if they provide an equivalent level of safety.

3.2

If a gas leak occurs, the gas fuel supply should not be restored until the leak has been found and repaired. Instructions to this effect should be placed in a prominent position in the machinery spaces.

3.3

The double wall piping system or the ventilated pipe or duct provided for the gas fuel piping should terminate at the ventilation hood or casing required by 5-8-16/3.4.

3.4

A ventilation hood or casing should be provided for the areas occupied by flanges, valves, etc., and for the gas fuel piping, at the gas fuel utilization units, such as boilers, diesel engines or gas turbines. If this ventilation hood or casing is not served by the exhaust ventilation fan serving the ventilated pipe or duct as specified in 5-8-16/3.1.2, 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 5-8-16/3.10. The master gas fuel valve required by 5-8-16/3.7 should close automatically if the required air flow is not established and maintained by the exhaust ventilation system. The ventilated hood or casing should be installed or mounted to permit the ventilating air to sweep across the gas utilization unit and be exhausted at the top of the ventilation hood or casing.

3.4 (ABS)

Ventilation equipment for the vented hood is to be capable of changing the air at least once in two minutes and in no case permit a pressure less than atmospheric in way of the burners.

3.5

The ventilation inlet and discharge for the required ventilation systems should be respectively from and to a safe location.

3.6

Each gas utilization unit should be provided with a set of three automatic valves. Two of these valves should be in series in the gas fuel pipe to the consuming equipment. The third valve should be in a pipe that vents, to a safe location in the open air, that portion of the gas fuel piping that is between the two valves in series. These valves should be arranged so that failure of the necessary forced draft, loss of flame on boiler burners, abnormal pressure in the gas fuel supply line, or failure of the valve control actuating medium will cause the two gas fuel valves which are in series to close automatically and the vent valve to open automatically. Alternatively, the function of one of the valves in series and the vent valve can be incorporated into one valve body so arranged that, when one of the above conditions occurs, flow to the gas utilization unit will be blocked and the vent opened. The three shut-off valves should be arranged for manual reset.

3.7

A master gas fuel valve that can be closed from within the machinery space should be provided within the cargo area. The valve should be arranged so as to close automatically if leakage of gas is detected, or loss of ventilation for the duct or casing or loss of pressurization of the double wall gas fuel piping occurs.

3.8

Gas fuel piping in machinery spaces should comply with 5-8-5/2 through 5-8-5/5 as far as found applicable. The piping should, as far as practicable, have welded joints. Those parts of the gas fuel piping, which are not enclosed in a ventilated pipe or duct according to 5-8-16/3.1 and are on the open deck outside the cargo area should have full penetration butt welded joints and should be fully radiographed.

3.9

Provision should be made for inerting and gas-freeing that portion of the gas fuel piping system located in the machinery space.

3.10

Gas detection systems provided in accordance with the requirements of 5-8-16/3.1 and 5-8-16/3.4 should comply with 5-8-13/6.2 and 5-8-13/6.4 through 5-8-13/6.8 as applicable; they should activate the alarm at 30% of the lower flammable limit and shut down the master gas fuel valve referred to in 5-8-16/3.7 before the gas concentration reaches 60% of the lower flammable limit.

3 (No text – *1 Oct. 1994*)

4 Gas make-up plant and related storage tanks (1 Oct. 1994)

4.1

All equipment (heaters, compressors, filters, etc.) for making-up the gas for its use as fuel, and the related storage tanks should be located in the cargo area in accordance with 5-8-3/1.5.4. If the equipment is in an enclosed space, the space should be ventilated according to 5-8-12/1 and be equipped with a fixed fire extinguishing system according to 5-8-11/5 and with a gas detection system according to 5-8-13/6, as applicable.

4.2

The compressors should be capable of being remotely stopped from a position which is always easily accessible, and also from the engine room. In addition, the compressors should be capable of automatically stopping when the suction pressure reaches a certain value depending on the set pressure of the vacuum relief valves of the cargo tanks. The automatic shut-down device of the compressors should have a manual resetting. Volumetric compressors should be fitted with pressure relief valves discharging into the suction line of the compressor. The size of the pressure relief valves should be determined in such a way that, with the delivery valve kept closed, the maximum pressure does not exceed by more than 10% the maximum working pressure. The requirements of 5-8-5/6.1.3 apply to these compressors.

4.3

If the heating medium for the gas fuel evaporator or heater is returned to spaces outside the cargo area it should first go through a degassing tank. The degassing tank should be located in the cargo area. Provisions should be made to detect and alarm the presence of gas in the tank. The vent outlet should be in a safe position and fitted with a flame screen.

4.4

Piping and pressure vessels in the gas fuel conditioning system should comply with Section 5-8-5.

4 (No Text – *1 Oct. 1994*)

5 Special requirements for main boilers (1 Oct. 1994)

5.1

Each boiler should have a separate uptake.

5.2

A system suitable to ensure the forced draught in the boilers should be provided. The particulars of such a system should be to the satisfaction of the Administration.

5.3

Combustion chambers of boilers should be of suitable form such as not to present pockets where gas may accumulate.

5.4

The burner systems should be of dual type, suitable to burn either oil fuel or gas fuel alone or oil and gas fuel simultaneously. Only oil fuel should be used during manoeuvring and port operations unless automatic transfer from gas to oil burning is provided in which case the burning of a combination of oil and gas or gas alone may be permitted provided the system is demonstrated to the satisfaction of the Administration.

It should be possible to change over easily and quickly from gas fuel operation to oil fuel operation. Gas nozzles should be fitted in such a way that gas fuel is ignited by the flame of the oil fuel burner. A flame scanner should be installed and arranged to assure that gas flow to the burner is cut off unless satisfactory ignition has been established and maintained. On the pipe of each gas burner a manually operated shut-off valve should be fitted. An installation should be provided for purging the gas supply piping to the burners by means of inert gas or steam, after the extinguishing of these burners.

5.5

Alarm devices should be fitted in order to monitor a possible decrease in liquid fuel oil pressure or a possible failure of the related pumps.

5.6

Arrangements should be made that, in case of flame failure of all operating burners for gas or oil or for a combination thereof, the combustion chambers of the boilers are automatically purged before relighting. Arrangements should also be made to enable the boilers to be manually purged. See 1996 Amendments to the IGC Code (Resolution MSC.59(67)).

5 Boiler Casings (ABS)

When the boilers are fitted with a double casing, care is to be exercised to preclude the possibility of gases leaking into and being trapped in pockets of the inner casing. Gas-detection probes within the casing and explosion-relief panels on the outer casing are to be provided.

6 Boiler Burners (ABS)

6.1 Firing Condition

The burners are to maintain complete and stable combustion under all operating conditions including the minimum rate of firing, or during any sudden change in gas firing rate between maximum and minimum rates.

6.2 Valve Marking

Important valves are to be plainly marked to indicate the service controlled. Detailed operating instructions are to be posted, including a sequence of valve operations, where this information is necessary for effective emergency action.

6 Special requirements for gas fired internal combustion engines and gas fired turbines *(1 Oct. 1994)*

Special provisions for gas fuelled internal combustion engines and for gas turbines will be considered by the Administration in each case.

8 Additional Requirements for Internal-combustion Engines and Gas Turbines (ABS/IACS)

Internal-combustion engines are to comply with the following additional requirements detailed in 5-8-16/9(ABS/IACS) through 5-8-16/17(ABS/IACS). Gas turbines are also to comply with these additional requirements, as applicable. However, special consideration will be given to alternative arrangements.

9 General (ABS/IACS) *(1998)*

Engines are to be of the compression-ignition, dual-fuel type using pilot-oil fuel ignition and arranged for rapid changeover to oil fuel. Only oil fuel is to be used when starting the engine during periods of unstable engine operation and during maneuvering and port operations. In case of shut-off of the gas supply, the engines are to be capable of continuous operation by oil fuel only.

10 Gas and Air Supply (ABS/IACS) *(1998)*

10.1 Gas Supply

Each cylinder is to have a separate gas supply and gas inlet valve. Flame arresters are to be provided at the inlet to the gas supply manifold for the engine. Arrangements are to be provided so that the gas supply to the engine can be shut off manually from the maneuvering platform. The arrangement and installation of the gas piping are to provide the necessary flexibility to accommodate the oscillating movements of the engine without risk of fatigue failure. The connecting of gas lines and the protection pipes or ducts in 5-8-16/3.1(IACS) to the gas fuel injection valves are to provide complete coverage by the protection pipes or ducts.

10.2 Starting Air

Means are to be provided to exclude gas from starting air if the engine is air-started. Starting air branch pipes to each cylinder are also to be provided with flame arresters.

10.3 Air Intakes

Air intakes are not to be located where gases or vapors could be introduced into the engine or turbine through the intake. An explosion relief valve or other appropriate protection against explosion is to be provided in the air inlet manifold.

11 Protection of Crankcase and Piston Underside Space (ABS/IACS) *(1998)*

In addition to the requirements of 4-2-1/7, consideration is to be given to the following.

11.1 Ventilation and Monitoring

For a trunk piston type engine, ventilation is to be provided for the crankcase to prevent accumulation of gas. Arrangements are to be made so that any blow-by gas may readily reach the vent. The crankcase vent is to be led to a safe location in the atmosphere through a flame arrester. The crankcase is also to be protected by an oil mist detector and gas detecting or equivalent equipment. For a cross-head type engine, the crankcase is to be protected by an oil mist detector or bearing temperature detector. Gas detection or equivalent equipment is to be provided for the piston underside space.

11.2 Explosion Relief Valves

The present Rule requirements for explosion relief valves in 4-2-1/7.1 are based on the low pressure expected to develop through the ignition of fuel or lubricating oil vapors. Since the pressures due to the ignition of the blow-by gas may be considerably greater, consideration is to be given to increasing the relief-valve areas. Also, since the detonation pressure depends on the length of flame travel, it is necessary to provide one or more relief valves in way of each crank throw. The area of the relief valves and their location will be subject to special consideration in each case.

11.3 Warning Notice

The warning notice required by 4-2-1/7.13.1 is to include a caution that the crankcase is not to be opened until adequate precautions have been taken to insure that no gas remains trapped in the crankcase.

12 Engine Protective Devices (ABS/IACS) *(1998)*

12.1 Automatic Shut-off Valves

In addition to the causes specified in 5-8-16/3.6, the two series gas fuel valves (interlocked gas valves) are to automatically shut off the flow of gas in the following cases

any of the failure conditions specified in 5-8-16/12.2(ABS/IACS)

the unit stops from any cause.

pressure drop in the space between concentric pipes, as specified in 5-8-16/3.1.1(IACS)

In addition to the causes specified in 5-8-16/3.7, the master gas valve is to automatically close in the following cases:

the oil mist detector or bearing temperature detector specified in 5-8-16/11.1(ABS/IACS) detects an abnormal condition

any gas fuel leakage is detected

pressure drop in the space between concentric pipes, as specified in 5-8-16/3.1.1(IACS)

high gas concentration, as specified in 5-8-16/12.4(ABS/IACS).

It is also recommended that the master gas valve close automatically upon activation of the interlocked gas valves.

12.2 Internal-combustion Engines

In addition to the protective devices required by 4-2-1/7, means are to be provided for shutting off the fuel supply to the engine from a readily accessible location outside of the machinery space. Details of required monitoring will be determined based on the outcome of the Failure Mode and Effect Analysis required by 5-8-16/1.3(ABS); however, the following table may be used for guidance.

Failure Condition	*Alarm*	*Automatic Shut-off of Interlocked Gas Valves*
Malfunction of gas fuel injection or pilot oil fuel injection valves	X	X
Exhaust gas temperature at each cylinder outlet and deviation from average	X	X
Cylinder pressure or ignition failure of each cylinder	X	X

12.3 Gas Turbines

In addition to the protective devices required by Section 4-2-3, the gas turbines are to be fitted with an automatic shut-down device for high exhaust temperatures.

12.4 Emergency Stop

The engine is to be stopped before the gas concentration detected by the gas detectors specified in 5-8-16/2.2 reach 60% of the lower flammable limit.

13 Regulators (ABS)

When the gas pressure on the upstream side of a regulator exceeds 350 mm (14 in.) of H_2O, a relief valve is to be installed on the downstream side of the regulator. This relief valve is to discharge to a safe location in the atmosphere through a flame arrester. The capacity of the relief valve is to be adequate to vent the volume of gas that would pass through the regulator if that device should fail.

14 Engine Exhaust and Scavenge Systems (ABS/IACS) *(1998)*

Explosion relief valves or other appropriate protection against explosion are to be provided in the exhaust and scavenge manifolds. The explosion-relief valves are to be of the return-seating type. The arrangement and location of the valves is to minimize the dangers from emission of flame.

The exhaust gas pipes from dual-fuel engines are not to be connected to the exhaust pipes of other engines or systems.

15 Machinery-space Ventilation (ABS)

Adequate ventilation of the machinery space is to be provided. Because of the design of the engine and its gas piping system, it may be necessary to provide a mechanically-vented hood. This vented hood is to exhaust to a safe location in the atmosphere through a flame arrester. No electric equipment is to be fitted within the hood, except that which is certified safe.

16 Operating Instructions (ABS)

Instructions for starting, operation, and routine maintenance are to be posted conspicuously on or near each gas-fired unit.

17 Requirements for Automatic or Remote Control of Propulsion Machinery (ABS) *(1994)*

Propulsion machinery using methane as fuel and intended for automatic operations or operations from a remote control station are to comply with the applicable requirements in Part 4, Chapter 9, in particular Section 4-9-7.

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PART

5

CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **17 Special Requirements**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General (1 Oct. 1994)

The provisions of this chapter are applicable where reference is made in column "i" in the table of Section 5-8-19. These are requirements additional to the general requirements of the Code.

2 Materials of construction (1 Oct. 1994)

Materials which may be exposed to cargo during normal operations should be resistant to the corrosive action of the gases. In addition, the following materials of construction for cargo tanks, and associated pipelines, valves, fittings and other items of equipment should not be used for certain products as specified in column "i" in the table of Section 5-8-19:

2.1

mercury, copper and copper-bearing alloys, and zinc;

2.2

copper, silver, mercury, magnesium and other acetylide-forming metals;

2.3

aluminum and aluminum-bearing alloys;

2.4

copper, copper alloys, zinc and galvanized steel;

2.5

aluminum, copper and alloys of either;

2.6

copper and copper-bearing alloys with greater than 1% copper.

3 Independent tanks

3.1

Products should be carried in independent tanks only.

3.2

Products should be carried in type C independent tanks and the provisions of 5-8-7/1.3 apply. The design pressure of the cargo tank should take into account any padding pressure or vapor discharge unloading pressure.

4 Refrigeration systems

4.1

Only the indirect system described in 5-8-7/2.4.2 should be used.

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:

4.2.1

using the indirect system described in 5-8-7/2.4.2 with the condenser inside the cargo tank; or

4.2.2

using the direct system or combined system described in 5-8-7/2.4.1 and 5-8-7/2.4.3 respectively, or the indirect system described in 5-8-7/2.4.2 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.

4.3

If the ship is to carry consecutively products as specified in 5-8-17/4.2 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 vapor from the second cargo, if compatible. Practical steps should be taken to ensure that polymers or peroxides do not accumulate in the cargo system.

5 Deck cargo piping

One hundred per cent radiography of all butt-welded joints in cargo piping exceeding 75 mm in diameter is required.

6 Exclusion of air from vapor spaces

Air should be removed from the cargo tanks and associated piping before loading and then subsequently excluded by:

6.1

introducing inert gas to maintain a positive pressure. Storage or production capacity of the inert gas should be sufficient to meeting 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

6.2

control of cargo temperatures such that a positive pressure is maintained at all times.

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 vapor is introduced to prevent negative pressures. For the purposes of this paragraph, dry air is air which has a dewpoint of -46°C or below at atmospheric pressure.

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:

8.1

name and amount of inhibitor added;

8.2

date inhibitor was added and the normally expected duration of its effectiveness;

8.3

any temperature limitations affecting the inhibitor;

8.4

the action to be taken should the length of the voyage exceed the effective lifetime of the inhibitors.

9 Permanently installed toxic gas detectors

9.1

Gas sampling lines should not be led into or through gas-safe spaces. Alarms referred to in 5-8-13/6.7 should be activated when the vapor concentration reaches the threshold limiting value.

9.2

The alternative of using portable equipment in accordance with 5-8-13/6.9 should not be permitted.

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 vapor or by icing up in adverse weather conditions. Ordinary protection screens should be fitted after removal of the flame screens.

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.*

12 Submerged electric cargo pumps

The vapor 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

13 Ammonia *(1 Oct. 1994)*

13.1

Anhydrous ammonia may cause stress corrosion cracking in containment and process systems made of carbon manganese steel or nickel steel. To minimize the risk of this occurring, measures detailed in 5-8-17/13.2 to 5-8-17/13.8 should be taken as appropriate.

13.2

Where carbon manganese steel is used, cargo tanks, process pressure vessels and cargo piping should be made of fine grained steel with a specified minimum yield strength not exceeding 355 N/mm^2 *and with an actual yield strength not exceeding 440* N/mm^2*. One of the following constructional or operational measures should also be taken*

13.2.1

lower strength material with a specified minimum tensile strength not exceeding 410 N/mm^2 *should be used; or*

13.2.2

cargo tanks, etc., should be post weld stress relief heat treated; or

13.2.3

carriage temperature should be maintained preferably at a temperature close to the product's boiling point of -33°C but in no case at a temperature above -20°C; or

13.2.4

the ammonia should contain not less than 0.1% w/w water.

13.3

If carbon manganese steels with higher yield properties are used other than those specified in 5-8-17/13.2, the completed cargo tanks, piping, etc. should be given a post weld stress relief heat treatment.

13.4

Process pressure vessels and piping of the condensate part of the refrigeration system should be given a post-weld stress relief heat treatment when made of materials mentioned in 5-8-17/13.1

13.5

The tensile and yield properties of the welding consumables should exceed those of the tank or piping material by the smallest practical amount.

13.6

Nickel steel containing more than 5% nickel and carbon manganese steel not complying with the requirements of 5-8-17/13.2 and 5-8-17/13.3 are particularly susceptible to ammonia stress corrosion cracking and should not be used for containment and piping systems for the carriage of this product.

13.7

Nickel steel containing not more than 5% nickel may be used provided the carriage temperature complies with the requirements specified in 5-8-17/13.2.3.

13.8

In order to minimize the risk of ammonia stress corrosion cracking, it is advisable to keep the dissolved oxygen content below 2.5 ppm/w/w. This can best be achieved by reducing the average oxygen content in the tanks prior to the introduction of liquid ammonia to less than the values given as a function of the carriage temperature T in the table below:

T(°C)	O_2 (% v/v)
-30 and below	0.90
-20	0.50
-10	0.28
0	0.16
10	0.10
20	0.05
30	0.03

Oxygen percentages for intermediate temperatures may be obtained by direct interpolation.

14 Chlorine

14.1 Cargo containment system

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.

14.1.2

The tank design vapor pressure should not be less than 13.5 bar (see also 5-8-7/1.3 and in 5-8-17/3.2 of this Section).

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.

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 vapor 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.

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.

14.1.6

The Administration and the port Administration may require that chlorine is carried in refrigerated state at a specified maximum pressure.

14.2 Cargo piping systems

14.2.1

Cargo discharge should be performed by means of compressed chlorine vapor from shore, dry air or another acceptable gas or fully submerged pumps. The pressure in the vapor 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.

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.

14.2.3

Relief valves of the cargo piping system should discharge to the absorption plant (see also 5-8-8/2.16).

14.3 Materials

14.3.1

The cargo tanks and cargo piping systems should be made of steel suitable for the cargo and for a temperature of -40°C, even if a higher transport temperature is intended to be used.

14.3.2

The tanks should be thermally stress relieved. Mechanical stress relief should not be accepted as an equivalent.

14.4 Instrumentation – safety devices

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.

14.4.2

During the gas-freeing on cargo tanks, vapors should not be discharged to the atmosphere.

14.4.3 (1 Oct. 1994)

A gas detecting system should be provided capable of monitoring chlorine concentrations of at least 1 ppm by volume. Suction points should be located:

14.4.3.1 near the bottom of the hold spaces;

14.4.3.2 in the pipes from the safety relief valves;

14.4.3.3 at the outlet from the gas absorbing plant;

14.4.3.4 at the inlet to the ventilation systems for the accommodation, service and machinery spaces and control stations;

14.4.3.5 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.

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.

14.5 Personnel protection

In addition to the requirements given in Section 5-8-14 the following requirements should be met:

14.5.1

The enclosed space required by 5-8-14/4.5 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 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 hours. One of the decontamination showers required by 5-8-14/4.3 should be located near the air-lock to the space.

14.5.2

A compressor and the necessary equipment for filling the air bottles should be provided.

14.5.3

One set of oxygen therapy equipment should be carried in the space referred to in 5-8-17/14.5.1.

14.6 Filling limits for cargo tanks

14.6.1

The requirements of 5-8-15/1.4.2 do not apply when it is intended to carry chlorine.

14.6.2

The chlorine content of the gas in the vapor space of the cargo tank after loading should be greater than 80% by volume.

15 Diethyl ether and vinyl ethyl ether

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.

15.2

Inert gas displacement may be used of discharging cargo from type C independent tanks provided the cargo system is designed for the expected pressure.

16 Ethylene oxide

16.1

For the carriage of ethylene oxide the requirements of 5-8-17/20 apply, with the additions and modifications as given in this section.

16.2

Deck tanks should not be used for the carriage of ethylene oxide.

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.

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, propellent 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.

16.5

Ethylene oxide should be discharged only by deepwell pumps or inert gas displacement. The arrangement of pumps should comply with 5-8-17/20.5.3.

16.6

Ethylene oxide should be carried refrigerated only and maintained at temperatures of less than 30°C.

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.

16.8

The protective padding of nitrogen gas as required by 5-8-17/20.15 should be such that the nitrogen concentration in the vapor space of the cargo tank will at no time be less than 45% by volume.

16.9

Before loading and at all times when the cargo tank contains ethylene oxide liquid or vapor, the cargo tank should be inerted with nitrogen.

16.10

The water spray system required by paragraph 5-8-17/20.17 and that required by 5-8-11/3 should operate automatically in a fire involving the cargo containment system.

16.11

A jettisoning arrangement should be provided to allow the emergency discharge of ethylene oxide in the event of uncontrollable self-reaction.

17 Isopropylamine and monoethylamine

Separate piping systems should be provided as defined in 5-8-1/3.32.

18 Methyl acetylene-propadiene mixtures

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

18.2

Examples of acceptable, stabilized compositions are:

18.2.1 Composition 1

18.2.1.1 maximum methyl acetylene to propadiene molar ratio of 3 to 1;

18.2.1.2 maximum combined concentration of methyl acetylene and propadiene of 65 mol per cent;

18.2.1.3 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

18.2.1.4 maximum combined concentration of propylene and butadiene of 10 mol per cent.

18.2.2 Composition 2

18.2.2.1 maximum methyl acetylene and propadiene combined concentration of 30 mol percent*;*

18.2.2.2 maximum methyl acetylene concentration of 20 mol per cent;

18.2.2.3 maximum propadiene concentration of 20 mol per cent;

18.2.2.4 maximum propylene concentration of 45 mol per cent;

18.2.2.5 maximum butadiene and butylenes combined concentration of 2 mol per cent;

18.2.2.6 minimum saturated C_4 hydrocarbon concentration of 4 mol per cent; and

18.2.2.7 minimum propane concentration of 25 mol per cent.

18.3

Other compositions may be accepted provided the stability of the mixture is demonstrated to the satisfaction of the Administration.

18.4

A ship carrying methyl acetylene-propadiene mixtures should preferably have an indirect refrigeration system as specified in 5-8-7/2.4.2. Alternatively, a ship not provided with indirect refrigeration may utilize direct vapor compression refrigeration subject to pressure and temperature limitations depending on the composition. For the example compositions given in 5-8-17/18.2, the following features should be provided:

18.4.1

A vapor compressor that does not raise the temperature and pressure of the vapor above 60°C and 17.5 bar gauge during its operation, and that does not allow vapor to stagnate in the compressor while it continues to run.

18.4.2

Discharge piping from each compressor stage or each cylinder in the same stage of a reciprocating compressor should have:

18.4.2.1 two temperature-actuated shutdown switches set to operate at 60°C or less;

18.4.2.2 a pressure-actuated shutdown switch set to operate at 17.5 bar gauge or less; and

18.4.2.3 a safety relief valve set to relieve at 18.0 bar gauge or less.

18.4.3

The relief valve required by 5-8-17/18.4.2.3 should vent to a mast meeting the requirements of 5-8-8/2.9, 5-8-8/2.10, 5-8-8/2.13 and 5-8-8/2.14 and should not relieve into the compressor suction line.

18.4.4

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.

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 5-8-1/3.20) or separate (as defined in 5-8-1/3.32) from piping and refrigeration systems for other tanks. This segregation applies to all liquid and vapor vent lines and any other possible connections, such as common inert gas supply lines.

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.

20 Propylene oxide and mixtures of ethylene oxide-propylene oxide with ethylene oxide content of not more than 30% by weight

20.1

Products transported under the provisions of this section should be acetylene-free.

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 catalyze polymerization, such as:

20.2.1.1 anhydrous ammonia and ammonia solutions;

20.2.1.2 amines and amine solutions;

20.2.1.3 oxidizing substances (e.g. chlorine).

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

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.

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

20.2.5

Tanks for the carriage of these products should be of steel or stainless steel construction.

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.

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.

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 behavior. 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.

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.

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:

20.3.4.1 Neoprene or natural rubber if it comes into contact with the products;

20.3.4.2 Asbestos or binders used with asbestos;

20.3.4.3 Materials containing oxides of magnesium, such as mineral wools.

20.4

Filling and discharge piping should extend to within 100 mm of the bottom of the tank or any sump.

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 vapor return to shore is used during tank loading, the vapor return system connected to a containment system for the product should be independent of all other containment systems.

20.5.2

During discharging operations, the pressure in the cargo tank should be maintained above 0.07 bar gauge.

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.

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.

20.7

Cargo hoses used for transfer of these products should be marked "FOR ALKYLENE OXIDE TRANSFER ONLY"

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.

20.9

Prior to disconnecting shorelines, the pressure in liquid and vapor lines should be relieved through suitable valves installed at the loading header. Liquid and vapor from these lines should not be discharged to atmosphere.

20.10

Tanks should be designed for the maximum pressure expected to be encountered during loading, carriage or unloading of cargo.

20.11

Tanks for the carriage of propylene oxide with a design vapor pressure of less than 0.6 bar and tanks for the carriage of ethylene oxide-propylene oxide mixtures with a design vapor pressure of less than 1.2 bar should have a cooling system to maintain the cargo below the reference temperature. For reference temperature see 5-8-15/1.4.1.

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.

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 these products is not independent as defined in 5-8-1/3.20 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 vapor piping, liquid and vapor vent lines and any other possible connections such as common inert gas supply lines.

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.

20.13.3

Before each initial loading of these products and before every subsequent return to such service, certification verifying that the required piping separation has been achieved should be obtained from a responsible person acceptable to the port Administration and carried on board the ship. Each connection between a blank flange and 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.

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.

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.

20.16

The cargo tank space should be tested prior to and after loading to ensure that the oxygen content is 2% by volume or less.

20.17 *(1 Oct. 1994)*

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. This water spray system should be capable of both local and remote manual operation and the arrangement should ensure that any spilled cargo is washed away. Remote manual operation should be arranged such that remote starting of pumps supplying water spray system and remote operation of any normally closed valves in the system can be carried out from a suitable location outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected. Additionally, a water hose with pressure to the nozzle, when ambient temperatures permit, should be connected ready for immediate use during loading and unloading operations.

21 Vinyl chloride

In cases where polymerization of vinyl chloride is prevented by addition of an inhibitor, 5-8-17/8 is applicable. In cases where no or insufficient inhibitor has been added, any inert gas used for the purposes of Subsection 6 should contain not more oxygen than 0.1%. Before loading is started, inert gas samples from the tanks and piping should be analyzed. When vinyl chloride is carried, a positive pressure should always be maintained in the tanks, also during ballast voyages between successive carriages.

PART

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CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **18 Operating Requirements**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Cargo information

1.1 *(1 Oct. 1994)*

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:

1.1.1

a full description of the physical and chemical properties necessary for the safe containment of the cargo,

1.1.2

action to be taken in the event of spills or leaks;

1.1.3

counter-measures against accidental personal contact;

1.1.4

fire-fighting procedures and fire-fighting media;

1.1.5

procedures for cargo transfer, gas-freeing, ballasting, tank cleaning and changing cargoes;

1.1.6

special equipment needed for the safe handling of the particular cargo;

1.1.7

minimum allowable inner hull steel temperatures; and

1.1.8

emergency procedures

1.2

Products required to be inhibited should be refused if the certificate required by 5-8-17/8 is not supplied.

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.

2 Compatibility

2.1

The master should ascertain that the quantity and characteristics of each product to be loaded are within the limits indicated in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and in the Loading and Stability information booklet provided for in 5-8-2/2.5 and that products are listed in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk as required under Section 3 of the Certificate.

2.2

Care should be taken to avoid dangerous chemical reactions if cargoes are mixed. This is of particular significance in respect of:

2.2.1

tank cleaning procedures required between successive cargoes in same tank; and

2.2.2

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 5-8-1/3.32

3 Personnel training •

3.1

Personnel involved in cargo operations should be adequately trained in handling procedures

3.2

All personnel should be adequately trained in the use of protective equipment provided on board and have basic training in the procedure, appropriate to their duties, necessary under emergency conditions

3.3 *(1 July 2003)*

Officers should be trained in emergency procedures to deal with conditions of leakage, spillage or fire involving the cargo, based on the guidelines developed by the Organization••, and a sufficient number of them should be instructed and trained in essential first aid for the cargoes carried.

• *Reference is made to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, 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.*

•• *Reference is made to the Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG), which provides advice on the treatment of casualties in accordance with the symptoms exhibited as well as on equipment and antidotes that may be appropriate for treating the casualty, and to the relevant provisions of the STCW Code, parts A and B.*

4 Entry into spaces

4.1

Personnel should not enter cargo tanks, hold spaces, void spaces, cargo handling spaces or other enclosed spaces where gas may accumulate, unless:

4.1.1

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

4.1.2

personnel wear breathing apparatus and other necessary protective equipment and the entire operation is under the close supervision of a responsible officer.

4.2

Personnel entering any space designed 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

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 the de-absorbing characteristics of the insulation material should be taken into account.

4.3.2

For internal insulation tanks, repairs should be carried out in accordance with the procedures provided for in paragraph 5-8-4/4.7.6

5 Carriage of cargo at low temperature

5.1

When carrying cargoes at low temperature:

5.1.1

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,

5.1.2

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

5.1.3

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

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 5-8-14/1 during cargo handling.

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.

8 Cargo transfer operations

8.1

Transfer operations including emergency procedures should be discussed between ship personnel and the personnel responsible at the shore facility prior to commencement and communications maintained throughout the transfer operations.

8.2

The closing time of the valve referred to in 5-8-13/3.1 (i.e. time from shutdown signal initiation to complete valve closure) should not be greater than:

$$\frac{3600U}{LR} \text{ (s)}$$

where

U = *ullage volume at operating signal level (m^3)*

LR = *maximum loading rate agreed between ship and shore facility (m^3/hr).*

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.

8.9 Additional operating requirements (1 July 2003)

Additional operating requirements will be found in the following paragraphs of the Rules

5-8-3/8.4, 5-8-3/8.5, 5-8-7/1.1.5, 5-8-8/2.5, 5-8-8/2.7, 5-8-9/4.2, 5-8-12/1.1, 5-8-12/1.10, 5-8-13/1.4, 5-8-14/2.5, 5-8-14/2.6, 5-8-14/3.1, 5-8-15/1, 5-8-15/2, 5-8-16/3.2, 5-8-17/4.2, 5-8-17/4.3, 5-8-17/6, 5-8-17/7, 5-8-17/12, 5-8-17/13, 5-8-17/14, 5-8-17/15, 5-8-17/16, 5-8-17/17, 5-8-17/18, 5-8-17/20.

PART

5

CHAPTER **8 Vessels Intended to Carry Liquefied Gases in Bulk**

SECTION **19 Summary of Minimum Requirements**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). See 5-8-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

Explanatory notes to the summary of minimum requirements (1 Oct. 1994)

UN Numbers	*The UN numbers as listed in the table of Section 5-8-19 are intended for information only.*	
Vapor detection required (column f)	*F*	*Flammable vapor detection*
	T	*Toxic vapor detection*
	O	*Oxygen analyser*
	F + T	*Flammable and toxic vapor detection*
Gauging types permitted (column g)	*I*	*Indirect or closed, as described in 5-8-13/2.2.1 and 5-8-13/2.2.2*
	C	*Indirect, or closed, as described in 5-8-13/2.2.1, 5-8-13/2.2.2 and 5-8-13/2.2.3*
	R	*Indirect, closed or restricted, as described in 5-8-13/2.2.1, 5-8-13/2.2.2, 5-8-13/2.2.3 and 5-8-13/2.2.4*
Refrigerant gases	*Non-toxic and non-flammable gases such as:*	

Product Name	*UN – No.*	*Density[kg/m^3]*	*Boiling Point [°C]*
Dichlorodifluoromethane (R 12)	*1028*	*1487*	*-30*
Dichloromonofluoromethane (R 21)	*1029*	*1410*	*9*
Dichlorotetrafluoromethane (R 114)	*1958*	*1510*	*3,6*
Monochlorodifluoromethane (R 22)	*1018*	*1414*	*-41*
Monochlorotetrafluoromethane (R 124)	*1021*		
Monochlorotrifluoromethane (R 13)	*1022*	*1526*	*-81,4*

Unless otherwise specified, as mixtures containing less than 5% total acetylenes may be transported with no further requirements than those provided for the major components. MFAG numbers are provided for information on the emergency procedure to be applied in the event of an incident involving the products covered by the IGC Code. Where any of the products listed are carried at low temperature from which frostbite may occur, MFAG no. 620 is also applicable.

a	b	c	d	e	f	g	h	i
Product name	*UN Number*	*Ship Type*	*Independent Tank Type C Required*	*Control of Vapor Space Within Cargo Tanks*	*Vapor Detection*	*Gauging*	*MFAG Table No.*	*Special requirements*
Acetaldehyde	*1089*	*2G/2PG*	*—*	*Inert*	*F + T*	*C*	*300*	*5-8-14/4.3; 5-8-14/4.4; 5-8-17/4.1; 5-8-17/6.1*
Ammonia, anhydrous	*1005*	*2G/2PG*	*—*	*—*	*T*	*C*	*725*	*5-8-14/4.2; 5-8-14/4.3; 5-8-14/4.4; 5-8-17/2.1; 5-8-17/13*
Butadiene	*1010*	*2G/2PG*	*—*	*—*	*F + T*	*R*	*310*	*5-8-17/2.2; 5-8-17/4.2; 5-8-17/4.3; 5-8-17/6; 5-8-17/8*
Butane	*1011*	*2G/2PG*	*—*	*—*	*F*	*R*	*310*	
Butane-propane mixtures	*1011/1978*	*2G/2PG*	*—*	*—*	*F*	*R*	*310*	
Butylenes	*1012*	*2G/2PG*	*—*	*—*	*F*	*R*	*310*	
Chlorine	*1017*	*1G*	*Yes*	*Dry*	*T*	*I*	*740*	*5-8-14/4; 5-8-17/3.2; 5-8-17/4.1; 5-8-17/5; 5-8-17/7; 5-8-17/9; 5-8-17/14*
*Diethyl ether**	*1155*	*2G/2PG*	*—*	*Inert*	*F + T*	*C*	*330*	*5-8-14/4.2; 5-8-14/4.3; 5-8-17/2.6; 5-8-17/3.1; 5-8-17/6.1; 5-8-17/10; 5-8-17/11; 5-8-17/15*
Dimethylamine	*1032*	*2G/2PG*	*—*	*—*	*F + T*	*C*	*320*	*5-8-14/4.2; 5-8-14/4.3; 5-8-14/4.4; 5-8-17/2.1*
Ethane	*1961*	*2G*	*—*	*—*	*F*	*R*	*310*	
Ethyl chloride	*1037*	*2G/2PG*	*—*	*—*	*F + T*	*R*	*340*	
Ethylene	*1038*	*2G*	*—*	*—*	*F*	*R*	*310*	
Ethylene oxide	*1040*	*1G*	*Yes*	*Inert*	*F + T*	*C*	*365*	*5-8-14/4.2; 5-8-14/4.3; 5-8-14/4.4; 5-8-14/4.6; 5-8-17/2.2; 5-8-17/3.2; 5-8-17/4.1; 5-8-17/5; 5-8-17/6.1; 5-8-17/16*
*Ethylene oxide-propylene oxide mixtures with ethylene oxide content of not more than 30% by weight**	*2983*	*2G/2PG*	*—*	*Inert*	*F + T*	*C*	*365*	*5-8-14/4.3; 5-8-17/3.1; 5-8-17/4.1; 5-8-17/6.1; 5-8-17/10; 5-8-17/11; 5-8-17/20*
*Isoprene**	*1218*	*2G/2PG*	*—*	*—*	*F*	*R*	*310*	*5-8-14/4.3; 5-8-17/8; 5-8-17/10; 5-8-17/12*
*Isopropylamine**	*1221*	*2G/2PG*	*—*	*—*	*F + T*	*C*	*320*	*5-8-14/4.2; 5-8-14/4.3; 5-8-17/2.4; 5-8-17/10; 5-8-17/11; 5-8-17/12; 5-8-17/17*

* *This cargo is covered also by the IBC Code.*

a	b	c	d	e	f	g	h	i
Product name	*UN Number*	*Ship Type*	*Independent Tank Type C Required*	*Control of Vapor Space Within Cargo Tanks*	*Vapor Detection*	*Gauging*	*MFAG Table No.*	*Special requirements*
Methane (LNG)	*1972*	*2G*	—	—	*F*	*C*	*620*	
Methyl acetylene-propadiene mixtures	*1060*	*2G/2PG*	—	—	*F*	*R*	*310*	*5-8-17/18*
Methyl bromide	*1062*	*1G*	*Yes*	—	*F + T*	*C*	*345*	*5-8-14/4; 5-8-17/2.3; 5-8-17/3.2; 5-8-17/4.1; 5-8-17/5; 5-8-17/9*
Methyl chloride	*1063*	*2G/2PG*	—	—	*F + T*	*C*	*340*	*5-8-17/2.3*
Monoethylamine[*]	*1036*	*2G/2PG*	—	—	*F + T*	*C*	*320*	*5-8-14/4.2; 5-8-14/4.3; 5-8-14/4.4; 5-8-17/2.1; 5-8-17/3.1; 5-8-17/10; 5-8-17/11; 5-8-17/12; 5-8-17/17*
Nitrogen	*2040*	*3G*	—	—	*O*	*C*	*620*	*5-8-17/19*
Pentanes (all isomers)[*]	*1265*	*2G/2PG*	—	—	*F*	*R*	*310*	*5-8-14/4.4; 5-8-17/10; 5-8-17/12*
Pentene (all isomers)[*]	*1265*	*2G/2PG*	—	—	*F*	*R*	*310*	*5-8-14/4.4; 5-8-17/10; 5-8-17/12*
Propane	*1978*	*2G/2PG*	—	—	*F*	*R*	*310*	
Propylene	*1077*	*2G/2PG*	—	—	*F*	*R*	*310*	
Propylene oxide[*]	*1280*	*2G/2PG*	—	*Inert*	*F + T*	*C*	*365*	*5-8-14/4.3; 5-8-17/3.1; 5-8-17/4.1; 5-8-17/6.1; 5-8-17/10; 5-8-17/11; 5-8-17/20*
Refrigerant gases (see notes)	—	*3G*	—	—	—	*R*	*350*	
Sulphur dioxide	*1079*	*1G*	*Yes*	*Dry*	*T*	*C*	*635*	*5-8-14/4; 5-8-17/3.2; 5-8-17/4.1; 5-8-17/5; 5-8-17/7; 5-8-17/9*
Vinyl chloride	*1086*	*2G/2PG*	—	—	*F + T*	*C*	*340*	*5-8-14/4.2; 5-8-14/4.3; 5-8-17/2.2; 5-8-17/2.3; 5-8-17/3.1; 5-8-17/6; 5-8-17/21*
Vinyl ethyl ether[*]	*1302*	*2G/2PG*	—	*Inert*	*F + T*	*C*	*330*	*5-8-14/4.2; 5-8-14/4.3; 5-8-17/2.2; 5-8-17/3.1; 5-8-17/6.1; 5-8-17/8; 5-8-17/10; 5-8-17/11; 5-8-17/15*
Vinylidene chloride[*]	*1303*	*2G/2PG*	—	*Inert*	*F + T*	*R*	*340*	*5-8-14/4.2; 5-8-14/4.3; 5-8-17/2.5; 5-8-17/6.1; 5-8-17/8; 5-8-17/10; 5-8-17/11*

[*] *This cargo is covered also by the IBC Code.*

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CHAPTER 8 **Vessels Intended to Carry Liquefied Gases in Bulk**

ANNEX 1 **Guidelines for the Uniform Application of the Survival Requirements of the Bulk Chemical Code and the Gas Carrier Code**

(approved by the Maritime Safety Committee at its forty-second session, 1980)

Preamble

The following should be considered as guidelines for the purpose of uniform application of the survival requirements of the Bulk Chemical Code and the Gas Carrier Code. Alternative methods to the suggested specific program of calculations and presentation, which demonstrate, to the Administration's satisfaction, compliance with the applicable survival criteria, may be accepted.

1 Alternative methods of calculation and presentation of ship survival capability

1.1 The parcel tanker will require a complete analysis of the limiting survival characteristics over the full range of intended loading conditions (as detailed in 5-8-A1/2);

1.2 The dedicated service tanker will require approval of calculations based on service conditions proposed by the builder or owner, in which case the certificate of fitness should be endorsed in respect of the conditions accepted;

1.3 The inherently safe ship is one that will meet survival requirements with the ship assumed to be at a maximum draught and trim with all compartments within the extent of damage assumed to be empty with maximum vertical center of gravity (adjusted for free liquids).

2 Minimum required metacentric height (GM) or maximum allowable height of the center of gravity (KG) as a function of the draught of the parcel tanker

2.1 A systematic investigation of damage survival characteristics should be undertaken by making calculations to obtain the minimum required GM or maximum allowable KG at a sufficient number of draughts within the operating range to permit the construction of a series of curves of "required GM" or "allowable KG" in relation to draught and cargo tank content in way of the damage. The curves must be sufficiently comprehensive to cover operational trim requirements.

2.2 Each of the curves thus constructed relates to one position of assumed damage only and the calculations should be repeated for each damage and lesser extent of damage to be assumed at any part of the ship.

2.3 Where it can be determined by inspection that the effect of certain assumed damage will be less onerous than other assumed damage, for which calculations are provided and curves prepared, then the investigation of such damage cases may be dispensed with.

2.4 The damage calculations should take account of:

2.4.1 tanks in way of the assumed damage filled with liquid at increments of about 25% between empty and the maximum weight of liquid, or liquids, intended to be carried in the particular tanks under consideration;

2.4.2 the distribution of liquids in the adjacent tanks concerned, which will give the most severe result, taking trim into account;

2.4.3 a number of draughts over the operating range, up to and including the tropical freeboard mark. The fresh water freeboards need not be considered;

2.4.4 the effect of damage involving the machinery space and adjacent tanks containing liquids over a number of draughts, as in 5-8-A1/2.4.3;

2.4.5 the ship in either the departure or the arrival condition, whichever will give the most severe result;

2.4.6 the ship without trim and a sufficient number of trims covering the operating range, in order to permit interpolation.

3 Particulars concerning survival capability calculations

3.1 The calculations should be based on moulded lines and include large appendages such as shaft bosses, skegs and bow thrusters.

3.2 The metacentric heights (GM), stability levers (GZ) and center of gravity positions (KG) for judging the final survival conditions should be calculated by the constant displacement (lost buoyancy) method.

