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REVISED GUIDANCE ON THE CONTINUED USE OF EXISTING IMO TYPE PORTABLE TANKS AND ROAD TANK VEHICLES FOR THE TRANSPORT OF DANGEROUS GOODS

1 The United Nations Committee of Experts on the Transport of Dangerous Goods (CETDG), at its eighteenth session in December 1996, adopted a new edition of the United Nations Recommendations on the Transport of Dangerous Goods (Model Regulations), which contain a