3.3 The calculations should be done for the ship freely trimming.

3.4 Only computer calculations acceptable to the Administration should be used.

3.5 Where the assumed damage causes the ship to trim by the stern, the ship in the intact condition should be assumed to have the largest allowable trim by the stern, consistent with operational requirements.

3.6 Where the assumed damage causes the ship to trim by the bow, the ship in the intact condition should be assumed to have the largest allowable trim by the bow, consistent with operational requirements.

3.7 Lesser extent of damage should be taken into account only where indicated by the presence of subdivision extending into the maximum extent of damage, e.g. double-bottom tanks, side ballast tanks, side cargo tanks, fuel tanks and void spaces. However, the following should be given attention:

3.7.1 "Lesser extent" means the reduction of any one of the three maximum dimensions of damage singly or in combination and also the assessment of the effect of damage affecting any combination of compartments within the maximum extent of damage.

3.7.2 Where any damage involves the release of very heavy cargo liquid, then heel to the intact side of the ship may take place. In such cases, the effect of lesser vertical extent of damage above the level of the tank top may result in the larger angle of heel, since otherwise the effect of cargo loss may be compensated by flood water entering the double-bottom tanks on the damaged side.

3.8 The number of calculations required to show compliance with survival requirements should be that necessary to obtain sufficient data for the loading manual and should be such that all loading conditions indicated in 5-8-A1/1 can be covered, i.e., no additional calculations should be necessary once the series of calculations has been executed.

3.9 Calculations to determine the displacement, trim and the vertical position of the center of gravity should be performed for each operational loading condition. The vertical position of the center of gravity should be corrected for free surface effects. One method would be to construct graphs showing the free surface moments of the criterion angle for all filling levels at a specific gravity of one. The free surface moments for all tanks can then be taken from the graphs and be multiplied by the cargo specific gravity.

3.10 In calculating the effect of free surface of consumable liquids, it is to be assumed that, for each type of liquid, at least one transverse pair or a single centerline tank has maximum free surface, and the tank or combination of tanks to be taken into account are to be those where the effect of free surfaces is the greatest; in each tank, the center of gravity of the contents is to be taken at the center of volume of the tank. The remaining tanks are to be assumed either completely empty or completely filled, and the distribution of consumable liquids among these tanks is to be such as to obtain the greatest possible height above the keel for the center of gravity.

3.11 To take account of the presence of structure within cargo compartments, a permeability of 0.95 should be assumed as stated in the Codes. Where, in particular cases such as the cargo tanks of gas carriers, this assumption would lead to a significant discrepancy in cargo tank volume, it is preferable to calculate the permeability taking into account actual tank structure, the volume of tank insulation should then be calculated separately and an appropriate permeability applied.

3.12 Attention should be paid to the possibility of progressive flooding through deck cargo pipes and common cargo tank ventilation pipes, if these are immersed at large angles of heel after damage. The possibility of progressive flooding through ballast piping passing through the assumed extent of damage, where positive action valves are not fitted to the ballast system at the open ends of the pipes in the tanks served, should be considered. Where remote control systems are fitted to ballast valves and these controls pass through the assumed extent of damage, then the effect of damage to the system should be considered to ensure that the valves would remain closed in that event.

3.13 Where the ship is required to be capable of sustaining bottom damage anywhere in its length (L), the following method should be used when damage is assumed to occur in the vicinity of the $0.3L$ position from the forward perpendicular:

3.13.1 When applying the longitudinal extent of damage applicable to the foremost part of the ship, no part of the damage should be assumed to extend abaft the $0.3L$ position from the forward perpendicular.

3.13.2 When applying the longitudinal extent of bottom damage applicable to the rest of the ship's length the damage should be assumed to extend to a foremost limit including a point at $0.3L$ minus 5 m abaft the forward perpendicular.

3.14 In ships carrying liquefied gases, large cargo tanks may be subdivided into sections by centerline and transverse bulkheads which are liquid-tight but which have openings near the top of the tank. These openings would permit spillage of cargo from one section of the cargo tank to another when the ship is heeled where the tank is undamaged, or loss of cargo due to spillage from sections of a damaged cargo tank. The effect of this spillage should be taken into account in calculations and also in any calculation of GM or KG for loading conditions where a "required GM" or "allowable KG" curve is to be used.

3.15 In ships carrying liquefied gases, the ability of longitudinal bulkheads fitted within cargo tanks to withstand the unequal pressures due to flooding of one section of cargo tank should only be considered in the final stage of flooding.

3.16 Where lubricating oil drain tanks fitted below the main engine would be affected by the vertical extent of bottom damage, then flooding of the engine-room by way of the drain tank and engine should be assumed to take place.

3.17 In ships with machinery spaces aft, the machinery space and steering gear compartment should be regarded as being common for damage purposes when any access is fitted in the after machinery space bulkhead, unless a remotely operated sliding watertight door is fitted, or the sill of the access openings fitted with hinged watertight doors which are to be kept closed at sea, is at least 0.3 m above the damage water line and will not be submerged within the minimum range of residual stability.

3.18 Where dry cargoes are carried at the same time as bulk liquid cargoes, which require compliance with the requirements of the Codes, then the permeability of the space carrying the dry cargo is to be ascertained.

3.19 The harmonized regulations specify that no account should be taken of cross-flooding arrangements to attain stipulated limits of heel in the final state of equilibrium after damage. However, compartments on the opposite sides of a ship could be regarded as single compartments from the aspect of flooding if they were to be linked by openings or ducts of sufficiently large area. In such cases, consideration should be given to the adequacy of tank airflow and to the effect of free surface.

4 Stability information and Certificate of Fitness

4.1 With regard to loading conditions to be submitted to the Administration (exclusive of the loading condition contained in loading and stability manual), the principal objective, at the stage of design evaluation, is that the Administration can satisfy itself that the calculations presented will cover all conditions of full and partial loading, including variations of draught and trim. To achieve this objective the Administration may either,

4.1.1 require a complete analysis of survival requirements over the full range of probable loading conditions; or

4.1.2 undertake approval on the basis of service conditions proposed by the builder or owner, in which case the Certificate of Fitness should be endorsed for the conditions accepted.

4.2 Particular attention should be paid to the provision of adequate stability data to enable the master to accurately take into account the effect of liquid heeling moments of the contents of undamaged tanks. These heeling moments vary with the specific gravity of the liquid and the percentage filling of the tanks and may change significantly in magnitude from condition to condition. Adequate information would include curves showing the variation of liquid heeling moment with the contents of each individual tank.

4.3 In addition to the usual loading information required under intact stability requirements, the master should be supplied with the following information pertaining to damage stability:

4.3.1 data relative to loading and distribution of cargo and ballast necessary to ensure compliance with damage survival requirements;

4.3.2 data relative to the ship's survival capabilities;

4.3.3 a damage control drawing showing the position of important fittings and listing instructions for their control;

4.3.4 data relating to the effect of free surface or liquid heeling moments of cargo tanks at all stages of filling;

4.3.5 example calculations and standard blank forms to facilitate calculations.

4.4 The following should be stated on the Certificate of Fitness:

4.4.1 the deepest draught or least freeboard permitted for those loading conditions which require greater freeboard than the International Load Line Certificate (1966);

4.4.2 the range of specific gravities of cargoes which may be carried, this relates to all cargoes;

4.4.3 the particular cargo tanks in which certain ranges of specific gravities of cargoes may be carried, if relevant;

4.4.4 details of fittings, valves etc., the control of which is essential for survival, together with instructions for control, operation and logging; and

4.4.5 identification of required loading and stability manual.

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CHAPTER 8 **Vessels Intended to Carry Liquefied Gases in Bulk**

ANNEX 2 **United States Coast Guard Additional Design and Structural Requirements for Non-US Flag Vessels Operating on the Navigable Waters of the United States**

1 Certificate of Fitness

The vessel must have a Certificate of Fitness issued by the flag administration that is endorsed with the name of the cargo that it is allowed to carry, indicating that the vessel is in compliance with the "International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk".

2 Shell and Deck Plating

2.1

The deck stringer and sheer strake is to be Grade E material or equivalent.

2.2

The strake of plating at the turn of the bilge is to be Grade D, Grade E or equivalent.

2.3

The remainder of the outer hull steel is to be in accordance with 5-8-4/9.1 and 5-8-6/Table 5.

2.4

The above grades of material are to be provided throughout the cargo area.

3 Contiguous Hull Material

The contiguous hull material is to comply with 5-8-4/9 and 5-8-6/Table 1 through 5-8-6/Table 5, as applicable. The temperature studies required by 5-8-4/8 are to assume the following ambient temperature.

3.1 All waters except Alaskan waters

a) Five knots air at -18°C (0°F).

b) Still sea water at 0°C (32°F).

3.2 Alaskan waters

a) Five knots air at -29°C (-20°F)

b) Still sea water at -2°C (28°F)

4 Allowable Stresses

4.1

The independent tanks, type B, primarily constructed of bodies of revolution, are to have allowable stresses from the formula given in 5-8-4/5.1, the factors for A, B, C and D from the following table.

	Nickel steel and carbon manganese steel values	*Austenitic steel values*	*Aluminum alloy values*
A	4.0	4.0	4.0
B	2.0	1.6	1.5
C	3.0	3.0	3.0
D	1.5	1.5	1.5

4.2

The independent tanks, type C, and process pressure vessels are to be in accordance with 5-8-4/5.1.6, except the factors of A and B are to be obtained from 5-8-A2/4.1.

5 Insulation

The insulation is to be determined in accordance with 5-8-4/8, using an ambient temperature indicated in 5-8-A2/3.

6 Cargo Temperature/Pressure Control

Where the entire cargo system is designed to withstand the full vapor pressure of the cargo under conditions of upper ambient design temperatures of 45°C (113°F) still air and 32°C (90°F) still water, the cargo system is to be designed to indefinitely maintain the cargo without venting to the atmosphere on all products except methane. For methane, the cargo system is to be designed to maintain the cargo without venting to the atmosphere for a minimum period of 21 days while the vessel is in port and assuming the upper ambient design temperatures mentioned above.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

CONTENTS

Note: Text in italics comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemical in Bulk (IBC Code). See 5-9-1/3.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 1 General (ABS)

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Classification

1.1 Chemical Carriers

1.1.1

In accordance with 1-1-3/3, the classification of ✠ **A1 Chemical Carrier** is to be assigned to vessels designed and specifically fitted for the carriage of dangerous or noxious liquid chemical substances and built to the requirements of this Chapter and other relevant sections of the Rules.

1.1.2

These requirements are intended to apply to steel vessels with machinery aft, regardless of their size, including those of less than 500 tons gross tonnage engaged in carriage of bulk cargo of dangerous or noxious liquid chemical substances other than petroleum or similar flammable products, as follows:

1.1.2(a) products having significant fire hazards in excess of those of petroleum products and similar flammable products.

1.1.2(b) products having significant hazards in addition to or other than flammability.

These Rules are limited to the liquids shown in the summary of minimum requirements in Section 5-9-17. Products that have been reviewed and determined not to present safety and pollution hazards to such an extent as to warrant the application of these Rules are found in Section 5-9-18.

Liquids covered are those having a vapor pressure not exceeding 2.8 bar (40.6 psi) absolute at a temperature of 37.8°C (100°F).

This Chapter applies to the cargo containment system and related systems. The remainder of the vessel is to comply with the hull and machinery requirements of the Rules, except as modified in this Chapter.

3 Format

This Chapter is based on technical requirements of the "International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk" (IBC Code), which are contained in their entirety and are required for classification.

The term "should be" is to be understood to read as "is to be" or "are to be" and unless otherwise specified, the term "Administration" is to be read as the "Bureau". The numbering system of the technical requirements reproduced herein follow the numbering contained in the IBC Code, except the prefix of the numbering has been modified to reflect Part 5, Chapter 9.

The parts in this Chapter which are classification requirements and not based on the Codes are presented in non-italics "Times New Roman" type style, etc. Under these parts, also interpretations of the Codes with their source such as IMO (International Maritime Organization), IACS (International Association of Classification Societies), etc. and additional Bureau requirements.

The parts of this Chapter which are operational, training or national requirements are presented in italic "Arial" type style, i.e., *operational, training or national requirements*, and are not required for classification, and are shown for information only.

The text contained in this Chapter that comes from the IBC Code is presented in italics "Times New Roman" type style.

5 Submission of Data

The following plans, calculations and information, as appropriate, are to be submitted in addition to those required by Section 1-1-7

i) Full particulars of the intended cargo or cargoes and its properties, including density, flashpoint, maximum vapor pressure, minimum and, if necessary, maximum temperature, and loading and carriage procedures.

ii) General arrangement plans of the vessel showing the position of the following:

Cargo, fuel oil, water ballast and other tanks, and void spaces Manholes in cargo tanks, opening for tank cleaning, any other opening of the cargo tanks.

Doors and other openings in cargo pump and compressor rooms and other gas dangerous rooms

Ventilation ducts of cargo pump and compressor rooms and other "gas-dangerous" spaces

Door, air-locks, manholes, ducts and other openings for "non-gas dangerous" spaces which are, however, adjacent to the cargo area including rooms inside and under the forecastle deck

Cargo piping, both liquid and gaseous phases, located under and above deck

Vent piping and gas freeing piping and protective devices such as flame screens, etc. fitted at the outlet end of the vents etc.

Gas-dangerous spaces

iii) Plans of the hull structure in way of the cargo tanks, including the installation of attachments, accessories, internal reinforcements, saddles for support and tie-down devices.

iv) Plans of the structure of the cargo tanks, including the installation of attachments, supports and attachment of accessories

For independent pressure cargo tanks, the standard or Code adopted for the construction and design is to be identified. Detailed construction drawings together with design calculations for the pressure boundary, tank support arrangement and analysis for the load distribution. Anti collision, chocking arrangement and design calculations.

v) Distribution of the grades and of the types of steel proposed for the structures of the hull and of the cargo tanks, including attachments, accessories, etc., together with the calculation of the temperatures on all of the structures which can be affected by the low temperatures of the cargo

vi) Results of direct calculations of the stresses in the hull and in the cargo tanks

vii) Specifications and plans of the insulation system and calculation of the heat balance

viii) Procedures and calculations of the cooling down, loading and unloading operations

ix) Loading and unloading systems, venting systems and gas-freeing systems, as well as a schematic diagram of the remote controlled valve system

x) Details and installation of the safety valves and relevant calculations of their relieving capacity

xi) Details and installation of the various monitoring and control systems, including the devices for measuring the level of the cargoes in the tanks and the temperatures in the containment system

xii) Schematic diagram of the ventilation system indicating the vent pipe sizes and height of the openings above the main deck

xiii) Schematic diagram of the refrigeration system together with the calculations concerning the refrigerating capacity

xiv) Details of the electrical equipment installed in the cargo area and of the electrical bonding of the cargo tanks and piping

xv) Details of testing procedures of cargo tanks and liquid and vapor systems

xvi) Diagram of inert-gas system or hold-space environmental-control system

xvii) Diagram of gas-detection system

xviii) Jettison arrangements, if provided

xix) Schematic-wiring diagrams

xx) Details of all cargo and vapor handling equipment

xxi) Details of fire extinguishing systems

xxii) Welding procedure

xxiii) Emergency shutdown arrangements

xxiv) Construction details of cargo and booster pumps and compressors including material specification.

xxv) Hazardous area drawing showing access, openings, vent outlets.

xxvi) Bilge and ballast arrangement for the cargo area.

xxvii) Emergency Towing Arrangement.

7 Still-water Bending-moment Calculations

Still-water bending-moment calculations for the anticipated loaded and ballasted conditions are to be submitted for all chemical carriers.

9 Loading Guidance

Loading guidance is to be as required by 3-2-1/7.

11 Hull Scantlings

The scantlings of the hull structure are to be generally in accordance with Part 5, Chapter 2 and other applicable sections of the Rules, which may be modified in accordance with the following paragraphs.

11.1 Arrangement

Tanks forward of the collision bulkhead are not to be arranged for the carriage of oil or other liquid substances that are flammable.

11.3 Hull Structure in Way of Tanks

The hull structure in way of independent cargo tanks, the foundations, chocks, keys and sway braces is to be of sufficient strength to support the containment system when subjected to design loadings.

11.5 Steering Gear

The steering gear is to be in accordance with Section 4-3-4 with the modification that the steering gear is to be arranged so that after a single failure in its piping system or one of the power units, the defect can be isolated so that this steering capability can be maintained or regained in 45 seconds or less.

13 Access *(1998)*

Satisfactory arrangements are to be provided to safeguard the crew in reaching all parts used in the necessary work of the ship. See 3-2-17/3.

15 Changes to Codes

Changes to IGC/IBC Codes, other than those of operational nature, will become ABS Rule requirements as of the effective date of the particular change to the Code.

17 Special Construction Requirements

17.1 Material

Hull structural material is to be in accordance with 3-1-2/1 and 3-1-2/3.

17.3 Cold Deformation

Materials subjected to cold deformation or strain are to be dealt with as may be required to maintain the specific impact properties. For formed material, see 2-4-1/3.13.

17.5 Welding

Details are to be in accordance with Part 2, Chapter 4.

19 Test Agenda *(1994)*

The agenda for the testing of tanks required by this section is to be submitted for review. Also by Section 3-7-1. The tests are to be witnessed by a Surveyor. In addition, for hydrostatic testing of pressure vessel type cargo tanks, see 4-4-1/7.11. For phosphorus tanks, see 5-9-15/7.2

21 International Certificate of Fitness

When the vessel is issued an International Certificate of Fitness For The Carriage of Dangerous Chemicals in Bulk by the Country of Registry or its agents other than the Bureau, such certificate will be accepted as evidence of compliance with the following requirements of this section.

5-9-2/2	Freeboard and intact stability
5-9-2/5	Damage assumptions
5-9-2/7	Flooding assumptions
5-9-2/8	Standard of damage
5-9-2/9	Survival requirements
5-9-11/1	Structural fire protection requirements.

On all other vessels, the Bureau will review the data and plans for compliance with these requirements.

When authorized by the Country of Registry and upon the request of the Owners of a classed vessel or one intended to be classed, the Bureau will review the plans, data, etc. and survey the vessel for compliance of these Rules and issue an International Certificate of Fitness For the Carriage of Dangerous Chemicals in Bulk in addition to the classification indicated in 5-9-1/17.

23 Petroleum Products

Where it is intended to carry petroleum products on a chemical carrier, a procedure manual is to be submitted for review showing the procedure to be followed for the change from a chemical product to a petroleum product and vice versa.

25 Surveys

See Sections 7-3-2 and 7-6-2 for survey requirements for vessels in service intended to carry chemicals in bulk.

1 Application

1.2A

For the purpose of the 1974 SOLAS Convention, the Code does not apply to ships which are engaged in the carriage of products included in Section 5-9-17 solely on the basis of their pollution characteristics and identified as such by an entry of "P" only in column d.

1.2B

For the purposes of MARPOL 73/78, the Code applies only to chemical tankers as defined in regulation 1(1) of Annex II thereof, which are engaged in the carriage of noxious liquid substances falling in to category A, B or C and identified as such by an entry of "A, B or C" in column c.

1.3 *(1 July 1994)*

For a product proposed for carriage in bulk, but not listed in Section 5-9-17 or Section 5-9-18 , the Administration and port Administrations involved in such carriage should prescribe the preliminary 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. For the evaluation of the pollution hazard of such a product and assignment of its pollution category, the procedure specified in regulation 3(4) of Annex II of MARPOL 73/78 must be followed.*

** "Adminstration" means "Flag State Adminstration."*

2 Hazards

Hazards of products covered by the Code include:

2.1

Fire hazard defined by flashpoint, boiling point, flammability limits and autoignition temperature of the chemical.

2.2

Health hazard defined by:

2.2.1

irritant or toxic effect on the skin or on the mucous membranes of the eyes, nose, throat and lungs in the gas or vapor state combined with vapor pressure; or

2.2.2

irritational effects on the skin in the liquid state; or

2.2.3

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;

LD_{50}: the concentration which is lethal by inhalation to 50% of the test subjects.

2.3

Water pollution hazard defined by human toxicity, water solubility, volatility, odor or taste, and relative density.

2.4

Air pollution hazard defined by:

2.4.1

emergency exposure limit (E.E.L.) or LC_{50};

2.4.2

vapor pressure;

2.4.3

solubility in water;

2.4.4

relative density of liquid;

2.4.5

vapor density.

2.5

Reactivity hazard defined by reactivity with:

2.5.1

other products; or

2.5.2

water; or

2.5.3

the product itself (including polymerization).

2.6

Marine pollution hazard as defined by:

2.6.1

bioaccumulation with attendant risk to aquatic life or human health or cause tainting to seafood;

2.6.2

damage to living resources;

2.6.3

hazard to human health; and

2.6.4

reduction of amenities.

3 Definitions

The following definitions apply unless expressly provided otherwise. (Additional definitions are given in individual chapters).

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.

3.2.1

"Administration" means the Government of the State whose flag the ship is entitled to fly.

For the purpose of classification, the term "Administration" unless otherwise specified, is to be read as the "Bureau". See 5-9-1/3(ABS).

3.2.2

"Port administration" means the appropriate authority of the country in the port of which the ship is loading or unloading.

3.3

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

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 meters.

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 or slop tanks and also deck areas throughout the entire length and breadth of the part of the ship over the above-mentioned spaces. Where independent tanks are installed in hold spaces, cofferdams, ballast or void spaces at the after end of the aftermost hold space or at the forward end of the forwardmost hold space are excluded from the cargo area.

3.6

"Cargo pump-room" is a space containing pumps and their accessories for the handling of the products covered by the Code.

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.

3.8

"Cargo tank" is the envelope designed to contain the cargo.

3.9

"Chemical tanker" is a cargo ship constructed or adapted and used for the carriage in bulk of any liquid product listed in Section 5-9-17.

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.

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.

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.

3.13

"Flashpoint" is the temperature in degrees Celsius at which a product will give off enough flammable vapor to be ignited. Values given in the Code are "closed cup test" determined by an approved flashpoint apparatus.

3.13 (ABS)

"Gravity tank." see 5-9-4/1.3.

3.14

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

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.

3.15.1 (ABS)

"International Certificate of Fitness" means an International Certificate of Fitness for Carriage of Dangerous Chemicals in Bulk issued under the "International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk," adopted by the Maritime Safety Committee of IMO.

3.15.2 (ABS)

"Independent tank", see 5-9-4/1.1

3.15.3 (ABS)

"Integral tank", see 5-9-4/1.2

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 meters.

3.17

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

3.17.1

internal combustion machinery used for main propulsion; or

3.17.2

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

3.17.3

any oil-fired boiler or oil fuel unit.

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 station, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces, and trunks to such spaces.

3.18A

"MARPOL 73/78" means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto.

3.18B

"Noxious liquid substance" means any substance designated in appendix II to Annex II of MARPOL 73/78 or provisionally assessed under the provisions of regulation 3(4) of that Annex as falling into category A, B, C or D.

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.

3.20

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

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.

3.21 (ABS)

"Pressure tank", see 5-9-4/1.4

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.

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.

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:

3.24.1

removing spool pieces or valves and blanking the pipe ends;

3.24.2

arrangement of two spectacle flanges in series with provisions for detecting leakage into the pipe between the two spectacle flanges.

3.25

"Service areas" 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. [Also see 5-8-1/3.33 (ABS)]

3.26

"1974 SOLAS Convention" means the International Convention for the Safety of Life at Sea, 1974.

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).

3.27A

"Standards for Procedures and Arrangements" means the Standards for Procedures and Arrangements for the Discharge of Noxious Liquid Substances called for by Annex II of MARPOL 73/78 adopted by the Marine Environment Protection Committee at its twenty-second session by resolution MEPC 18(22) as may be amended by the Organization.

3.28

"Vapor density" or the relative density of vapor is the ratio of the mass of a volume of vapor gas (with no air present) to the mass of an equal volume of air at the same pressure and temperature. Vapor density below or above 1 indicates whether the vapor or gas is lighter or heavier than air.

3.29

"Vapor pressure" is the equilibrium pressure of the saturated vapor above the liquid expressed in bars absolute at a specified temperature.

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.

4 Equivalents

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.

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 and Parties to MARPOL 73/78 for the information of their officers.

5 Surveys and certification

5.1 Survey procedure

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.

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:

5.1.2.1 require repairs to a ship; and

5.1.2.2 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.

• Port State authority has the meaning as presented in chapter 1, regulation 19 of the 1978 Protocol to the 1974 SOLAS Convention.

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.*

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.

5.2 Survey Requirements

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:

5.2.1.1 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 ensure that the structure, equipment, fittings, arrangements and material fully comply with the applicable provisions of the Code.

5.2.1.2 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.

5.2.1.3 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 halfway 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.

5.2.1.4 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.

5.2.1.5 An additional survey, either general or partial according to the circumstances, should be made when required after an investigation prescribed in 5-9-1/5.3.3 , 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.

5.3 Maintenance of conditions after survey

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.

5.3.2

After any survey of the ship under 5-9-1/5.2 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.

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 5-9-1/5.2.1.5 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.

5.4 Issue of International Certificate of Fitness

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 engaged in international voyages which complies with the relevant requirements of the Code.

5.4.2

The certificate issued under provisions of this section should be available on board for inspection at all times.

5.5 Issue or endorsement of International Certificate of Fitness by another Government

5.5.1

A Party to the 1974 SOLAS Convention and to MARPOL 73/78 may, at the request of another Party, 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.

5.6 Duration and validity of the International Certificate of Fitness

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.

5.6.2

No extension of the 5 year period of the certificate should be permitted.

5.6.3

The certificate should cease to be valid:

5.6.3.1 if the surveys are not carried out within the period specified by 5-9-1/5.2 ;

5.6.3.2 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 5-9-1/5.3.1 and 5-9-1/5.3.2. 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.

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PART

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CHAPTER 9 **Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION 2 Ship Survival Capability• and Location of Cargo Tanks

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

•Reference is made to the Guidelines for the Uniform Application of the Survival Requirements of the Bulk Chemical Code and the Gas Carrier Code. See Annex 5-9-A1.

1 General

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.

1.2

Ships subject to the Code should be designed to one of the following standards:

1.2.1

A "type 1 ship" is a chemical tanker intended to transport Section 5-9-17 products with very severe environmental and safety hazards which require maximum preventive measures to preclude an escape of such cargo.

1.2.2

A "type 2 ship" is a chemical tanker intended to transport Section 5-9-17 products with appreciably severe environmental and safety hazards which require significant preventive measures to preclude an escape of such cargo.

1.2.3

A "type 3 ship" is a chemical tanker intended to transport Section 5-9-17 products with sufficiently severe environmental and safety hazards which require a moderate degree of containment to increase survival capability in a damaged condition.

Thus a type 1 ship is a chemical tanker intended for the transportation of products considered to present the greatest overall hazard and type 2 and type 3 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.

1.3

The ship type required for individual products is indicated in column "e" in the table of Section 5-9-17.

1.4

If a ship is intended to carry more than one product listed in Section 5-9-17 , 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 Freeboard and intact stability

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

The stability of the ship in all seagoing conditions should be to a standard which is acceptable to the Administration.

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 center tank has a free surface and the tank or combination of tanks to be taken in 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.

2.4

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.

2.5

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.

3 Shipside discharges below the freeboard deck

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:

3.1.1

one automatic nonreturn valve with a positive means of closing from above the freeboard deck; or

3.1.2

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

3.2

For the purpose of this chapter "summer waterline" and "freeboard deck", have the meanings as defined in the International Convention on Load Lines in force.

3.3

The automatic nonreturn valves referred to in 5-9-2/3.1.1 and 5-9-2/3.1.2 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 5-9-2/9.

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.

5 Damage assumptions

5.1

The assumed maximum extent of damage should be:

5.1.1	*Side damage:*		
5.1.1.1	*Longitudinal extent:*	$^{1}/_{3}L^{2/3}$ *or 14.5 m, whichever is less*	
5.1.1.2	*Transverse extent: measured inboard from the ship's side at right angles to the centerline at the level of the summer load line*	*B/5 or 11.5 m, whichever is less*	
5.1.1.3	*Vertical extent: from the moulded line of the bottom shell plating at centerline*	*upwards without limit*	
5.1.2	*Bottom damage:*	*For 0.3L from the forward perpendicular of the ship*	*Any other part of the ship*
5.1.2.1	*Longitudinal extent:*	$^{1}/_{3}L^{2/3}$ *or 14.5 m, whichever is less*	$^{1}/_{3}L^{2/3}$ *or 5 m, whichever is less*
5.1.2.2	*Transverse extent:*	*B/6 or 10 m, whichever is less*	*B/6 or 5 m, whichever is less*
5.1.2.3	*Vertical extent:*	*B/15 or 6 m, whichever is less measured from the moulded line of the bottom shell plating at centerline (see 5-9-2/6.2)*	*B/15 or 6 m, whichever is less measured from the moulded line of the bottom shell plating at centerline (see 5-9-2/6.2)*

5.2

If any damage of a lesser extent than the maximum damage specified in 5-9-2/5.1 would result in a more severe condition, such damage should be considered.

6 Location of cargo tanks

6.1

Cargo tanks should be located at the following distances inboard:

6.1.1

Type 1 ships: from the side shell plating not less than the transverse extent of damage specified in 5-9-2/5.1.1.2 and from the moulded line of the bottom shell plating at centerline not less than the vertical extent of damage specified in 5-9-2/5.1.2.3 and nowhere less than 760 mm from the shell plating. This requirement does not apply to the tanks for diluted slops arising from tank washing.

6.1.2

Type 2 ships: from the moulded line of the bottom shell plating at centerline not less than the vertical extent of damage specified in 5-9-2/5.1.2.3 and nowhere less than 760 mm from the shell plating. This requirement does not apply to the tanks for diluted slops arising from tank washing.

6.1.3

Type 3 ships: no requirement.

6.1 Interpretation of 5-9-2/6.1 (IMO)

Any cargo tank may be used for holding contaminated cargo pump-room bilge water and cargo tank washings irrespective of the cargo tank location requirements of 5-9-2/6.

6.2

Except for type 1 ships, suction wells installed in cargo tanks may protrude into the vertical extent of bottom damage specified in 5-9-2/5.1.2.3 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.

6.2 Interpretation of 5-9-2/6.2 (IMO)

The area of suction well should not be greater than that required to accommodate equipment such as cargo pumps, suction pipes, valves, associated heating coils, etc., and to ensure efficient flow and the necessary access for cleaning and maintenance.

7 Flooding assumptions

7.1

The requirements of 5-9-2/9 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.

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*

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.

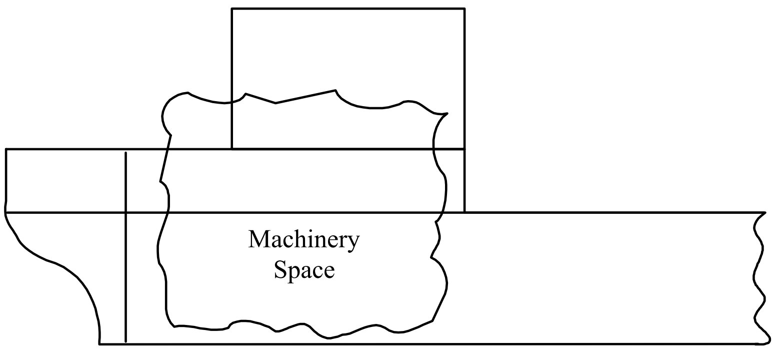
7.4

Every watertight division within the maximum extent of damage defined in 5-9-2/5.1 and considered to have sustained damage in positions given in 5-9-2/8.1 should be assumed to be penetrated. Where damage less than the maximum is being considered in accordance with 5-9-2/5.2, only watertight divisions or combinations of watertight divisions within the envelope of such lesser damage should be assumed to be penetrated.

7.5

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

FIGURE 1
Longitudinal extent of damage to superstructure (5-9-2/7.8 and 5-9-2/8.1)



7.6

Equalization arrangements requiring mechanical aids such as valves or cross-leveling pipes, if fitted, should be considered for the purpose of reducing an angle of heel or attaining the minimum range of residual stability to meet the requirements of 5-9-2/9 and sufficient residual stability should be maintained during all stages where equalization is used. Spaces which are linked by ducts of large cross-sectional area may be considered to be common.

7.7

If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in 5-9-2/5, arrangements should be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

7.8

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

7.8.1

they are separated from the damaged space by watertight divisions and the requirements of 5-9-2/9.3 in respect of these intact spaces are complied with; and

7.8.2

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 5-9-2/9; however the immersion of any other openings capable of being closed weathertight may be permitted.

7 Interpretation of 5-9-2/7.8 and 5-9-2/8.1 (IMO)

The longitudinal extent of damage to superstructure in the instance of side damage to a machinery space aft under 5-9-2/8.1 should be the same as the longitudinal extent of the side damage to the machinery space (see 5-9-2/Figure 1).

8 Standard of damage

8.1

Ships should be capable of surviving the damage indicated in 5-9-2/5 with the flooding assumptions in 5-9-2/7 to the extent determined by the ship's type according to the following standards: (See 5-9-2/7 (IMO).)

8.1.1

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

8.1.2

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

8.1.3

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;

8.1.4

A type 3 ship of more than 225 m in length should be assumed to sustain damage anywhere in its length;

8.1.5

A type 3 ship of 125 m in length or more but not exceeding 225 m in length should be assumed to sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft;

8.1.6

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.

8 Interpretation of 5-9-2/8.1.3 and 5-9-2/8.1.5 (IMO)

The concept of a stepped machinery space forward bulkhead is already implied in 5-9-3/2.1 and in regulation II-2/56 of the 1974 SOLAS Convention as amended. For damage stability considerations when such a bulkhead contains a step more than 3 m in length, damage should be treated as shown in 5-9-2/Figure 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 5-9-2/8.1.3 and 5-9-2/8.1.6, special dispensation 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.

9 Survival requirements

9.1

Ships subject to the Code should be capable of surviving the assumed damage specified in 5-9-2/5 to the standard provided in 5-9-2/8 in a condition of stable equilibrium and should satisfy the following criteria.

9.2 In any stage of flooding:

9.2.1

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;

9.2.2

the maximum angle of heel due to unsymmetrical flooding should not exceed 25°, except that this angle may be increased to 30° if no deck immersion occurs;

9.2.3

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 5-9-2/9.3.

9.3 At final equilibrium after flooding:

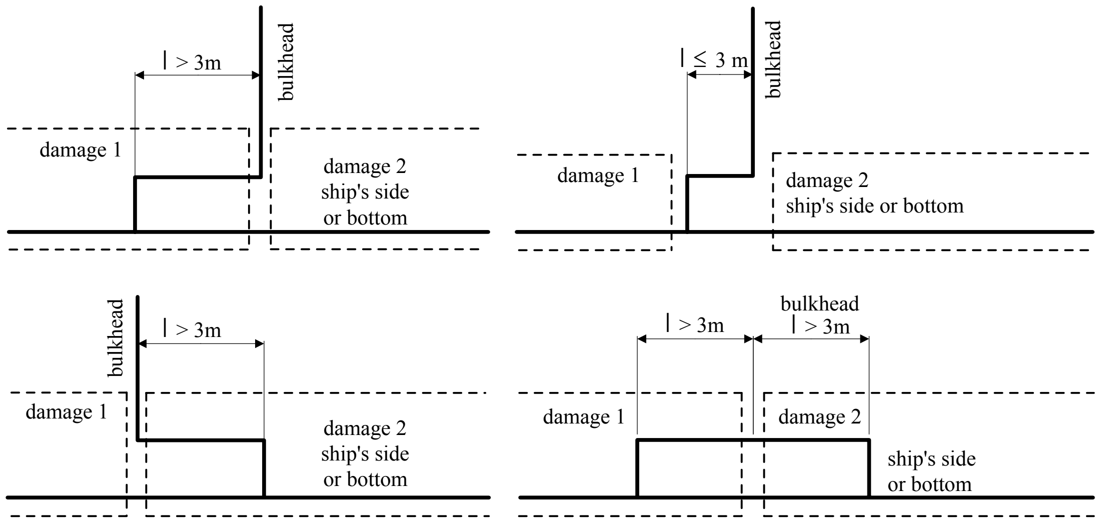
9.3.1

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 5-9-2/9.2.1 and other openings capable of being closed weathertight may be permitted; and

9.3.2

the emergency source of power should be capable of operating.

FIGURE 2
Damage to stepped machinery space forward bulkhead (Damages are not simultaneous) (5-9-2/8.1.3 and 5-9-2/8.1.5)



9 Interpretation of 5-9-2/9.3.1 (IMO)

The 20° range may be measured from any angle commencing between the position of equilibrium and the angle of 25° (or 30° if no deck immersion occurs).

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CHAPTER **9 Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION **3 Ship Arrangements**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Cargo segregation

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.

1.2

Cargoes, residues of cargoes or mixtures containing cargoes which react in a hazardous manner with other cargoes, residues or mixtures, should:

1.2.1

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;

1.2.2

have separate pumping and piping systems which should not pass through other cargo tanks containing such cargoes, unless encased in a tunnel; and

1.2.3

have separate tank venting systems.

1.2 Interpretation of 5-9-3/1.2, 5-9-15/16.2.3 and 5-9-15/16.2.4 (IMO)

A cruciform joint (see 5-9-3/Figure 3) can be considered a double barrier for the purpose of segregation as follows:

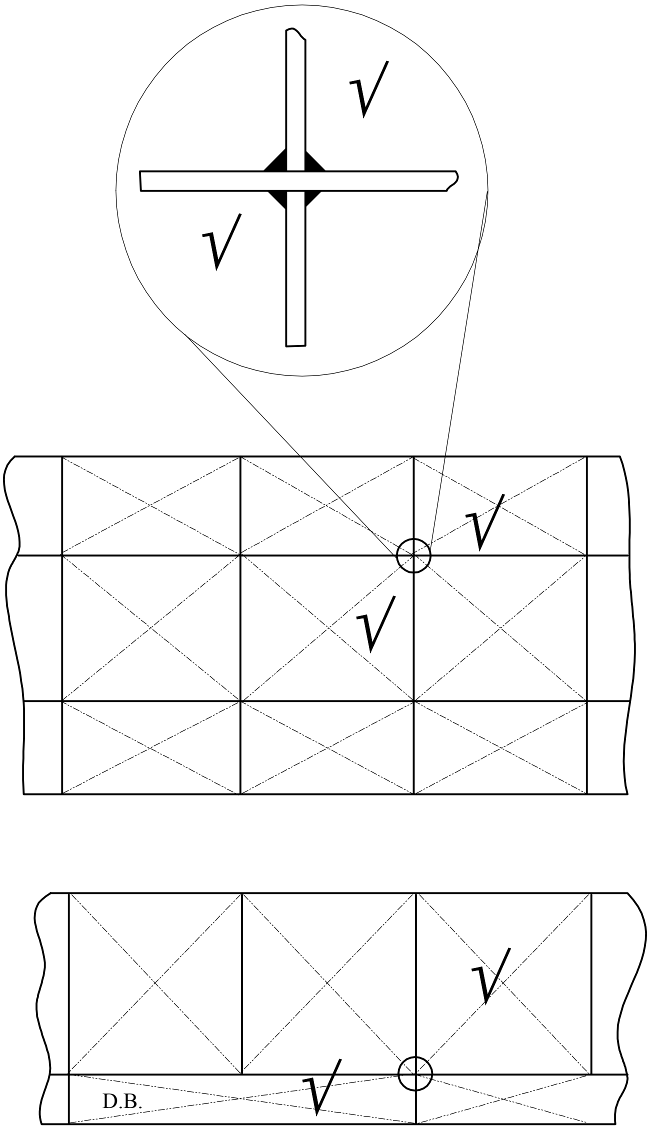
1.2.1

between mutually hazardous reactive cargoes;

1.2.2

between water reactive cargoes and water.

FIGURE 3
Segregation of mutually hazardous reactive cargoes (5-9-3/1.2.1, 5-9-15/16.2.3 and Section 5-9-4)



1.3

Cargo piping should not pass through any accommodation, service or machinery space other than cargo pump-rooms or pump-rooms.

1.3 Interpretation of 5-9-3/1.3 (IMO)

The siting of cargo piping is considered to be adequately covered by 5-9-3/7

1.4

Cargoes subject to the Code should not be carried in either the fore or aft peak tank.

2 *Accommodation, service and machinery spaces and control stations*

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.

2.2

In order to guard against the danger of hazardous vapors, 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.

2.2 Interpretation of 5-9-3/2.2 (IMO)

Compliance with other relevant paragraphs of the Code and in particular with 5-9-3/2.3, 5-9-3/7, 5-9-8/2.2, 5-9-12/1.5 and 5-9-15/12, where applicable would also ensure compliance with this paragraph.

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 vapor 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.

2.3 Interpretation of 5-9-3/2.3 (IMO)

Air outlets are subject to the same requirements as air inlets and air intakes. This interpretation also applies to 5-9-3/2.2, 5-9-3/7.4, 5-9-8/2.3, 5-9-15/12.1.3 and 5-9-19/3.8.

Access facing the cargo area or in prohibited zones should be restricted to stores for cargo-related and safety equipment, cargo control stations and emergency showers.

For all chemical tankers regardless of the cargo to be carried, where a deckhouse is substituted for a superstructure and liquid could flow along the sides of the house, the house front should be continued to the sides of the ship in the form of a sill, or a separate spillage barrier should be arranged as described in regulation II-2/56.6 of the 1974 SOLAS Convention, as amended. Also see 5-9-3/7.7 (IMO)

3 Cargo pump-rooms

3.1

Cargo pump-rooms should be so arranged as to ensure:

3.1.1

unrestricted passage at all times from any ladder platform and from the floor; and

3.1.2

unrestricted access to all valves necessary for cargo handling for a person wearing the required personnel protective equipment.

3.1 Interpretation of 5-9-3/3.1 (IMO)

In general, a cargo pump-room should be provided with one set of access/escape ladders. Where it is envisaged that personnel are normally employed in a pump-room or the pump-room is unusually large, the Administration may require an additional means of escape. Two doorways from the pump-room house, emerging above the weather deck are preferable.

3.2

Permanent arrangements should be made for hoisting an injured person with a rescue line while avoiding any projecting obstacles.

3.3

Guard railings should be installed on all ladders and platforms.

3.4

Normal access ladders should not be fitted vertical and should incorporate platforms at suitable intervals. •

• *Reference is made to the Recommendation on Safe Access to and Working in Large Tanks (resolution A.272(VIII)) as amended by resolution A.330(IX).*

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. (Also see 5-9-2/6.1 (IMO).)

3.6

Pump discharge pressure gauges should be provided outside the cargo pump-room.

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.

3.7 Interpretation of 5-9-3/3.7 (IMO)

Lubrication or other means of ensuring permanence of gastight seals should be effected from outside of the cargo pump-room.

4 Access to spaces in the cargo area

4 Interpretation of 5-9-3/4 (IMO)

Although fuel oil tanks are not included in the definition of "cargo area", where such tanks are adjacent to cargo tanks, the requirements of 5-9-3/4 are applicable.

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.

4.1 Interpretation of 5-9-3/4.1 (IMO)

To take care of restrictions in the movement of personnel and to limit the time needed for a possible emergency escape, two separate means of access should be provided in double bottom tanks and similar spaces where obstructions impede movement. The two accesses should be as widely separated as practicable.

The provision of only one access may be approved in special circumstances if the ability to readily traverse the space or to remove an injured person can be proved to the satisfaction of the Administration.

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.

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.

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.

5 Bilge and ballast arrangements

5.1

Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks should be independent of similar equipment serving cargo tanks and of cargo tanks themselves. Discharge arrangements for permanent ballast tanks sited immediately adjacent to cargo tanks should be outside machinery spaces and accommodation spaces. Filling arrangements may be in the machinery spaces provided that such arrangements ensure filling from tank deck level and non-return valves are fitted.

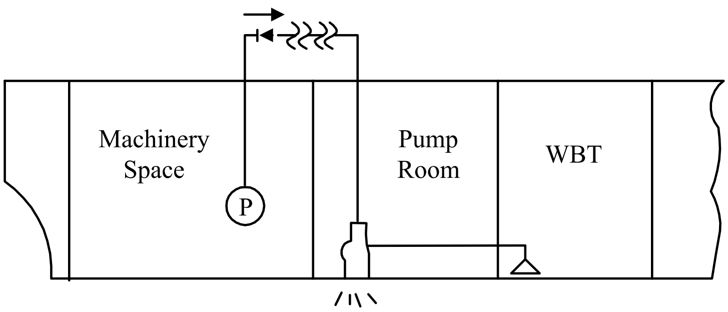
5.1 Interpretation of 5-9-3/5.1 (IMO)

An eductor situated in the cargo area using water power from the machinery spaces is acceptable for discharge purposes, provided a non-return valve and means of separation are fitted in the supply line and the supply line is above deck level. A non-return valve and means of separation should be located outside of the machinery space. (see 5-9-3/Figure 4)

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 nonreturn valves are fitted.

FIGURE 4
Discharge arrangement of permanent ballast tanks sited immediately adjacent to cargo tanks (5-9-3/5.1)



5.2 Interpretation of 5-9-3/5.2 (IMO)

The filling arrangement may consist of a portable spool piece or flexible hose plus an isolating valve on the inlet to the cargo tank. This isolating valve is in addition to the required non-return valve. Consideration should be given to the arrangement of in-tank piping and the creation of static electricity.

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.

5.3 Interpretation of 5-9-3/5.3 (IMO)

The relaxation at the end of the paragraph should be limited to spaces not enclosing piping which may contain cargo.

5.4 (ABS/IACS) *(2004)*

For integrated cargo and ballast system requirements, see 5-9-10/5.

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.

7 *Bow or stern loading and unloading arrangements*

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.

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 vapors required to comply with 5-9-15/12.1, unless specifically approved by the Administration.

7.3

In addition to 5-9-5/1, the following provisions apply:

7.3.1

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.

7.3.2

The shore connection should be fitted with a shutoff valve and a blank flange.

7.3.3

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.

7.3.4

Spray shields should be provided at the connections specified in 5-9-3/7.3.1 as well as collecting trays of sufficient capacity with means for the disposal of drainage.

7.3.5

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.

7.3.6

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.

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 (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 5-9-3/2.3 and this paragraph is not possible, the Administration may approve relaxations from the above requirements.*

7.5

Air pipes and other openings to enclosed spaces not listed in 5-9-3/7.4 should be shielded from any spray which may come from a burst hose or connection.

7.6

Escape routes should not terminate within the coamings required by 5-9-3/7.7 or within a distance of 3m beyond the coamings.

7.7

Continuous coamings of suitable height should be fitted to keep any spills on deck and away from the accommodation and service areas.

7.7 Interpretation of 5-9-3/7.7 (IMO)

The expression "suitable height" should mean the height of the coaming is to be approximately 150 mm, however, nowhere is it to be less than 50 mm above the upper edge of the sheer strake.

7.8

Electrical equipment within the coamings required by 5-9-3/7.7 or within a distance of 3 m beyond the coamings should be in accordance with the requirements of Section 5-9-10.

7.9

Fire-fighting arrangements for the bow or stern loading and unloading areas should be in accordance with 5-9-11/3.16.

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 or cargo pumps from the cargo shore connection location.

8 Temperature of Steam and Heating Media within the Cargo Area (IACS/ABS) *(1999)*

The maximum temperature of steam or heating media within the cargo area is to take into consideration the temperature class (i.e., auto-ignition temperature) of the cargoes being carried.

PART

5

CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 4 Cargo Containment

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Definitions

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.

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.

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.

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.

1.1 Integral Tanks (ABS) *(1994)*

Tankers designed for the carriage of chemical cargoes in integral tanks are to be designed and constructed in accordance with these Rules. The scantlings of the tank boundaries, plating, stiffeners, etc. are to be not less than required by Part 5, Chapter 2, as modified below.

1.1.1 PV Valve Setting

Where integral tanks are fitted with pressure/vacuum relief valves in tank venting system, the valves are to be set within 0.7 bar (0.71 kgf/cm^2, 10.2 psi) above atmospheric and 0.07 bar (0.07 kgf/cm^2, 1.0 psi) below atmospheric.

1.1.2 Scantling Head

The scantling head h in m (ft) is to be taken as the greater of h_n or h_o,as defined below.

1.1.2(a) Normal Head (h_n).

$$h_n = ph_t + h_a \quad \text{m (ft)}$$

where

p = 1.0 where the specific gravity of liquid is 1.05 or less

= specific gravity of the liquid where it is in excess of 1.05

h_t = the distance in m (ft) from the lower edge of the plate or the middle of the area supported to the top of the tank at side

h_a = the greater of h_{a1} or h_{a2} and not less than the distance in m (ft) to the top of the hatch.

h_{a1} = $0.02L$ for 61m (200 ft) $< L \leq$ 122 m (400 ft)

= 2.44 m (8 ft) for $L >$ 122 m (400 ft)

h_{a2} = 9.95 p_v (9.75 p_v, 2.25 p_v)

p_v = pressure-vacuum valve pressure setting, in bar (kgf/cm^2, psi)

1.1.2(b) Overflow condition (h_o)

h_o = $(2/3)(p\ h_s + 9.95\ p_s)$ m (p_s in bar)

= $(2/3)(p\ h_s + 9.75\ p_s)$ m (p_s in kgf/cm^2)

= $(2/3)(p\ h_s + 2.25\ p_s)$ ft (p_s in psi)

where

h_s = head in m (ft) to the spill valve or rupture disk

p_s = relieving pressure in bar (kgf/cm^2, psi) of spill valve or rupture disc.

Where no spill valve or rupture disc is fitted, h_s is to be taken to the highest point that the liquid may rise and p_s may be taken as zero.

1.1.3 Liquid Level Control

Provision is to be made to guard against liquid rising to a height that would exceed the above and this may be done using high level alarms, overflow control systems, or spill valves together with gauging and tank filling procedures.

1.3 Independent Gravity Tanks (ABS)

1.3.1 PV Valve Setting

Where independent gravity tanks are fitted with pressure/vacuum relief valves in tank venting system, the valves are to be set within 0.7 bar (0.71 kgf/cm^2, 10.2 psi) above atmospheric, and 0.07 bar (0.07 kgf/cm^2, 1.0 psi) below atmospheric.

1.3.2 Scantling Head and Liquid Level Control

Independent gravity tanks are to comply with the requirements in 5-9-4/1.1(ABS), except that where piping arrangements are such that the independent tank cannot be filled with ballast water, p need not be taken in excess of the actual specific gravity of the liquid.

Additionally, h_2 is not to be less than 2.4 m (7.9 ft) for phosphorus tanks. See 5-9-15/7.2

1.5 Carriage of Heated Cargoes (ABS)

Where cargoes are to be carried at high temperatures, consideration is to be given to loading arrangement of heated cargoes, temperature distribution and thermal stresses induced by heating (See also Section 5-9-7 and 5-9-16/6).

2 Tank type requirements for individual products

Requirements for both installation and design of tank types for individual products are shown in column "f" in the table of Section 5-9-17.

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PART

5

CHAPTER **9 Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION 5 Cargo Transfer

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Piping scantlings

1.1

Subject to the conditions stated in 5-9-5/1.4 the wall thickness (t) of pipes should not be less than:

$$t = \frac{t_o + b + c}{1 - \frac{a}{100}} \quad (mm)$$

where:

t_o = *theoretical thickness*

$t_o = PD/(20\,Ke + P)$ *(mm)*

with

P = *design pressure (bar) referred to in 5-9-5/1.2*

D = *outside diameter (mm)*

K = *allowable stress (N/mm^2) referred to in 5-9-5/1.5*

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:*

$$b = \frac{Dt_o}{2.5r} \quad (mm)$$

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 (%).*

1.2

The design pressure P in the formula for t_o in 5-9-5/1.1 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.

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:

1.3.1

for piping systems or components which may contain some liquid, the saturated vapor pressure at 45°C;

1.3.2

the pressure setting of the associated pump discharge relief valve;

1.3.3

the maximum possible total pressure head at the outlet of the associated pumps when a pump discharge relief valve is not installed.

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.

1.5

For pipes, the allowable stress to be considered in the formula for t_o in 5-9-5/1.1 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 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 $B = 1.8$

1.6.1

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

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 5-9-5/1.1 or, if this is impracticable or would cause excessive local stresses, these loads should be reduced, protected against or eliminated by other design methods.

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 5-9-5/1.2. (Also see Section 4-6-5.)

1.6.4

For flanges not complying with a standard the dimensions for flanges and associated bolts should be to the satisfaction of the Administration. (Also see 4-6-5/13.)

2 Piping fabrication and joining details

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.

2.2

Cargo piping should be joined by welding except:

2.2.1

for approved connections to shutoff valves and expansion joints; and

2.2.2

for other exceptional cases specifically approved by the Administration.

2 Interpretation of 5-9-5/2.2.2 (IMO)

Cargo piping should be welded, except for necessary flanged connections to valves, expansion joints (as permitted in 5-9-5/2.2.1), spool pieces and similar fittings or where required for coating, lining, fabrication, inspection or maintenance.

2.3

The following direct connections of pipe lengths, without flanges may be considered:

2.3.1

Butt welded joints with complete penetration at the root may be used in all applications.

2.3.2

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.

2.3.3

Screwed connections acceptable to the Administration should only be used for accessory lines and instrumentation lines with external diameters of 25 mm or less.

2.4

Expansion of piping should normally be allowed for by the provision of expansion loops or bends in the piping system.

2.4.1

Bellows may be specially considered by the Administration in each case.

2.4.2

Slip joints should not be used.

2.5

Welding, post weld heat treatment and nondestructive testing should be performed in accordance with Recognized Standards.

2.5 Interpretation of 5-9-5/2.5 (ABS) *(2002)*

Where steel cargo piping is provided, not less than 5% of the butt welded joints are to be non-destructively examined at random by radiography to the satisfaction of the Surveyor. Dependent upon the results of this NDT examination, the percentage of the butt welded joints to be examined may be increased by the Surveyor.

3 Flange connections

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.

3.2

Flanges should comply with standards acceptable to the Administration as to their type, manufacture and test.

4 Test requirements for piping

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.

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.

4.3

After assembly on board, each cargo piping system should be tested for leaks to a pressure depending on the method applied.

5 Piping arrangements

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 5-9-2/6) 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.

5.2

Cargo piping, located below the main deck, may run from the tank it serves and penetrate tank bulkheads or boundaries common to longitudinally or transversally adjacent cargo tanks, ballast tanks, empty tanks, pump-rooms or cargo pump-rooms provided that inside the tank it serves it is fitted with a stop valve operable from the weather deck and provided cargo compatibility is assured in the event of piping failure. As an exception, where a cargo tank is adjacent to a cargo pump-room, the stop valve operable from the weather deck may be situated on the tank bulkhead on the cargo pump-room side, provided an additional valve is fitted between the bulkhead valve and the cargo pump. The Administration may, however, accept a totally enclosed hydraulically operated valve located outside the cargo tank, provided that the valve is:

5.2.1

designed to preclude the risk of leakage;

5.2.2

fitted on the bulkhead of the cargo tank which it serves;

5.2.3

suitably protected against mechanical damage;

5.2.4

fitted at a distance from the shell, as required for damage protection;

5.2.5

operable from the weather deck.

5.2.1 Interpretation of 5-9-5/5.2.1 (IMO)

The intent is to guard against the hazard of cargo leaking past a valve gland into the space where the valve is located.

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.

5.4

Cargo piping installed in pipe tunnels should also comply with the requirements of 5-9-5/5.1 and 5-9-5/5.2. 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

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.

6 Cargo transfer control systems

6.1

For the purpose of adequately controlling the cargo, cargo transfer systems should be provided with:

6.1.1

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;

6.1.2

one stop valve at each cargo hose connection;

6.1.3

remote shutdown devices for all cargo pumps and similar equipment.

6.1.1 Interpretation of 5-9-5/6.1.1 (IMO)

The provisions of 5-9-5/6.1.1 are not intended to be additional to those of 5-9-5/5.2 and 5-9-5/5.3 for cargo piping below deck.

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.

6.3

For certain products additional cargo transfer control requirements are shown in column "o" in the table of Section 5-9-17.

7 Ship's cargo hoses

7.1

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

7.1 Interpretation of 5-9-5/7.1 (IMO)

This paragraph applies to cargo hoses carried on board the vessel and "compatibility with the cargo" means that:

7.1.1

the cargo hose does not lose its mechanical strength or deteriorate unduly when in contact with the cargo, and

7.1.2

the cargo hose material does not affect the cargo in a hazardous way.

Consideration must be given to internal and external surfaces with respect to the above where hoses may be used as an integral part of, or connected to emergency cargo pumps and submerged in the cargo tank.

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.

7.3 (1 July 2003)

For cargo hoses installed onboard ships on or after 1 July 2002, each new type of cargo hose, complete with end-fittings, should be prototype-tested at a normal ambient temperature with 200 pressure cycles from zero to at least twice the specified maximum working pressure. After this cycle pressure test has been carried out, the prototype test should demonstrate a bursting pressure of at least 5 times its specified maximum working pressure at the extreme service temperature. Hoses used for prototype testing should not be used for cargo service. Thereafter, before being placed in service, each new length of cargo hose produced should be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure but not more than two-fifths of its bursting pressure. The hose should be stenciled or otherwise marked with the date of testing, its specified maximum working pressure and, if used in services other than the ambient temperature services, its maximum and minimum service temperature, as applicable. The specified maximum working pressure should not be less than 10 bar (145 psi) gauge.

PART

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 6 Materials of Construction

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

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.

1.2

Where applicable the following should be taken into account in selecting the material of construction:

1.2.1

notch ductility at the operating temperature;

1.2.2

corrosive effect of the cargo;

1.2.3

possibility of hazardous reactions between the cargo and the material of construction; and

1.2.4

suitability of linings;

2 Special requirements for materials

2.1

For certain products special requirements apply in respect of materials indicated by symbols in column "m" in the table of Section 5-9-17 , as stipulated in 5-9-6/2.2, 5-9-6/2.3 and 5-9-6/2.4.

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 of their vapor where referred to in column "m" in the table of Section 5-9-17:

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.

2 Interpretation of 5-9-6/2.2 and 5-9-6/2.4 (IMO)

Cargo pump-room structure, fittings and equipment other than electrical apparatus, which are normally only exposed to vapors from the pump-room bilges, are not subject to the requirements of these paragraphs. Electrical items are subject to 5-9-6/2.3.

2.3

Materials normally used in electrical apparatus, such as copper, aluminum and insulation, should as far as practicable be protected, e.g. by encapsulation, to prevent contact with vapors of products where referred to by Z in column "m" in the table of Section 5-9-17.

2.4

The following materials of construction which may come into contact with certain products or their vapor should be used for tanks, pipelines, valves, fittings and other equipment, where referred to in column "m" in the table of Section 5-9-17 as follows: (See 5-9-6/2.2 (IMO).)

Y1 Steel covered with a suitable protective lining or coating, aluminum 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.

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 "m" in the table of Section 5-9-17. Short lengths of external pipes connected to cargo tanks may be permitted by the Administration if they are provided with fire-resistant insulation.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 7 Cargo Temperature Control

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

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.

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 5-9-15/13.6.)

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.

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.

1.5

Means should be provided for measuring the cargo temperature.

1.5.1

The means for measuring the cargo temperature should be of restricted or closed type, respectively, when a restricted or closed gauging device is required for individual substances as shown in column "j" in the table of Section 5-9-17.

1.5.2

A restricted temperature measuring device is subject to the definition for a restricted gauging device in 5-9-13/1.1.2, e.g., a portable thermometer lowered inside a gauge tube of the restricted type.

1.5.3

A closed temperature measuring device is subject to the definition for closed gauging device in 5-9-13/1.1.3, e.g. a remote-reading thermometer of which the sensor is installed in the tank.

1.5.4

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 5-9-16/6.)

1.6

When products for which 5-9-15/12, 5-9-15/12.1 or 5-9-15/12.3 are listed in column "o" in the table of Section 5-9-17 are being heated or cooled, the heating or cooling medium should operate in a circuit:

1.6.1

which is independent of other ship's services, except for another cargo heating or cooling system, and which does not enter the machinery space; or

1.6.2

which is external to the tank carrying toxic products; or

1.6.3

where the medium is sampled to check for the presence of cargo before it is re-circulated 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.

1.6.3 Interpretation of 5-9-7/1.6.3 (ABS)

The sampling equipment may be of portable or fixed type.

2 Additional requirements

For certain products, additional requirements contained in Section 5-9-15 are shown in column "o" in the table of Section 5-9-17.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 8 Cargo Tank Venting and Gas-Freeing Arrangements *(1 July 1994)*

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Application

1.1 *(1 July 2003)*

Unless expressly provided otherwise, this Section applies to ships constructed on or after 1 January 1994.

1.2

Ships constructed before 1 January 1994 should comply with the requirements of this Section which were in force prior to the above date.

1.3

For the purpose of the requirements in this Section, the term "ship constructed" is as defined in regulation II-1/1.3.1 of the 1974 SOLAS Convention as amended.

1.4

Ships constructed on or after 1 July 1986 but before 1 January 1994 which fully comply with the requirements of the Code applicable at that time may be regarded as complying with the requirements of regulation II-2/59 of SOLAS 74.

1.5

For ships to which the Code applies, the requirements of this Section should apply in lieu of regulation II-2/59.1 and 59.2 of the 1974 SOLAS Convention, as amended.

1.6 *(1 July 2003)*

Ships constructed on or after 1 July 1986, but before 1 July 2002 should comply with the requirements of paragraph 5-9-8/3.3 by the date of the first scheduled dry-docking after 1 July 2002, but not later than 1 July 2005. However, the Administration may approve relaxation of requirements in 5-9-8/3.3 for ships of less than 500 gross tonnage which were constructed on or after 1 July 1986, but before 1 July 2002.

2 Cargo tank venting

2.1

All cargo tanks should be provided with a venting system appropriate to the cargo being carried and these systems should be independent of the air pipes and venting systems of all other compartments of the ship. Tank venting systems should be designed so as to minimize the possibility of cargo vapor accumulating about the decks, entering accommodation, service and machinery spaces and control stations and, in the case of flammable vapors entering or collecting in spaces or areas containing sources of ignition. Tank venting systems should be arranged to prevent entrance of water into the cargo tanks and at the same time, vent outlets should direct the vapor discharge upwards in the form of unimpeded jets.

2.2

The venting systems should be connected to the top of each cargo tank and as far as practicable the cargo vent lines should be self-draining back to the cargo tanks under all normal operational conditions of list and trim. Where it is necessary to drain venting systems above the level of any pressure/vacuum valve, capped or plugged drain cocks should be provided.

2.3

Provision should be made to ensure that the liquid head in any tank does not exceed the design 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 5-9-15/19.

2.3 Interpretation of 5-9-8/2.3 (IMO)

When large amounts of drainage from vent lines is envisaged, provision for a hose connection to a drain line draining to a suitable slop tank should be provided.

2.4

Tank venting systems should be designed and operated so as to ensure that neither pressure nor vacuum created in the cargo tanks during loading or unloading exceeds tank design parameters. The main factors to be considered in the sizing of a tank venting system are as follows:

2.4.1

design loading and unloading rate;

2.4.2

gas evolution during loading: this should be taken account of by multiplying the maximum loading rate by a factor of at least 1.25;

2.4.3

density of the cargo vapor mixture;

2.4.4

pressure loss in vent piping and across valves and fittings;

2.4.5

pressure/vacuum settings of relief devices.

2.5

Tank vent piping connected to cargo tanks of corrosion-resistant material, or to tanks which are lined or coated to handle special cargoes, as required by the Code, should be similarly lined or coated, or constructed of corrosion-resistant material.

2.6

The master should be provided with the maximum permissible loading and unloading rates for each tank or group of tanks consistent with design of the venting systems.

2 Interpretation of Section 5-9-8 (IMO) Proposal for Venting Arrangements on Board Chemical Tankers

The following arrangement may be accepted as providing a level of protection equivalent to that requested by SOLAS, regulation II-2/59.1.5 and contained in the annex to MSC/Circ.373/Rev.1. The arrangement may be used on non-inerted or inerted cargo tanks with vent pipe sizes up to and including 100 mm in diameter.

2.1

Piping systems referred to in Section 5-9-8 may be provided with the following;

2.1.1

pressure/vacuum valves with the following characteristics:

Constructed in accordance with the appropriate sections of MSC/Circ.373/Rev. 1 excluding the type test procedures for flame arresting capabilities:

Opening overpressure of at least 0.18 bar;

2.1.2

a flame-arresting device fitted at the pipe outlet which has been tested for flashback in accordance with paragraph 3.2.2 and, where applicable, paragraph 2.5.4 of MSC/Circ.373/Rev.1;

2.1.3

the vacuum side of the valve to be protected with a flamescreen as defined in MSC/Circ.373/Rev.1 or a device tested for flashback.

2.2

It should be ensured that when the valve is open, a minimum flow velocity of at least 10 m/sec is maintained at the outlet of the assembly above the flame-arresting device.

3 Types of tank vent systems

3.1

An open tank venting system is a system which offers no restriction except for friction losses to the free flow of cargo vapors to and from the cargo tanks during normal operations. An open venting system may consist of individual vents from each tank, or such individual vents may be combined into a common header or headers, with due regard to cargo segregation. In no case should shutoff valves be fitted either to the individual vents or to the header.

3.2 *(1 July 2003)*

A controlled tank venting system is a system in which pressure and vacuum relief valves or pressure/ vacuum valves are fitted to each tank to limit the pressure or vacuum in the tank. A controlled venting system may consist of individual vents from each tank or such individual vents, on the pressure side only as may be combined into a common header or headers with due regard to cargo segregation. In no case should shutoff valves be fitted either above or below pressure or vacuum relief valves or pressure/ vacuum valves. Provision may be made for bypassing a pressure or vacuum relief valve or a pressure/vacuum valve under certain operating conditions provided that the requirement of 5-9-8/3.6 is maintained and that there is suitable indication to show whether or not the valve is bypassed.

3.3 *(1 July 2003)*

On ships constructed on or after 1 July 2002, controlled tank venting systems should consist of a primary and a secondary means of allowing full flow relief of vapor to prevent overpressure or underpressure in the event of failure of one means. Alternatively, the secondary means may consist of pressure sensors fitted in each tank with a monitoring system in the ship's cargo control room or at a position from which cargo operations are normally carried out. Such monitoring equipment should also provide an alarm facility which is activated by detection of overpressure or underpressure conditions within a tank.

3.4

The position of vent outlets of a controlled tank venting system should be arranged:

3.4.1

at a height of not less than 6 m above the weather deck or above a raised walkway if fitted within 4 m of the raised walkway:

3.4.2

at a distance of at least 10 m measured horizontally from the nearest air intake or opening to accommodation, service and machinery spaces and ignition sources.

3.5 *(1 July 2003)*

The vent outlet height referred to in 5-9-8/3.4.1 may be reduced to 3 m above the deck or a raised walkway, as applicable, provided that high velocity venting valves of a type approved by the Administration directing the vapor/air mixture upwards in an unimpeded jet with an exit velocity of at least 30 m/s are fitted.

3.6

Controlled tank venting systems fitted to tanks to be used for cargoes having a flashpoint not exceeding 60°C (closed cup test) should be provided with devices to prevent the passage of flame into the cargo tanks. The design, testing and locating of the devices should comply with the requirements of the Administration which should contain at least the standards adopted by the Organization. •

• *Reference is made to the Revised Standards for the Design, Testing and Locating of Devices to Prevent the Passage of Flame into Cargo Tanks in Tankers (MSC/Circ.373/Rev.1).*

3.7

In designing venting systems and in the selection of devices to prevent the passage of flame for incorporation into the tank venting system, due attention should be paid to the possibility of the blockage of these systems and fittings by, for example, the freezing of cargo vapor, polymer build up, atmospheric dust or icing up in adverse weather conditions. In this context it should be noted that flame arresters and flame screens are more susceptible to blockage. Provisions should be made such that the system and fittings may be inspected, operationally checked, cleaned or renewed as applicable.

3.8

Reference in 5-9-8/3.1 and 5-9-8/3.2 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.

4 Venting requirements for individual products

Venting requirements for individual products are shown in column "g" and additional requirements in column "o" in the table of Section 5-9-17.

5 Cargo tank gas-freeing•

• Reference is made to the Revised Factors to be taken into Consideration when Designing Cargo Tanks Venting and Gas-Freeing Arrangements (MSC/Circ.450/Rev.1) and to the Revised Standards for the Design, Testing and Locating of Devices to Prevent the Passage of Flame into Cargo Tanks in Tankers (MSC/Circ.373/Rev.1).

5.1

The arrangements for gas-freeing cargo tanks used for cargoes other than those for which open venting is permitted should be such as to minimize the hazards due to the dispersal of flammable or toxic vapors in the atmosphere and to flammable or toxic vapor mixtures in a cargo tank. Accordingly, gas-freeing operations should be carried out such that vapor is initially discharged:

5.1.1

through the vent outlets specified in 5-9-8/3.3 and 5-9-8/3.4; or

5.1.2

through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 30 m/s maintained during the gas freeing operation; or

5.1.3

through outlets at least 2 m above the cargo tank deck level with a vertical efflux velocity of at least 20 m/s which are protected by suitable devices to prevent the passage of flame.

When the flammable vapor concentration at the outlets has been reduced to 30% of the lower flammable limit and in the case of a toxic product the vapor concentration does not present a significant health hazard, gas freeing may thereafter be continued at cargo tank deck level.

5.2

The outlets referred to in 5-9-8/5.1.2 and 5-9-8/5.1.3 may be fixed or portable pipes.

5.3

In designing a gas-freeing system in conformity with 5-9-8/5.1 particularly in order to achieve the required exit velocities of 5-9-8/5.1.2 and 5-9-8/5.1.3, due consideration should be given to the following:

5.3.1

materials of construction of system;

5.3.2

time to gas-free;

5.3.3

flow characteristics of fans to be used;

5.3.4

the pressure losses created by ducting, piping, cargo tank inlets and outlets;

5.3.5

the pressure achievable in the fan driving medium (e.g., water or compressed air);

5.3.6

the densities of the cargo vapor/air mixtures for the range of cargoes to be carried.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 9 Environmental Control

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

Vapor spaces within cargo tanks and, in some cases, spaces surrounding cargo tanks may be required to have specially controlled atmospheres.

1.2

There are four different types of control for cargo tanks, as follows:

1.2.1 Inerting

By filling the cargo tank and associated piping systems and, where specified in Section 5-9-15, the spaces surrounding the cargo tanks, with a gas or vapor which will not support combustion and which will not react with the cargo, and maintaining that condition.

1.2.2 Padding

By filling the cargo tank and associated piping systems with a liquid, gas or vapor which separates the cargo from the air, and maintaining that condition.

1.2.3 Drying

By filling the cargo tank and associated piping systems with moisture-free gas or vapor with a dewpoint of -40°C or below at atmospheric pressure, and maintaining that condition.

1.2.4 Ventilation

Forced or natural.

1.3

Where inerting or padding of cargo tanks is required:

1.3.1

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.

1.3.2

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.

1.3.3

Where padding is used, similar arrangements for supply of the padding medium should be made as required for inert gas in 5-9-9/1.3.1 and 5-9-9/1.3.2.

1.3.4

Means should be provided for monitoring ullage spaces containing a gas blanket to ensure that the correct atmosphere is being maintained.

1.3.5

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.

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 5-9-9/1.3. 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.

1 Amendments to SOLAS (IMO)

SOLAS has been amended by MSC.13 (57) and comes into force on 1 February 1992 which revises the requirements on inert gas systems on some liquefied gas carriers and chemical carriers and the revised text of Regulations II-2/55 to read as follows:

Regulation 55

Application

1. Unless expressly provided otherwise, this part shall apply to tankers carrying crude oil and petroleum products having a flashpoint not exceeding 60°C (closed cup test), as determined by an approved flashpoint apparatus, and a Reid vapor pressure which is below atmospheric pressure and other liquid products having a similar fire hazard.

2. Where liquid cargoes other than those referred to in paragraph 1 above 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.

3. This paragraph applies to all ships which are combination carriers. Such ships shall not carry solid cargoes unless all cargo tanks are empty of oil and gas-freed or unless the arrangements provided in each case are to the satisfaction of the Administration and in accordance with the relevant operational requirements contained in the Guidelines for Inert Gas Systems.•

• Reference is made to Regulation for Inert Gas Systems on Chemical Tankers adopted by the Organization by resolution A.567(14). See Annex 5-9-A4.

4. Tankers carrying petroleum products having a flashpoint exceeding 60°C (closed cup test), as determined by an approved flashpoint apparatus, shall comply with the provisions of part C, except that in lieu of the fixed fire-extinguishing system required in regulation 53 they shall be fitted with a fixed deck foam system which shall comply with the provisions of regulation 61.

5. The requirements for inert gas systems of regulation 60 need not be applied to:

.1 chemical tankers constructed before, on or after 1 July 1986 when carrying cargoes described in paragraph 1, provided that they comply with the requirements for inert gas systems on chemical tankers developed by the Organization•; or

• Reference is made to Regulation for Inert Gas Systems on Chemical Tankers adopted by the Organization by resolution A.567(14). See Annex 5-9-A4.

.2 chemical tankers constructed before 1 July 1986, when carrying crude oil or petroleum products, provided that they comply with the requirements for inert gas systems on chemical tankers carrying petroleum products developed by the Organization••; or

•• Reference is made to Interim Regulation for Inert Gas Systems on Chemical Tankers Carrying Petroleum Products, adopted by the Organization by resolution A.473(XII). See Annex 5-9-A3.

.3 gas carriers constructed before, on or after 1 July 1986 when carrying cargoes described in paragraph 1, provided that they are fitted with cargo tank inerting arrangements equivalent to those specified in paragraph 5-9-9/1.5.1 or 5-9-9/1.5.2; or

.4 chemical tankers and gas carriers when carrying flammable cargoes other than crude oil or petroleum products such as cargoes listed in chapters VI and VII of the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk or chapters 17 and 18 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk:

.4.1 if constructed before 1 July 1986; or

.4.2 if constructed on or after 1 July 1986, provided that the capacity of tanks used for their carriage does not exceed 3,000 m^3 and the individual nozzle capacities of tank washing machines do not exceed 17.5 m^3/h and the total combined throughput from the number of machines in use in a cargo tank at any one time does not exceed 110 m^3/h.

1.1 Oil Fired Inert Gas Systems on Chemical Carriers (IACS) *(1999)*

In addition to 5-9-9/1(IMO) , the following requirements apply where an inert gas system based on oil fired inert gas generators is fitted onboard chemical tankers. Other sources of inert gas will be specially considered.

1.1.1 Alternative to Water Seal

As an alternative to the water seal in the inert gas line on deck, an arrangement consisting of two shut-off valves in series with a venting valve in between may be accepted, provided:

1.1.1(a) the operation of the valve is automatically executed and signal(s) for opening/closing are taken from the process directly, (e.g., inert gas flow or differential pressure)

1.1.1(b) alarm for faulty operation of the valves is provided, (e.g. the operational status of “blower stop” and “supply valve(s) open” is an alarm condition).

1.1.1(c) (1999) upon loss of power, the block valves are to automatically close and the bleed valve is to automatically open.

1.1.2 Additional Requirements *(1999)*

The requirements in 5-1-7/25.7.1 and 4-7-2/1.1 are to be complied with.

1.2 Nitrogren Generator Inert Gas Systems on Chemical Carriers (IACS) *(1999)*

In addition to 5-9-9/1(IMO), where a nitrogen generator system is installed onboard a chemical tanker, it is to comply with the requirements in 5-1-7/25.41, except for 5-1-7/25.41.1, 5-1-7/25.41.2(a) and 5-1-7/25.41.2(c) and where the connections to the cargo tanks, hold spaces or cargo piping are not permanent, the non-return devices required by 5-1-7/25.41.4 may be substituted by two non-return valves.

2 *Environmental control requirements for individual products*

The required types of environmental control for certain products are shown in column “h” in the table of Section 5-9-17.

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CHAPTER **9 Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION **10 Electrical Installations**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

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.

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 5-9-8/2.2.1, having regard to 5-9-10/1.4.

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 vapors liable to be encountered.

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.**

**Reference is made to the Recommendations published by the International Electrotechnical Commission and in particular to Publication 92-502.*

1.4

Electrical equipment and wiring should not be installed in the hazardous locations referred to in 5-9-10/2, unless essential for operational purposes, when the exceptions listed in 5-9-10/2.3 are permitted.

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 relevent authorities recognized by the Administration for operation in the flammable atmosphere concerned, as indicated in column "i" in the table of Section 5-9-17.

1.6

Absence of information on temperature class and apparatus group in column "i" in the table of Section 5-9-17 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 5-9-10/2.2 applied.

2 Hazardous locations and types of equipment and wiring

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 recommended that intrinsically safe systems and circuits are used for measurement, monitoring, control and communication purposes.

2.2

Cargoes with a flashpoint exceeding 60°C (closed cup test):

2.2.1

Cargo tanks and cargo piping are the only hazardous locations for such cargoes which have no qualification in column "o" in the table of Section 5-9-17. 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.

2.2.2

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.

2.2.3

Where the cargo is heated to within 15°C of its flash-point 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.

2.2.4

Where the cargo is heated above its flashpoint value, the requirements of 5-9-10/2.3 are applicable.

2.3

For cargoes with a flashpoint not exceeding 60°C (closed cup test) without qualification in column "o" in the table of Section 5-9-17, 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:

2.3.1

Cargo tanks and cargo piping:

No additional electrical equipment is permitted.

2.3.2

Void spaces adjacent to, above or below integral tanks.

2.3.2.1 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.

2.3.2.2 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 5-9-10/2.3.2.1.

2.3.3

Hold spaces containing independent cargo tanks:

2.3.3.1 Through runs of cable without any additional protection.

2.3.3.2 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.

2.3.3.3 Electrical depth sounding or log devices and impressed current cathodic protection system anodes or electrodes. These devices should be housed in gastight enclosures.

2.3.4

Cargo pump-rooms and pump-rooms in the cargo area:

2.3.4.1 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.

2.3.4.2 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.

2.3.4.3 Flameproof general alarm audible indicator.

2.3.5

Zones on open deck, or semi-enclosed spaces on open deck, within 3 m of any cargo tank outlet, gas or vapor 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 tank block, 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:

2.3.5.1 equipment of a certified safe type, adequate for open deck use;

2.3.5.2 through runs of cables.

2.3.5 Interpretation of 5-9-10/2.3.5 (IMO)

For this purpose, the length of the cargo area on open deck to be measured is to extend between the forward bulkhead of the foremost cargo tank and the after bulkhead of the aftermost cargo tank or, when independent tanks are fitted, the forward bulkhead of the foremost hold space and the after bulkhead of the aftermost hold space.

2.3.6

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:

2.3.6.1 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.

2.3.6.2 through runs of cables.

2.3.7

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.

3 Bonding

Independent cargo tanks should be electrically bonded to the hull. All gasketed cargo pipe joints and hose connections should be electrically bonded.

4 Electrical requirements for individual products

Electrical requirements for individual products are shown in column "i" in the table of Section 5-9-17.

5 Integrated Cargo and Ballast Systems (IACS) *(2004)*

5.1 Application

The following requirements are applicable to integrated cargo and ballast systems installed on chemical tankers (i.e., vessels constructed primarily to carry liquid chemical cargo in bulk). The integrated cargo and ballast system means any integrated hydraulic and/or electric system used to drive both cargo and ballast pumps (including active control and safety systems, but excluding passive components, e.g., piping).

5.3 Functional Requirements

The operation of cargo and/or ballast systems may be necessary, under certain emergency circumstances or during the course of navigation, to enhance the safety of tankers. As such, measures are to be taken to prevent cargo and ballast pumps becoming inoperative simultaneously due to a single failure in the integrated cargo and ballast system, including its control and safety systems.

5.5 Design features

The following design features are to be fitted:

i) the emergency stop circuits of the cargo and ballast systems are to be independent from the circuits for the control systems. A single failure in the control system circuits or the emergency stop circuits are not to render the integrated cargo and ballast system inoperative;

ii) manual emergency stops of the cargo pumps are to be arranged in such a way that they do not cause the ballast pump power pack to stop and thus make the ballast pumps inoperable;

iii) the control systems are to be provided with backup power supply, which may be satisfied by a duplicate power supply from the main switchboard. The failure of any power supply is to provide audible and visible alarm activation at each location where the control panel is fitted.

iv) in the event of failure of the automatic or remote control systems, a secondary means of control is to be made available for the operation of the integrated cargo and ballast system. This is to be achieved by manual overriding and/or redundant arrangements within the control systems.

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CHAPTER **9 Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION **11 Fire Protection and Fire Extinction**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Application

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:

1.1.1

regulations 60, 61, 62 and 63 should not apply;

1.1.2

regulation 56.2, i.e. the requirements for location of the main cargo control station, need not apply;

1.1.3

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;

1.1.4

the provisions of 5-9-11/3 should apply in lieu of regulation 61; and

1.1.5

the provisions of 5-9-11/2 should apply in lieu of regulation 63.

1.2 *(1 July 1994)*

Notwithstanding the provisions of 5-9-11/1.1, ships engaged solely in the carriage of products which are non-flammable (entry NF in column "i" of the table of minimum requirements) need not comply with 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 5-9-11/2 and 5-9-11/3 hereunder need not apply.

1.3 *(1 July 1994)*

For ships engaged solely in the carriage of products with flashpoint above 60°C (entry "yes" in column "i" of the table of minimum requirements) requirements of chapter II-2 of the 1983 SOLAS amendments may apply as specified in regulation II-2/55.4 in lieu of the provisions of this Section.

2 Cargo pump-rooms

2.1

The cargo pump-room of any ship should be provided with a fixed fire-extinguishing system as follows:

2.1.1

a carbon dioxide system as specified in regulation II-2/5.1 and .2 of the 1983 SOLAS amendments. A notice should be exhibited at the controls stating that the system is only to be used for fire-extinguishing and not for inerting purposes, due to the electrostatic ignition hazard. The alarms referred to in regulation II-2/5.1.6 of the 1983 SOLAS amendments should be safe for use in a flammable cargo vapor-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

2.1.2 [Not applicable for new construction (ABS)]

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 vapor-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*

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.

2.3

A fire-extinguishing system consisting of either a fixed pressure water-spray system or a high-expansion foam system could be provided for a cargo pump-room if 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.

3 Cargo area•

• *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. (See Annex 5-9-A2).*

3.1

Every ship should be provided with a fixed deck foam system in accordance with the requirements of 5-9-11/3.2 to 5-9-11/3.12.

3.1 Interpretation of 5-9-11/3.5.3 and 5-9-11/3.7 (IMO)

For ships of less than 4000 tonnes deadweight, the minimum capacity of a monitor should be 1000 ℓ/min and the application rate should be at least 10 ℓ/min/m^2, of the surface to be protected.

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. Regular protein foams should not be used.

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.

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.

3.5

The rate of supply foam solution should not be less than the greatest of the following.

3.5.1

2 ℓ/min per square meter of the cargo tanks decks area, where cargo tanks deck area means the maximum breadth of the ship times the total longitudinal extent of the cargo tank spaces;

3.5.2

20 ℓ/min per square meter of the horizontal sectional area of the single tank having the largest such area;

3.5.3

10 ℓ/min per square meter 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.

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 5-9-11/3.5.1, 5-9-11/3.5.2 and 5-9-11/3.5.3.

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 5-9-11/3.5.1 or 5-9-11/3.5.2 should be delivered from each monitor. The capacity of any monitor should be at least 10 ℓ/min of foam solution per square meter 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. (See 5-9-11/3.1 (IMO))

3.8

The distance from the monitor to the farthest extremity of the protected area forward of that monitor should not be more than 75% of the monitor throw in still air conditions.

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.

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 not be 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.

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.

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.

3.12 Interpretation of 5-9-11/3.12 (IMO)

The simultaneous use of the minimum number of jets of water should be possible on deck over the full length of the ship, in the accommodation, service spaces, control spaces and machinery spaces.

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.

3.14

Suitable portable fire-extinguishing equipment for the products to be carried should be provided and kept in good operating order.

3.14 Interpretation of 5-9-11/3.14 (IMO)

The capacity of portable fire-extinguishing equipment should be as specified in the 1974 SOLAS Convention, as amended.

3.15

Where flammable cargoes are to be carried all sources of ignition should be excluded from hazardous locations referred to in 5-9-10/2.

3.16

Ships fitted with bow or stern loading and unloading arrangements should be provided with one additional foam monitor meeting the requirements of 5-9-11/3.7 and one additional applicator meeting the requirements of 5-9-11/3.10. 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.

4 Special requirements

"Fire-extinguishing media determined to be effective for certain products are listed in column "1" in the table of Section 5-9-17".

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CHAPTER **9 Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION **12 Mechanical Ventilation in the Cargo Area**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

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. However, for products addressed under 5-9-11/1.2 and 5-9-11/1.3, except acids and products for which 5-9-15/17 apply, regulation II-2/59.3 of the 1983 SOLAS Amendments may apply in lieu of the provisions of this Section.

1 *Spaces normally entered during cargo handling operations*

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.

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.

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 vapors or both (taking into account their vapor 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 5-9-15/17.

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.

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.

1.6

Ventilation intakes should be so arranged as to minimize the possibility of recycling hazardous vapors from any ventilation discharge opening.

1.7

Ventilation ducts should not be led through accommodation, service and machinery spaces or other similar spaces.

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 Section 5-9-10 should be of nonsparking construction defined as:

1.8.1

impellers or housing of nonmetallic construction, due regard being paid to the elimination of static electricity;

1.8.2

impellers and housing of nonferrous materials;

1.8.3

impellers and housing of austenitic stainless steel; and

1.8.4

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.

1.8 Nonsparking Fans (IACS/ABS) *(1993)*

See 5-8-12/1.9(IACS/ABS)

1.9

Sufficient spare parts should be carried for each type of fan on board, required by this chapter.

1.10

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

1.10 Protection Screen (ABS) *(1993)*

See 5-8-12/1.11(ABS).

2 Pump-rooms and other enclosed spaces normally entered

Pump-rooms and other enclosed spaces normally entered, which are not covered by 5-9-12/1.1, should be fitted with mechanical ventilation systems, capable of being controlled from outside such spaces and complying with the requirements of 5-9-12/1.3, 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.

2 Interpretation of 5-9-12/2 (IMO)

A pump-room is subject to this paragraph whether or not control for pumps and valves is fitted external to the pump-room.

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 5-9-12/1.8.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 13 Instrumentation

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Gauging

1.1

Cargo tanks should be fitted with one of the following types of gauging devices:

1.1.1

"Open device", which makes use of an opening in the tanks and may expose the gauger to the cargo or its vapor. An example of this is the ullage opening.

1.1.2

"Restricted device", which penetrates the tank and which, when in use, permits a small quantity of cargo vapor 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.

1.1 Interpretation of 5-9-13/1.1 and 5-9-15/19 (IMO)

In almost all cases, a code cargo which requires a high level alarm and overflow control also requires a closed gauging device.

A cargo tank containing such a product, therefore, requires three sensors:

1.1.1

level gauging

1.1.2

high level alarm

1.1.3

overflow control

The sensing elements for 5-9-13/1.1.1, 5-9-13/1.1.2 and 5-9-13/1.1.3 should be separated, although sensors for 5-9-13/1.1.2 and 5-9-13/1.1.3 (reed switches, float chambers, electronic devices, etc.) may be contained in the same tube

Electronic, pneumatic, hydraulic circuits required for sensors 5-9-13/1.1.1, 5-9-13/1.1.2 and 5-9-13/1.1.3 should be independent of each other, such that a fault on any one will not render either of the others inoperative.

Where processing units are used to give digital or visual indication such as in a bridge space, the independency of circuitry should be maintained at least beyond this point. The power should be supplied from distribution boards.

Where a control room or a bridge space containing a modular unit is envisaged, separate level indication and visual alarms must be provided for each of the functions 5-9-13/1.1.1, 5-9-13/1.1.2 or 5-9-13/1.1.3. An audible alarm must also be provided, but since this is not directional it need not be separate. An audible alarm must also be arranged in the cargo area. Where there is no control room, an audible and visual alarm should be arranged at the cargo control station.

Testing of sensors should be arranged from outside of the tanks, although entry into product clean tanks is not precluded.

Simulation testing of electronic circuits or circuits which are self-monitoring is acceptable.

1.1 Interpretation of 5-9-13/1.1.2 (IACS)

A restricted device could be a sounding pipe with inside diameter not exceeding 200 mm, with vapor tight cover.

1.1.3

"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.

1.2

Gauging devices should be independent of the equipment required under 5-9-15/19 .

1.3

Open gauging and restricted gauging should be allowed only where:

1.3.1

open venting is allowed by the Code; or

1.3.2

means are provided for relieving tank pressure before the gauge is operated.

1.4

Types of gauging for individual products are shown in column "j" in the table of Section 5-9-17.

2 *Vapor detection*

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 vapors in question. If such instruments are not capable of testing for both toxic concentrations and flammable concentrations, then two separate sets of instruments should be provided.

2.2

Vapor detection instruments may be portable or fixed. If a fixed system is installed, at least one portable instrument should be provided.

2.3

When toxic vapor detection equipment is not available for some products which require such detection, as indicated in column "i" in the table of Section 5-9-17, 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 5-9-14/2.4 and 5-9-16/4.2.2.

2.4

Vapor detection requirements for individual products are shown in column "k" in the table of Section 5-9-17.

3 (IACS) *(1998)*

For flammable gas monitoring of the cargo area, sampling type gas analyzing units which are not intended for a hazardous location may be located outside of cargo areas (e.g., in cargo control room, navigating bridge or engine room) when mounted on the inside of the front bulkhead and subject to compliance with the following:

3.1

Sampling lines are not to pass through gas safe spaces unless permitted by 5-9-13/3.5.

3.2

The non-safe type gas analyzing unit is to be installed in a safe area and the gas sampling lines are to be fitted with flame arresters. Sample gas is to be led to the atmosphere. The outlets are to be fitted with flame screens and are to be located in a safe location.

The area within 3 m (10 ft) of the outlet pipe is to be considered a hazardous location.

3.3

Where sampling pipes pass through bulkheads separating safe and dangerous areas, the penetrations are to be of an approved type having fire integrity at least as effective as the bulkhead. A manual isolation valve is to be fitted at each penetration on the gas safe side.

3.4 *(2002)*

The gas detection equipment, including sampling piping, sampling pumps, solenoids, analyzing units, etc., is to be contained in a reasonably gas-tight steel cabinet (e.g., fully enclosed steel cabinet with gasketed door) being monitored by its own sampling point. The entire gas analyzing unit is to be automatically shut down when the gas concentration inside the cabinet reaches 30% of the lower flammability limit.

3.5

Where it is impracticable to mount the cabinet on the front bulkhead, sampling pipes are to be of steel or other equivalent material and without any detachable connections, except for the isolating valves at the bulkhead and analyzing units. Runs of sampling pipes within safe space is to be of the shortest possible length.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 14 Personnel Protection

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Protective equipment

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 shield or both. The protective clothing and equipment should cover all skin so that no part of the body is unprotected.

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.

1.2 Interpretation of 5-9-14/1.2 (IMO)

Lockers for work clothes and protective equipment which are not new or have not undergone a thorough cleaning process should not open directly into accommodation spaces.

1.3

Protective equipment should be used in any operation which may entail danger to personnel

2 Safety equipment

2.1

Ships carrying cargoes for which 5-9-15/12, 5-9-15/12.1 or 5-9-15/12.3 is listed in column "m" in the table of Section 5-9-17 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.

2.2

One complete set of safety equipment should consist of:

2.2.1

one self-contained air-breathing apparatus (not using stored oxygen);

2.2.2

protective clothing, boots, gloves and tight-fitting goggles;

2.2.3

fireproof lifeline with belt resistant to the cargoes carried; and

2.2.4

explosion-proof lamp.

2.3

For the safety equipment required in 5-9-14/2.1, all ships should carry the following, either:

2.3.1

one set of fully charged spare air bottles for each breathing apparatus;

2.3.2

a special air compressor suitable for the supply of high-pressure air of the required purity;

2.3.3

a charging manifold capable of dealing with sufficient spare breathing apparatus air bottles for the breathing apparatus; or

2.3.4

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.

2.4

A cargo pump-room on ships carrying cargoes which are subject to the requirements of 5-9-15/18 or cargoes for which in column "i" in the table of Section 5-9-17 toxic vapor detection equipment is required but is not available should have either:

2.4.1

a low-pressure line system with hose connections suitable for use with the breathing apparatus required by 5-9-14/2.1. 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 hour 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

2.4.2

an equivalent quantity of spare bottled air in lieu of the low-pressure air line

2.4 Interpretation of 5-9-14/2.4.2 (IMO)

The equivalent quantity of spare bottled air in lieu of the low-pressure air line should be at least 4800 liters.

2.5

At least one set of safety equipment as required by 5-9-14/2.2 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

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.

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.

2.8 *(1 July 1994)*

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:

2.8.1

filter type respiratory protection is unacceptable.

2.8.2

self-contained breathing apparatus should have normally at least a duration of service of 15 min;

2.8.3

emergency escape respiratory protection should not be used for fire-fighting 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 "n" in the table of Section 5-9-17.

2.9 *(1 July 2003)*

The ship should have on board medical first-aid equipment including oxygen resuscitation equipment and antidotes for cargoes to be carried, based on the guidelines developed by the Organization•.

• *Reference is made to the Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG) which provides advice on the treatment of casualties in accordance with the symptoms exhibited as well as on equipment and antidotes that may be appropriate for treating the casualty.*

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.

2.10 Interpretation of 5-9-14/2.10 (ABS)

In general, as a minimum, a decontamination shower and an eyewash are provided at the front of the after house or superstructure on the main deck, port and starboard.

PART

5

CHAPTER **9 Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION **15 Special Requirements**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

The provisions of this chapter are applicable where specific reference is made in column "m" in the table of Section 5-9-17. These requirements are additional to the general requirements of the Rules.

1 Acetone cyanohydrin and lactonitrile solution (80% or less)

Acetone cyanohydrin and lactonitrile solution (80% or less) 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:

1.1

name and amount of stabilizer added;

1.2

date stabilizer was added and duration of effectiveness;

1.3

any temperature limitations qualifying the stabilizer's effective lifetime;

1.4

the action to be taken should the length of voyage exceed the effective lifetime of the stabilizer.

2 Ammonium nitrate solution, 93% or less

2.1

The ammonium nitrate solution should contain at least 7% by weight of water. The acidity (pH) of the cargo when diluted with ten parts of water to one part of cargo by weight should be between 5.0 and 7.0. The solution should not contain more than 10 ppm chloride ions, 10 ppm ferric ions, and should be free of other contaminants.

2.2

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.

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.

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.

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 hours. 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.

2.6

A fixed installation should be provided to inject ammonia gas into the cargo. Controls for this system should be located on the navigation bridge. For this purpose, 300 kg of ammonia per 1,000 tonnes of ammonium nitrate solution should be available on board.

2.6 Interpretation of 5-9-15/2.6 (IMO)

For the purpose of injecting ammonia, the cargo may be circulated by means of the cargo pump. Gaseous ammonia may be injected into the circulating cargo.

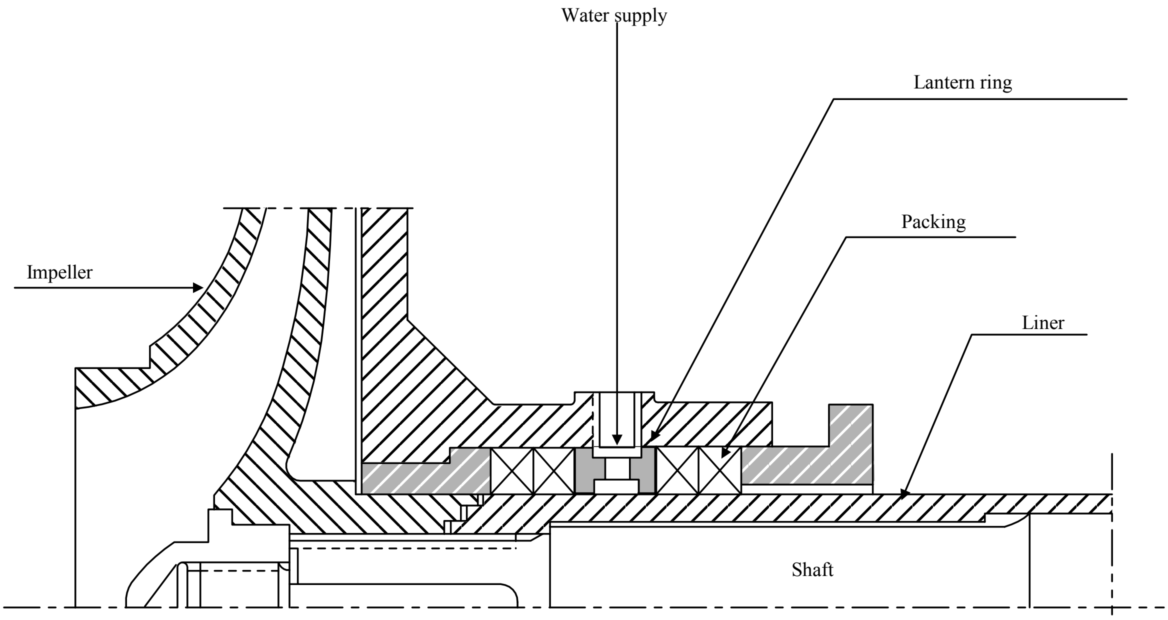
2.7

Cargo pumps should be of the centrifugal deepwell type or of the centrifugal type with water flushed seals.

2.7 Interpretation of 5-9-15/2.7 (IMO)

The seal for the centrifugal pump should be a stuffing box provided with a lantern ring. Fresh water under pressure should be injected into the stuffing box at the location of the lantern ring (see 5-9-15/Figure 1).

FIGURE 1
Water flushed seal in chemical pump (5-9-15/2.7)



2.8

Vent piping should be fitted with approved weatherhoods to prevent clogging. Such weatherhoods should be accessible for inspection and cleaning.

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.

3 Carbon disulphide (1 July 2003)

Carbon disulphide may be carried either under a water pad or under a suitable inert gas pad as specified in the following paragraphs.

Carriage under water pad

3.1 (1 July 2003)

Provision should be made to maintain a water pad in the cargo tank during loading, unloading and transit. In addition, a suitable inert gas pad should be maintained in the ullage space during transit.

3.2

All openings should be in the top of the tank, above the deck.

3.3

Loading lines should terminate near the bottom of the tank.

3.4

A standard ullage opening should be provided for emergency sounding.

3.5

Cargo piping and vent lines should be independent of piping and vent lines used for other cargo.

3.6 *(1 July 2003)*

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 (176°F).

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.

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.

3.9

Safety relief valves should be of stainless steel construction.

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 5-9-10/2.3 .

Carriage under suitable inert gas pad

3.11 *(1 July 2003)*

Carbon disulphide should be carried in independent tanks with a design pressure of not less than 0.6 bar gauge.

3.12 *(1 July 2003)*

All openings should be located on the top of the tank, above the deck.

3.13 *(1 July 2003)*

Gaskets used in the containment system should be of a material which does not react with, or dissolve in, carbon disulphide.

3.14 *(1 July 2003)*

Threaded joints should not be permitted in the cargo containment system, including the vapor lines.

3.15 *(1 July 2003)*

Prior to loading, the tank(s) should be inerted with suitable inert gas until the oxygen level is 2% by volume or lower. Means should be provided to automatically maintain a positive pressure in the tank using suitable inert gas during loading, transport and discharge. The system should be able to maintain this positive pressure between 0.1 and 0.2 bar gauge, and should be remotely monitored and fitted with over/underpressure alarms.

3.16 *(1 July 2003)*

Hold spaces surrounding an independent tank carrying carbon disulphide should be inerted by a suitable inert gas until the oxygen level is 2% or less. Means should be provided to monitor and maintain this condition throughout the voyage. Means should also be provided to sample these spaces for carbon disulphide vapor.

3.17 *(1 July 2003)*

Carbon disulphide should be loaded, transported and discharged in such a manner that venting to the atmosphere does not occur. If carbon disulphide vapor is returned to shore during loading or to the ship during discharge, the vapor return system should be independent of all other containment systems.

3.18 *(1 July 2003)*

Carbon disulphide should be discharged only by submerged deepwell pumps or by a suitable inert gas displacement. The submerged deepwell pumps should be operated in a way that prevents heat build-up in the pump. The pump should also be equipped with a temperature sensor in the pump housing with remote readout and alarm in the cargo control room. The alarm should be set at 80°C. The pump should also be fitted with an automatic shut-down device, if the tank pressure falls below atmospheric pressure during the discharge.

3.19 *(1 July 2003)*

Air should not be allowed to enter the cargo tank, cargo pump or lines while carbon disulphide is contained in the system.

3.20 *(1 July 2003)*

No other cargo handling, tank cleaning or deballasting should take place concurrent with the loading or discharge of carbon disulphide.

3.21 *(1 July 2003)*

A water spray system of sufficient capacity should be provided to blanket effectively the area surrounding the loading manifold, the exposed deck piping associated with product handling and the tank domes. The arrangement of piping and nozzles should be such as to give an uniform distribution rate of 10 ℓ/m^2/min. Remote manual operation should be arranged such that remote starting of pumps supplying the water-spray system and remote operation of any normally closed valves in the system can be carried out from a suitable location outside the cargo area adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected. The water-spray system should be capable of both local and remote manual operation, and the arrangement should ensure that any spilled cargo is washed away. Additionally, a water hose with pressure to the nozzle when atmospheric temperature permits, should be connected ready for immediate use during loading and unloading operations.

3.22 *(1 July 2003)*

No cargo tanks should be more than 98% liquid-full at the reference temperature (R).

3.23 *(1 July 2003)*

The maximum volume (VL) of cargo to be loaded in a tank should be:

$$VL = 0.98\,V(\rho_R/\rho_L)$$

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, i.e. the temperature at which the vapor pressure of the cargo corresponds to the set pressure of the pressure relief valve.*

3.24 *(1 July 2003)*

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.

3.25 *(1 July 2003)*

Zones on open deck, or semi-enclosed spaces on open deck within three meters of a tank outlet, gas or vapor outlet, cargo pipe flange or cargo valve of a tank certified to carry carbon disulphide, should comply with the electrical equipment requirements specified for carbon disulphide in column "i", Section 5-9-17. Also, within the specified zone, no other heat sources, like steam piping with surface temperatures in excess of 80°C should be allowed.

3.26 *(1 July 2003)*

Means should be provided to ullage and sample the cargo without opening the tank or disturbing the positive suitable inert gas blanket.

3.27 *(1 July 2003)*

The product should be transported only in accordance with a cargo handling plan that has been approved by the Administration. Cargo handling plans should show the entire cargo piping system. A copy of the approved cargo handling plan should be available on board. The International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk should be endorsed to include reference to the approved cargo handling plan.

4 Diethyl ether

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.

4.2

Pressure relief valve settings should not be less than 0.2 bar gauge for gravity tanks.

4.3

Inert gas displacement may be used for discharging cargo from pressure tanks provided the cargo system is designed for the expected pressure.

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.

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.

4.6

Provision should be made to maintain the inert gas pad in the cargo tank during loading, unloading and transit.

5 Hydrogen peroxide solutions

Hydrogen peroxide solutions over 60% but not over 70% by weight.

5.1

Hydrogen peroxide solutions over 60% but not over 70% should be carried in dedicated ships only and no other cargoes should be carried.

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.

5.3

Pump-rooms should not be used for cargo transfer operations.

5.4

Cargo tanks should be separated by cofferdams from oil fuel tanks or any other space containing flammable or combustible materials.

5.5

Tanks intended for the carriage of hydrogen peroxide should not be used for seawater ballast.

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.

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.

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 hour period or when the temperature in the tank exceeds 40°C.

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.

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:

5.10.1

The product should be diluted from the original concentration to 35% by weight within 5 minutes of the spill.

5.10.2

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.

5.10.2 Interpretation of 5-9-15/5.10.2 (IMO)

Piping/hose failure should be assumed to be total.

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:

5.11.1

name and amount of stabilizer added;

5.11.2

date stabilizer was added and duration of effectiveness;

5.11.3

any temperature limitations qualifying the stabilizer's effective lifetime;

5.11.4

the action to be taken should the length of voyage exceed the effective lifetime of the stabilizer.

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 hydrogen peroxide. He should certify to the master that the cargo has been loaded in a stable condition.

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 nonflammable coveralls, suitable gloves, boots and eye protection.

Hydrogen peroxide solutions over 8% but not over 60% by weight

5.14

The ship's shell plating should not form any boundaries of tanks containing this product.

5.15

Hydrogen peroxide should be carried in tanks thoroughly and effectively cleaned of all traces of previous cargoes and their vapors or ballast. Procedures for inspection, cleaning, passivation and loading of tanks should be in accordance with MSC/Circ. 394. A certificate should be on board the passivation requirement may be waived by an Administration for domestic shipments of short duration. Particular care in this respect is essential to ensure the safe carriage of hydrogen peroxide.

5.15.1

When hydrogen peroxide is carried no other cargoes should be carried simultaneously.

5.15.2

Tanks which have contained hydrogen peroxide may be used for other cargoes after cleaning in accordance with the procedures outlined in MSC/Circ. 394.

5.15.3

Consideration in design should provide minimum internal tank structure, free draining, no entrapment and ease of visual inspection.

5.16

Cargo tanks and associated equipment should be either pure aluminum (99.5%) or solid stainless steel of types suitable for use with hydrogen peroxide (e.g., 304, 304L, 316, 316L, 316Ti). Aluminum 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.

5.17

Cargo tanks should be separated by a cofferdam from fuel oil tanks or any other space containing materials incompatible with hydrogen peroxide.

5.18

Temperature sensors should be installed at the top and bottom of the tank. Remote temperature readouts and continuous monitoring should be located on the navigating bridge. If the temperature in the tank rises above 35°C, visible and audible alarms should activate on the navigating bridge.

5.19

Fixed oxygen monitors (or gas sampling lines) should be provided in void spaces adjacent to tanks to detect leakage of the cargo into these spaces. The enhancement of flammability by oxygen enrichments should be recognized. Remote readouts, continuous monitoring (if gas sampling lines are used, intermittent sampling is satisfactory) and visible and audible alarms similar to those for the temperature sensors should also be located on the navigating bridge. The visible and audible alarms activate if the oxygen concentration in these void spaces exceeds 30% by volume. Two portable oxygen monitors should also be available as back-up systems.

5.20

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 hour period or when the temperature in the tank exceeds 40°C.

5.21

Cargo tank venting systems with filtration should have pressure vacuum relief valves for normal controlled venting, and a device for emergency venting, should tank pressure rise rapidly as a result of an uncontrolled decomposition rate, as stipulated in 5-9-15/5.20. These venting systems should be designed in such a manner that there is no introduction of seawater into the cargo tank even under heavy sea conditions. Emergency venting should be sized on the basis of tank design pressure and tank size.

5.22

A fixed water-spray system should be provided for diluting and washing away any concentrated solution spilled on deck. The areas covered by the water-spray should include the manifold/ hose connections and the tank tops of those tanks designated for the carriage of hydrogen peroxide solutions. The minimum application rate should satisfy the following criteria:

5.22.1

The product should be diluted from the original concentration to 35% by weight within 5 minutes of the spill.

5.22.2

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 the cargo in the event of tank overfill or a piping/hose failure, and the time necessary to begin application of dilution water with actuation at the cargo control location or on the navigating bridge.

5.23

Hydrogen peroxide should be stabilized to prevent decomposition. A certificate of stabilization should be provided by the manufacturer, and kept on board, specifying:

5.23.1

name and amount of stabilizer added;

5.23.2

date stabilizer was added and duration of effectiveness;

5.23.3

any temperature limitations qualifying the stabilizer's effective lifetime;

5.23.4

the action to be taken should the product become unstable during the voyage.

5.24

Only those hydrogen peroxide solutions which have a maximum decomposition rate of 1% per year at 25°C should be carried. Certification from the shipper that the product meets this standard should be presented to the master and kept on board. A technical representative of the manufacturer should be on board to monitor the transfer operations and have the capability to test the stability of the hydrogen peroxide. He should certify to the master that the cargo has been loaded in a stable condition.

5.25

Protective clothing that is resistant to hydrogen peroxide should be provided for each crew member involved in cargo transfer operations. Protective clothing should include coveralls that are nonflammable, suitable gloves, boots and eye protection.

5.26

During transfer of hydrogen peroxide the related piping system should be separated from all other systems. Cargo hoses used for transfer of hydrogen peroxide should be marked "FOR HYDROGEN PEROXIDE TRANSFER ONLY".

6 Motor fuel anti-knock compounds (containing lead alkyls)

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.

6.2

If a cargo pump-room is located on deck level according to 5-9-15/18, the ventilation arrangements should be in compliance with 5-9-15/17.

6.3

Entry into cargo tanks used for the transportation of these cargoes is not permitted unless approved by the Administration.

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.

7 Phosphorus, yellow or white

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.

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.

7.3

Tanks should be so designed as to minimize the interfacial area between the liquid phosphorus and its water pad.

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.

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.

7.6

Phosphorus should be loaded at a temperature not exceeding 60°C.

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.

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.

7.9

Void spaces referred to in 5-9-15/7.8 should be provided with effective means of mechanical ventilation which should be capable of being sealed off quickly in an emergency.

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.

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.

7.12

Ship-to-shore loading and discharge connections should be of a type approved by the Administration.

8 Propylene oxide and mixtures of ethylene oxide/propylene oxide with an ethylene oxide content of not more than 30% by weight

8.1

Products transported under the provisions of this section should be acetylene free.

8.2

Unless cargo tanks are properly cleaned, these products should not be carried in tanks which have contained as one of the three previous cargoes any products known to catalyst polymerization, such as:

8.2.1

mineral acids (e.g. sulfuric, hydrochloric, nitric);

8.2.2

carbonxylic acids and anhydrides (e.g. formic, acetic);

8.2.3

halogenated carboxylic acids (e.g. chloracetic);

8.2.4

sulphonic acids (e.g. benzene sulphonic);

8.2.5

caustic alkalis (e.g. sodium hydroxide, potassium hydroxide);

8.2.6

ammonia and ammonia solutions;

8.2.7

amines and amine solutions;

8.2.8

oxidizing substances.

8.3

Before loading, tanks should be thoroughly and effectively cleaned, to remove all traces of previous cargoes from tanks and associated pipework, except where the immediately prior cargo has been propylene oxide or ethylene oxide/propylene oxide mixtures. Particular care should be taken in the case of ammonia in tanks made of steel other than stainless steel.

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 these products.

8.5

Tanks should be entered and inspected prior to each initial loading of these products to ensure freedom from contamination, heavy rust deposits and visible structural defects. When cargo tanks are in continuous service for these products, such inspections should be performed at intervals of not more than two years.

8.6

Tanks for the carriage of these products should be of steel or stainless steel construction.

8.7

Tanks for the carriage of these products may be used for their cargoes after thorough cleaning of tanks and associated pipework systems by washing or purging.

8.8

All valves, flanges, fittings and accessory equipment should be of a type suitable for use with the products and should be constructed of steel or stainless steel 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.

8.9

Gaskets should be constructed of materials which do not react with, dissolve in, or lower the autoignition temperature of, these products and which are fire-resistant and possess adequate mechanical behavior. The surface presented to the cargo should be polytetrafluore-thylene (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.

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, these products.

8.11

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:

8.11.1

Neoprene or natural rubber, if it comes into contact with the products.

8.11.2

Asbestos, or binders used with asbestos.

8.11.3

Materials containing oxides of magnesium, such as mineral wools.

8.12

Threaded joints should not be permitted in the cargo liquid and vapor lines.

8.13

Filling and discharge piping should extend to within 100 mm of the bottom of the tank or any sump pit.

8.14.1

The containment system for a tank containing these products should have a valved vapor return connection.

8.14.2

The products should be loaded and discharged in such a manner that venting of the tanks to atmosphere does not occur. If vapor return to shore is used during tank loading, the vapor return system connected to a containment system for the product should be independent of all other containment systems.

8.14.3

During discharge operations, the pressure in the cargo tank must be maintained above 0.07 bar gauge.

8.15

The cargo may 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.

8.16

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.

8.17

Cargo hoses used for transfer of these products should be marked "FOR ALKYLENE OXIDE TRANSFER ONLY".

8.18

Cargo tanks, void spaces and other enclosed spaces, adjacent to an integral gravity cargo tank carrying propylene oxide, should either contain a compatible cargo (those cargoes specified in 5-9-15/8.2 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 these products and oxygen. The oxygen content of these spaces should be maintained below 2%. Portable sampling equipment is satisfactory.

8.19

In no case should air be allowed to enter the cargo pump or piping system while these products are contained within the system.

8.20

Prior to disconnecting shore-lines, the pressure in liquid and vapor lines should be relieved through suitable valves installed at the loading header. Liquid and vapor from these lines should not be discharged to atmosphere.

8.21

Propylene oxide may be carried in pressure tanks or in independent or integral gravity tanks. Ethylene oxide/propylene oxide mixtures should be carried in independent gravity tanks or pressure tanks. Tanks should be designed for the maximum pressure expected to be encountered during loading, conveying and discharging cargo.

8.22.1

Tanks for the carriage of propylene oxide with a design pressure less than 0.6 bar gauge and tanks for the carriage of ethylene oxide/propylene oxide mixtures with a design pressure less than 1.2 bar gauge should have a cooling system to maintain the cargo below the reference temperature.

8.22.2

The refrigeration requirement for tanks with a design pressure less than 0.6 bar gauge may be waived 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. The area and times of year for which such carriage would be permitted should be included in the conditions of carriage of the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk.

8.23.1

Any cooling system should maintain the liquid temperature below the boiling temperature at the containment pressure. At least two complete cooling plants automatically regulated by variations within the tanks should be provided. Each cooling plant should be complete with the necessary auxiliaries for proper operation. The control system should also be capable of being manually operated. An alarm should be provided to indicate malfunctioning of the temperature controls. The capacity of each cooling system should be sufficient to maintain the temperature of the liquid cargo below the reference temperature• of the system.

• *See 5-9-15/8.22.1*

8.23.2

An alternative arrangement may consist of three cooling plants, any two of which should be sufficient to maintain the liquid temperatures below the reference temperature.•

• *See 5-9-15/8.22.1*

8.23.3

Cooling media which are separated from the products by a single wall only should be nonreactive with the products.

8.23.4

Cooling systems requiring compression of the products should not be used.

8.24

Pressure relief valve settings should not be less than 0.2 bar gauge and for pressure 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 propylene oxide/ethylene oxide mixtures.

8.25.1

The piping system for tanks to be loaded with these products should be separated (as defined in 5-9-1/3.24) 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 5-9-1/3.15), the required piping separation should be accomplished by the removal of spool pieces, valves, or other pipe section, and the installation of blank flanges at these locations. The required separation applies to all liquid and vapor piping, liquid and vapor vent lines and any other possible connections, such as common inert gas supply lines.

8.25.2

These products 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.

8.25.3

Before each initial loading of these products and before every subsequent return to such service, certification verifying that the required piping separation has been achieved should be obtained from a responsible person acceptable to the Port Administration and carried on board the ship. Each connection between a blank flange and a pipeline flange should be fitted with a wire and seal by the responsible person to ensure that inadvertent removal of the blank flange is impossible.

8.26.1

No cargo tanks should be more than 98% liquid full at the reference temperature.•

• See 5-9-15/8.22.1

8.26.2

The maximum volume to which a cargo tank should be loaded is:

$$V_L = 0.98\ V\left(\frac{p_R}{p_L}\right)$$

where

V_L = *maximum volume to which the tank may be loaded*

V = *volume of tank*

p_R = *relative density of cargo at the reference temperature•*

p_L = *relative density of cargo at the loading temperature and pressure.*

• See 5-9-15/8.22.1

8.26.3

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.

8.27

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.

8.28

The cargo tank vapor space should be tested prior to and after loading to ensure that the oxygen content is 2% by volume or less.

8.29 *(1 July 1994)*

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-min. Remote manual operation should be arranged such that remote starting of pumps supplying the water spray system and remote operation of any normally closed valves in the system can be carried out from a suitable location outside the cargo area, adjacent to the accommodation spaces and readily accessible and operable in the event of fire in the areas protected. The water-spray system should be capable of both local and remote manual operation, and the arrangement should ensure that any spilled cargo is washed away. Additionally, a water hose with pressure to the nozzle, when atmospheric temperatures permit, should be connected ready for immediate use during loading and unloading operations.

8.30

A remotely operated, controlled closing-rate, shutoff valve should be provided at each cargo hose connection used during cargo transfer.

9 Sodium chlorate solution, 50% or less

9.1

Tanks and associated equipment which have contained this product may be used for other cargoes after thorough cleaning by washing or purging.

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.

10 Sulphur liquid

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 vapor space for all conditions of carriage, i.e. below 1.85% by volume.

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.

10.3

Ventilation systems should be so designed and arranged as to preclude depositing of sulphur within the system.

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 vapor.

10.5

Connections should be provided to permit sampling and analysing of vapor in void spaces.

10.6

Cargo temperature controls should be provided to ensure that the temperature of the sulphur does not exceed 155°C.

11 Acids

11.1

The ship's shell plating should not form any boundaries of tanks containing mineral acids.

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.

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.

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.

11.5

Because of the danger of evolution of hydrogen when these substances are being carried, the electrical arrangements should comply with 5-9-10/2.3.1, 5-9-10/2.3.2, 5-9-10/2.3.3, 5-9-10/2.3.4, 5-9-10/2.3.6 and 5-9-10/2.3.7. 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.

11.6

Substances subjected to the requirements of this section should be segregated from oil fuel tanks, in addition to the segregation requirements in 5-9-3/1.1.

11.7

Provision should be made for suitable apparatus to detect leakage of cargo into adjacent spaces.

11.8

The cargo pump-room bilge pumping and drainage arrangements should be of corrosion-resistant materials.

12 Toxic products

12.1

Exhaust openings of tank vent systems should be located:

12.1.1

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;

12.1.2

not less than 6 m above the fore and aft gangway, if fitted within 6 m of the gangway; and

12.1.3

15 m from any opening or air intake to any accommodation and service spaces;

12.1.4

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 vapor-air mixture upwards in an unimpeded jet with an exit velocity of at least 30 m/s, are fitted.

12.2

Tank venting systems should be provided with a connection for a vapor return line to the shore installation.

12.2 Interpretation of 5-9-15/12.2 (IACS)

Tank venting systems should be provided with a stop valve for vapor return line to shore.

12.3

Products should:

12.3.1

not be stowed adjacent to oil fuel tanks;

12.3.2

have separate piping systems; and

12.3.3

have tank vent systems separate from tanks containing nontoxic products.

(See also 5-9-3/7.2)

12.4

Cargo tank relief valve settings should be a minimum of 0.2 bar gauge.

13 Cargoes protected by additives *(1 July 1994)*

13.1

Certain cargoes, with a reference in column "o" in the Section 5-9-17, by the nature of their chemical make-up tend, under certain conditions of temperature, exposure to air or contact with a catalyst, to undergo polymerization, decomposition, oxidation or other chemical changes. Mitigation of this tendency is carried out by introducing small amounts of chemical additives into the liquid cargo or by controlling the cargo tank environment.

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.

13.3

Care should be taken to ensure that these cargoes are sufficiently protected to prevent deleterious chemical change at all times during the voyage. Ships carrying such cargoes should be provided with a certificate of protection from the manufacturer, and kept during the voyage, specifying

13.3.1

the name and amount of additive present;

13.3.2

whether the additive is oxygen dependent;

13.3.3

date additive was put in the product and duration of effectiveness;

13.3.4

any temperature limitations qualifying the additive's effective lifetime; and

13.3.5

the action to be taken should the length of voyage exceed the effective lifetime of the additive.

13.4

Ships using the exclusion of air as the method of preventing oxidation of the cargo should comply with 5-9-9/1.3.

13.5

A product containing an oxygen dependent additive should be carried without inertion (in tanks of a size not greater than 3,000 m^3). Such cargoes should not be carried in a tank requiring inertion under the requirements of SOLAS chapter II-2.

13.6

Venting systems should be of a design that eliminates blockage from polymer build-up. Venting equipment should be of a type that can be checked periodically for adequacy of operation.

13.6 Interpretation of 5-9-15/13.6 (IMO)

Internal obstructions should be avoided beyond the requirement for pressure vacuum valves and flame screens which should be accessible for inspection and maintenance.

13.7

Crystallization or solidification of cargoes normally carried in the molten state can lead to depletion of inhibitor in parts of the tanks 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.

14 Cargoes with a vapor pressure greater than 1.013 bar absolute at 37.8°C

14.1

For a cargo referenced in column "o" in the table of Section 5-9-17 to this section, a mechanical refrigeration system should be provided unless the cargo system is designed to withstand the vapor pressure of the cargo at 45°C. Where the cargo system is designed to withstand the vapor 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.

14.2

A mechanical refrigeration system should maintain the liquid temperature below the boiling temperature at the cargo tank design pressure.

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.

14.4

Connections should be provided for returning expelled gases to shore during loading.

14.4 Interpretation of 5-9-15/14.4 (IACS)

Tank venting systems should be provided with a stop valve for vapor return line to shore.

14.5

Each tank should be provided with a pressure gauge which indicates the pressure in the vapor space above the cargo.

14.6

Where the cargo needs to be cooled, thermometers should be provided at the top and bottom of each tank.

14.7.1

No cargo tanks should be more than 98% liquid full at the reference temperature (R).

14.7.2

The maximum volume (V_L) of cargo to be loaded in a tank should be:

$$V_L = 0.98V\left(\frac{p_R}{p_L}\right)$$

where

V = *volume of the tank*

p_R = *relative density of cargo at the reference temperature (R)*

p_L = *relative density of cargo at the loading temperature and pressure*

R = *reference temperature is the temperature at which the vapor pressure of the cargo corresponds to the set pressure of the pressure relief valve.*

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 Cargoes with low ignition temperature and wide flammability range (1 July 1994)

(Text deleted)

16 Cargo contamination

16.1

Where column "o" in the table of Section 5-9-17 refers to this section, alkaline or acidic materials, such as caustic soda or sulfuric acid, should not be allowed to contaminate the cargo.

16.2

Where column "o" in the table of Section 5-9-17 refers to this section water should not be allowed to contaminate this cargo. In addition, the following provisions apply:

16.2.1

Air inlets to pressure/vacuum relief valves of tanks containing the cargo should be situated at least 2 m above the weather deck.

16.2.2

Water or steam should not be used as the heat transfer media in a cargo temperature control system required by Section 5-9-7.

16.2.3

The cargo should not be carried in cargo tanks adjacent to permanent ballast or water tanks unless the tanks are empty and dry. (See Section 5-9-3/1.2(IMO).)

16.2.4

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. (See 5-9-3/1.2(IMO).)

17 Increased ventilation requirements

For certain products, the ventilation system as described in 5-9-12/1.3 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.

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.

18 Interpretation of 5-9-15/18 (IMO)

No circumstances can be foreseen where an Administration might allow any relaxation.

19 Overflow control

(See 5-9-13/1.1(IMO).)

19.1

The provisions of this section are applicable where specific reference is made in column "o" in the table of Section 5-9-17, and are in addition to the requirements for gauging devices.

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.

19.3

Loading operations should be terminated at once in the event of any system essential for safe loading becoming inoperative.

19.4

Level alarms should be capable of being tested prior to loading.

19.5

The high-level alarm system required under 5-9-15/19.6 should be independent of the overflow control system required by 5-9-15/19.7 and should be independent of the equipment required by 5-9-13/1.

19.6

Cargo tanks should be fitted with a visual and audible high-level alarm which complies with 5-9-15/19.1 to 5-9-15/19.5 and which indicates when the liquid level in the cargo tank approaches the normal full condition.

19.7

A tank overflow control system required by this section should:

19.7.1

come into operation when the normal tank loading procedures fail to stop the tank liquid level exceeding the normal full condition;

19.7.2

give a visual and audible tank overflow alarm to the ship's operator; and

19.7.3

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.

19.8

The loading rate (LR) of the tank should not exceed:

$$LR = \frac{3600U}{t} \quad (m^3/h)$$

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.

20 Octyl nitrates, all isomers

20.1

The carriage temperature of the cargo should be maintained below 100°C to prevent the occurrence of a self-sustaining, exothermic decomposition reaction.

20.2

The cargo may not be carried in independent pressure vessels permanently affixed to the vessel's deck unless:

20.2.1

the tanks are sufficiently insulated from fire; and

20.2.2

the vessel has a water deluge system for the tanks such that the cargo temperature is maintained below 100°C and the temperature rise in the tanks does not exceed 1.5°C/hour for a fire of 650°C.

21 Temperature sensors (1 July 1994)

Temperature sensors should be used to monitor the cargo pump temperature to detect overheating due to pump failures.

PART

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CHAPTER 9 **Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION 16 **Operational Requirements•**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

• *Attention is also drawn to the operation guidelines contained in the ICS Tanker Safety Guide (Chemicals)*

1 *Maximum allowable quantity of cargo per tank*

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.

1.2

The quantity of cargo required to be carried in a type 2 ship should not exceed 3,000 m^3 in any one tank.

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.

2 *Cargo information*

2.1

A copy of this Code, or national regulations incorporating the provision of this Code, should be on board every ship covered by this Code.

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.

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.

2.3.1

a full description of the physical and chemical properties, including reactivity necessary for the safe containment of the cargo;

2.3.2

action to be taken in the event of spills or leaks;

2.3.3

countermeasures against accidental personal contact;

2.3.4

fire-fighting procedures and fire-fighting media;

2.3.5

procedures for cargo transfer, tank cleaning, gas-freeing and ballasting;

2.3.6

for those cargoes required to be stabilized or inhibited in accordance with 5-9-15/1, 5-9-15/5.11 or 5-9-15/13.3, the cargo should be refused if the certificate required by these paragraphs is not supplied.

2.4

If sufficient information necessary for the safe transportation of the cargo is not available, the cargo should be refused.

2.5

Cargoes which evolve highly toxic imperceptible vapors should not be transported unless perceptible additives are introduced into the cargo.

2.6

Where column "o" in the table of Section 5-9-17 refers to this paragraph, the cargo's viscosity at 20°C should be specified on a shipping document and if the cargo's viscosity exceeds 25 mPa.s at 20°C, the temperature at which the cargo has a viscosity of 25 mPa.s should be specified in the shipping document.

2.7

Where column "o" in the table of Section 5-9-17 refers to this paragraph, the cargo's viscosity at 20°C should be specified on a shipping document and if the cargo's viscosity exceeds 60 mPa.s at 20°C the temperature at which the cargo has a viscosity of 60 mPa.s should be specified in the shipping document.

2.8

Where column "o" in the table of Section 5-9-17 refers to this paragraph and the possibility exists that it will be unloaded within a Special Area•, the cargo's viscosity at 20°C should be specified on a shipping document and if the cargo's viscosity exceeds 25 mPa.s at 20°C the temperature at which the cargo has a viscosity of 25 mPa.s should be specified in the shipping document

• Special Areas are defined in regulation 1(7) of Annex II to MARPOL73/78

2.9

Where column "o" in the table of Section 5-9-17 refers to this paragraph, the cargo's melting point should be indicated in the shipping document.

3 Personnel training ••

•• Reference is made to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, 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

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.

3.2

Personnel involved in cargo operations should be adequately trained in handling procedures

3.3 *(1 July 2003)*

Officers should be trained in emergency procedures to deal with conditions of leakage, spillage or fire involving the cargo, based on the guidelines developed by the Organization•••, and a sufficient number of them should be instructed and trained in essential first aid for cargoes carried.

••• Reference is made to the Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG), which provides advice on the treatment of casualties in accordance with the symptoms exhibited as well as on equipment and antidotes that may be appropriate for treating the casualty, and to the relevant provisions of the STCW Code, parts A and B.

4 Opening of and entry into cargo tanks

4.1

During handling and carriage of cargoes producing flammable or toxic vapors, 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.

4.2

Personnel should not enter cargo tanks, void spaces around such tanks, cargo handling spaces or other enclosed spaces unless:

4.2.1

the compartment is free of toxic vapors and not deficient in oxygen; or

4.2.2

personnel wear breathing apparatus and other necessary protective equipment, and the entire operation is under the close supervision of a responsible officer.

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.

5 Stowage of cargo samples

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.

5.2

The stowage space should be:

5.2.1

cell-divided in order to avoid shifting the bottles at sea;

5.2.2

made of material fully resistant to the different liquids intended to be stowed; and

5.2.3

equipped with adequate ventilation arrangements.

5.3

Samples which react with each other dangerously should not be stowed close to each other.

5.4

Samples should not be retained on board longer than necessary.

6 Cargoes not to be exposed to excessive heat

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 5-9-7/1.5.4).

6.2

Heating coils in tanks carrying this product should be blanked off or secured by equivalent means.

6.3

Heat-sensitive products should not be carried in deck tanks which are not insulated.

7 Additional operational requirements (1 July 2003)

The Code contains additional operational requirements in:

5-9-3/1.1	5-9-13/2.3	5-9-15/8.3	5-9-15/8.26.2
5-9-3/1.2.1	5-9-13/2.4	5-9-15/8.4	5-9-15/8.26.3
5-9-3/1.2.2	5-9-14	5-9-15/8.5	5-9-15/8.27
5-9-3/1.4	5-9-15/1	5-9-15/8.7	5-9-15/8.28
5-9-3/5.2	5-9-15/3.1	5-9-15/8.14.2	5-9-15/8.29
5-9-3/7.4	5-9-15/3.7	5-9-15/8.14.3	5-9-15/9
5-9-7/1.2	5-9-15/3.8	5-9-15/8.16	5-9-15/10.1
5-9-7/1.6.3	5-9-15/4.6	5-9-15/8.17	5-9-15/11.4
5-9-8/3.6	5-9-15/5	5-9-15/8.18	5-9-15/11.6
5-9-9/1.4	5-9-15/6.1	5-9-15/8.19	5-9-15/12.3.1
5-9-9/2	5-9-15/6.3	5-9-15/8.20	5-9-15/13
5-9-11/3.2	5-9-15/6.4	5-9-15/8.23.3	5-9-15/14.7.1
5-9-11/4	5-9-15/7.1	5-9-15/8.23.4	5-9-15/14.7.2
5-9-12/1.2	5-9-15/7.6	5-9-15/8.25.1	5-9-15/14.7.3
5-9-12/2	5-9-15/7.11	5-9-15/8.25.2	5-9-15/16
5-9-13/2.1	5-9-15/8.1	5-9-15/8.25.3	5-9-15/19.8
5-9-13/2.2	5-9-15/8.2	5-9-15/8.26.1	

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PART

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

SECTION 16A Additional Measures for the Protection of the Marine Environment

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

The requirements of this chapter apply to ships carrying products noted as category A, B or C noxious liquid substances in Section 5-9-17.

2 Condition of carriage

2.1

The condition of carriage of products listed in the International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk should reflect the requirements of regulation 5A of Annex II of MARPOL 73/78.

2.2

A category B substance with a melting point equal to or greater than 15°C should not be carried in a cargo tank any boundary of which is formed by a ship's shell plating and should only be carried in a cargo tank fitted with a cargo heating system.

3 Procedures and arrangements manual

3.1

Each ship should be provided with a Procedures and Arrangements Manual developed for the ship in accordance with the provisions of the Standards for the Procedures and Arrangements and approved by the Administration.

3.2

Each ship should be fitted with equipment and arrangements identified in its Procedures and Arrangements Manual.

PART

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CHAPTER 9 **Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION 17 **Summary of Minimum Requirements** *(1 July 1994)*

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

Mixtures of noxious liquid substances presenting pollution hazards only and which are provisionally assessed under regulation 3(4) of Annex II of MARPOL 73/78, may be carried under the requirements of the Code applicable to the appropriate position of the entry in this Section for noxious liquids not otherwise specified.

Explanatory Notes	
Product name (column a)	The product names are not identical with the names given in previous issues of the Code, or the BCH Code (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.
Pollution category (column c)	The letter A, B, C or D means the pollution category assigned to each product under Annex II of MARPOL 73/78. "III" means the product was evaluated and found to fall outside the categories A, B, C or D. Pollution category in brackets indicates that the product is provisionally categorized and that further data are necessary to complete the evaluation of their pollution hazards. Until the hazard evaluation is completed, the pollution category assigned is used.
Hazards (column d)	S means that the product is included in the Code because of its safety hazards; P means that the product is included in the Code because of its pollution hazards; and S/P means that the product is included in the Code because of both its safety and pollution hazards.
Ship type (column e)	1 = ship type 1 (5-9-2/1.2) 2 = ship type 2 (5-9-2/1.2) 3 = ship type 3 (5-9-2/1.2)
Tank type (column f)	1 = independent tank (5-9-4/1.1) 2 = integral tank (5-9-4/1.2) G = gravity tank (5-9-4/1.3) P = pressure tank (5-9-4/1.4)

Tank vents (column g)	Open:	open venting
	Cont:	controlled venting
	SR:	safety relief valve
Tank environmental control• (column h) • "No" indicates nil requirements.	Inert:	inerting (5-9-9/1.2.1)
	Pad:	liquid or gas (5-9-9/1.2.2)
	Dry:	drying (5-9-9/1.2.3)
	Vent:	natural or forced (5-9-9/1.2.4)
Electrical equipment (column i)	T1 to T6	temperature classes•• ••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.
	IIA, IIB or IIC	apparatus groups••(see above)
	NF:	non-flammable product (5-9-10/1.6)
	Yes:	flashpoint exceeding 60°C (closed cup test) (5-9-10/1.6)
	No:	flashpoint not exceeding 60°C (closed cup test) (5-9-10/1.6)
Gauging (column j)	O:	open gauging (5-9-13/1.1.1)
	R:	restricted gauging (5-9-13/1.1.2)
	C:	closed gauging (5-9-13/1.1.3)
	I:	indirect gauging (5-9-13/1.1.3)
Vapor detection• (column k) • "No" indicates nil requirements.	F:	flammable vapors
	T:	toxic vapors
Fire protection (column 1)	A:	alcohol-resistant foam or multi-purpose foam
	B:	regular foam, encompasses all foams that are not of an alcohol-resistant type, including fluoroprotein and aqueous-film-forming foam (AFFF)
	C:	water-spray
	D:	dry chemical••• ••• Dry chemical powder systems when used may require an additional water system for boundary cooling. This is normally provided in sufficient quantities by the standard fire main system required by regulation II-2/ 4 of the 1974 SOLAS Convention as amended.
	No:	no special requirements under this Code
Materials of construction (column m)	N:	see 5-9-6/2.2
	Z:	see 5-9-6/2.3
	Y:	see 5-9-6/2.4
	A blank indicates no special guidance given for materials of construction	
Respiratory and eye protection (column n)	E:	see 5-9-14/2.8
	No:	no special requirements under this code

Minimum Requirements

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Acetic acid		D	S	3	2G	Cont.	No	T1	IIA	No	R	F	A	Y1, Z	E	5-9-15/11.2 to 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8, 5-9-15/19.6
Acetic anhydride	1715	D	S	2	2G	Cont.	No	T2	IIA	No	R	F-T	A	Y1	E	5-9-15/11.2 to 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8, 5-9-15/19.6
Acetone cyanohydrin	1541	A	S/P	2	2G	Cont.	No	T1	IIA	Yes	C	T	A	Y1	E	5-9-15/12, 5-9-15/17, 5-9-15/18, 5-9-15/19, 5-9-16/6
Acetonitrile	1648	III	S	2	2G	Cont.	No	T2	IIA	No	R	F-T	A		No	5-9-15/12, 5-9-15/19.6
Acrylamide solution (50% or less)	2074	D	S	2	2G	Open	No		NF		C	No	No		No	5-9-15/12.3, 5-9-15/13, 5-9-15/16.1, 5-9-15/19.6, 5-9-16/6.1
Acrylic acid	2218	D	S	3	2G	Cont.	No	T2	IIA	No	R	F-T	A	Y1	No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1
Acrylonitrile	1093	B	S/P	2	2G	Cont.	No	T1	IIB	No	C	F-T	A	N3, Z	E	5-9-15/12, 5-9-15/13, 5-9-15/17, 5-9-15/19
Adiponitrile	2205	D	S	3	2G	Cont.	No		IIB	Yes	R	T	A		No	
Alachlor technical (90% or more)		B	S/P	3	2G	Open	No			Yes	O	No	A, C	Y1	No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Alcohol (C_{12}-C_{15}) poly (1-6) ethoxylates		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Alcohol (C_{12}-C_{15}) poly (7-19) ethoxylates		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6
Alcohol (C_{12}-C_{15}) poly (20+) ethoxylates		C	P	3	2G	Open	No			Yes	O	No	A		No	
Alcohol (C_6-C_{17})(secondary)poly(3-6) ethoxylates		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Alcohol (C_6-C_{17})(secondary)poly(7-12) ethoxylates		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9
Alkanes (C_6-C_9)		(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Alkaryl polyethers (C_9-C_{20})		B	P	3	2G	Open	No			Yes	O	No	A, B		No	5-9-15/19.6, 5-9-16/2.6
Alkyl acrylate-vinyl pyridine copolymer in toluene		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Alkyl benzene/-indane/-indene mixture (C_{12}-C_{17} total carbon)		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Alkyl (C_3-C_4) benzenes		A	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Alkyl (C_5-C_8) benzenes		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Alkyl benzene sulphonic acid	2586, 2584	C	S/P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.7, 5-9-16/2.8
Alkyl benzene sulphonic acid, sodium salt solution		C	P	3	2G	Open	No	NF				O	No	No	No	5-9-16/2.7, 5-9-16/2.8, 5-9-16/2.9
Alkyl (C_7-C_9) nitrates		B	S/P	2	2G	Open	No			Yes	O	No	A,B		No	5-9-15/19.6, 5-9-15/20, 5-9-16/6
Allyl alcohol	1098	B	S/P	2	2G	Cont.	No	T2	IIB	No	C	F-T	A		E	5-9-15/12, 5-9-15/17, 5-9-15/19
Allyl chloride	1100	B	S/P	2	2G	Cont.	No	T2	IIA	No	C	F-T	A		E	5-9-15/12, 5-9-15/17, 5-9-15/19
Aluminium chloride (30% or less)/ Hydrochloric acid (20% or less) solution		D	S	3	1G	Cont.	No	NF			R	T	No		E(f)	5-9-15/11
2-(2-Aminoethoxy) ethanol	3055	D	S	3	2G	Open	No			Yes	O	No	A,D	N2	No	5-9-15/19.6
Aminoethyl ethanolamine		(D)	S	3	2G	Open	No	T2	IIA	Yes	O	No	A	N1	No	
N-Aminoethylpiperazine	2815	D	S	3	2G	Cont.	No			Yes	R	T	A	N2	No	5-9-15/19.6
2-Amino-2-methyl-1-propanol (90% or less)		D	S	3	2G	Open	No			Yes	O	No	A	N1	No	
Ammonia aqueous (28% or less)	2672 (m)	C	S/P	3	2G	Cont.	No	NF			R	T	A,B, C	N4	E(a)	
Ammonium bisulphite Solution (70% or less)		D	S	3	2G	Cont.	No	NF			R	T	No	Y5	No	5-9-15/16.1, 5-9-15/16.2
Ammonium nitrate solution (93% or less)		D	S	2	1G	Open	No	NF			O	No	No	Y4	No	5-9-15/2, 5-9-15/11.4, 5-9-15/11.6, 5-9-15/18, 5-9-15/19.6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Ammonium sulphide solution (45% or less)	2683	B	S/P	2	2G	Cont.	No			No	C	F-T	A	N1	E	5-9-15/12, 5-9-15/16.1, 5-9-15/17, 5-9-15/19, 5-9-16/6
Ammonium thiocyanate (25% or less)/ Ammonium thiosulphate (20% or less) solution		(C)	P	3	2G	Open	No	NF			O	No	No		No	
Ammonium thiosulphate solution (60% or less)		(C)	P	3	2G	Open	No	NF			O	No	No		No	5-9-16/2.9
Amyl acetate (all isomers)	1104	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Aniline	1547	C	S/P	2	2G	Cont.	No	T1	IIA	Yes	C	T	A		No	5-9-15/12, 5-9-15/17, 5-9-15/19
Aviation alkylates (C_8 paraffins and isoparaffins BPT 95—120°C) (bb)		(C)	P	3	2G	Cont.	No			No	R	F	B		No	5-9-15/19.6
Benzene and mixtures having 10% benzene or more•	1114(t)	C	S/P	3	2G	Cont.	No	T1	IIA	No	C	F-T	A,B		No	5-9-15/12.1, 5-9-15/17, 5-9-15/19.6, 5-9-16/2.9
Benzene sulphonyl chloride	2225	D	S	3	2G	Cont.	No			Yes	R	T	A,D	N1	No	5-9-15/19.6
Benzyl acetate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Benzyl alcohol		C	P	3	2G	Open	No			Yes	O	No	A		No	
Benzyl chloride	1738	B	S/P	2	2G	Cont.	No	T1	IIA	Yes	C	T	A,B		E	5-9-15/12, 5-9-15/13, 5-9-15/17, 5-9-15/19
Butene oligomer		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Butyl acetate (all isomers)		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Butyl acrylate (all isomers)		B	S/P	2	2G	Cont.	No	T2	IIB	No	R	F-T	A		No	5-9-15/13, 19.6, 5-9-16/6.1, 5-9-16/6.2
Butylamine (all isomers)		C	S/P	2	2G	Cont.	No			No	R	F-T	A	N1	E	5-9-15/12, 5-9-15/17, 5-9-15/19.6
Butylbenzene (all isomers)	2709	A	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Butyl benzyl phthalate		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Butyl butyrate (all isomers)		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6

• For mixtures containing no other components with safety hazards and where the pollution category is C or less.

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Butyl/Decyl/Cetyl/Eicosyl methacrylate mixture		D	S	3	2G	Cont.	No			Yes	R	No	A,D		No	5-9-15/13, 5-9-16/6.1, 5-9-16/6.2
1,2-Butylene oxide	3022	C	S/P	3	2G	Cont.	Inert	T2	IIB	No	R	F	A,C	Z	No	5-9-15/8.1 to 5-9-15/8.7, 5-9-15/8.12, 5-9-15/8.13, 5-9-15/8.16 to 5-9-15/8.19, 5-9-15/8.21, 5-9-15/8.25.1 to 5-9-15/8.25.3, 5-9-15/8.27, 5-9-15/8.29, 5-9-15/19.6
n-Butyl ether	1149	C	S/P	3	2G	Cont.	Inert	T4	IIB	No	R	F-T	A		No	5-9-15/4.6, 5-9-15/12, 5-9-15/19.6
Butyl methacrylate		D	S	3	2G	Cont.	No		IIA	No	R	F-T	A,D		No	5-9-15/13, 5-9-16/6.1, 5-9-16/ 6.2
n-Butyl propionate	1914	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Butyraldehyde (all isomers)		C	S/P	3	2G	Cont.	No	T3	IIA	No	R	F-T	A		No	5-9-15/16.1, 5-9-15/19.6
Butyric acid	2820	D	S	3	2G	Cont.	No			Yes	R	No	A	Y1	No	5-9-15/11.2 to 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8
Calcium alkyl (C_9) phenolsulphide/ polyolefin phosphorosulphide mixture		A	P	2	2G	Open	No			Yes	O	No	A,B		No	5-9-15/19.6
Calcium hypochlorite solution (15% or less)		C	S/P	3	2G	Cont.	No		NF		R	No	No	N5	No	5-9-15/16.1
Calcium hypochlorite solution (more than 15%)		B	S/P	3	2G	Cont.	No		NF		R	No	No	N5	No	5-9-15/16.1, 19.6
Calcium long chain alkyl salicylate (C_{13+})		C	P	3	2G	Open	No			Yes	O	No	A, B		No	5-9-16/2.7, 5-9-16/2.8
Camphor oil		B	S/P	2	2G	Cont.	No		IIA	No	R	F	A,B		No	5-9-15/19.6
Carbolic oil		A	S/P	2	2G	Cont.	No			Yes	C	F-T	A		No	5-9-15/12, 5-9-15/19
Carbon disulphide	1131	B	S/P	2	1G	Cont.	Pad+ Inert	T6	IIC	No	C	F-T	C		E	5-9-15/3, 5-9-15/12, 5-9-15/19
Carbon tetrachloride	1846	B	S/P	3	2G	Cont.	No		NF		C	T	No	Z	E	5-9-15/12, 5-9-15/17, 5-9-15/19.6
Cashew nut shell oil (untreated)		D	S	3	2G	Cont.	No			Yes	R	T	A,B		No	
Cetyl/Eicosyl methacrylate mixture		III	S	3	2G	Open	No			Yes	O	No	A,D		No	5-9-15/13, 5-9-16/6.1, 5-9-16/ 6.2

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Chloroacetic acid (80% or less)	1750	C	S/P	2	2G	Cont.	No	NF			C	No	No	Y5	No	5-9-15/11.2, 11.4, 11.6 to 11.8, 12.3, 19, 5-9-16/2.9
Chlorinated paraffins (C_{10}-C_{13})		A	P	1	2G	Open	No			Yes	O	No	A		No	5-9-15/19
Chlorobenzene	1134	B	S/P	3	2G	Cont.	No	T1	IIA	No	R	F-T	A,B		No	5-9-15/19.6
Chloroform	1888	B	S/P	3	2G	Cont.	No	NF			R	T	No		E	5-9-15/12, 5-9-15/19.6
Chlorohydrins (crude)		(D)	S	2	2G	Cont.	No		IIA	No	C	F-T	A		No	5-9-15/12, 5-9-15/19
4-Chloro-2-methylphenoxyacetic acid, dimethylamine salt solution		(C)	P	3	2G	Open	No	NF			O	No	No	N1	No	
o-Chloronitrobenzene	1578	B	S/P	2	2G	Cont.	No			Yes	C	T	A,B, D		No	5-9-15/12, 5-9-15/17, 5-9-15/18, 5-9-15/19, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/ 2.2
2- or 3- Chloropropionic acid	2511(n)	(C)	S/P	3	2G	Open	No			Yes	O	No	A	Y1	No	5-9-15/11.2 to 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8, 5-9-16/2.7 to 5-9-16/2.9
Chlorosulphonic acid	1754	C	S/P	1	2G	Cont.	No	NF			C	T	No		E	5-9-15/11.2 to 5-9-15/11.8, 5-9-15/12, 5-9-15/16.2, 5-9-15/19
m-Chlorotoluene	2238	B	S/P	3	2G	Cont.	No			No	R	F-T	A,B		No	5-9-15/19.6
o-Chlorotoluene	2238	A	S/P	3	2G	Cont.	No			No	R	F-T	A,B		No	5-9-15/19.6
p-Chlorotoluene	2238	B	S/P	2	2G	Cont.	No			No	R	F-T	A,B		No	5-9-15/19.6, 5-9-16/2.9
Chlorotoluenes (mixed isomers)	2238	A	S/P	2	2G	Cont.	No			No	R	F-T	A,B		No	5-9-15/19.6
Coal tar		A	S/P	2	2G	Cont.	No	T2	IIA	Yes	R	No	B,D		No	5-9-15/19.6
Coal tar naphtha solvent		B	S/P	3	2G	Cont.	No	T3	IIA	No	R	F-T	A,D		No	5-9-15/19.6
Coal tar pitch (molten)		D	S	3	1G	Cont.	No	T2	IIA	Yes	R	No	B,D		No	5-9-15/19.6
Cobalt naphthenate in solvent naphtha		A	S/P	2	2G	Cont.	No			No	R	F-T	A,D		No	5-9-15/19.6
Coconut oil fatty acid		C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.7, 5-9-16/2.8, 5-9-16/2.9
Creosote (coal tar)		A	S/P	2	2G	Open	No	T2	IIA	Yes	O	No	A,D		No	5-9-15/19.6
Creosote (wood)		A	S/P	2	2G	Open	No	T2	IIA	Yes	O	No	A,D		No	5-9-15/19.6
Cresols (all isomers)	2076	A	S/P	2	2G	Open	No	T1	IIA	Yes	O	No	A,B		No	5-9-15/19.6
Cresylic acid, dephenolized		A	S/P	2	2G	Open	No			Yes	O	No	A,B		No	5-9-15/19.6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Cresylic acid, sodium salt solution		A	S/P	2	2G	Open	No			Yes	O	No	No	N8	No	5-9-15/19.6
Crotonaldehyde	1143	A	S/P	2	2G	Cont.	No	T3	IIB	No	R	F-T	A		E	5-9-15/12, 5-9-15/16.1, 5-9-15/17, 5-9-15/19.6
1,5,9-Cyclododecatriene		A	S/P	1	2G	Cont.	No			Yes	R	T	A	N2	No	5-9-15/13, 5-9-15/19, 5-9-16/6.1, 5-9-16/6.2
Cycloheptane (bb)	2241	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Cyclohexane (bb)	1145	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.9
Cyclohexanone	1915	D	S	3	2G	Open	No	T2	IIA	No	R	F-T	A	N5	No	5-9-15/19.6
Cyclohexanone, cyclohexanol mixture		D	S	3	2G	Cont.	No			Yes	R	F-T	A	N5	No	
Cyclohexyl acetate	2243	(B)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Cyclohexylamine	2357	C	S/P	3	2G	Cont.	No	T3	IIA	No	R	F-T	A,C	N1	No	5-9-15/19.6
1,3-Cyclopentadiene dimer (molten)		B	P	2	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Cyclopentane (bb)	1146	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Cyclopentene	2246	(B)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
p-Cymene (bb)	2046	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Decanoic acid		C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.7, 5-9-16/2.8, 5-9-16/2.9
Decene		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Decyl acetate		(B)	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Decyl acrylate		A	S/P	2	2G	Open	No	T3	IIA	Yes	O	No	A,C, D	N2	No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Decyl alcohol (all isomers)		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.9(s)
Decyloxytetrahydro-thiophene dioxide		A	S/P	2	2G	Cont.	No			Yes	R	T	A		No	5-9-15/19.6
Dibutylamine		C	S/P	3	2G	Cont.	No	T2	IIA	No	R	F-T	A,C, D	N4	No	5-9-15/19.6
Dibutyl hydrogen phosphonate		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6 5-9-16/2.6
Dibutyl phthalate		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Dichlorobenzenes (all isomers)		B	S/P	2	2G	Cont.	No	T1	IIA	Yes	R	T	A,B, D	N5	No	5-9-15/19.6, 5-9-16/2.6(x), 5-9-16/2.9(y), 5-9-16A/2.2(z)

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
1,1-Dichloroethane	2362	D	S	3	2G	Cont.	No	T2	IIA	No	R	F-T	A		E	5-9-15/19.6
Dichloroethyl ether		B	S/P	2	2G	Cont.	No	T2	IIA	No	R	F-T	A	N5	No	5-9-15/19.6
1,6 Dichlorohexane		B	S/P	2	2G	Cont.	No			No	R	T	A,B		No	5-9-15/19.6
2,2-Dichloroisopropyl ether	2490	C	S/P	2	2G	Cont.	No			Yes	R	T	A,C, D	N5	No	5-9-15/12, 5-9-15/17, 5-9-15/19
Dichloromethane	1593	D	S	3	2G	Cont.	No	T1	IIA	Yes	R	T	No		No	
2,4-Dichlorophenol	2021	A	S/P	2	2G	Cont.	Dry			Yes	R	T	A	N1	No	5-9-15/19.6
2,4-Dichlorophenoxyacetic acid, diethanolamine salt solution		A	S/P	3	2G	Open	No	NF			O	No	No	N1	No	5-9-15/19.6
2,4-Dichlorophenoxyacetic acid, dimethylamine salt solution (70% or less)		A	S/P	3	2G	Open	No	NF			O	No	No	N1	No	5-9-15/19.6
2,4-Dichlorophenoxyacetic acid, triisopropanolamine salt solution		A	S/P	3	2G	Open	No	NF			O	No	No	N1	No	5-9-15/19.6
1,1 Dichloropropane		C	S/P	2	2G	Cont.	No			No	R	F-T	A,B	Z	No	5-9-15/12, 5-9-15/19.6
1,2-Dichloropropane	1279	C	S/P	2	2G	Cont.	No	T1	IIA	No	R	F-T	A,B	Z	No	5-9-15/12, 5-9-15/19.6
1,3-Dichloropropane		D	S	2	2G	Cont.	No	T1	IIA	No	R	F-T	A,B		No	5-9-15/12, 5-9-15/19.6
1,3-Dichloropropene	2047	B	S/P	2	2G	Cont.	No	T2	IIA	No	C	F-T	A,B		E	5-9-15/12, 5-9-15/17, 5-9-15/18, 5-9-15/19
Dichloropropene/Dichloropropane mixtures		B	S/P	2	2G	Cont.	No			No	C	F-T	A,B, D		E	5-9-15/12, 5-9-15/17, 5-9-15/18, 5-9-15/19
2,2-Dichloropropionic acid		D	S	3	2G	Cont.	Dry			Yes	R	No	A	Y5	No	5-9-15/11.2, 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8
Diethanolamine		D	S	3	2G	Open	No	T1	IIA	Yes	O	No	A	N2	No	
Diethylamine	1154	C	S/P	3	2G	Cont.	No	T2	IIA	No	R	F-T	A	N1	E	5-9-15/12, 5-9-15/19.6
Diethylaminoethanol	2686	C	S/P	3	2G	Cont.	No	T2	IIA	No	R	F-T	A,C	N1	No	5-9-15/19.6
2,6-Diethylaniline		C	S/P	3	2G	Open	No			Yes	O	No	B,C, D	N4	No	5-9-15/19.6, 5-9-16/2.9
Diethylbenzene	2049	A	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Diethylenetriamine	2079	D	S	3	2G	Open	No	T2	IIA	Yes	O	No	A	N2	No	

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	UN Number	Pollution Category	Hazards	Ship Type	Tank Type	Tank Vent	Tank Environmental Control	Class	Group	Flashpoint 60°C	Gauging	Vapor Detection	Fire Protection	Materials of Construction	Respiratory and Eye Protection	Special Requirements
Diethyl ether	1155	III	S	2	1G	Cont.	Inert	T4	IIB	No	C	F-T	A	N7	E	5-9-15/4, 5-9-15/14, 5-9-15/19
Di(2-ethylhexyl)phosphoric acid	1902	C	S/P	3	2G	Open	No			Yes	O	No	A,D	N2	No	
Diethyl phthalate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Diethyl sulphate	1594	(B)	S/P	2	2G	Cont.	No			Yes	C	T	A	N3	No	5-9-15/19.6
Diglycidyl ether of bisphenol A		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6
Diglycidyl ether of bisphenol F		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6
Di-n-hexyl adipate		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Diisobutylamine	2361	(C)	S/P	2	2G	Cont.	No			No	R	F-T	A,C, D	N1	No	5-9-15/12.3, 5-9-15/19.6
Diisobutylene	2050	B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Diisobutyl phthalate		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6
Diisopropanolamine		C	S/P	3	2G	Open	No	T2	IIA	Yes	O	No	A	N2	No	5-9-16/2.7, 5-9-16/2.8, 5-9-16/2.9
Diisopropylamine	1158	C	S/P	2	2G	Cont.	No	T2	IIA	No	C	F-T	A	N2	E	5-9-15/12, 5-9-15/19
Diisopropylbenzene (all isomers)		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
N,N-Dimethylacetamide solution (40% or less)		D	S	3	2G	Cont.	No			Yes	R	T	B	N4	No	5-9-15/12.1, 5-9-15/17
Dimethyl adipate		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.9
Dimethylamine solution (45% or less)	1160	C	S/P	3	2G	Cont.	No	T2	IIA	No	R	F-T	A,C, D	N1	No	5-9-15/12, 5-9-15/19.6
Dimethylamine solution (greater than 45% but not greater than 55%)	1160	C	S/P	2	2G	Cont.	No			No	C	F-T	A,C, D	N1	E	5-9-15/12, 5-9-15/17, 5-9-15/19
Dimethylamine solution (greater than 55% but not greater than 65%)	1160	C	S/P	2	2G	Cont.	No			No	C	F-T	A,C, D	N1	E	5-9-15/12, 5-9-15/14, 5-9-15/17, 5-9-15/19
N,N-Dimethylcyclohexylamine	2264	C	S/P	2	2G	Cont.	No			No	R	F-T	A,C	N1	No	5-9-15/12, 5-9-15/17, 5-9-15/19.6
Dimethylethanolamine	2051	D	S	3	2G	Cont.	No	T3	IIA	No	R	F-T	A,D	N2	No	5-9-15/19.6
Dimethylformamide	2265	D	S	3	2G	Cont.	No	T2	IIA	No	R	F-T	A,D		No	5-9-15/19.6
Dimethyl glutarate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Dimethyl hydrogen phosphite		(B)	S/P	3	2G	Cont.	No			Yes	R	T	A,D		No	5-9-15/12.1
Dimethyl octanoic acid		(C)	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.8, 5-9-16/2.9

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	Electrical Equipment *Group*	Electrical Equipment *Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Dimethyl phthalate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Dimethyl succinate		C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.9
Dinitrotoluene (molten)	1600	A	S/P	2	2G(o)	Cont.	No			Yes	C	T	A		No	5-9-15/12, 5-9-15/17, 5-9-15/19, 5-9-15/21
1,4-Dioxane	1165	D	S	2	2G	Cont.	No	T2	IIB	No	C	F-T	A		No	5-9-15/12, 5-9-15/19
Dipentene	2052	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Diphenyl		A	P	1	2G	Open	No			Yes	O	No	B		No	5-9-15/19
Diphenylamine reaction product with 2,2,4-Trimethylpentene		(A)	S/P	1	2G	Open	No			Yes	O	No	A		No	5-9-15/19
Diphenylamines, alkylated		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Diphenyl/Diphenyl ether mixtures		A	P	1	2G	Open	No			Yes	O	No	B		No	5-9-15/19
Diphenyl ether		A	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Diphenylether/Diphenyl phenyl ether mixture		A	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Diphenylmethane diisocyanate	2489	(B)	S/P	2	2G	Cont.	Dry			Yes (b)	C	T(b)	A,B, C(c), D	N5	No	5-9-15/12, 5-9-15/16.2, 5-9-15/17, 5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Diphenylol propane-epichlorohydrin resins		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6
Di-n-propylamine	2383	C	S/P	3	2G	Cont.	No			No	R	F-T	A	N2	No	5-9-15/12.3, 5-9-15/19.6
Dodecene (all isomers)		(B)	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Dodecyl alcohol		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Dodecylamine/Tetradeclyamine mixture		A	S/P	2	2G	Cont.	No			Yes	R	T	A,D	N2	No	5-9-15/19.6
Dodecyldimethylamine/Tetradecyl dimethylamine mixture		A	S/P	2	2G	Open	No			Yes	O	No	B,C, D	N4	No	5-9-15/19.6
Dodecyl diphenyl ether disulphonate solution		A	S/P	2	2G	Open	No	NF			O	No	No		No	5-9-15/19.6
Dodecyl methacrylate		III	S	3	2G	Open	No			Yes	O	No	A		No	5-9-15/13

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	Electrical Equipment *Group*	Electrical Equipment *Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Dodecyl/Pentadecyl methacrylate mixture		III	S	3	2G	Open	No			Yes	O	No	A,D		No	5-9-15/13, 5-9-16/6.1, 5-9-16/6.2
Dodecyl phenol		A	P	1	2G	Open	No			Yes	O	No	A		No	5-9-15/19
Drilling brines (containing Zinc salts)		B	P	3	2G	Open	No			Yes	O	No	No		No	5-9-15/19.6
Epichlorohydrin	2023	A	S/P	1	2G	Cont.	No		IIB	No	C	F-T	A		E	5-9-15/12, 5-9-15/17, 5-9-15/19
Ethanolamine	2491	D	S	3	2G	Open	No	T2	IIA	Yes	O	F-T	A	N2	No	
2-Ethoxyethyl acetate	1172	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Ethyl acrylate	1917	A	S/P	2	2G	Cont.	No	T2	IIB	No	R	F-T	A		E	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Ethylamine	1036	(C)	S/P	2	1G	Cont.	No	T2	IIA	No	C	F-T	C,D	N2	E	5-9-15/12, 5-9-15/14, 5-9-15/19.6
Ethylamine solutions (72% or less)	2270	(C)	S/P	2	2G	Cont.	No			No	C	F-T	A,C	N1	E	5-9-15/12, 5-9-15/14, 5-9-15/17, 5-9-15/19
Ethylamyl ketone	2271	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Ethylbenzene	1175	B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
N-Ethylbutylamine		(C)	S/P	3	2G	Cont.	No			No	R	F-T	A	N1	No	5-9-15/12.3, 19.6
Ethyl butyrate	1180	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Ethylcyclohexane (bb)		(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
N-Ethylcyclohexylamine		D	S	3	2G	Cont.	No			No	R	F-T	A	N1	No	5-9-15/19.6
Ethylene chlorohydrin	1135	C	S/P	2	2G	Cont.	No	T2	IIA	No	C	F-T	A,D		E	5-9-15/12, 5-9-15/17, 5-9-15/19
Ethylene cyanohydrin		(D)	S	3	2G	Open	No		IIB	Yes	O	No	A		No	
Ethylenediamine	1604	C	S/P	2	2G	Cont.	No	T2	IIA	No	R	F-T	A	N2	No	5-9-15/19.6, 5-9-16/2.9
Ethylene dibromide	1605	B	S/P	2	2G	Cont.	No		NF		C	T	No		E	5-9-15/12, 5-9-15/19.6, 5-9-16/2.9
Ethylene dichloride	1184	B	S/P	2	2G	Cont.	No	T2	IIA	No	R	F-T	A,B	N4	No	5-9-15/19
Ethylene glycol butyl ether acetate		(C)	P	3	2G	Open	No			Yes	O	No	A		No	
Ethylene glycol diacetate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Ethylene glycol methyl ether acetate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Ethylene glycol monoalkyl ethers		D	S	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	Electrical Equipment *Group*	Electrical Equipment *Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Ethylene oxide/Propylene oxide mixture with an Ethylene oxide content of not more than 30% in weight	2983	C	S/P	2	1G	Cont.	Inert	T2	IIB	No	C	F-T	A,C		No	5-9-15/8, 5-9-15/12, 5-9-15/14, 5-9-15/19
Ethyl-3-ethoxypropionate		C	P	3	2G	Cont.	No			No	R	No	A		No	5-9-15/19.6
2-Ethylhexyl acrylate		B	S/P	3	2G	Open	No	T3	IIB	Yes	O	No	A		No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
2-Ethylhexylamine	2276	B	S/P	2	2G	Cont.	No			No	R	F-T	A	N2	No	5-9-15/12, 5-9-15/19.6
Ethylidene norbornene		B	S/P	3	2G	Cont.	No			No	R	F-T	A,D	N4	No	5-9-15/12.1, 5-9-15/16.1, 5-9-15/19.6
Ethyl methacrylate	2277	(D)	S	3	2G	Cont.	No	T2	IIA	No	R	F-T	A,D		No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/ 6.2
o-Ethylphenol		(A)	S/P	3	2G	Open	No	T1	IIA	Yes	O	No	B		No	5-9-15/19.6
2-Ethyl-3-propylacrolein		(A)	S/P	3	2G	Cont.	No		IIA	No	R	F-T	A		No	5-9-15/19.6
Ethyltoluene		(B)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Ferric chloride solutions	2582	C	S/P	3	2G	Open	No		NF		O	No	No		No	5-9-15/11, 19.6, Part 5, 5-9-16/2.9
Ferric nitrate/Nitric acid solution		C	S/P	2	2G	Cont.	No		NF		R	T	No		E	5-9-15/11, 5-9-15/19
Fluorosilicic acid (20-30%) in water solution	1778	C	S/P	3	1G	Cont.	No		NF		R	T	No		E	5-9-15/11
Formaldehyde solutions (45% or less)	1198(d), 2209	C	S/P	3	2G	Cont.	No	T2	IIB	No	R	F-T	A		E(e)	5-9-15/16.1, 5-9-15/19.6, 5-9-16/2.9
Formic acid	1779	D	S	3	2G	Cont.	No	T1	IIA	No	R	T(v)	A	Y2, Y3	E	5-9-15/11.2 to 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8, 5-9-15/19.6
Fumaric adduct of rosin, water dispersion		B	P	3	2G	Open	No			Yes	O	No	No		No	5-9-15/19.6, 5-9-16/2.6
Furfural	1199	C	S/P	3	2G	Cont.	No	T2	IIB	No	R	F-T	A		No	5-9-15/16.1, 5-9-15/19.6
Furfuryl alcohol	2874	C	P	3	2G	Open	No			Yes	O	No	A		No	
Glutaraldehyde solutions (50% or less)		D	S	3	2G	Open	No		NF		O	No	No		No	5-9-15/16.1
Glycidyl ester of C10 trialkylacetic acid		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	UN Number	Pollution Category	Hazards	Ship Type	Tank Type	Tank Vent	Tank Environmental Control	Electrical Equipment: Class	Electrical Equipment: Group	Electrical Equipment: Flashpoint 60°C	Gauging	Vapor Detection	Fire Protection	Materials of Construction	Respiratory and Eye Protection	Special Requirements
Heptane (all isomers) (bb)	1206	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Heptanol (all isomers) (q)		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Heptene (all isomers) (bb)		C	P	3	2G	Cont.	No.			No	R	F	A		No	5-9-15/19.6
Heptyl acetate		(B)	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Hexamethylenediamine solution	1783	C	S/P	3	2G	Cont.	No			Yes	R	T	A	N2	No	5-9-15/19.6, 5-9-16/2.9
Hexamethyleneimine	2493	C	S/P	2	2G	Cont.	No			No	R	F-T	A,C	N1	No	5-9-15/19.6
Hexane (all isomers)(bb)	1208	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Hexene (all isomers)(bb)		(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Hexyl acetate	1233	B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Hydrochloric acid	1789	D	S	3	1G	Cont.	No	NF			R	T	No		E(f)	5-9-15/11
Hydrogen peroxide solutions (over 8% but not over 60%)	2014, 2984	C	S/P	3	2G	Cont.	No	NF			C	No	No		No	5-9-15/5.14 to 5-9-15/5.26, 5-9-15/18, 5-9-15/19.6
Hydrogen peroxide solutions (over 60% but not over 70%)	2015	C	S/P	2	2G	Cont.	No	NF			C	No	No		No	5-9-15/5.1 to 5-9-15/5.13, 5-9-15/19.6
2-Hydroxyethyl acrylate		B	S/P	2	2G	Cont.	No			Yes	C	T	A		No	5-9-15/12, 5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
2-Hydroxy-4-(methylthio)butanoic acid		C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.7, 5-9-16/2.8
Isophoronediamine	2289	D	S	3	2G	Cont.	No			Yes	R	T	A	N2	No	
Isophorone diisocyanate	2290	B	S/P	2	2G	Cont.	Dry			Yes	C	T	A,B, D	N5	No	5-9-15/12, 5-9-15/16.2, 5-9-15/17, 5-9-15/19.6
Isoprene	1218	C	S/P	3	2G	Cont.	No	T3	IIB	No	R	F	B		No	5-9-15/13, 5-9-15/14, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Isopropanolamine		C	S/P	3	2G	Open	No	T2	IIA	Yes	O	F-T	A	N2	No	5-9-16/2.8, 2.9
Isopropylamine	1221	C	S/P	2	2G	Cont.	No	T2	IIA	No	C	F-T	C,D	N2	E	5-9-15/12, 5-9-15/14, 5-9-15/19
Isopropylcyclohexane (bb)		(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.7, 5-9-16/2.8
Isopropyl ether	1159	D	S	3	2G	Cont.	Inert			No	R	F	A		No	5-9-15/4.6, 5-9-15/13.3, 5-9-15/19.6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Lactonitrile solution (80% or less)		B	S/P	2	1G	Cont.	No			Yes	C	T	A,C, D	Y1	E	5-9-15/1, 5-9-15/12, 5-9-15/17, 5-9-15/18, 5-9-15/19, 5-9-16/2.6, 5-9-16/6
Lauric acid		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Lauryl polyglucose (50% or less)		(B)	P	3	2G	Open	No			Yes	O	No	No		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Liquid chemical wastes		A	S/P	2	2G	Cont.	No			No	C	F-T	A		E	5-9-15/12, 5-9-15/19.6, 5-9-20/5.1
Long chain alkaryl polyether (C_{11}-C_{20})		C	P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-16/2.7, 5-9-16/2.8
Long chain polyetheramine in alkyl (C_2-C_4) benzenes		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.7, 5-9-16/2.8
Long chain polyetheramine in aromatic solvent		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.7, 5-9-16/2.8
Magnesium long chain alkyl salicylate (C_{11+})		C	P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-16/2.7, 5-9-16/2.8
Maleic anhydride	2215	D	S	3	2G	Cont.	No			Yes	R	No	A(g), C		No	
Mercaptobenzothiazol, sodium salt solution		B	S/P	3	2G	Open	No		NF		O	No	No	N1	No	5-9-15/19.6, 5-9-16/2.9
Mesityl oxide	1229	D	S	3	2G	Cont.	No	T2	IIB	No	R	F-T	A		No	5-9-15/19.6
Metam sodium solution		A	S/P	3	2G	Open	No		NF		O	No	No	N1	No	5-9-15/19.6
Methacrylic acid	2531	D	S	3	2G	Cont.	No			Yes	R	T	A	Y1	No	5-9-15/13, 5-9-16/ 6.1
Methacrylic resin in ethylene dichloride		B	S/P	2	2G	Cont.	No	T2	IIA	No	R	F-T	A,B	N4	No	5-9-15/19, 5-9-16/2.6
Methacrylonitrile	3079	D	S	2	2G	Cont.	No			No	C	F-T	A	N4,Z	E	5-9-15/12, 5-9-15/13, 5-9-15/17, 5-9-15/19
Methyl acrylate	1919	B	S/P	2	2G	Cont.	No	T1	IIB	No	R	F-T	A		E	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Methylamine solutions (42% or less)	1235	C	S/P	2	2G	Cont.	No			No	C	F-T	A,C, D	N1	E	5-9-15/12, 5-9-15/17, 5-9-15/19

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Methylamyl acetate	1233	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Methylamyl alcohol	2053	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Methyl butyrate	1237	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Methylcyclohexane (bb)	2296	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Methylcyclopentadiene dimer		(B)	P	3	2G	Cont.	No			No	R	F	B		No	5-9-15/19.6
Methyl diethanolamine		D	S	3	2G	Open	No			Yes	O	No	A	N2	No	
2-Methyl-6-ethyl aniline		C	S/P	3	2G	Open	No			Yes	O	No	A,D		No	
2-Methyl-5-ethyl pyridine	2300	(B)	S/P	3	2G	Open	No		IIA	Yes	O	No	A,D	N4	No	5-9-15/19.6
Methyl formate	1243	D	S	2	2G	Cont.	No			No	R	F-T	A		E	5-9-15/12, 5-9-15/14, 5-9-15/19
Methyl heptyl ketone		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
2-Methyl-2-hydroxy-3-butyne		III	S	3	2G	Cont.	No		IIA	No	R	F-T	A,B, D	N6	No	5-9-15/19.6
Methyl methacrylate	1247	D	S	2	2G	Cont.	No	T2	IIA	No	R	F-T	A		No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Methyl naphthalene (molten)		A	S/P	2	2G	Cont.	No			Yes	R	No	A, D		No	5-9-15/19.6
2-Methylpyridine	2313	D	S	2	2G	Cont.	No			No	C	F	A	N4	No	5-9-15/12.3, 5-9-15/19.6
3-Methylpyridine	2313	C	S/P	2	2G	Cont.	No			No	C	F	A,C	N4	No	5-9-15/12.3, 5-9-15/19
4-Methylpyridine	2313	D	S	2	2G	Cont.	No			No	C	F-T	A	N4	No	5-9-15/12.3, 5-9-15/19, 5-9-16/2.9
Methyl salicylate		(B)	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
alpha-Methylstyrene	2303	A	S/P	3	2G	Cont.	No	T1	IIB	No	R	F-T	A,D•		No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Morpholine	2054	D	S	3	2G	Cont.	No	T2	IIA	No	R	F	A	N2,Z	No	5-9-15/19.6
Motor fuel anti-knock compounds (containing lead alkyls)	1649	A	S/P	1	1G	Cont.	No	T4	IIA	No	C	F-T	A,C		E	5-9-15/6, 5-9-15/12, 5-9-15/18, 5-9-15/19
Naphthalene (molten)	2304	A	S/P	2	2G	Cont.	No	T1	IIA	Yes	R	No	A,D		No	5-9-15/19.6
Napthenic acids		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6

• Only certain alcohol resistant foams are effective.

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Neodecanoic acid		C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.8
Nitrating acid (mixture of sulphuric and nitric acids)	1796	(C)	S/P	2	2G	Cont.	No	NF			C	T	No		E	5-9-15/11, 15-9-15/6.2, 5-9-15/17, 5-9-15/19
Nitric acid (less than 70%)	2031	C	S/P	2	2G	Cont.	No	NF			R	T	No		E	5-9-15/11, 5-9-15/19
Nitric acid (70% and over)	2031, 2032(h)	C	S/P	2	2G	Cont.	No	NF			C	T	No		E	5-9-15/11, 5-9-15/19
Nitrobenzene	1662	B	S/P	2	2G	Cont.	No	T1	IIA	Yes	C	T	A,D		No	5-9-15/12, 5-9-15/17, 5-9-15/18, 5-9-15/19, 5-9-16/2.9
o-Nitrophenol (molten)	1663	B	S/P	2	2G	Cont.	No			Yes	C	T	A,D		No	5-9-15/12, 5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
1- or 2-Nitropropane	2608	D	S	3	2G	Cont.	No	T2	IIB	No	R	F-T	A		No	5-9-15/19.6
Nitropropane (60%)/Nitroethane (40%) mixture		D	S	3	2G	Cont.	No			No	R	F-T	A(u)	N4	No	5-9-15/19.6
(o- or p-) Nitrotoluenes	1664	B	S/P	2	2G	Cont.	No		IIB	Yes	C	T	A,B		No	5-9-15/12, 5-9-15/17, 5-9-15/19, 5-9-16/2.9
Nonane (all isomers) (bb)	1920	(C)	P	3	2G	Cont.	No			No	R	F	B,C		No	5-9-15/19.6
Nonene (all isomers)		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Nonyl Acetate		(C)	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Nonyl alcohol (all isomers)		C	P	3	2G	Open	No			Yes	O	No	A		No	
Nonyl phenol		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Nonyl phenol poly(4-12) ethoxylates		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2(a)
Noxious liquid, N.F, (1) n.o.s. (tradename..., contains...) S.T.1, Cat.A•		A	P	1	2G	Open	No			Yes	O	No	A		No	5-9-15/19
Noxious liquid, F, (2) n.o.s.		A	P	1	2G	Cont.	No			No	R	F	A		No	5-9-15/19

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N.F:	Flashpoint exceeding 60°C (closed cup test)	S.T. :	Ship type
F:	Flashpoint not exceeding 60°C (closed cup test)	Cat.:	Pollution category
n.o.s.:	not otherwise specified	m.p.:	Melting point

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
(tradename..., contains...) S.T.1, Cat.A•																
Noxious liquid, N.F, (3) n.o.s. (tradename..., contains...) S.T.2, Cat.A•		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Noxious liquid, F, (4) n.o.s. (tradename..., contains...) S.T.2, Cat.A•		A	P	2	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Noxious liquid, N.F, (5) n.o.s. (tradename..., contains...) S.T.2, Cat.B•		B	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, [5-9-16/2.6, 5-9-16/2.9] ••
(Noxious liquid, N.F, (6) n.o.s. tradename..., contains...) S.T.2, Cat.B•, mp 15°C+		B	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, [5-9-16/2.6] ••, 5-9-16/2.9, 5-9-16A/2.2
Noxious liquid, F, (7) n.o.s. (tradename…, contains…) S.T.2, Cat.B•		B	P	2	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, [5-9-16/2.6, 5-9-16/2.9] ••
Noxious liquid, F, (8) n.o.s. (tradename..., contains...) S.T.2, Cat.B•, mp 15°C+		B	P	2	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, [5-9-16/2.6] ••, 5-9-16/2.9, 5-9-16A/2.2
Noxious liquid, N.F, (9) n.o.s. (tradename..., contains...) S.T.3, Cat.A•		A	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Noxious liquid, F, (10) n.o.s. (tradename..., contains...) S.T.3, Cat.A•		A	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6

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N.F:	Flashpoint exceeding 60°C (closed cup test)	S.T. :	Ship type
F:	Flashpoint not exceeding 60°C (closed cup test)	Cat.:	Pollution category
n.o.s.:	not otherwise specified	m.p.:	Melting point

•• For high viscosity or high melting point cargoes

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Noxious liquid, N.F, (11) n.o.s. (tradename..., contains...) S.T.3, Cat.B•		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, [5-9-16/2.6, 5-9-16/2.9]••
Noxious liquid, N.F, (12) n.o.s. (tradename..., contains...) S.T.3, Cat.B•, mp 15°C+		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, [5-9-16/2.6, 5-9-16/2.9]••, 5-9-16/2.9, 5-9-16A/2.2
Noxious liquid, F, (13) n.o.s. (tradename..., contains...) S.T.3, Cat.B•		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, [5-9-16/2.6, 5-9-16/2.9] ••
Noxious liquid, F, (14) n.o.s. (tradename..., contains...) S.T.3, Cat.B•, mp 15°C+		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, [5-9-16/.6] •• 5-9-16/2.9, 5-9-16A/2.2
Noxious liquid, N.F, (15) n.o.s. (tradename..., contains...) S.T.3, Cat.C•		C	P	3	2G	Cont.	No			Yes	O	No	A		No	[5-9-16/2.7 to 5-9-16/2.9] ••
Noxious liquid, F, (16) n.o.s. (tradename..., contains...) S.T.3, Cat.C•		C	P	3	2G	Cont.	No			No	R	F	A		No	[5-9-16/2.7 to 5-9-16/2.9] ••
Octane (all isomers)	1262	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Octanol (all isomers)		C	P	3	2G	Open	No			Yes	O	No	A		No	
Octene (all isomers)		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
n-Octyl acetate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Octyl aldehydes	1191	(B)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.9
Olefin mixtures (C_5-C_7) (bb)		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Olefin mixtures (C_5-C_{15})		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
alpha-Olefins (C_6-C_{18}) mixtures		B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-

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F:	Flashpoint not exceeding 60°C (closed cup test)	Cat.:	Pollution category
n.o.s.:	not otherwise specified	m.p.:	Melting point

•• For high viscosity or high melting point cargoes

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
																16/2.9
Oleum	1831	C	S/P	2	2G	Cont.	No		NF		C	T	No		E	5-9-15/11.2 to 5-9-15/11.8, 5-9-15/12.1, 5-9-15/16.2, 5-9-15/17, 5-9-15/19, 5-9-16/2.7, 5-9-16/2.8
Oleylamine		A	S/P	2	2G	Cont.	No			Yes	R	T	A		No	5-9-15/19.6
Palm kernel acid oil		C	P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-16/2.7 to 5-9-16/2.9
Paraldehyde	1264	C	S/P	3	2G	Cont.	No	T3	IIB	No	R	F	A		No	5-9-15/19.6, 5-9-16/2.9
Pentachloroethane	1669	B	S/P	2	2G	Cont.	No		NF		R	T	No		No	5-9-15/12, 5-9-15/17, 5-9-15/19.6
1,3-Pentadiene		C	S/P	3	2G	Cont.	No			No	R	F-T	A,B		No	5-9-15/13, 5-9-15/19.6, 5-9-16/6
Pentane (all isomers) (bb)	1265	(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/14, 5-9-15/19.6
Pentene (all isomers) (bb)		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/14, 5-9-15/19.6
n-Pentyl propionate		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Perchloroethylene	1897	B	S/P	3	2G	Cont.	No		NF		R	T	No		No	5-9-15/12.1, 5-9-15/12.2, 5-9-15/19.6
Phenol	2312	C	S/P	2	2G	Cont.	No	T1	IIA	Yes	C	T	A		No	5-9-15/12, 5-9-15/19, 5-9-16/2.7, 5-9-16/2.8, 5-9-16/2.9
1-Phenyl-1-xylyl ethane (bb)		C	P	3	2G	Open	No			Yes	O	No	A,B		No	
Phosphoric acid	1805	D	S	3	2G	Open	No		NF		O	No	No		No	5-9-15/11.1 to 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8
Phosphorus, yellow or white		A	S/P	1	1G	Cont.	Pad + (vent or inert)			No (k)	C	No	C		E	5-9-15/7, 5-9-15/19
Phthalic anhydride (molten)	2214	C	S/P	3	2G	Cont.	No	T1	IIA	Yes	R	No	A,D		No	5-9-16/2.7 to 5-9-16/2.9
alpha-Pinene		A	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
beta-Pinene	2368	B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Pine oil	1272	C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.7, 5-9-16/2.8
Poly(2^+)cyclic aromatics		A	P	2	2G	Cont.	No			Yes	R	No	A,D		No	5-9-15/19.6
Polyalkyl (C_{18}-C_{22}) acrylate in Xylene		C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.7, 5-9-16/2.8

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	UN Number	Pollution Category	Hazards	Ship Type	Tank Type	Tank Vent	Tank Environmental Control	Class	Group	Flashpoint 60°C	Gauging	Vapor Detection	Fire Protection	Materials of Construction	Respiratory and Eye Protection	Special Requirements
Polyalkylene oxide polyol		C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.7, 5-9-16/2.8
Polyethylene polyamines		(C)	S/P	3	2G	Open	No			Yes	O	No	A	N2	No	5-9-16/2.9
Polyferric sulphate solution		(C)	S/P	3	2G	Open	No		NF		O	No	No	Y4	No	
Polymethylene polyphenyl isocyanate		D	S	2	2G	Cont.	Dry			Yes (b)	C	T (b)	A	N5	No	5-9-15/12, 5-9-15/16.2, 5-9-15/19.6
Polyolefinamine in alkyl (C_2-C_4) benzenes		(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.7, 5-9-16/2.8
Polyolefinamine in aromatic solvent		(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.7, 5-9-16/2.8
Polyolefin phosphorosulphide—barium derivative (C_{28}-C_{250})		C	P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-16/2.7, 5-9-16/2.8
Potassium chloride solution (10% or more)		C	P	3	2G	Open	No		NF		O	No	No		No	
Potassium hydroxide solution	1814	C	S/P	3	2G	Open	No		NF		O	No	No	N8	No	5-9-16/2.9
Potassium oleate		C	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Potassium polysulphide, Potassium thisulphate solution (41% or less)		(C)	S/P	3	2G	Open	No		NF		O	No	No	N2	No	5-9-15/16.1, 5-9-15/19.6
n-Propanolamine		C	S/P	3	2G	Open	No			Yes	O	No	A,D	N2	No	5-9-16/2.9
beta-Propiolactone		D	S	2	2G	Cont.	No		IIA	Yes	R	T	A		No	
Propionaldehyde	1275	C	S/P	3	2G	Cont.	No			No	R	F-T	A		E	5-9-15/16.1, 5-9-15/17, 5-9-15/19.6
Propionic acid	1848	D	S	3	2G	Cont.	No	T1	IIA	No	R	F	A	Y1	E	5-9-15/11.2 to 5-9-15/11.4, 5-9-15/11.6 to 5-9-15/11.8, 5-9-15/19.6
Propionic anhydride	2496	C	S/P	3	2G	Cont.	No	T2	IIA	Yes	R	T	A	Y1	No	
Propionitrile	2404	C	S/P	2	1G	Cont.	No	T1	IIB	No	C	F-T	A,D		E	5-9-15/12, 5-9-15/17, 5-9-15/18, 5-9-15/19
n-Propylamine	1277	C	S/P	2	2G	Cont.	Inert	T2	IIA	No	C	F-T	A,D	N2	E	5-9-15/12, 5-9-15/19
Propylbenzene (all isomers)		A	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
n-propyl chloride	1278	D	S	3	2G	Cont.	No			No	R	F	A,B		No	5-9-15/19.6
Propylene dimer (bb)		(C)	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Propylene oxide	1280	C	S/P	2	2G	Cont.	Inert	T2	IIB	No	C	F-T	A,C	Z	No	5-9-15/8, 5-9-15/12.1, 5-9-15/14, 5-9-15/19
Propylene tetramer	2850	B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Propylene trimer	2057	B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Pyridine	1282	D	S	3	2G	Cont.	No	T1	IIA	No	R	F	A	N4	No	5-9-15/19.6
Rosin		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Rosin soap (disproportionated) solution		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Sodium aluminate solution	1819	D	S	3	2G	Open	No		NF		O	No	No	N1	No	
Sodium borohydride (15% or less)/ Sodium hydroxide solution		C	S/P	3	2G	Open	No		NF		O	No	No	N1	No	5-9-16/2.7
Sodium alkyl (C_{14}-C_{17}) Sulphonates 60-65% solution		B	P	3	2G	Open	No		NF		O	No	No		No	5-9-16/2.6
Sodium chlorate solution (50% or less)	2428	III	S	3	2G	Open	No		NF		O	No	No		No	5-9-15/9, 5-9-15/16.1, 5-9-15/19.6
Sodium dichromate solution (70% or less)		C	S/P	2	2G	Open	No		NF		C	No	No	N2	No	5-9-15/12.3, 5-9-15/19
Sodium hydrogen sulphide (6% or less)/ Sodium carbonated (3% or less) solution		B	P	3	2G	Open	No		NF		O	No	No		No	5-9-15/19.6
Sodium hydrogen sulphite solution (45% or less)	2693	D	S	3	2G	Open	No		NF		O	No	No		No	
Sodium hydrosulphide solution (45% or less)	2949	B	S/P	3	2G	Cont.	Vent or Pad (gas)		NF		R	T	No		No	5-9-15/16.1, 5-9-15/19.6, 5-9-16/2.9
Sodium hydrosulphide/Ammonium sulphide solution		B	S/P	2	2G	Cont.	No			No	C	F-T	A	N1	E	5-9-15/12, 5-9-15/14, 5-9-15/16.1, 5-9-15/17, 5-9-15/19, 5-9-16/6

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	UN Number	Pollution Category	Hazards	Ship Type	Tank Type	Tank Vent	Tank Environmental Control	Electrical Equipment			Gauging	Vapor Detection	Fire Protection	Materials of Construction	Respiratory and Eye Protection	Special Requirements
								Class	Group	Flashpoint 60°C						
Sodium hydroxide solution	1824	D	S	3	2G	Open	No		NF		O	No	No	N8	No	
Sodium hypochlorite solution (15% or less)	1791	C	S/P	3	2G	Cont.	No		NF		R	No	No	N5	No	5-9-15/16.1
Sodium nitrite solution	1500	B	S/P	2	2G	Open	No		NF		O	No	No		No	5-9-15/12.3.1, 5-9-15/12.3.2, 5-9-15/16.1, 5-9-15/19
Sodium petroleum sulfonate		B	S/P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6
Sodium silicate solution		C	P	3	2G	Open	No			Yes	O	No	A		No	
Sodium suphide solution (15% or less)		B	S/P	3	2G	Cont.	No		NF		C	T	No	N5	No	5-9-15/16.1, 5-9-15/19.6, 5-9-16/2.9
Sodium sulphite solution (25% or less)		C	P	3	2G	Open	No		NF		O	No	No		No	5-9-15/16.1, 5-9-15/19.6, 5-9-16/2.9
Sodium tartrates/ sodium succinates solution		D	S	3	2G	Open	No			Yes	O	No	A,B	Y5	No	
Sodium thiocyanate (56% or less) solution		(B)	P	3	2G	Open	No			Yes	O	No	No		No	5-9-15/19.6
Styrene monomer	2055	B	S/P	3	2G	Cont.	No	T1	IIA	No	R	F	A,B	N4,Z	No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Sulphohydrocarbon long chain (C_{18+}) alkalamine mixture		B	P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-15/19.6, 5-9-16/2.6
Sulphur (molten)	2448	III	S	3	1G	Open	Vent or Pad (gas)	T3		Yes (1)	O	F-T	No		No	5-9-15/10
Sulphuric acid	1830	C	S/P	3	2G	Open	No		NF		O	No	No		No	5-9-15/11, 5-9-15/16.2, 5-9-16/2.8, 5-9-16/2.9
Sulphuric acid, spent	1832	C	S/P	3	2G	Open	No		NF		O	No	No		No	5-9-15/11, 5-9-15/16.2, 5-9-16/2.8, 5-9-16/2.9
Tall oil (crude and distilled)		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9, 5-9-16A/2.2
Tall oil (fatty acid, barium salt)		B	S/P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6
Tall oil fatty acid (resin acids less than		(C)	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.7 to 5-9-16/2.9

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
20%)																
Tall oil soap (disproportionated) solution		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-16/2.9
Tetrachloroethane	1702	B	S/P	3	2G	Cont.	No		NF		R	T	No		No	5-9-15/12, 5-9-15/17, 5-9-15/19.6
Tetraethylene pentamine	2320	D	S	3	2G	Open	No			Yes	O	No	A	N1	No	
Tetrahydrofuran	2056	D	S	3	2G	Cont.	No	T3	IIB	No	R	F-T	A		No	5-9-15/19.6
Tetrahydronapthalene (bb)		C	P	3	2G	Open	No			Yes	O	No	A		No	
Tetramethylbenzene (all isomers)		A	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.9, 5-9-16A/2.2
Toluene (bb)	1294	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Toluenediamine	1709	C	S/P	2	2G	Cont.	No			Yes	C	T	A,D	N1	E	5-9-15/12, 5-9-15/17, 5-9-15/19, 5-9-16/2.7, 5-9-16/2.9
Toluene diisocyanate	2078	C	S/P	2	2G	Cont.	Dry	T1	IIA	Yes	C	F-T	A, C(c), D	N4	E	5-9-15/12, 5-9-15/16.2, 5-9-15/17, 5-9-15/19, 5-9-16/2.9
o-Toluidine	1708	C	S/P	2	2G	Cont.	No			Yes	C	T	A		No	5-9-15/12, 5-9-15/17, 5-9-15/19
Tributyl phosphate		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
1,2,4-Trichlorobenzene	2321	B	S/P	2	2G	Cont.	No			Yes	R	T	A,B		No	5-9-15/19.6, 5-9-16/2.9, 5-9-16A/2.2
1,1,1-Trichloroethane	2831	C	P	3	2G	Open	No			Yes	O	No	A		No	
1,1,2-Trichloroethane		C	S/P	3	2G	Cont.	No		NF		R	T	No		No	5-9-15/12.1, 5-9-15/19.6
Trichloroethylene	1710	C	S/P	3	2G	Cont.	No	T2	IIA	Yes	R	T	No		No	5-9-15/12, 5-9-15/16.1, 5-9-15/17, 5-9-15/19.6
1,2,3-Trichloropropane		C	S/P	2	2G	Cont.	No			Yes	C	T	A,B, D		No	5-9-15/12, 5-9-15/17, 5-9-15/19
1,1,2-Trichloro-1,2,2-Trifluoroethane		C	P	3	2G	Open	No		NF		O	No	No		No	
Tricresyl phosphate (containing less than 1% ortho-isomer)		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Tricresyl phosphate (containing 1% or more ortho-isomer)	2574(j)	A	S/P	1	2G	Cont.	No	T2	IIA	Yes	C	No	A,B		No	5-9-15/12.3, 5-9-15/19
Tridecanoid acid		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.6, 5-9-

	b	c	d	e	f	g	h	i′	i″	i‴	j	k	l	m	n	o
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	Electrical Equipment *Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
																16/2.9, 5-9-16A/2.2
Triethanolamine		D	S	3	2G	Open	No		IIA	Yes	O	No	A	N1	No	
Triethylamine	1296	C	S/P	2	2G	Cont.	No	T2	IIA	No	R	F-T	A,C	N2	E	5-9-15/12, 5-9-15/19.6
Triethylbenzene		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Triethylenetetramine	2259	D	S	3	2G	Open	No	T2	IIA	Yes	O	No	A	N1	No	
Triethyl phosphite	2323	B	S/P	2	2G	Cont.	No			No	R	F-T	A,B		No	5-9-15/12.1, 5-9-15/19.6
Triisopropylated phenyl phosphates		A	P	2	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Trimethylacetic acid		D	S	3	2G	Cont.	No			Yes	R	No	A	Y1	No	5-9-15/11.2 to 5-9-15/11.8
Trimethylamine solution (30% or less)	1297	C	S/P	2	2G	Cont.	No			No	C	F-T	A,C	N1	E	5-9-15/12, 5-9-15/14, 5-9-15/19, 5-9-16/2.9
Trimethylbenzenes (all isomers)		A	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6,
Trimethylhexamethylenediamine (2,2,4- and 2,4,4-isomers)	2327	D	S	3	2G	Open	No			Yes	O	No	A,C	N1	No	5-9-15/19.6
Trimethylhexamethylene diisocyanate (2,2,4- and 2,4,4-isomers)	2328	B	S/P	2	2G	Cont.	Dry			Yes	C	T	A, C(c)		No	5-9-15/12, 5-9-15/16.2, 5-9-15/17, 5-9-15/19.6
2,2,4-Trimethyl-1,3-pentanedio-1-1-isobutyrate		C	P	3	2G	Open	No			Yes	O	No	A		No	
Trimethyl phosphite	2329		S	3	2G	Cont.	No			No	R	F-T	A,D		No	5-9-15/12.1, 5-9-15/16.2, 5-9-15/19.6
1,3,5-Trioxane		D	S	3	2G	Cont.	No			No	R	F	A,D		No	5-9-15/19.6
Trixylyl phosphate		A	P	1	2G	Open	No			Yes	O	No	A		No	5-9-15/19
Turpentine	1299	B	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Undecanoic acid		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-16/2.6, 5-9-16/2.9
1-Undecene		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6
Undecyl alcohol		B	P	3	2G	Open	No			Yes	O	No	A		No	5-9-15/19.6, 5-9-16/2.9, 5-9-16A/2.2(r)
Urea/Ammonium nitrate solution (containing aqua ammonia)		C	S/P	3	2G	Cont.	No	NF			R	T	A	N4	No	
Valeraldehyde (all isomers)	2058	C	S/P	3	2G	Cont.	Inert	T3	IIB	No	R	F-T	A		No	5-9-15/4.6, 5-9-15/16.1, 5-9-15/19.6

	b	*c*	*d*	*e*	*f*	*g*	*h*	*i′*	*i″*	*i‴*	*j*	*k*	*l*	*m*	*n*	o
								Electrical Equipment								
Product Name	*UN Number*	*Pollution Category*	*Hazards*	*Ship Type*	*Tank Type*	*Tank Vent*	*Tank Environmental Control*	*Class*	*Group*	*Flashpoint 60°C*	*Gauging*	*Vapor Detection*	*Fire Protection*	*Materials of Construction*	*Respiratory and Eye Protection*	Special Requirements
Vinyl acetate	1301	C	S/P	3	2G	Cont.	No	T2	IIA	No	R	F	A		No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Vinyl ethyl ether	1302	C	S/P	2	1G	Cont.	Inert	T3	IIB	No	C	F-T	A	N6	E	5-9-15/4, 5-9-15/13, 5-9-15/14, 5-9-15/19, 5-9-16/6.1, 5-9-16/6.2
Vinylidene chloride	1303	D	S	2	2G	Cont.	Inert	T2	IIA	No	R	F-T	B	N5	E	5-9-15/13, 5-9-15/14, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Vinyl neodecanoate		B	S/P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-15/13, 5-9-15/16.1, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
Vinyl toluene	2618	A	S/P	3	2G	Cont.	No		IIA	No	R	F	A,B	N1	No	5-9-15/13, 5-9-15/19.6, 5-9-16/6.1, 5-9-16/6.2
White spirit, low (15-20%) aromatic	1300	(B)	P	2	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6
Xylenes (bb)	1307	C	P	3	2G	Cont.	No			No	R	F	A		No	5-9-15/19.6, 5-9-16/2.9(w)
Xylenol	2261	B	S/P	3	2G	Open	No		IIA	Yes	O	No	A,B		No	5-9-15/19.6, 5-9-16/2.9, 5-9-16A/2.2
Zinc alkaryl dithiophosphate (C_7-C_{16})		(C)	P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-16/2.7, 5-9-16/2.8
Zinc alkyl dithiophosphate (C_3-C_{14})		B	P	3	2G	Open	No			Yes	O	No	A,B		No	5-9-15/19.6, 5-9-16/2.6

a Applies to Ammonia aqueous, (28% or less) but not below 10%.

Ammonia aqueous (28% or less)

b If the product to be carried contains flammable solvents such that the flashpoint does not exceed 60°C c.c., then special electrical systems and the flammable vapor detector should be provided.

Diphenyl methane diisocyanate

Polymethylene polyphenyl isocyanate

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.

Diphenylmethane diisocyanate

Toluene diisocyanate

Trimethylhexamethylene diisocyanate (2,2,4- and 2,4,4- isomers)

d UN number 1198 only applies if flashpoint is below 60°C c.c.

Formaldehyde solutions (45% or less)

e Applies to Formaldehyde solutions (45% or less), but not below 5%.

Formaldehyde solutions (45% or less)

f Applies to Hydrochloric acid not below 10%.

Aluminium chloride (30% or less)/Hydrochloric acid (20% or less) solution

Hydrochloric acid

g Dry chemical cannot be used because of the possibility of an explosion.

Maleic anhydride

h UN number 2032 assigned to red fuming nitric acid.

Nitric acid (70% and over)

i UN number depends on boiling point of substance.

Polyethylene polyamines

Polymethylene polyphenyl isocyanate

j UN number assigned to this substance containing more than 3% of ortho-isomer.

Tricresyl phosphate (containing 1% or more 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 c.c.

Phophorus (yellow or white)

l Sulphur (molten) has a flashpoint above 60°C c.c., however, electrical equipment should be certified safe for gases evolved.

Sulphur (molten)

m UN number 2672 refers to 10-35% ammonia solutions.

Ammonia aqueous (28% or less)

n UN number 2511 applies to 2-Chloropropionic acid only.

2- or 3-Chloropropionic acid

o Dinitrotoluene should not be carried in deck tanks.

Dinitrotoluene (molten)

p (Deleted)

q Requirements are based on those isomers having a flashpoint of 60°C c.c. or less; some isomers have a flashpoint greater than 60°C c.c., and therefore the requirements based on flammability would not apply to such isomers.

Heptanol (all isomers)

r Reference 5-9 16A/2.2 applies to 1-Undecyl alcohol only.

Undecyl alcohol

s Applies to n-Decyl alcohol only.

Decyl alcohol (all isomers)

t UN number 1114 applies to Benzene.

Benzene and mixtures having 10% benzene or more

u Dry chemicals should not be used as a fire-fighting medium.

Nitropropane (60%)/Nitroethane (40%) mixture

v Confined spaces should be tested for both Formic acid vapors and Carbon monoxide gas, a decomposition product.
Formic acid

w Applies to p-Xylene only.
Xylenes

x Applies to p-isomer and mixtures containing p-isomer viscosity of which is 25 mPa.s at 20°C.
Dichlorobenzenes (all isomers)

y Applies to p-isomer and mixtures containing p-isomer melting point of which is 0°C and above.
Dichlorobenzenes (all isomers)

z Applies to p-isomer and mixtures containing p-isomer melting point of which is 15°C and above.
Dichlorobenzenes (all isomers)

aa Applies only to products with melting point of 15°C and above.
Nonyl phenol poly(4-12)ethoxylates

bb Applies to oil-like substances identified in accordance with the provisions of the unified interpretation of regulation 14 of Annex II of MARPOL 73/78 agreed by the MEPC.

PART

5

CHAPTER 9 **Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION 18 **List of Chemicals to Which the Code Does Not Apply** *(1 July 1994)*

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1

The following are chemicals which have been reviewed for their safety and pollution hazards and determined not to present hazards to such an extent as to warrant application of the Code. This may be used as a guide in considering bulk carriage of chemicals whose hazards have not yet been evaluated.

2

Although the chemicals listed in this Section 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

Some chemicals are identified as falling into pollution category D and, therefore, subject to certain operational requirements of Annex II of MARPOL 73/78.

4

Liquid mixtures which are provisionally assessed under regulation 3(4) of Annex II of MARPOL 73/78 as falling into pollution category D, and which do not present safety hazards, may be carried under the entry for noxious liquids not otherwise specified in this subsection. Similarly, those mixtures provisionally assessed as falling outside pollution category A, B, C, or D, and which do not present safety hazards, may be carried under the entry for non-noxious liquids not otherwise specified in this Section.

Explanatory Notes

Product name (column a)	*In some cases, the product names may not be identical with the names given in previous issues of the IBC Code or the BCH Code (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.*
Pollution category (column c)	*The letter D means the pollution category assigned to each product under Annex II of MARPOL 73/78. "III" means the product was evaluated and found to fall outside the categories A, B, C or D.* *Pollution category in brackets indicates that the product is provisionally categorized and that further data are necessary to complete the evaluation of their pollution hazards. Until the hazard evaluation is completed, the pollution category assigned is used.*

a	*b*	*c*
Product name	*UN number*	*Pollution Category for operational discharge (regulation 3 of Annex II)*
Acetone	1090	III
Alcohols (C_{13+})	—	III
Alcoholic beverages, n.o.s.	3065	III
Acrylonitrile-Styrene copolymer dispersion in polyether polyol	—	D
n-Alkanes (C_{10+})	—	III
Alkenyl (C_{11+}) amide	—	D
Alkyl (C_{8+}) amine, alkenyl (C_{12+}) acid ester mixture	—	D
Alkyl (C_{9+}) benzenes	—	III
Alkyl dithiothiadiazole (C_6–C_{24})	—	D
Aluminium sulphate solution	—	D
Aminoethyldiethanolamine/ Aminoethylethanolamine solution	—	III
2-Amino-2-hydroxymethyl-1,3- propanediol solution (40% or less)	—	III
Ammonium hydrogen phosphate solution	—	D
Ammonium polyphosphate solution	—	D
Ammonium sulphate solution	—	D
n-Amyl alcohol	1105	D
sec-Amyl alcohol	1105	D
tert-Amyl alcohol	1105	III
Amyl alcohol, primary	1105	D
Animal and fish oils, n.o.s. including: Cod liver oil, Lanolin, Neatsfoot oil, Pilchard oil, Sperm oil	—	D
Animals and fish oils and distillates acids, n.o.s. including: Animal acid oil, Fish acid oil, Lard acid oil, Mixed acid oil, Mixed general acid oil, Mixed hard acid oil, Mixed soft acid oil	—	D
Apple juice	—	III
Aryl polyolefin (C_{11}–C_{50})	—	D
Benzene tricarboxylic acid, trioctyl ester	—	III

a	*b*	*c*
Product name	*UN number*	*Pollution Category for operational discharge (regulation 3 of Annex II)*
Brake fluid base mix: (Poly (2-8) alklene (C_2–C_3) glycols/Polyalkylene (C_2– C_{10}) glycols monoalkyl (C_1–C_4) ethers and their borate esters)[1]	—	D
n-Butyl alcohol	1120	III
sec-Butyl alcohol	1120	III
tert-Butyl alcohol	1120	III
Butylene glycol	—	D
Butyl stearate	—	III
gamma-Butyrolactone	—	D
Calcium carbonate slurry	—	III
Calcium hydroxide slurry	—	D
Calcium long chain alkaryl sulphonate (C_{11}–C_{50})	—	D
Calcium long chain alkyl phenate sulphide (C_8–C_{40})	—	D
Calcium long chain phenolic amine (C_8– C_{40})	—	III
Calcium nitrate/Magnesium nitrate/Potassium chloride solution	—	III
epsilon-Caprolactam (molten or aqueous solutions)	—	D
Chlorinated paraffins (C_{14}–C_{17}) (with 52% chlorine)	—	III
Choline chloride solutions	—	D
Citric acid (70% or less)	—	D
Clay slurry	—	III
Coal slurry	—	III
Coconut oil fatty acid methyl ester	—	D
Cyclohexanol	—	D
Decahydronaphthalene	1147	(D)
Dextrose solution	—	III
Diacetone alcohol	1148	D
Dialkyl (C_7–C_{13}) phthalates	—	D
Diethylene glycol	—	D
Diethylene glycol dibutyl ether	—	D
Diethylene glycol diethyl ether	—	III
Diethylene glycol phthalate	—	D
Diethylenetriamine pentaacetic acid, pentasodium salt solution	—	III
Di(2-ethylhexyl)adipate	—	D
Diheptyl phthalate	—	III
Dihexyl phthalate	—	III
1,4-Dihydro-9,10-dihydroxy antracene, disodium salt solution	—	D
Diisobutyl ketone	1157	D
Diisononyl adipate	—	D
Diisooctyl phthalate	—	III
Diisopropyl naphthalene (bb)	—	D
Dimethyl polysiloxane	—	III
2,2-Dimethylpropane-1,3-diol	—	(D)

[1] Use "Brake fluid base mix" as a proper name on the shipping document.

a	*b*	*c*
Product name	*UN number*	*Pollution Category for operational discharge (regulation 3 of Annex II)*
Dinonyl phthalate	—	D
Dioctyl phthalate	—	III
Dipropylene glycol	—	III
Ditridecyl phthalate	—	D
Diundecyl phthalate	—	D
Dodecane (all isomers)	—	III
Dodecenyl succinic acid, dipotassium salt solution	—	(D)
Dodecyl benzene	—	III
Dodecylxylene	—	III
Drilling brines including: Calcium bromide solution, Calcium chloride solution, Sodium chloride solution	—	III
2-Ethoxyethanol	1171	D
Ethyl acetate	1173	D
Ethyl acetoacetate	—	(D)
Ethyl alcohol	1170	III
Ethylene carbonate	—	III
Ethylenediamine tetraacetic acid, tetrasodium salt solution	—	D
Ethylene glycol	—	D
Ethylene glycol acetate	—	(D)
Ethylene glycol methyl butyl ether	—	D
Ethylene glycol phenyl ether	—	D
Ethylene glycol phenyl ether/Diethylene glycol phenyl ether mixture	—	D
Ethylene-vinyl acetate copolymer (emulsion)	—	III
2-Ethylhexanoic acid	—	D
Ethyl propionate	1195	D
Fatty acid (saturated C_{13+})	—	III
Ferric hydroxyethylethylene diamine triacetic acid, trisodium salt solution	—	D
Fish solubles[2]	—	III
Formamide	—	D
Glucose solution	—	III
Glycerine	—	III
Glycerine (83%), Dioxanedimethanol (17% mixture)	—	D
Glycerol monooleate	—	D
Glycerol polyalkoxylate	—	III
Glyceryl triacetate	—	(III)
Glycine, sodium salt solution	—	III
Glyoxal solution (40% or less)	—	D
n-Heptanoic acid	—	D
Hexamethylenediamine adipate solution (50% in water)	—	D
Hexamethylene glycol	—	III
Hexamethylenetetramine solutions	—	D
Hexanoic acid	—	D

[2] Water-based fish meal products

a	*b*	*c*
Product name	*UN number*	*Pollution Category for operational discharge (regulation 3 of Annex II)*
Hexanol	2282	D
Hexylene glycol	—	III
N-(Hydroxyethyl)ethylenediamine triacetic acid, trisodium salt solution	—	D
Isoamyl alcohol	1105	D
Isobutyl alcohol	1212	III
Isobutyl formate	2393	D
Iso- & cyclo-Alkanes (C_{10}–C_{11})	—	D
Iso- & cyclo-Alkanes (C_{12+})	—	III
Isophorone	—	D
Isopropyl acetate	1220	III
Isopropyl alcohol	1219	III
Kaolin slurry	—	III
Lactic acid	—	D
Lard	—	III
Latex:		
Carboxylated stryrene-butadiene copolymer	—	III
Styrene-butadiene rubber	—	III
Latex, ammonia (1% or less) inhibited	—	D
Lignin sulphonic acid, sodium salt solution	—	III
Long chain alkaryl sulphonic acid (C_{16} – C_{60})	—	D
Long chain alkylphenate/phenol sulfide	—	III
Magnesium chloride solution	—	III
Magnesium hydroxide slurry	—	III
Magnesium long chain alkarylsulphonate (C_{11}–C_{50})	—	D
3-Methyoxy-1-butanol	—	III
3-Methoxybutyl acetate	—	D
Methyl acetate	1231	III
Methyl acetoacetate	—	D
Methyl alcohol	1230	III
Methylamyl ketone	1110	D
Methyl propyl ketone	1249	D
N-Methyl-2-pyrrolidone	—	D
N-Methylglucamine solution (70% or less)	—	III
Methyl butenol	—	(D)
Methyl tert-butyl ether	2398	D
Methyl butyl ketone	—	D
Methyl butynol	—	D
Methyl ethyl ketone	1193	III
Methyl isobutyl ketone	1245	D
3-Methyl-3-methoxy butanol	—	III
3-Methyl-3-methoxy butyl acetate	—	III
Molasses	—	III

a	*b*	*c*
Product name	*UN number*	*Pollution Category for operational discharge (regulation 3 of Annex II)*
Myrcene	—	D
Naphthalene sulphonic acid/formaldehyde copolymer, sodium salt solution	—	D
Nitrilotriacetic acid, trisodium salt solution	—	D
Nonanoic acid (all isomers)	—	D
Nonyl methacrylate monomer	—	(D)
Noxious liquid, n.o.s. (17) (trade name…, containing…) Cat. D[3]	—	D
Non-noxious liquid, n.o.s. (18) (trade name…,containing…) Appendix III [3]	—	III
Octanoic acid (all isomers)	—	D
Octyl decyl adipate	—	III
Olefins (C_{13+}, all isomers)	—	III
Olefin/alkyl esther copolymer (molecular weight 2000+)	—	D
Oleic acid	—	D
Palm oil fatty acid methyl ester	—	D
Palm stearin	—	D
Paraffin wax	—	III
Pentaethylenehexamine	—	D
Pentanoic acid	—	D
Petrolatum	—	(III)
Polulnotenyl succinimide	—	D
Poly(2-8)alkylene glycol monoalkyl(C_1– C_6) ether	—	D
Poly(2-8)alkylene glycol monoalkyl(C_1– C_6) ether acetate	—	D
Polyaluminium chloride solution	—	III
Polybutene	—	III
Polyether (molecular weight 2000+)	—	D
Polyethylene glycol	—	III
Polyethylene glycol dimethyl ether	—	III
Polyglycerin, sodium salt solution (containing less than 3% sodium hydroxide)	—	III
Polyglycerol	—	III
Poly(4+)isobutylene	—	III
Polyolefin (molecular weight 300+)	—	III
Polyolefin amide alkeneamine (C_{28+})	—	D
Polyolefin amide alkeneamine borate (C_{28}–C_{250})	—	D
Polyolefin amide alkeneamine molybdenum oxysulfide	—	III
Polyolefin amide alkeneamine polyol	—	D
Polyolefin anhydride	—	D
Polyolefin ester (C_{28}–C_{250})	—	D
Polyolefin phenolic amine (C_{28}–C_{250})	—	D
Poly(20)oxyethylene soritan monooleate	—	III
Poly(5+)propylene	—	III
Polypropylene glycol	—	D

[3] In case of a specific n.o.s. (not otherwise specified) cargo assessed as falling within this n.o.s. group that is carried on a ship, this entry, including the cargo's trade name and one or two principle components, should be provided in the shipping document.

a	*b*	*c*
Product name	*UN number*	*Pollution Category for operational discharge (regulation 3 of Annex II)*
Polysiloxane	—	III
n-Propyl acetate	1276	D
n-Propyl alcohol	1274	III
Propylene/butylene copolymer	—	III
Propylene glycol	—	III
Propylene glycol monalkyl ether	—	(D)
Propylene glycol methyl ether acetate	—	D
Sodium acetate solutions	—	(D)
Sodium aluminosilicate slurry	—	III
Sodium benzoate	—	D
Sodium carbonate solution	—	D
Sodium poly(4+)acrylate solutions	—	III
Sodium sulphate solution	—	III
Sorbitol solution	—	III
Sulphohydrocarbon (C_3–C_{88})	—	D
Sulpholane	—	D
Tallow	—	D
Tallow fatty acid	—	(D)
Tetraethylene glycol	—	III
Tridecane	—	III
Tridecyl acetate	—	III
Triethyl phosphate	—	D
Triethylene glycol	—	III
Triisopropanolamine	—	III
Trimethylol propane polyethyoxylate	—	D
2,2,4-Trimethyl 1-1,3 pentanedioldiisobutyrate	—	III
Tripropylene glycol	—	III
Urea/Ammonium mono- and di-hydrogen phosphate/Potassium chloride solution	—	(D)
Urea/Ammonium nitrate solution	—	D
Urea/Ammonium phosphate solution	—	D
Urea formaldehyde resin solution	—	III
Urea solution	—	III
Vegetable oil, n.o.s. including: Beechnut oil, Castor oil, Cocoa butter, Coconut oil, Corn oil, Cottonseed oil, Ground-nut oil, Hazelnut oil, Linseed oil, Nut-meg butter, Oiticica oil, Olive oil, Palm nut oil, Palm oil, Peel oil (oranges and lemons), Perilla oil, Poppy oil, Raising seed oil, Rape seed oil, Rice bran oil, Safflower oil, Salad oil, Sesame oil, Soya bean oil, Sunflower oil, Tucum oil, Tung oil, Walnut oil.	—	D
Vegetable acid oils and distillates, n.o.s. including: Corn acid oil, Cottonseed acid oil, Dark mixed acid oil, Ground-nut acid oil, Mixed acid oil, Mixed general acid oil, Mixed hard acid oil, Mixed soft acid oil, Rapeseed acid oil, Safflower acid oil, Soya acid oil, Sunflower seed acid oil	—	D
Vegetable protein solution (hydrolysed)	—	III
Water	—	III
Waxes	—	D
Zinc alkenyl carboxamide	—	D

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PART

5

CHAPTER 9 **Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION 19 **Requirements for Ships Engaged in the Incineration at Sea of Liquid Chemical Waste**

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 General

1.1

Section 5-9-1 to Section 5-9-16 apply to incinerator ships, as relevant, and as supplemented or modified by the provisions of this chapter.

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.•

•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.

1.3

The following additional definitions apply:

1.3.1

"Incinerator space" is a gastight space containing solely the incinerator and its associated auxiliaries.

1.3.2

"Incinerator blower space" is a space containing the blowers which supply combustion air to the incinerator burners.

1.3.3

"Dumping Convention" means the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter at Sea, 1972.

1.3.4

"Cargo area" is that part of the ship defined in 5-9-1/3.5, excluding incinerators and chemical waste piping leading to the incinerators.

1.4

During the periodical and intermediate surveys required under 5-9-1/5.2.1.2 and 5-9-1/5.2.1.3, 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.

2 Ship survival capability and location of cargo tanks

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.

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.

3 Ship arrangements

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.

3.2

Tanks and pumps, other than those described in 5-9-19/3.3, 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 5-9-3/1 should apply to such tanks and equipment to the same extent as they apply to cargo tanks.

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 5-9-19/5.3)

3.4

Liquids which have been used for cleaning cargo pipes and cargo tanks as well as for pump-room 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.

3.5

Where necessary, compliance with 5-9-3/2.1 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.

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 5-9-19/3.5, the requirements of 5-9-3/2.3 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.

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.

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.

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.

4 Cargo containment and incinerator standards

4.1

Integral gravity tanks may be used for hazardous wastes.

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 5-9-6/1 apply.

•The standards set out by the Dumping Convention for the control of incineration of wastes and other matter at sea should also be observed.

4.3

The steel structure of the incinerator including supports and other fixtures should be designed for the most unfavorable static angle of heel within the range of 0° to 30°, taking into account the dynamic loads due to the ship's motion.

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.

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.

5 Cargo transfer

5.1

The requirements of 5-9-5/1 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:

5.1.1

be fitted at least 760 mm inboard;

5.1.2

if outside the cargo area, be on the open deck;

5.1.3

be clearly marked; and

5.1.4

be so designed as to allow draining and purging.

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.

5.3

Oil fuel 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 nonreturn valves inside the incinerator space.

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.

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.

6 Materials of construction

6.1

5-9-6/2 – special requirements for materials – is replaced by the following:

6.1.1

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 vapor.

6.1.2

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 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.

6.1.3

In determining the scantlings of the cargo system the corrosivity of the waste should be taken into account.

7 Tank vent systems

7.1

The provisions for controlled venting systems – Section 5-9-8 and 5-9-15/12 apply, except 5-9-8/2.1 and 5-9-15/12.3.

8 Cargo tank environmental control

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.

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.

8.3

The oxygen content of the atmosphere in an inerted tank should not exceed 8% by volume in any part of the tank.

8.4

An audible and visual alarm should be provided to indicate when the pressure in the vapor space of an inerted cargo tank is less than 0.07 bar gauge.

9 Electrical installation

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.

9.2

All other electrical installations which are fitted in the spaces referred to in 5-9-19/9.1 should be of the certified safe type unless the following conditions are complied with:

9.2.1

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.

9.2.2

Installations not of a certified safe type should be automatically switched off in case of loss of the pressure required by 5-9-19/11.2.1 and 5-9-19/11.3.1. A reasonable time delay may be permitted by the Administration before these installations are switched off.

9.2.3

Installations not of a certified safe type should comply as a minimum with IP 55[•] or equivalent protection.

[•]Reference is made to the Recommendations published by the International Electrotechnical Commission and in particular to Publication 44

10 Fire protection and fire extinguishing

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.

11 Mechanical ventilation in the cargo area and in the incinerator location

11.1

For cargo pump-rooms the provisions of 5-9-15/17 – increased ventilation requirements – apply.

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.

11.2.1

The air pressure should always be positive to the pressure within the furnace (see also 5-9-19/9.2.2).

11.2.2

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.

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.

11.3.1

The air pressure should always be positive to the pressure within the furnace (see also 5-9-19/9.2.2)

11.3.2

A minimum capacity of 20 changes of air per hour should be provided based upon the total volume of the incinerator blower space.

12 Instrumentation and control

12.1

Closed gauging devices described in 5-9-13/1.1.3 should be fitted and overflow control systems required in 5-9-15/19 should be provided.

12.2

Vapor detection instruments for toxic and flammable products described in 5-9-13/2 should be fitted.

13 Personnel protection

13.1

The safety equipment described in 5-9-14/2 , including respiratory and eye protection for every person on board described in 5-9-14/2.8, should be provided.

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CHAPTER **9 Vessels Intended to Carry Chemical Cargoes in Bulk**

SECTION **20 Transport of Liquid Chemical Wastes** *(1 July 1994)*

Note: Text in *italics* comes from the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). See 5-9-1/3. Operational, training, or national requirements are shown in *Arial Italic*.

1 Preamble

1.1

Maritime transport of liquid chemical wastes could present a threat to human health and to the environment.

1.2

Liquid chemical wastes should, therefore, be transported in accordance with relevant international conventions and recommendations and, in particular, where it concerns maritime transport in bulk, with the requirements of this Code.

2 Definitions

For the purpose of this Section.

2.1

"Liquid chemical wastes" are substances, solutions or mixtures, offered for shipment, containing or contaminated with one or more constituents which are subject to the requirements of this Code and for which no direct use is envisaged but which are carried for dumping, incineration or other methods of disposal other than at sea.

2.2

"Transboundary movement" means maritime transport of wastes from an area under the national jurisdiction of one country to or through an area under the national jurisdiction of another country, or to or through an area not under the national jurisdiction of any country, provided at least two countries are concerned by the movement.

3 Applicability

3.1

The requirements of this Section are applicable to the transboundary movement of liquid chemical wastes in bulk by seagoing ships and should be considered in conjunction with all other requirements of this Code.

3.2

The requirements of this Section do not apply to:

3.2.1

wastes derived from shipboard operations which are covered by the requirements of MARPOL 73/78; and

3.2.2

liquid chemical wastes carried by ships engaged in the incineration of such wastes at sea which are covered by Section 5-9-19;

3.2.3

substances, solutions or mixtures containing or contaminated with radioactive materials which are subject to the applicable requirements for radioactive materials.

4 Permitted shipments

4.1

Transboundary movement of wastes is permitted to commence only when:

4.1.1

notification has been sent by the competent authority of the country of origin, or by the generator or exporter through the channel of the competent authority of the country of origin, to the country of final destination; and

4.1.2

the competent authority of the country of origin, having received the written consent of the country of final destination stating that the wastes will be safely incinerated or treated by other methods of disposal, has given authorization to the movement.

5 Documentation

5.1

In addition to the documentation specified in 5-9-16/2 ships engaged in transboundary movement of liquid chemical wastes should carry on board a waste movement document issued by the competent authority of the country of origin.

6 Classification of liquid chemical wastes

6.1

For the purpose of the protection of the marine environment all liquid chemical wastes transported in bulk should be treated as Category A noxious liquid substances, irrespective of the actual evaluated category.

7 Carriage and handling of liquid chemical wastes

7.1

Liquid chemical wastes should be carried in ships and cargo tanks in accordance with the minimum requirements for liquid chemical wastes specified in Section 5-9-17, unless there are clear grounds indicating that the hazards of the wastes would warrant:

7.1.1

carriage in accordance with the ship type 1 requirements; or

7.1.2

any additional requirements of this Code applicable to the substance or, in case of a mixture, its constituent presenting the predominant hazard.

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CHAPTER 9 **Vessels Intended to Carry Chemical Cargoes in Bulk**

ANNEX 1 **Guidelines for the Uniform Application of the Survival Requirements of the Bulk Chemical Code and the Gas Carrier Code**

(approved by the Maritime Safety Committee at its forty-second session, 1980)

Preamble

The following should be considered as guidelines for the purpose of uniform application of the survival requirements of the Bulk Chemical Code and the Gas Carrier Code. Alternative methods to the suggested specific program of calculations and presentation, which demonstrate, to the Administration's satisfaction, compliance with the applicable survival criteria, may be accepted.

1 Alternative methods of calculation and presentation of ship survival capability

1.1 The parcel tanker will require a complete analysis of the limiting survival characteristics over the full range of intended loading conditions (as detailed in 5-9-A1/2);

1.2 The dedicated service tanker will require approval of calculations based on service conditions proposed by the builder or owner, in which case the certificate of fitness should be endorsed in respect of the conditions accepted;

1.3 The inherently safe ship is one that will meet survival requirements with the ship assumed to be at a maximum draught and trim with all compartments within the extent of damage assumed to be empty with maximum vertical center of gravity (adjusted for free liquids).

2 Minimum required metacentric height (GM) or maximum allowable height of the center of gravity (KG) as a function of the draught of the parcel tanker

2.1 A systematic investigation of damage survival characteristics should be undertaken by making calculations to obtain the minimum required GM or maximum allowable KG at a sufficient number of draughts within the operating range to permit the construction of a series of curves of "required GM" or "allowable KG" in relation to draught and cargo tank content in way of the damage. The curves must be sufficiently comprehensive to cover operational trim requirements.

2.2 Each of the curves thus constructed relates to one position of assumed damage only and the calculations should be repeated for each damage and lesser extent of damage to be assumed at any part of the ship.

2.3 Where it can be determined by inspection that the effect of certain assumed damage will be less onerous than other assumed damage, for which calculations are provided and curves prepared, then the investigation of such damage cases may be dispensed with.

2.4 The damage calculations should take account of:

2.4.1 tanks in way of the assumed damage filled with liquid at increments of about 25% between empty and the maximum weight of liquid, or liquids, intended to be carried in the particular tanks under consideration;

2.4.2 the distribution of liquids in the adjacent tanks concerned which will give the most severe result, taking trim into account;

2.4.3 a number of draughts over the operating range, up to and including the tropical freeboard mark. The fresh water freeboards need not be considered;

2.4.4 the effect of damage involving the machinery space and adjacent tanks containing liquids over a number of draughts as in 5-9-A1/2.4.3;

2.4.5 the ship in either the departure or the arrival condition, whichever will give the most severe result;

2.4.6 the ship without trim and a sufficient number of trims covering the operating range, in order to permit interpolation.

3 Particulars concerning survival capability calculations

3.1 The calculations should be based on moulded lines and include large appendages such as shaft bosses, skegs and bow thrusters.

3.2 The metacentric heights (GM), stability levers (GZ) and center of gravity positions (KG) for judging the final survival conditions should be calculated by the constant displacement (lost buoyancy) method.

3.3 The calculations should be done for the ship freely trimming.

3.4 Only computer calculations acceptable to the Administration should be used.

3.5 Where the assumed damage causes the ship to trim by the stern, the ship in the intact condition should be assumed to have the largest allowable trim by the stern, consistent with operational requirements.

3.6 Where the assumed damage causes the ship to trim by the bow, the ship in the intact condition should be assumed to have the largest allowable trim by the bow, consistent with operational requirements.

3.7 Lesser extent of damage should be taken into account only where indicated by the presence of subdivision extending into the maximum extent of damage, e.g., double-bottom tanks, side ballast tanks, side cargo tanks, fuel tanks and void spaces. However, the following should be given attention:

3.7.1 "Lesser extent" means the reduction of any one of the three maximum dimensions of damage singly or in combination and also the assessment of the effect of damage affecting any combination of compartments within the maximum extent of damage.

3.7.2 Where any damage involves the release of very heavy cargo liquid, then heel to the intact side of the ship may take place. In such cases, the effect of lesser vertical extent of damage above the level of the tank top may result in the larger angle of heel, since otherwise the effect of cargo loss may be compensated by flood water entering the double-bottom tanks on the damaged side.

3.8 The number of calculations required to show compliance with survival requirements should be that necessary to obtain sufficient data for the loading manual and should be such that all loading conditions indicated in 5-9-A1/1 can be covered, i.e., no additional calculations should be necessary once the series of calculations has been executed.

3.9 Calculations to determine the displacement, trim and the vertical position of the center of gravity should be performed for each operational loading condition. The vertical position of the center of gravity should be corrected for free surface effects. One method would be to construct graphs showing the free surface moments of the criterion angle for all filling levels at a specific gravity of one. The free surface moments for all tanks can then be taken from the graphs and be multiplied by the cargo specific gravity.

3.10 In calculating the effect of free surface of consumable liquids, it is to be assumed that for each type of liquid, at least one transverse pair or a single centerline tank has maximum free surface, and the tank or combination of tanks to be taken into account are to be those where the effect of free surfaces is the greatest; in each tank the center of gravity of the contents is to be taken at the center of volume of the tank. The remaining tanks are to be assumed either completely empty or completely filled, and the distribution of consumable liquids among these tanks is to be such as to obtain the greatest possible height above the keel for the center of gravity.

3.11 To take account of the presence of structure within cargo compartments, a permeability of 0.95 should be assumed as stated in the Codes. Where, in particular cases such as the cargo tanks of gas carriers, this assumption would lead to a significant discrepancy in cargo tank volume, it is preferable to calculate the permeability taking into account actual tank structure, the volume of tank insulation should then be calculated separately and an appropriate permeability applied.

3.12 Attention should be paid to the possibility of progressive flooding through deck cargo pipes and common cargo tank ventilation pipes, if these are immersed at large angles of heel after damage. The possibility of progressive flooding through ballast piping passing through the assumed extent of damage, where positive action valves are not fitted to the ballast system at the open ends of the pipes in the tanks served, should be considered. Where remote control systems are fitted to ballast valves and these controls pass through the assumed extent of damage, then the effect of damage to the system should be considered to ensure that the valves would remain closed in that event.

3.13 Where the ship is required to be capable of sustaining bottom damage anywhere in its length (L), the following method should be used when damage is assumed to occur in the vicinity of the $0.3L$ position from the forward perpendicular:

3.13.1 When applying the longitudinal extent of damage applicable to the foremost part of the ship, no part of the damage should be assumed to extend abaft the $0.3L$ position from the forward perpendicular.

3.13.2 When applying the longitudinal extent of bottom damage applicable to the rest of the ship's length, the damage should be assumed to extend to a foremost limit including a point at $0.3L$ minus 5 m abaft the forward perpendicular.

3.14 In ships carrying liquefied gases, large cargo tanks may be subdivided into sections by centerline and transverse bulkheads which are liquid-tight but which have openings near the top of the tank. These openings would permit spillage of cargo from one section of the cargo tank to another when the ship is heeled where the tank is undamaged, or loss of cargo due to spillage from sections of a damaged cargo tank. The effect of this spillage should be taken into account in calculations and also in any calculation of GM or KG for loading conditions where a "required GM" or "allowable KG" curve is to be used.

3.15 In ships carrying liquefied gases, the ability of longitudinal bulkheads fitted within cargo tanks to withstand the unequal pressures due to flooding of one section of cargo tank should only be considered in the final stage of flooding.

3.16 Where lubricating oil drain tanks fitted below the main engine would be affected by the vertical extent of bottom damage, then flooding of the engine-room by way of the drain tank and engine should be assumed to take place.

3.17 In ships with machinery spaces aft, the machinery space and steering gear compartment should be regarded as being common for damage purposes when any access is fitted in the after machinery space bulkhead, unless a remotely operated sliding watertight door is fitted, or the sill of the access openings, fitted with hinged watertight doors which are to be kept closed at sea, is at least 0.3 m above the damage water line and will not be submerged within the minimum range of residual stability.

3.18 Where dry cargoes are carried at the same time as bulk liquid cargoes, which require compliance with the requirements of the Codes, then the permeability of the space carrying the dry cargo is to be ascertained.

3.19 The harmonized regulations specify that no account should be taken of cross-flooding arrangements to attain stipulated limits of heel in the final state of equilibrium after damage. However, compartments on the opposite sides of a ship could be regarded as single compartments from the aspect of flooding if they were to be linked by openings or ducts of sufficiently large area. In such cases, consideration should be given to the adequacy of tank airflow and to the effect of free surface.

4 Stability information and Certificate of Fitness

4.1 With regard to loading conditions to be submitted to the Administration (exclusive of the loading condition contained in loading and stability manual), the principal objective at the stage of design evaluation is that the Administration can satisfy itself that the calculations presented will cover all conditions of full and partial loading, including variations of draught and trim. To achieve this objective, the Administration may either

4.1.1 require a complete analysis of survival requirements over the full range of probable loading conditions; or

4.1.2 undertake approval on the basis of service conditions proposed by the builder or owner, in which case the Certificate of Fitness should be endorsed for the conditions accepted.

4.2 Particular attention should be paid to the provision of adequate stability data to enable the master to accurately take into account the effect of liquid heeling moments of the contents of undamaged tanks. These heeling moments vary with the specific gravity of the liquid and the percentage filling of the tanks and may change significantly in magnitude from condition to condition. Adequate information would include curves showing the variation of liquid heeling moment with the contents of each individual tank.

4.3 In addition to the usual loading information required under intact stability requirements, the master should be supplied with the following information pertaining to damage stability:

4.3.1 data relative to loading and distribution of cargo and ballast necessary to ensure compliance with damage survival requirements;

4.3.2 data relative to the ship's survival capabilities;

4.3.3 a damage control drawing showing the position of important fittings and listing instructions for their control;

4.3.4 data relating to the effect of free surface or liquid heeling moments of cargo tanks at all stages of filling;

4.3.5 example calculations and standard blank forms to facilitate calculations.

4.4 The following should be stated on the Certificate of Fitness:

4.4.1 the deepest draught or least freeboard permitted for those loading conditions which require greater freeboard than the International Load Line Certificate (1966);

4.4.2 the range of specific gravities of cargoes which may be carried, this relates to all cargoes;

4.4.3 the particular cargo tanks in which certain ranges of specific gravities of cargoes may be carried, if relevant;

4.4.4 details of fittings, valves etc., the control of which is essential for survival, together with instructions for control, operation and logging; and

4.4.5 identification of required loading and stability manual.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

ANNEX 2 Calculation of the Capacity of Foam Systems for Chemical Tankers

1 In 5-9-11/3.14 of the Bulk Chemical Code (5-9-11/3; IBC Code) concerning fire-extinguishing arrangements for cargo tank areas, the foam supply has to be determined in accordance with paragraphs 5-9-A2/3.14.5 to 5-9-A2/3.14.7. In order to provide for a correct interpretation of the requirements, the Sub-Committee on Fire Protection agreed on the following example for a calculation of foam system for a chemical tanker of 10,000 tonnes deadweight.

2 The Maritime Safety Committee at its forty-fourth session agreed that this example be followed when calculating the capacity of foam systems for chemical tankers.

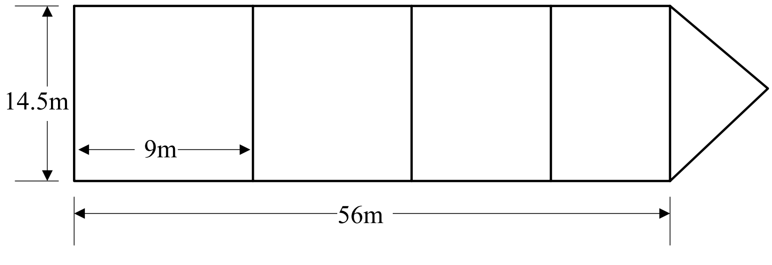
Example of foam system calculation for chemical tanker of 10,000 dwt

Ship particulars

— Beam	= 14.5 m
— Length of cargo area	= 56 m
— Length of largest cargo tank	= 9 m
— Cargo deck area	= 14.5 m × 56 m = 812 m^2
— Horizontal sectional area of single largest tank	= 14.5 m × 9 m = 130.5 m^2

(*Note:* For the purpose of this illustration, a single tank encompasses the entire beam of the ship)

— Proposed monitor spacing	= 9 m
— Area protected by largest monitor	= 9 m × 14.5 m = 130.5 m^2



Calculations

1 Determination of foam supply rate:

3.14.5 The largest of:

3.14.5(a) — the foam supply rate based upon the entire cargo deck area.
$2\ l/m^2/min \times 812\ m^2 = 1{,}624\ l/min$

3.14.5(b) — the foam supply rate based upon the horizontal sectional area of the single largest tank
$20\ l/m^2/min \times 130.5\ m^2 = 2{,}610\ l/min$

3.14.5(c) — the foam supply rate based upon the area protected by the largest monitor
$10\ l/m^2/min \times 130.5\ m^2 = {}^*1{,}305\ l/min$
(* Shall not be less than 1,250 l/min)

The foam supply rate is therefore 2,610 l/min, which is the largest of the three above calculated rates.

2 Determination of the required quantity of foam concentrate:

3.14.6 — 2,610 l/min is the foam supply rate from regulation 5-9-A2/3.14.5. This flow rate for thirty minutes will require 30 min × 2,610 l/min = 78,300 liters of foam-water solution. If a 5% foam concentrate is used, then 5% of the 78,300 liters must be foam concentrate, or 0.05 × 78,300 = 3915 liters

3 Determination of the minimum monitor capacity:

3.14.7 — Each monitor must supply at least:

(a) 50% of the required foam rate; or
(b) $10\ l/m^2/min$ for the area it protects; or
(c) 1,250 l/min, whichever is greater

50% of the foam supply rate = 2,610 l/min × 0.5 = 1,305 l/min

$10\ l/m^2/min$ times the area the monitor protects = $130.5\ m^2 \times 10\ l/m^2/min = 1{,}305\ l/min$

The minimum monitor capacity is therefore 1,305 l/min.

Designer wishes to increase monitor spacing to 15 meters between monitors.

1 Recalculate required foam supply:

3.14.5(a) —same as before—1,624 l/min

3.14.5(b) —same as before—2,610 l/min

3.14.5(b) — larger area covered by monitor is $15\ m \times 14.5 = 217.5\ m^2$
$10\ l/m^2/min \times 217.5\ m^2 = 2{,}175\ l/min$

The required foam rate therefore remains 2,610 liters per minute.

2 Recalculate required foam concentrate supply:

3.14.6 — The minimum foam supply rate has not changed, therefore, 3915 liters of foam concentrate are still required.

3 Recalculate minimum monitor capacity:

3.14.7 — 50% of foam supply rate 2,610 l/min × 0.5 = 1,305 l/min

$10\ l/m^2/min$ of area protected by monitor = $10\ l/m^2/min \times 217.5\ m^2 = 2{,}175\ l/min$

The new minimum monitor capacity is therefore 2,175 l/min.

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

ANNEX 3 Resolution A.473(XII)

Adopted on 19 November 1981

Agenda item 10(b)

INTERIM REGULATION FOR INERT GAS SYSTEMS ON CHEMICAL TANKERS CARRYING PETROLEUM PRODUCTS

A

THE ASSEMBLY,

RECALLING Article 16 of the Convention on the Inter-Governmental Maritime Consultative Organization,

RECOGNIZING that Regulation 60 of Chapter 11-2 of the 1978 Protocol relating to the International Convention for the Safety of Life at Sea, 1974, requires new and existing chemical tankers of a certain size, when carrying petroleum products, to be fitted with a fixed inert gas system at specific dates,

RECOGNIZING ALSO that such ships by the same Regulation are required to have a fixed inert gas system when carrying other liquid products having a similar fire hazard,

RECOGNIZING FURTHER the unique feature of parcel chemical tankers requiring separation of cargo piping and of vent piping due to the wide spectrum of chemicals carried,

RECOGNIZING FURTHER the stringent purity levels required by certain chemicals and compatibility and reactivity problems related to a wide range of chemicals,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its forty-fourth session,

1. ADOPTS the Interim Regulation for Inert Gas Systems on Chemical Tankers Carrying Petroleum Products, set out in the Annex to this resolution;
2. URGES Governments concerned, under the provisions of Regulation 5 of Chapter I of the International Convention for the Safety of Life at Sea, 1974, to apply to chemical tankers as appropriate the Interim Regulation as equivalent to Regulation 62 of Chapter II-2 of the 1974 SOLAS Convention under Regulation 60 of the 1978 Protocol with respect to inert gas systems;
3. REQUESTS Governments to inform IMCO as soon as possible on measures taken to implement this Interim Regulation.

B

THE ASSEMBLY,

HAVING ADOPTED the Interim Regulation for Inert Gas Systems on Chemical Tankers Carrying Petroleum Products,

RECOGNIZING that the Interim Regulation has been developed for the inerting of cargo tanks on chemical tankers containing petroleum products,

1. URGES the Maritime Safety Committee as a long-term goal to investigate a possible extension of the Interim Regulation to the inerting of cargo tanks containing other flammable liquids, and to investigate other alternatives for achieving equivalent protection against fire or explosion or both to that required by Regulation 60 of Chapter II-2 of the 1978 Protocol relating to the 1974 SOLAS Convention of ships carrying flammable cargoes, and as a result of these investigations, to develop final requirements for chemical tankers and gas carriers;

2. AGREES that compliance with additional provisions which will be contained in the final requirements should not be required to be applied to ships the keel of which is laid before the date of coming into force of the final requirements.

ANNEX

INTERIM REGULATION FOR INERT GAS SYSTEMS ON CHEMICAL TANKERS CARRYING PETROLEUM PRODUCTS

PREAMBLE

Administrations are invited to accept the inert gas systems referred to in this Regulation for chemical tankers for which certificates of fitness are issued under the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (resolution A.212(VII)). Inert gas systems supplied by one or more oil-fired inert gas generators may be accepted. An Administration may accept systems using inert gases from other sources provided that an equivalent standard of safety is achieved.

This Regulation relates to the carriage in chemical tankers of petroleum products which include crude oil, fuel oil, sludge, oil refuse and refined products (other than petrochemicals which are subject to the provisions of Annex II of the 1973 MARPOL Convention) and, without limiting the generality of the foregoing, include the substances listed in Appendix I to Annex I of the 1973 MARPOL Convention having a flashpoint not exceeding 60°C as determined by an approved flashpoint apparatus and whose Reid vapor pressure is below atmospheric pressure except when such tanks are cleaned, gas freed and maintained in the gas free condition.

The application dates stipulated in Chapter II-2 of the 1978 SOLAS Protocol apply to chemical tankers covered by this Regulation.

INTERIM REGULATION

1 Inert gas generator systems[•] shall be designed, constructed and tested to the satisfaction of the Administration. They shall be designed and operated so as to render and maintain the atmosphere of cargo tanks[••] non-flammable at all times when such tanks are used for the carriage of petroleum products as defined above.

[•] "Inert gas generator system" means the machinery dedicated to the production and supply of inert gas and includes the air blowers, combustion chambers, oil fuel pumps and burners, gas coolers/ scrubbers and automatic combustion control and supervisory equipment, e.g. flame failure devices.

[••] Throughout this Regulation the term "cargo tank" includes also "slop tanks containing oil residues".

2 The systems shall be capable of:

2.1 inerting empty cargo tanks by reducing the oxygen content of the atmosphere in each tank to a level at which combustion cannot be supported;

2.2 maintaining the atmosphere in all parts of each cargo tank designated to carry flammable products requiring protection by an inert gas system with an oxygen content not exceeding 8 per cent by volume and at a positive pressure at all times in port and at sea except when it is necessary for such a tank to be gas free;

2.3 eliminating the need for air to enter a tank during normal operations except when it is necessary for such a tank to be gas free;

2.4 purging empty cargo tanks of flammable vapor, so that subsequent gas freeing operations will at no time create a flammable atmosphere within the tank.

3.1 The systems shall be capable of delivering inert gas to the cargo tanks at a rate of at least 125 per cent of the maximum rate of discharge capacity of the ship expressed as a volume. An Administration may accept inert gas systems having a lower delivery capacity provided that the maximum rate of discharge of cargoes from cargo tanks being protected by the system is restricted to 80 per cent of the inert gas capacity.

3.2 The systems shall be capable of delivering inert gas with an oxygen content of not more than 5 per cent by volume in the inert gas supply main to the cargo tanks at any required rate of flow.

4.1 Suitable fuel in sufficient quantity shall be provided for the inert gas generators.

4.2 The inert gas generators shall be located outside the cargo tank area as defined in the Bulk Chemical Code. Spaces containing inert gas generators should have no direct access to accommodation, service or control station spaces, but may be located in machinery spaces. If they are not located in machinery spaces they shall be located in a compartment reserved solely for their uses. Such a compartment shall be separated by a gastight steel bulkhead and/or deck from accommodation, service and control station spaces as defined in the Bulk Chemical Code. Adequate positive pressure type mechanical ventilation shall be provided for such a compartment. Access to such compartments located aft shall be only from an open deck outside the cargo tank area. Access shall be located on the end bulkhead not facing the cargo area and/or on the outboard side of the superstructure or deckhouse at a distance of at least 25 per cent of the length of the ship but not less than 5 m from the end of the superstructure or deckhouse facing the cargo area. In the case of such a compartment being located in the forecastle, access shall be through the deckhead forward of the cargo area.

4.3 Inert gas piping systems shall not pass through accommodation, service and control station spaces.

5.1 Means shall be provided which will effectively cool the volume of gas specified in 5-9-A3/3 and remove solids and sulphur combustion products. The cooling water arrangements shall be such that an adequate supply of water will always be available without interfering with any essential services on the ship. Provision shall also be made for an alternative supply of cooling water.

5.2 Filters or equivalent devices shall be fitted to minimize the amount of water carried over to the inert gas main.

6.1 Two air blowers shall be fitted to each inert gas generator, which together shall be capable of delivering to the cargo tanks, required to be protected by the system, at least the volume of gas required by 5-9-A3/3. An Administration may permit only one blower if it is capable of delivering to the protected cargo tanks the total volume of gas required by 5-9-A3/3, provided that sufficient spares for the air blower and its prime mover are carried on board to enable any failure of the air blower and its prime mover to be rectified.

6.2 The inert gas systems shall be so designed that the maximum pressure which they can exert on any cargo tank will not exceed the test pressure of any cargo tank.

6.3 Where more than one inert gas generator is provided suitable shut-off arrangements shall be provided on the discharge outlet of each generator plant.

6.4 Arrangements shall be made to vent the inert gas to the atmosphere in case the inert gas produced is off-specification, e.g. during starting-up or in case of equipment failure.

6.5 Where inert gas generators are served by positive displacement blowers a pressure relief device shall be provided to prevent excess pressure being developed on the discharge side of the blower.

7 Two fuel oil pumps shall be fitted to each inert gas generator. An Administration may permit only one fuel oil pump on condition that sufficient spares for the fuel oil pump and its prime mover are carried on board to enable any failure of the fuel oil pump and its prime mover to be rectified by the ship's crew.

8 A gas-regulating valve shall be fitted in the inert gas supply main. This valve shall be automatically controlled to close as required in 5-9-A3/17.2 and 5-9-A3/17.3. It shall also be capable of automatically regulating the flow of inert gas to the cargo tanks unless other means are provided to automatically control the inert gas flow rate.

9.1 At least two non-return devices, one of which shall be a water seal, shall be fitted in the inert gas supply main in order to prevent the return of flammable vapor to the inert gas generator and to any gas-safe space under all normal conditions of trim, list and motion of the ship. They shall be located between the automatic valve required by 5-9-A3/8 and the first connection to any cargo tank or cargo pipeline. An Administration may permit an alternative arrangement or device providing a measure of safety equivalent to that of a water seal.

9.2 The devices referred to in 5-9-A3/9.1 shall be located in the cargo tank area on deck.

9.3 The water seal referred to in 5-9-A3/9.1 shall be capable of being supplied by two separate pumps, each of which shall be capable of maintaining an adequate supply at all times.

9.4 The arrangement of the water seal and its associated provisions shall be such that it will prevent backflow of flammable vapors and will ensure the proper functioning of the water seal under operating conditions.

9.5 Provision shall be made to ensure that any water seal is protected against freezing, in such a way that the integrity of water seal is not impaired by overheating.

9.6 A water loop or other approved arrangement shall also be fitted to all associated water supply and drain piping and to all venting or pressure sensing piping leading to gas-safe spaces. • Means shall be provided to prevent such loops from being emptied by vacuum.

• Gas-safe space is a space in which the entry of hydrocarbon gases would produce hazards with regard to flammability or toxicity

9.7 Any water seal or equivalent device and all loop arrangements shall be capable of preventing the return of flammable vapors to an inert gas generator at a pressure equal to the test pressure of the cargo tanks.

9.8 The second device shall be a non-return valve or equivalent capable of preventing the return of vapors or liquids or both and fitted between the water seal (or the equivalent device) required in 5-9-A3/9.1 and the first connection from the inert gas main to a cargo tank. It shall be provided with positive means of closure. As an alternative to positive means of closure, an additional valve having such means of closure may be provided between the non-return valve and the first connection to the cargo tanks to isolate the water seal (or equivalent device).

9.9 As an additional safeguard against the possible leakage of flammable liquids or vapors back from the deck main, means shall be provided to permit this section of the line between the valve having positive means of closure referred to in 5-9-A3/8 and the valve referred to in 5-9-A3/8 to be vented in a safe manner when the first of these valves is closed.

10.1 The inert gas main may be divided into two or more branches between the non-return devices required by 5-9-A3/9.1 and the cargo tanks.

10.2 Inert gas supply mains shall be fitted with branch piping leading to each cargo tank designated for the carriage of flammable products required to be inerted by this Regulation. Each cargo tank containing or loading products not required to be inerted shall be separated from the inert gas main by:

10.2.1 removing spool pieces, valves or other pipe sections, and blanking the pipe ends; or

10.2.2 arrangement of two spectacle flanges in series with provisions for detecting leakage into the pipe between the two spectacle flanges.

10.3 Means shall be provided to protect cargo tanks against the effect of overpressure or vacuum caused by thermal variations when the cargo tanks are isolated from the inert gas mains.

10.4 Piping systems shall be so designed as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

10.5 Suitable arrangements shall be provided to enable the inert gas main to be connected to an external supply of inert gas.

11 Unless the arrangements for venting of all vapors displaced from the cargo tanks during loading and ballasting comply with the requirements of the Bulk Chemical Code for controlled venting, such arrangements shall comply with Regulation 58(a) of Chapter II-2 of SOLAS 1974 and shall consist either of one or more mast risers or a number of high velocity vents. The inert gas supply mains shall not be used for such venting.

12.1 The arrangements for inerting, purging or gas freeing of empty tanks as required in 5-9-A3/2 shall be to the satisfaction of the Administration and shall be such that the accumulation of flammable vapors in pockets formed by the internal structural members in a tank is minimized.

12.2 When in accordance with 5-9-A3/3 and Administration permits a system designed to supply only one or two tanks simultaneously, the outlet pipes should be sized such that an exit velocity in the outlet pipes of 20 m/s can be maintained.

13 Means shall be provided for continuously indicating the temperature and pressure of the inert gas at the discharge side of the system, whenever it is operating.

14.1 Instrumentation shall be fitted for continuously indicating and permanently recording, when the inert gas is being supplied:

14.1.1 the pressure of the inert gas supply mains between the non-return devices required by 5-9-A3/9.1 and the cargo tanks; and

14.1.2 the oxygen content of the inert gas in the inert gas supply main.

14.2 The devices referred to in 5-9-A3/14.1 shall be placed in the cargo control room where provided. Where no cargo control room is provided, they shall be placed in a position easily accessible to the officer in charge of cargo operations.

14.3 in addition, meters shall be fitted:

14.3.1 in the navigating bridge to indicate at all times the pressure referred to in 5-9-A3/14.1.1; and

14.3.2 in the machinery control room or in the machinery space to indicate the oxygen content referred to in 5-9-A3/14.1.2.

15 Portable instruments for measuring oxygen and flammable vapor concentration shall be provided. In addition, suitable arrangement shall be made on each cargo tank such that the condition of the tank atmosphere can be determined using these portable instruments.

16 Suitable means shall be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments, referred to in 5-9-A3/14.1 and 5-9-A3/15.

17.1 Audible and visual alarms shall be provided to indicate:

17.1.1 low water pressure or low water flow rate to the cooling and scrubbing arrangement referred to in 5-9-A3/5.1;

17.1.2 low fuel supply;

17.1.3 high gas temperature as referred to in 5-9-A3/13;

17.1.4 failure of the power supply to the inert gas generators;

17.1.5 oxygen content in excess of 8 per cent by volume as referred to in 5-9-A3/14.1.2;

17.1.6 failure of the power supply to the indicating devices as referred to in 5-9-A3/14.1 and to the automatic control systems for the gas regulating valve referred to in 5-9-A3/8 and the inert gas generator;

17.1.7 low water level in the water seal as referred to in 5-9-A3/9.1;

17.1.8 gas pressure less than 100 mm water gauge as referred to in 5-9-A3/14.1;

17.1.9 high gas pressure as referred to in 5-9-A3/14.1.1

17.2 Automatic shut-down of the gas regulating valve and of the fuel oil supply to the inert gas generator shall be arranged on predetermined limits being reached in respect of 5-9-A3/17.1.1 and 5-9-A3/17.1.3.

17.3 Automatic shut-down of the gas regulating valve shall be arranged in respect of 5-9-A3/17.1.4.

17.4 In respect of 5-9-A3/17.1.5, when the oxygen content of the inert gas exceeds 8 per cent by volume, immediate action shall be taken to improve the gas quality. Unless the quality of the inert gas improves, all operations in those tanks to which inert gas is being supplied shall be suspended so as to avoid air being drawn into the tanks. The deck isolation valve referred to in 5-9-A3/9.8 shall be closed and the off-specification gas shall be vented to atmosphere.

17.5 The alarms required in 5-9-A3/17.1.5, 5-9-A3/17.1.6 and 5-9-A3/17.1.8 shall be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew. All other alarms required by this Annex 5-9-A3 shall be audible to responsible members of the crew either as individual alarms or as a group alarm.

17.6 In respect of 5-9-A3/17.1.7 the Administration shall be satisfied as to the maintenance of an adequate reserve of water at all times and the integrity of the arrangements to permit the automatic formation of the water seal when the gas flow ceases. The audible and visual alarm on the low level of water in the water seal shall operate when the inert gas is not being supplied.

17.7 An audible alarm system independent of that required in 5-9-A3/17.1.8 or automatic shut-down of cargo pumps shall be provided to operate on predetermined limits of low pressure in the inert gas mains being reached.

18 Detailed instruction manuals shall be provided on board, covering the operations, safety and maintenance requirements and occupational health hazards relevant to the inert gas system and its application to the cargo tank system. The manuals shall include guidance on procedures to be followed in the event of a fault or failure of the inert gas system.

PART

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CHAPTER 9 Vessels Intended to Carry Chemical Cargoes in Bulk

ANNEX 4 Resolution A.567(14)

Adopted on 20 November 1985

Agenda item 10(b)

REGULATION FOR INERT GAS SYSTEMS ON CHEMICAL TANKERS

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

RECALLING ALSO resolution A.473(XII) which was adopted to provide an interim solution for the requirements of inert gas systems applicable to chemical tankers carrying petroleum products, pending the possible development of final requirements applicable to chemical tankers carrying all flammable cargoes,

RECOGNIZING that the development of such requirements is not needed on the basis of results of scientific studies undertaken by industry, but that the extension of the regulation in resolution A.473(XII) to cover the carriage of petroleum and other liquid products would meet the purpose,

NOTING that regulation II-2/60 of the International Convention for the Safety of Life at Sea, 1974 (1974 SOLAS Convention) as amended requires **inter alia** new and existing tankers of a certain size, including chemical tankers, when carrying petroleum products, to be fitted with a fixed inert gas system by specific dates,

NOTING FURTHER that the draft amendment to regulation II-2/55.5 of the 1974 SOLAS Convention as amended (resolution A.566(14)) exempts certain chemical tankers and gas carriers carrying flammable products from the requirements for inert gas systems of regulation II-2/ 60 of that Convention under certain conditions,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its fifty-first session,

3. ADOPTS the Regulation for Inert Gas Systems on Chemical Tankers set out in the Annex to the present resolution, which supersedes resolution A.473(XII);

4. INVITES Governments to apply the above Regulation to chemical tankers for the purpose of the implementation of the draft amendment to regulation II-2/ 55.5.

ANNEX

REGULATION FOR INERT GAS SYSTEMS ON CHEMICAL TANKERS

PREAMBLE

Administrations are invited to accept the inert gas systems referred to in this Regulation for chemical tankers for which certificates of fitness are issued under the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (resolution A.212(VII)) and under the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (resolution MSC.4(48)).

This regulation shall be applied to chemical tankers as required by the draft amendment to regulation II-2/55.5 of the 1974 SOLAS Convention as amended (resolution A.566(14)).

REGULATION

5. Inert gas generator systems• shall be designed, constructed and tested to the satisfaction of the Administration. They shall be designed and operated so as to render and maintain the atmosphere of cargo tanks•• non-flammable at all times except when such tanks are required to be maintained empty and gas-free. Inert gas systems supplied by one or more oil-fired inert gas generators may be accepted. An Administration may accept systems using inert gas from other sources provided that an equivalent standard of safety is achieved.

• "Inert gas generator system" means the machinery dedicated to the production and supply of inert gas and includes the air blowers, combustion chambers, oil fuel pumps and burners, gas coolers/ scrubbers and automatic combustion control and supervisory equipment, e.g. flame failure devices.

•• Throughout this Regulation the term "cargo tank" includes also "slop tanks containing oil residues"

6. The systems shall be capable of:

2.1 inerting empty cargo tanks by reducing the oxygen content of the atmosphere in each tank to a level at which combustion cannot be supported;

2.2 maintaining the atmosphere, in all parts of each cargo tank designated to carry flammable products requiring protection by an inert gas system, with an oxygen content not exceeding 8% by volume and at a positive pressure at all times in port and at sea except when it is necessary for such a tank to be gas-free;

2.3 eliminating the need for air to enter a tank during normal operations except when it is necessary for such a tank to be gas-free;

2.4 purging empty cargo tanks of flammable vapor, so that subsequent gas-freeing operations will at no time create a flammable atmosphere within the tank.

3.1 The systems shall be capable of delivering inert gas to the cargo tanks at a rate of at least 125% of the maximum rate of discharge capacity of the ship expressed as a volume. An Administration may accept inert gas systems having a lower delivery capacity provided that the maximum rate of discharge of cargoes from cargo tanks being protected by the system is restricted to 80% of the inert gas capacity.

3.2 The systems shall be capable of delivering inert gas with an oxygen content of not more than 5% by volume in the inert gas supply main to the cargo tanks at any required rate of flow.

4.1 Suitable fuel in sufficient quantity shall be provided for the inert gas generators.

4.2 The inert gas generators shall be located outside the cargo tank area as defined in the Bulk Chemical Code and the International Bulk Chemical Code. Spaces containing inert gas generators should have no direct access to accommodation, service or control station spaces, but may be located in machinery spaces. If they are not located in machinery spaces they shall be located in a compartment reserved solely for their use. Such a compartment shall be separated by a gastight steel bulkhead and/or deck from accommodation, service and control station spaces as defined in the Bulk Chemical Code and the International Bulk Chemical Code. Adequate positive-pressure-type mechanical ventilation shall be provided for such a compartment. Access to such compartments located aft shall be only from an open deck outside the cargo tank area. Access shall be located on the end bulkhead not facing the cargo area and/or on the outboard side of the superstructure or deckhouse at a distance of at least 25% of the length of the ship but not less than 5 m from the end of the superstructure or deckhouse facing the cargo area. In the case of such a compartment being located in the forecastle, access shall be through the deckhead forward of the cargo area.

4.3 Inert gas piping systems shall not pass through accommodation, service and control station spaces.

5.1 Means shall be provided which will effectively cool the volume of gas specified in 5-9-A4/3.1 and remove solids and sulphur combustion products. The cooling water arrangements shall be such that an adequate supply of water will always be available without interfering with any essential services on the ship. Provision shall also be made for an alternative supply of cooling water.

5.2 Filters or equivalent devices shall be fitted to minimize the amount of water carried over to the inert gas main.

6.1 Two air blowers shall be fitted to each inert gas generator, which together shall be capable of delivering to the cargo tanks, required to be protected by the system, at least the volume of gas required by 5-9-A4/3. An Administration may permit only one blower if it is capable of delivering to the protected cargo tanks the total volume of gas required by 5-9-A4/3.1, provided that sufficient spares for the air blower and its prime mover are carried on board to enable any failure of the air blower and its prime mover to be rectified.

6.2 The inert gas systems shall be so designed that the maximum pressure which they can exert on any cargo tank will not exceed the test pressure of any cargo tank.

6.3 Where more than one inert gas generator is provided, suitable shutoff arrangements shall be provided on the discharge outlet of each generator plant.

6.4 Arrangements shall be made to vent the inert gas to the atmosphere in case the inert gas produced is off-specification, e.g. during starting-up or in case of equipment failure.

6.5 Where inert gas generators are served by positive displacement blowers, a pressure relief device shall be provided to prevent excess pressure being developed on the discharge side of the blower.

7 Two fuel oil pumps shall be fitted to each inert gas generator. An Administration may permit only one fuel oil pump on condition that sufficient spares for the fuel oil pump and its prime mover are carried on board to enable any failure of the fuel oil pump and its prime mover to be rectified by the ship’s crew.

8 A gas regulating valve shall be fitted in the inert gas supply main. This valve shall be automatically controlled to close as required in 5-9-A4/17.2 and 5-9-A4/17.3. It shall also be capable of automatically regulating the flow of inert gas to the cargo tanks unless other means are provided to automatically control the inert gas flow rate.

9.1 At least two nonreturn devices, one of which shall be a water seal, shall be fitted in the inert gas supply main in order to prevent the return of flammable vapor to the inert gas generator and to any gas-safe space under all normal conditions of trim, list and motion of the ship. They shall be located between the automatic valve required by 5-9-A4/8 and the first connection to any cargo tank or cargo pipeline. An Administration may permit an alternative arrangement or device providing a measure of safety equivalent to that of a water seal.

9.2 The devices referred to in 5-9-A4/9.1 shall be located in the cargo tank area on deck.

9.3 The water seal referred to in 5-9-A4/9.1 shall be capable of being supplied by two separate pumps, each of which shall be capable of maintaining an adequate supply at all times.

9.4 The arrangement of the water seal and its associated provisions shall be such that it will prevent backflow of flammable vapors and will ensure the proper functioning of the water seal under operating conditions.

9.5 Provisions shall be made to ensure that any water seal is protected against freezing, in such a way that the integrity of water seal is not impaired by overheating.

9.6 A water loop or other approved arrangement shall also be fitted to all associated water supply and drain piping and to all venting or pressure sensing piping leading to gas-safe spaces.• Means shall be provided to prevent such loops from being emptied by vacuum.

•Gas-safe space is a space in which the entry of hydrocarbon gases would produce hazards with regard to flammability or toxicity.

9.7 Any water seal or equivalent device and all loop arrangements shall be capable of preventing the return of flammable vapors to an inert gas generator at a pressure equal to the test pressure of the cargo tanks.

9.8 The second device shall be a non-return valve or equivalent capable of preventing the return of vapors or liquids or both and fitted between the water seal (or the equivalent device) required in 5-9-A4/9.1 and the first connection from the inert gas main to a cargo tank. It shall be provided with positive means of closure. As an alternative to positive means of closure, an additional valve having such means of closure may be provided between the nonreturn valve and the first connection to the cargo tanks to isolate the water seal (or equivalent device).

9.9 As an additional safeguard against the possible leakage of flammable liquids or vapors back from the deck main, means shall be provided to permit this section of the line between the valve having positive means of closure referred to in 5-9-A4/9.8 and the valve referred to in 5-9-A4/8 to be vented in a safe manner when the first of these valves is closed.

10.1 The inert gas main may be divided into two or more branches between the nonreturn devices required by 5-9-A4/9.1 and the cargo tanks.

10.2 Inert gas supply mains shall be fitted with branch piping leading to each cargo tank designated for the carriage of flammable products required to be inerted by this Regulation. Each cargo tank containing or loading products not required to be inerted shall be separated from the inert gas main by:

10.2.1 removing spool-pieces, valves or other pipe sections, and blanking the pipe ends; or

10.2.2 arrangement of two spectacle flanges in series with provisions for detecting leakage into the pipe between the two spectacle flanges.

10.3 Means shall be provided to protect cargo tanks against the effect of overpressure or vacuum caused by thermal variations when the cargo tanks are isolated from the inert gas mains.

10.4 Piping systems shall be so designed as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

10.5 Suitable arrangements shall be provided to enable the inert gas main to be connected to an external supply of inert gas.

11 Unless the arrangements for venting of all vapors displaced from the cargo tanks during loading and ballasting comply with the requirements of the BCH and IBC Codes for controlled venting, such arrangements shall comply with regulation II-2/ 59.1 of SOLAS 1974 as amended and shall consist either of one or more mast risers or of a number of high velocity vents.

12 The arrangements for inerting, purging or gas-freeing of empty tanks as required in 5-9-A4/2 shall be to the satisfaction of the Administration and shall be such that the accumulation of hydrocarbon vapors in pockets formed by the internal structural members in a tank is minimized and that:

12.1 on individual cargo tanks the gas outlet pipe, if fitted, shall be positioned as far as practicable from the inert gas/air inlet and in accordance with regulation II-2/ 59.1.9.3 of the 1974 SOLAS Convention as amended, or 8.2.2.3 of the IBC Code. The inlet of such outlet pipes may be located either at deck level or at not more than 1 m above the bottom of the tank;

12.2 the cross-sectional area of such gas outlet pipe referred to in 5-9-A4/12.1 shall be such that an exit velocity of at least 20 m/sec can be maintained when any three tanks are being simultaneously supplied with inert gas. Their outlets shall extend not less than 2 m above deck level. When in accordance with 5-9-A4/3.1 an Administration permits a system designed to supply only one or two tanks simultaneously, the outlet pipes should be sized such that an exit velocity in the outlet pipes of 20 m/sec can be maintained;

12.3 each gas outlet referred to in 5-9-A4/12.2 shall be fitted with suitable blanking arrangements.

13 Means shall be provided for continuously indicating the temperature and pressure of the inert gas at the discharge side of the system, whenever it is operating.

14.1 Instrumentation shall be fitted for continuously indicating and permanently recording, when the inert gas is being supplied:

14.1.1 the pressure of the inert gas supply mains between the nonreturn devices required by 5-9-A4/9.1 and the cargo tanks; and

14.1.2 the oxygen content of the inert gas in the inert gas supply main.

14.2 The devices referred to in 5-9-A4/14.1 shall be placed in the cargo control room where provided. Where no cargo control room is provided, they shall be placed in a position easily accessible to the officer in charge of cargo operations.

14.3 In addition, meters shall be fitted:

14.3.1 in the navigating bridge to indicate at all times the pressure referred to in 5-9-A4/14.1.1; and

14.3.2 in the machinery control room or in the machinery space to indicate the oxygen content referred to in 5-9-A4/14.1.2.

15 Portable instruments for measuring oxygen and flammable vapor concentration shall be provided. In addition, suitable arrangement shall be made on each cargo tank such that the condition of the tank atmosphere can be determined using these portable instruments.

16 Suitable means shall be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments, referred to in 5-9-A4/14.1 and 5-9-A4/15.

17.1 Audible and visual alarms shall be provided to indicate:

17.1.1 low water pressure or low water flow rate to the cooling and scrubbing arrangement referred to in 5-9-A4/5.1;

17.1.2 low fuel supply;

17.1.3 high gas temperature as referred to in 5-9-A4/13;

17.1.4 failure of the power supply to the inert gas generators;

17.1.5 oxygen content in excess of 8 per cent by volumes as referred to in 5-9-A4/14.1.2;

17.1.6 failure of the power supply to the indicating devices as referred to in 5-9-A4/14.1 and to the automatic control systems for the gas regulating valve referred to in 5-9-A4/8 and the inert gas generator;

17.1.7 low water level in the water seal as referred to in 5-9-A4/9.1;

17.1.8 gas pressure less than 100 mm water gauge as referred to in 5-9-A4/14.1;

17.1.9 high gas pressure as referred to in 5-9-A4/14.1.1.

17.2 Automatic shutdown of the gas regulating valve and of the fuel oil supply to the inert gas generator shall be arranged on predetermined limits being reached in respect of 5-9-A4/17.1.1 and 5-9-A4/17.1.3.

17.3 Automatic shutdown of the gas regulating valve shall be arranged in respect of 5-9-A4/17.1.4.

17.4 In respect of 5-9-A4/17.1.5, when the oxygen content of the inert gas exceeds 8% by volume, immediate action shall be taken to improve the gas quality. Unless the quality of the inert gas improves, all operations in those tanks to which inert gas is being supplied shall be suspended so as to avoid air being drawn into the tanks. The deck isolation valve referred to in 5-9-A4/9.8 shall be closed and the off-specification gas shall be vented to atmosphere.

17.5 The alarms required in 5-9-A4/17.1.5, 5-9-A4/17.1.6 and 5-9-A4/17.1.8 shall be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew. All other alarms required by this Annex 5-9-A4 shall be audible to responsible members of the crew either as individual alarms or as a group alarm.

17.6 In respect of 5-9-A4/17.1.7 the Administration shall be satisfied as to the maintenance of an adequate reserve of water at all times and the integrity of the arrangements to permit the automatic formation of the water seal when the gas flow ceases. The audible and visual alarm on the low level of water in the water seal shall operate when the inert gas is not being supplied.

17.7 An audible alarm system independent of that required in 5-9-A4/17.1.8 or automatic shutdown of cargo pumps shall be provided to operate on predetermined limits of low pressure in the inert gas mains being reached.

18 Detailed instruction manuals shall be provided on board, covering the operations, safety and maintenance requirements and occupational health hazards relevant to the inert gas system and its application to the cargo tank system. The manuals shall include guidance on procedures to be followed in the event of a fault or failure of the inert gas system.

PART

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CHAPTER

10 Vessels Intended to Carry Vehicles

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PART

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CHAPTER 10 Vessels Intended to Carry Vehicles *(1999)*

SECTION 1 Introduction

1 General

1.1 Classification

1.1.1

In accordance with 1-1-3/3, the classification ✠ **A1 Vehicle Carrier** is to be assigned to vessels designed and primarily fitted for the carriage of vehicles and built to the requirements of Section 5-10-2 in this Chapter and other relevant sections of the Rules.

1.1.2

In accordance with 1-1-3/3, the classification ✠ **A1 Vehicle Passenger Ferry** is to be assigned to vessels designed and fitted for the carriage of both passengers and vehicles and built to the requirements of Section 5-10-3 in this Chapter and other relevant sections of the Rules.

Such vessels that carry more than twelve passengers on an international voyage or on a short international voyage are to have a Passenger Ship Safety Certificate from the Administration of registry, or its agent, evidencing the vessel's compliance with the requirements of the International Convention for the Safety of Life at Sea 1974, as amended.

1.3 Application

1.3.1

The requirements of Section 5-10-2 are intended to apply to vessels intended to carry roll-on/roll-off (ro-ro) cargoes (e.g., vehicles, cargoes in pallets or in containers and loaded and unloaded by wheeled vehicles, etc.) on exposed or enclosed single deck or multiple exposed/enclosed decks.

1.3.2

The requirements of Section 5-10-3 are intended to apply to vessels designed for passenger and/or vehicle ferry service. Such vessels are also to comply with the applicable safety requirements as specified in the ABS *Guide for Building and Classing Passenger Vessels*.

1.5 Scope

This Chapter is intended to cover the additional hull construction, machinery and safety equipment requirements to class a vessel as a vehicle carrier.

3 Definitions

3.1 Vehicle Carrier

A *Vehicle Carrier* is a vessel designed and fitted for the carriage of vehicles only.

3.3 Vehicle Passenger Ferry

A *Vehicle Passenger Ferry* is a vessel designed and fitted for the carriage of vehicles and more than twelve (12) passengers.

3.5 Ro-Ro Cargo Spaces

Ro-Ro Cargo Spaces are spaces not normally subdivided in any way and extending to either a substantial length or the entire length of the vessel in which goods [packaged or in bulk, in or on road cars, vehicles (including road tankers), trailer containers, pallets, demountable tanks or in or on similar stowage units or other receptacles] can be loaded and unloaded normally in horizontal direction.

3.7 Open Ro-Ro Cargo Spaces

Open Ro-Ro Cargo Spaces are ro-ro cargo spaces open at both ends or open at one end and provided with adequate natural ventilation effective over the entire length through permanent openings in the side plating or deck head to the satisfaction of the Administration.

3.9 Closed Ro-Ro Cargo Spaces

Closed Ro-Ro Cargo Spaces are ro-ro cargo spaces which are neither open ro-ro cargo spaces nor weather decks.

3.11 Weather Deck

A *Weather Deck* is a deck which is completely exposed to the weather from above and from at least two sides.

3.13 Special Category Spaces

Special Category Spaces are enclosed spaces above or below the bulkhead deck intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access.

PART

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CHAPTER 10 **Vessels Intended to Carry Vehicles** *(1999)*

SECTION 2 **Vehicle Carrier**

1 Longitudinal Strength

1.1 General

The longitudinal strength is to be in accordance with Section 3-2-1 in addition to the following.

The bottom shell and decks considered effective in calculating the longitudinal hull girder strength are generally to be longitudinally framed.

1.3 Bending Moment and Shear Force

1.3.1 Still Water Bending Moment and Shear Force

Still water bending moment and shear force calculations are to be submitted. These calculations are to be carried out for all anticipated loaded and ballast conditions. The distribution of lightship weight is also to be shown.

1.3.2 Wave-Induced Bending Moment and Shear Force

Wave-induced bending moment and shear force may be obtained from the equations in 3-2-1/3.5. Where the block coefficient is less than 0.60, the wave-induced bending moment and shear force are to be calculated using a block coefficient of 0.60.

1.3.3 Effect of Bowflare Slamming on Vertical Hull Girder Bending Moment and Shear Force

Where the vessel has considerable bow flare [e.g., a forebody parameter, $A_r d_k$ (see 5-5-3/11.3.3), greater than 70 m^2 (753 ft^2)], the effect of bowflare slamming on vertical hull girder bending moment and shear force is to be considered. Where a direct calculation for assessment of this effect is not available, the load factor, k_u, as specified in 5-5-3/11.3.3, may be used to obtain an approximate wave-induced bending moment ($k_u M_{ws}$) and shear force ($k_u F_{wp}$) with the effect of bowflare. The coefficient, k_u, is to be in association with wave-induced sagging moment and the coefficient, μ, in the equation is 5225 (2862) instead of 7475 (4094).

1.3.4 Total Bending Moment

The total bending moment is to be obtained as the maximum algebraic sum (see sign convention in 3-2-1/3.1) of still-water bending moment and wave-induced bending moment with effect of bowflare slamming.

Special consideration may be given to the minimum M_t under the condition given in 5-10-2/1.5.4 below.

1.5 Buckling Strength

1.5.1

All longitudinal structural members that may be subject to hull girder bending, whether or not they are included in the calculation of the hull girder section modulus, are to have their buckling strength assessed under 3-2-1/19 of the Rules.

1.5.2

Depending on the structural arrangement, the following members are to be checked for compressive stress due to longitudinal bending:

1.5.2(a) Decks and Longitudinal Bulkheads with Longitudinal Framing

Plating

Longitudinals and girders

1.5.2(b) Side Shell with Longitudinal Framing

Plating

Longitudinals and stringers

1.5.2(c) Side Shell with Transverse Framing

Plating

Stringers or longitudinal intercostals (if fitted)

1.5.2(d) Bottom Shell and Inner Bottom with Longitudinal Framing

Plating

Longitudinals and girders

1.5.3

Where longitudinally framed decks are not considered as an effective part of the hull girder, the plating need not comply with 3-2-1/19. Longitudinals of such decks are to comply with 3-2-1/19 and in determining the inertia, I_a, of the longitudinals, the effective width of the plating is not to be taken more than b_{wL}, as obtained from 5-10-2/1.5.3(a) below.

Transversely framed decks are not to be considered as an effective part of the hull girder. The plating need not comply with 3-2-1/19. Longitudinals of such decks are to comply with 3-2-1/19 and in determining the inertia, I_a, of the longitudinals, the effective width of the plating is not to be taken more than b_{wT}, as obtained from 5-10-2/1.5.3(b) below.

1.5.3(a) For long plate (compression on the short edges)

$$b_{wL} = C_e s$$

where

$$C = 2.25/\beta - 1.25/\beta^2 \quad \text{for } \beta \geq 1.25$$

$$= 1.0 \quad \text{for } \beta < 1.25$$

β = $(f_y/E)^{1/2}\, s/t$

s = frame or beam spacing, in mm (in.)

t = plate thickness, in mm (in.)

E = Young's modulus, in N/cm^2 (kgf/cm^2, lbf/in^2) for steel 2.06×10^7 (2.10×10^6, 30×10^6)

f_y = specified minimum yield point of the material, in N/cm^2 (kgf/cm^2, lbf/in^2)

1.5.3(b) For wide plate (compression on the long edges)

$$b_{wT}/\ell = C_e s/\ell + 0.115(1 - s/\ell)(1 + 1/\beta^2)^2 \leq 1.0$$

ℓ = spacing of transverses/girders

1.5.4

Where it can be shown that under all loading conditions the still water bending moment is hogging at any point along the length of the vessel, the minimum hogging still water bending moment at the location considered may be deducted from the sagging wave bending moment, but the resulting total bending moment is to be not less than $0.9M_{ws}$ unless the following applies.

This total bending moment (e.g., $M_t = 0.9M_{ws}$) may be further reduced, provided that a statistical analysis of wave-induced bending moment is carried out, taking into account the effect of the hull form including bow flare.

The distribution of the total bending moment (e.g., $M_t = 0.9M_{ws}$) may be obtained using the distribution factor, M, given in 3-2-1/Figure 2.

3 Loading Guidance

In addition to the conditions listed in 3-2-A2/Table 1 for vessels that hog in still water for all service conditions, the condition 1.3 is to include the condition from 5-10-2/1.5.4 in which the total bending moment is obtained by deducting the minimum hogging still-water bending moment from the sagging wave bending moment. This total bending moment, or $0.9M_{ws}$, if greater, is the limiting total bending moment for the buckling strength of the structure above the neutral axis.

5 Transverse Strength

5.1 General

Where transverse webs are supported by pillars, transverse web frames, partial bulkheads or complete bulkheads are to be fitted between the vehicle decks and superstructure decks. Longitudinal and transverse bulkheads are to be effectively developed below the vehicle and superstructure decks. The web frames are to comply with Section 3-2-6

The transverse webs, partial bulkheads or complete bulkheads above the lowest vehicle deck are to be arranged in way of transverse bulkheads and transverse webs under the lowest vehicle deck.

Where transverse webs are supported by pillars, longitudinal girders of the same depth as the transverses are to be arranged, under pillars, throughout the vehicle decks to distribute the vehicle wheel loads onto the adjacent transverse webs.

The transverse strength is to be assessed to determine the deflection and stresses.

5.3 Strength

All cargo conditions are to be investigated on the basis of the following:

5.3.1

Cargo load due to static and dynamic forces based on a roll angle of 30 degrees and a period of 10 seconds. Other values may be considered based on direct calculations.

5.3.2

Static sea pressure to the waterline in the heeled condition.

5.3.3

In general, the calculations are to be based on a 3D FEM analysis of the typical transverse structure of the vessel between two main transverse bulkheads.

Where deck girders are arranged as indicated in 5-10-2/5.1, assessment of the transverse strength of the structure at locations other than where the FEM analysis is carried out is to be based on the results of the FEM analysis, particularly with reference to the effectiveness of the longitudinal girders to evenly distribute the vehicle wheel loads onto the deck transverses.

5.3.4 Allowable stresses

Henky-von Mises	0.80 of the minimum yield strength of the material
Shear stress	0.37 of the minimum yield strength of the material (*)

* Higher shear stress may be acceptable, provided that resultant Henky-von Mises stress is within the allowable limit.

5.3.5

The effective width of deck plating to be used in determining the section modulus, and moment of inertia of the deck transverses is to comply with 5-10-2/11.7.1.

7 Bottom Structure

Bottom structures are to be in accordance with Section 3-2-4.

9 Side Construction

9.1 General

The side shell up to the strength deck is generally to be longitudinally framed. The shell plating and framing are to be in accordance with the following:

9.3 Shell Plating

Shell plating below the freeboard deck is to be in accordance with Section 3-2-2, where D_s is as given in 3-2-2/3.

Side shell plating for 2.3 m (7.5 ft) above the freeboard deck is to be in accordance with 3-2-2/3.9, however, 3-2-2/5.1 is not applicable. At the forward and after ends, the plating for 0.1L from each end may be of the thickness obtained from 3-2-2/5.7 and 3-2-2/5.9 for forecastle and poop side plating, respectively.

Side shell plating more than 2.3 m (7.5 ft) above the freeboard deck is to be not less than given by the following equation, but not to exceed that obtained from 3-2-2/5.9 aft of 0.25L from forward and 3-2-2/5.7 forward of 0.25L from forward.

$$t = (s/645)\sqrt{(L-15.2)(d/D_s)} + 1.5 \text{ mm} \qquad \text{for } L \le 305 \text{ m}$$

$$t = (s/828)\sqrt{(L+175)(d/D_s)} + 1.5 \text{ mm} \qquad \text{for } 305 \text{ m} < L \le 427 \text{ m}$$

$$t = (s/1170)\sqrt{(L-50)(d/D_s)} + 1.5 \text{ mm} \qquad \text{for } L \le 1000 \text{ ft}$$

$$t = (s/1500)\sqrt{(L+574)(d/D_s)} + 1.5 \text{ mm} \qquad \text{for } 1000 < L \le 1400 \text{ ft}$$

where

L = length of vessel, as defined in 3-1-1/3.1, in m (ft)

d = molded draft, as defined in 3-1-1/9, in m (ft)

D_s = molded depth, in m (ft), as defined in 3-2-2/3.1 through 3-2-2/3.7

s = spacing of transverse frames or longitudinals, in mm (in.)

9.5 Side Framing

Side framing below the bulkhead or freeboard deck is to be in accordance with Section 3-2-5.

Transverse framing in the first tween deck above the bulkhead or freeboard deck is to be in accordance with 3-2-5/5.3, Type A frame requirements.

Longitudinal framing in the first tween deck above the bulkhead or freeboard deck is to be in accordance with 3-2-5/5.3, Type A frame requirements, where ℓ and s are, respectively, the spacing of the side vertical webs and the spacing of the longitudinals.

Side framing in the second and higher tween decks above the bulkhead or freeboard deck is to be in accordance with 3-2-11/3.5, but need not exceed that obtained from 3-2-5/5.3, Type A frame requirements.

11 Deck Structure

11.1 General

Vehicle loading arrangement plans showing vehicle positions and dimensions, wheel load and wheel imprint data, and lashing plan are to be submitted. The requirements are based on the vehicles having rubber tires.

11.3 Deck Plating

11.3.1 Strength Deck

The plating is to be longitudinally framed and is to be not less than the value given in equation 2a of 3-2-3/Table 2 or as required by this section.

11.3.2 Vehicle Decks

The plating is to be longitudinally framed and is to be not less thickness than given in 3-2-3/5.7 and 3-2-3/5.17. Wheel loads, imprint sizes, vehicle dimensions and clearance are to be shown on plans. In the equation $t = kKn\sqrt{CW}$, the factor K may be obtained from the following:

$$K = [21.99 + 0.316(a/s)^2 - 5.328(a/s) + 2.6(a/s)(b/s) - 0.895(b/s)^2 - 7.624(b/s)]10^{-2}$$

where

k = 8.05 (25.2, 1)

n = 1.0 where $\ell/s \geq 2.0$ and 0.85 where $\ell/s \geq 1.0$, for intermediate values of ℓ/s, n is to be obtained by interpolation

C = 1.5 for wheel loads of vehicles stowed at sea and

1.1 for vehicles operating in port

W = static wheel load, in kN (tf, Ltf)

a = the wheel imprint dimension, in mm (in.), parallel to the longer edge, ℓ, of the plate panel, and in general, the lesser wheel imprint dimension

b = the wheel imprint dimension, in mm (in.), perpendicular to the longer edge, ℓ, of the plate panel, and in general, the larger wheel imprint dimension

s = the spacing of deck beams or deck longitudinals, in mm (in.)

ℓ = the length of the plate panel, in m (in.)

If the deck is to be considered an effective part of the hull girder, the plating is to comply with the buckling requirements of 3-2-1/19. The thickness is to be not less than 4.5 mm (0.18 in.).

11.3.3 Accommodation Deck

See 3-2-3/5.

11.5 Deck Longitudinals and Beams

The scantlings of longitudinals and beams of the vehicle decks are to be based on the specified static wheel loads or the specified uniform deck design load, whichever is greater.

Longitudinals subject to wheel loads are to be calculated as a continuous beam – three equal spans. The allowable stresses are to be as given in 3-2-7/5. For the vehicle used only in port, the allowable stresses of 80% of yield may be used.

For crew and passenger accommodation spaces, see 2/15.5 of the *Guide for Building and Classing Passenger Vessels*.

The deck longitudinals of all strength decks are to comply with the buckling requirements of 3-2-1/19.

11.7 Deck Girders and Deck Transverses

11.7.1 Strength

The scantlings of deck transverses and girders are to be based on the specified uniform vehicle deck design loading, or for the vehicle static wheel loading on each transverse, whichever is greater. For uniform load, the section modulus is to be not less than the values given by 3-2-8/5.3 and 3-2-8/5.5. The scantlings of the transverses and girders under wheel loads may be calculated assuming fixed end conditions. For allowable stresses, see 3-2-7/Table 2.

For crew accommodations, see 3-2-7/3.

Where the buckling strength of deck plating is not sufficient, the effective width of deck plating to be used in determining the section modulus and moment of inertia of deck transverses and deck girders is not to be taken more than given in 3-1-2/13.3 or than given below:

	Longitudinally framed deck	*Transversely framed deck*
Deck transverse	b_{WT} in 5-10-2/1.5.3(b)	b_{WL} in 5-10-2/1.5.3(a)
Deck girder	b_{WL} in 5-10-2/1.5.3(a)	b_{WT} in 5-10-2/1.5.3(b)

11.7.2 Stiffness

The deflection of the members is not to be more than 0.00182ℓ, where ℓ is the unsupported span of the member. The deflection is to be calculated for the specified uniform deck design load assuming fixed end conditions.

The scantlings of girders and transverses and beams loaded with vehicles may also be determined by direct engineering analysis.

11.9 Pillars

Pillars are to be in accordance with Section 3-2-8. Where the pillars support vehicle decks, they are to be based on the uniform vehicle deck design load or on the resulting individual vehicle loads from the structure supported by the pillar, whichever is greater.

Where possible, pillars above the lowest vehicle deck are to be in line with those under the lowest vehicle deck. Where not possible, the bending strength and shear strength of the transverses and girders are to be based on the uniform vehicle deck design loads, or the individual vehicle wheel loads of the deck they support, whichever is greater, plus the pillar loads that the deck transverse or girder supports.

11.11 Retractable Decks

Plate thickness and scantlings of the stiffeners are to be not less than the value given by 3-2-3/5.15.

11.13 Lashing Points

Vehicle decks are to have a sufficient number of lashing points that are to be supported by the deck structure or specially arranged headers. The loads on the lashing points are to be not less than 200 kN (20,400 kg, 20 tons) or the rated breaking strength of the lashing point fitting, whichever is greater. These loads are for one securing device; where more than one securing device is to be attached to a lashing point, the load is to be increased proportionately. The deck strength member is to have a section modulus, *SM*, not less than that obtained from the following equation:

$SM = M/f$ cm^2 (in^2)

M = maximum bending moment due to lashing load, in kN-cm (kgf-cm, tonf-in)

f = design stress given below

The sectional area of the web of the deck structural member, *A*, is to be not less than that obtained from the following equation:

$$A = \frac{F}{\tau} \quad \text{cm}^2\ (\text{in}^2)$$

F = maximum shear force due to lashing load, in kN (kgf, tons)

τ = design stress given below

normal or bending stress (f): $1.0Y$

shear stress (τ): $0.56Y$

Y = minimum yield strength of material, as defined in 2-1-1/13, or 72% of the specified minimum tensile strength, whichever is lesser, kN/cm^2 (kgf/cm^2, $tons/in^2$)

11.15 Hatch Covers

Plate thickness and scantlings of the stiffeners are not to be less than the values given by 3-2-15/13.7 and 3-2-15/13.5.

11.17 Vehicle Ramps

11.17.1 General

Ramps used for the loading and unloading of vehicles are to have plating thickness not less than the value given by 3-2-3/5.7 and 3-2-3/5.17. A Cargo Gear Certificate will be issued for a ramp in full compliance with the following requirements.

11.17.2 Operating Condition

During the loading and unloading of vehicles, the vessel is not to heel more than 5° in relation to the dock. This is presumed for plan approval, and it is to be verified by operating personnel prior to loading and unloading that the end of the ramp in contact with the dock bears on the dock for the full width of the ramp.

Where these operating conditions cannot be attained, design is to be based on one corner of the ramp being supported by the dock.

Special consideration will be given where the shoreside end of the ramp is supported by a floating structure.

11.17.3 Strength

The scantlings of the stiffeners are to be calculated assuming the ends simply supported and with an allowable bending stress of 0.6 yield and shear of 0.4 yield. Where ramps are also used as doors, the plating thickness is to be not less than the value calculated for side shell plating using the ramp stiffener spacing, but in no case less than the minimum required side shell plate at the same location.

11.19 Bow Doors, Inner Doors, Side Shell Doors and Stern Doors

The arrangement and construction of bow doors, inner doors, side shell doors and stern doors are to comply with the requirements of 3-2-16/3.

11.21 Protection from Damage Caused by Vehicles

Casings, ventilators, vent ducts and pipes, etc. that pierce the bulkhead deck and extend watertight into vehicle space are to be protected from damage caused by vehicles.

13 Fore-end Strengthening

13.1 General

The structural configurations, plating and framing systems in the fore-end area located beyond 0.4L amidships are to comply with the applicable requirements in 3-2-4/13, 3-2-5/7, 3-2-6/5, 3-2-7/3, 3-2-2/5 and 3-2-3/5.

13.3 Structure Strengthening for Impact Loads

In addition to 5-10-2/13.1, appropriate strengthening is to be considered in the design of hull structure in the fore-end areas where the hull structure is subject to impact loads (e.g., bottom and bowflare slamming). The hull structure scantlings in the fore-end areas may be assessed in accordance with 5-5-6/23 when a direct calculation of impact loads is not available.

15 Higher Strength Material

Where the top or bottom flange of the hull girder, or both, is constructed of higher-strength material, the requirements of 3-2-1/5 are to apply.

Deck plating of higher-strength material is to be in accordance with 3-2-3/7.

Where deck longitudinals, deck transverses or deck girders are of higher-strength material, the required section modulus, SM_{hts}, is to be not less than that obtained from the following equation:

$$SM_{hts} = SM_{ms} \cdot q \qquad \text{cm}^3 \text{ (in}^3\text{)}$$

where

SM_{ms} = required section modulus for ordinary strength steel, cm^3 (in^3)

q = 235/Y N/mm^2 (24/Y kgf/mm^2, 24,000/Y psi)

Y = specified minimum yield point or yield strength of the higher-strength material, in N/mm^2 (kgf/mm^2, psi), as defined in 2-1-1/13, or 72% of the specified minimum tensile strength, whichever is lesser

Deck plating to which higher-strength material deck longitudinals, deck transverses or deck girders are attached is to be of the same higher-strength material.

The deflection of deck transverses and deck girders is not to be more than 0.00182ℓ, where ℓ is the unsupported span of the member. The deflection is to be calculated for the specified uniform deck design load assuming fixed end conditions.

Where deck transverses and girders are not of the same strength material, the web and face bar of the higher strength material member are to be continuous in way of intersections. At intersections, the face bars of each member are to be the same thickness, a local thicker face bar is to be provided for members having thinner face bars clear of the intersection.

17 Ventilation and Electrical Equipment in Ro-Ro Cargo Spaces

Ro-ro cargo spaces are to comply with the requirements in 5-10-4/3.5 and 5-10-4/3.7.

19 Fire Detection and Extinguishing Arrangements in Ro-Ro Cargo Spaces

Ro-ro cargo spaces are to comply with 5-10-4/3.1 and 5-10-4/3.3.

21 Carriage of Dangerous Goods

Vessels carrying dangerous goods are to comply with Chapter II-2, Regulation 54 of the International Convention for the Safety of Life at Sea (SOLAS) 1974 and Amendments in force.

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PART

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CHAPTER **10 Vessels Intended to Carry Vehicles** *(1999)*

SECTION **3 Vehicle Passenger Ferry**

1 General

1.1 Passenger Ship Safety Certificates

See 1/1.7 of the *Guide for Building and Classing Passenger Vessels*.

1.3 Independent Review

See 1/1.9 of the *Guide for Building and Classing Passenger Vessels*.

1.5 Administration Approval

See 1/1.11 of the *Guide for Building and Classing Passenger Vessels*.

3 Hull Scantlings

The scantlings of the hull are generally to be in accordance with Section 5-10-2 of this Chapter, Sections in Part 3 and other applicable Sections of the Rules, which may be modified in accordance with the following paragraphs.

3.1 Rudders and Steering Gear

Rudders and steering gear are to be in accordance with Section 3-2-14 and Section 4-3-4. The steering gear is to be trial-tested in accordance with 4-3-4/21.7, 4-3-4/23.3 and 4-3-4/25.7.

3.3 Bottom Structures

The bottom structures are also to be in accordance with 2/5 of the *Guide for Building and Classing Passenger Vessels*.

3.5 Deck Plating

3.5.1 Passenger Deck

See 2/15.1 of the *Guide for Building and Classing Passenger Vessels*.

3.5.2 Train Deck

Decks used for the transport of railroad cars will be specially considered.

3.7 Deck Longitudinals and Beams

See 2/15.5 of the *Guide for Building and Classing Passenger Vessels*.

3.9 Pillars

In addition to the requirements in 5-10-2/11.9, pillars are to be arranged at regular intervals under the lowest vehicle deck, considering the need to minimize vibration.

PART

5

CHAPTER 10 Vessels Intended to Carry Vehicles

SECTION 4 Cargo Safety

1 Application

Provisions of Part 5, Chapter 10, Section 4 (referred to as Section 5-10-4) apply to vessels fitted with ro-ro cargo spaces, which may be utilized to carry cargoes and vehicles with fuel in their tanks for their own propulsion. Ro-ro cargo spaces are spaces not normally subdivided in any way and extending to either a substantial length or the entire length of the vessel in which goods (packaged or in bulk, in or on rail or road cars, vehicles (including rail or road tankers), trailers, containers, pallets, demountable tanks, etc.) can be loaded or unloaded normally in a horizontal direction.

Requirements for cargo spaces, other than ro-ro cargo spaces, intended for the carriage of vehicles with fuel in their tanks are also covered in this section.

The provisions of 4-1-1/1.5, specifying conditions for assigning the machinery class notation **AMS**, are applicable to vehicle carriers and vessels fitted with ro-ro cargo spaces in addition to the provisions of this section.

3 Ro-Ro Cargo Spaces

3.1 Fire Detection

A fixed fire detection and fire alarm system complying with the requirements of 4-7-3/11 is to be fitted. The fixed fire detection system is to be capable of rapidly detecting the onset of fire. The type of fire detectors and their spacing and location are to be submitted for review in each case and are to take into account the effects of ventilation and other relevant factors. After being installed, the system is to be tested under normal ventilation conditions and is to give a satisfactory response time.

3.3 Fire Extinguishing Arrangements

3.3.1 Ro-Ro Spaces Capable of Being Sealed

3.3.1(a) Fixed gas fire-extinguishing system. Ro-ro cargo spaces capable of being sealed are to be fitted with a fixed gas fire-extinguishing system complying with the provisions of 4-7-3/3, except that:

if aCO_2 system is fitted, the quantity of gas available is to be at least sufficient to give a minimum volume of free gas equal to 45% of the gross volume of the largest such cargo space which is capable of being sealed, and the arrangements are to be such as to ensure that at least two thirds of the gas required for the relevant space can be introduced within 10 minutes;

any other fixed gas fire-extinguishing system or fixed high expansion foam fire extinguishing system may be fitted, provided that an equivalent protection is achieved.

3.3.1(b) Fixed pressure water-spray system. (2002) As an alternative to 5-10-4/3.3.1(a), a fixed pressure water-spray system complying with the provisions of SOLAS Reg II-2/37.1.3, and designed for manual operation may be fitted. However, the drainage and pumping arrangements are to be such as to prevent the build-up of free surfaces. If this is not possible, the adverse effect upon the stability of the added weight and free surface of water is to be taken into account in the approval of the stability information. Reference is made to IMO Resolution A.123(V) *Recommendation on Fixed Fire-Extinguishing Systems for Special Category Spaces*, and IMO MSC/Circ. 914 *Guidelines for the approval of alternative fixed water-based fire-fighting systems for special category services*.

3.3.2 Ro-Ro Spaces Not Capable of Being Sealed

Ro-ro spaces not capable of being sealed are to be fitted with a fixed pressure water-spray system complying with the provisions of 5-10-4/3.3.1(b).

3.3.3 Portable Extinguishers

At least one portable extinguisher is to be provided at each access to any ro-ro cargo space. In addition, at each vehicle deck level where vehicles with fuel in their tanks are carried, sufficient portable extinguishers suitable for fighting oil fires are to be provided such that they are not more than 20 m (65 ft) apart on both sides of the vessel. The one located at the access may be credited for this purpose.

3.3.4 Water Fog and Foam Applicators

Each ro-ro cargo space intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion is, in addition to the foregoing, as applicable, to be provided with:

at least three water fog applicators;

one portable foam applicator unit complying with the provisions of 4-7-3/15.3, provided that at least two such units are available in the vessel for use in such ro-ro cargo spaces.

3.3.5 Ro-Ro Cargo Spaces Intended to Carry Dangerous Goods

3.3.5(a) Separation of ro-ro cargo spaces. In applying the requirements of 5-10-4/3.3.5(b), the following Rules for separation of ro-ro cargo spaces are to be complied with:

A separation is to be provided between a closed ro-ro cargo space and an adjacent open ro-ro cargo space. The separation is to be such as to minimize the passage of dangerous vapors and liquids between these spaces. Alternatively, such separation need not be provided if the ro-ro cargo space is considered a closed cargo space over its entire length and is to fully comply with the relevant special requirements of 5-10-4/3.

A separation is to be provided between a closed ro-ro cargo space and the adjacent weather deck. The separation is to be such as to minimize the passage of dangerous vapors and liquids between the two spaces. Alternatively, a separation need not be provided if the arrangements of the closed ro-ro cargo spaces are in accordance with those required for dangerous goods carried on the adjacent weather deck.

3.3.5(b) Requirements. In addition to complying with the foregoing requirements, as applicable, ro-ro cargo spaces intended for the carriage of dangerous goods are to comply with the following tabulated requirements, except when carrying dangerous goods in limited quantities (as defined in section 18 of the General Introduction of *IMDG Code*):

5-10-4/Table 1 provides a description of the list of dangerous goods, as defined in *IMDG Code*.

5-10-4/Table 2 provides the application of the requirements described in 4-7-2/7.3 to different ro-ro cargo spaces.

5-10-4/Table 3 provides the application of the requirements described in 4-7-2/7.3 to the different classes of dangerous goods, except solid dangerous goods in bulk.

3.5 Ventilation Systems

3.5.1 Capacity

Closed ro-ro spaces are to be provided with an effective power ventilation system sufficient to provide at least six air changes per hour based on an empty hold.

3.5.2 Operation of the Ventilation System

Ventilation fans are normally to be run continuously whenever vehicles are onboard. Where this is impracticable, they are to be operated for a limited period daily as weather permits and in any case for a reasonable period prior to discharge, after which period the ro-ro space is to be proved gas-free. One or more portable combustible gas detecting instruments are to be carried onboard for this purpose.

3.5.3 Arrangements of the Ventilation System

The ventilation system of the ro-ro cargo space is to be entirely separate from other ventilation systems. Ventilation ducts serving ro-ro cargo spaces capable of being effectively sealed are to be separated for each cargo space. The ventilation is to be so arranged as to prevent air stratification and the formation of air pockets. Inlets for exhaust ducts are to be located within 450 mm (17.75 in.) above the vehicle deck. Outlets are to be located in a safe position, having regard to sources of ignition near the outlets. Ventilation ducts, including dampers, are to be of steel or equivalent. See also 5-10-4/3.7.2(c).

3.5.4 Control of the Ventilation System

The ventilation system is to be capable of being controlled from a position outside of the ro-ro cargo spaces. Means are to be provided to indicate any loss of the required ventilation capacity on the navigation bridge. Arrangements are to be provided to permit a rapid shutdown and effective closure of the ventilation system in case of fire, taking into account the weather and sea conditions.

3.5.5 Ro-Ro Cargo Spaces Intended to Carry Dangerous Goods

Ro-ro cargo spaces intended to carry dangerous goods are to have a ventilation system complying with 4-7-2/7.3.4. See 5-10-4/3.3.5, 5-10-4/Table 2 and 5-10-4/Table 3.

TABLE 1
Dangerous Goods Classes

Class	*Substance*
1 (1.1 through 1.6)	Explosives
2.1	Flammable gases (compressed, liquefied or dissolved under pressure)
2.2	Non flammable gases (compressed, liquefied or dissolved under pressure)
2.3	Toxic gases
3 (3.1 through 3.3)	Flammable liquids
4.1	Flammable solids
4.2	Substances liable to spontaneous combustion
4.3	Substances which, in contact with water, emit flammable gases
5.1	Oxidizing substances
5.2	Organic peroxides
6.1	Toxic substances
6.2	Infectious substances
7	Radioactive materials
8	Corrosives
9	Miscellaneous dangerous substances and articles, that is, any substance which experience has shown, or may show, to be of such a dangerous character that the provisions for dangerous substance transportation are to be applied.

TABLE 2
Application of Requirements to Different Ro-Ro Cargo Spaces

		Ro-Ro spaces		
4-7-2/...	*Requirements*	*Closed* [(1)]	*Open* [(2)]	*Weather deck* [(3)]
7.3.1(a)	Availability of water	x	x	x
7.3.1(b)	Quantity of water	x	x	x
7.3.1(c)	Underdeck cargo space cooling	x	x	-
7.3.1(d)	Alternative to cooling by water	x	x	-
7.3.2	Sources of ignition	x	x	-
7.3.3	Detection system	x	-	-
7.3.4	Ventilation	x	-	-
7.3.5	Bilge pumping	x	-	-
7.3.6	Personnel protection	x	x	x
7.3.7	Portable fire extinguisher	-	x	x
7.3.8	Insulation of machinery space boundary	x	x	x
7.3.9	Water-spray system	x [(4)]	x	-

Notes

1 Closed ro-ro spaces are ro-ro cargo spaces which are neither open ro-ro spaces nor weather decks.

2 Open ro-ro cargo spaces are ro-ro cargo spaces either open at both ends, or open at one end and provided with adequate natural ventilation effective over their entire length through permanent openings in the side plating or deckhead.

3 Weather deck is a deck which is completely exposed to the weather from above and from at least two sides.

4 Apply only to closed ro-ro cargo spaces not capable of being sealed.

TABLE 3
Application of the Requirements in 4-7-2/7.3 to Different Classes of Dangerous Goods Except Solid Dangerous Goods in Bulk

Dangerous goods class	*4-7-2/paragraph:*												
	7.3.1				*7.3.2*	*7.3.3*	*7.3.4*		*7.3.5*	*7.3.6*	*7.3.7*	*7.3.8*	*7.3.9*
	(a)	*(b)*	*(c)*	*(d)*			*(a)*	*(b)*					
1.1 – 1.6	x	x	x	x	x	x						x [2]	x
1.4S	x	x				x							x
2.1	x	x			x	x	x	x		x		x	x
2.2	x	x				x				x		x	x
2.3	x	x				x	x			x		x	x
3.1, 3.2	x	x			x	x	x	x	x	x	x	x	x
3.3	x	x				x				x	x	x	x
4.1	x	x				x	x [1]			x	x	x	x
4.2	x	x				x	x [1]			x	x	x	x
4.3	x	x				x	x			x	x	x	x
5.1	x	x				x	x [1]			x	x	x [3]	x
5.2	x	x								x			x
6.1 liquids	x	x				x			x	x			x
6.1 liquids ≤23°C	x	x			x	x	x	x	x	x	x	x	x
6.1 liquids >23°C ≤61°C	x	x				x	x	x	x	x	x	x	x
6.1 solids	x	x				x	x [1]			x			x
8 liquids	x	x				x				x			x
8 liquids ≤23°C	x	x			x	x	x	x	x	x	x	x	x
8 liquids >23°C ≤61°C	x	x				x	x	x		x	x	x	x
8 solids	x	x				x				x			x
9	x						x [1]			x [4]			x

Notes

1 When ''mechanically ventilated spaces'' are required by the *IMDG Code*, as amended.

2 Stow 3 m (10 ft) horizontally away from the machinery space boundaries in all cases.

3 Refer to the *IMDG Code*.

4 As appropriate to the goods being carried.

3.7 Electrical Installations in Ro-Ro Cargo Spaces

3.7.1 Application

These requirements are additional to, or modifying that of Section 4-8-1 through Section 4-8-4, as appropriate.

3.7.2 Ro-Ro Cargo Spaces Intended to Carry Vehicles with Fuel in Their Tanks

3.7.2(a) Hazardous areas. Areas where flammable or explosive gases, vapors or dust are normally present or likely to be present are known as hazardous areas. Closed ro-ro cargo spaces carrying motor vehicles with fuel in their tanks for their own propulsion are to be regarded as hazardous areas. Electrical equipment and wiring, except where permitted otherwise in 5-10-4/3.7.2(b) below, are to be of the types certified safe and suitable for use in flammable petrol and air mixture. Specifically, the following certified safe equipment may be used:

intrinsically safe type (Ex ia and ib);

flame proof type (Ex d Group IIA T3);

pressurized or purged type (Ex p); and

increased safety type (Ex e).

3.7.2(b) Alternative electrical equipment. Electrical equipment of a type so enclosed and protected as to prevent the escape of sparks, e.g., protection degree of IP55 or equivalent, is permitted in cargo spaces:

above a height of 450 mm (17.75 in.) from vehicle deck, and

above a height of 450 mm (17.75 in.) from vehicle platform, if fitted, except platforms which may be invaded by petrol vapor from a perforated vehicle platform above.

In such cases, the ventilation system is to be so designed and operated as to provide continuous ventilation of the cargo spaces at the rate of at least ten air changes per hour whenever vehicles are onboard.

3.7.2(c) Exhaust ventilation duct. Electrical equipment and wiring in an exhaust ventilation duct is to be of a type certified safe for use in explosive petrol and air mixtures (see 5-10-4/3.7.2(a) above), and the outlet from any exhaust duct is to be sited in a safe location, having regard to other possible sources of ignition. Exhaust fans are to be of non-sparking construction complying with 4-8-3/11.

3.7.3 Ro-Ro Cargo Spaces Intended to Carry Dangerous Goods

Ro-ro cargo spaces intended to carry dangerous goods are not to be fitted with electrical equipment, unless it is essential for operational purposes. Where fitted, the provisions of 4-7-2/7.3.2 are to be complied with; see 5-10-4/3.3.5, 5-10-4/Table 2 and 5-10-4/Table 3.

3.9 Drainage or Bilge Pumping of Ro-Ro Cargo Spaces

3.9.1 Application

Where a gravity drain system is fitted, the system is to comply with the provisions of 4-6-4/3. Where a bilge pumping system is fitted, the system is to comply with the provisions of 4-6-4/5.

3.9.2 Ro-Ro Cargo Spaces Intended to Carry Vehicles with Fuel in Their Tanks

Gravity drains from ro-ro cargo spaces carrying motor vehicles with fuel in their tanks for their own propulsion are not to be led to machinery or other spaces where sources of ignition may be present.

3.9.3 Ro-Ro Cargo Spaces Intended to Carry Dangerous Goods

3.9.3(a) Flammable and toxic substances. Enclosed ro-ro cargo spaces intended to carry flammable or toxic dangerous goods are to be designed to ensure against the pumping of such liquids through machinery space piping or pumps; see 5-10-4/Table 2 and 5-10-4/Table 3, and also of 4-7-2/7.3.5.

3.9.3(b) Explosives. Enclosed ro-ro cargo spaces intended to carry explosives, for which the provisions for either cooling or flooding of the space by copious quantities of water is required, the bilge pumping arrangements are to be such as to prevent the build-up of free surfaces. If this is not possible, the adverse effect upon the stability of the added weight and the free surface of water is to be taken into account in the approval of the vessel's stability information. See 5-10-4/Table 2 and 5-10-4/Table 3, and of 4-7-2/7.3.1(c) and 4-7-2/7.3.1(d).

3.9.4 Ro-Ro Cargo Spaces Fitted with Water-spray System

Ro-ro cargo spaces fitted with fixed pressure water-spray systems are to have drainage or bilge pumping arrangements complying with the requirements of 5-10-4/3.3.1(b).

3.11 Permanent Opening in Ro-Ro Cargo Spaces

Permanent openings in the side plating, the ends or deckhead of open and closed ro-ro cargo spaces are to be so situated that a fire in the cargo space does not endanger stowage areas and embarkation stations for survival craft and accommodation spaces, service spaces and control stations in superstructures and deckhouses above the cargo spaces.

5 Cargo Spaces, Other Than Ro-Ro Cargo Spaces, Intended to Carry Vehicles with Fuel in Their Tanks

Cargo spaces, other than ro-ro cargo spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, are to comply with the provisions of 5-10-4/3, except that in lieu of 5-10-4/3.1, a sample extraction smoke detection system complying with the provisions of 4-7-3/13 may be permitted and 5-10-4/3.3.4 may be omitted.

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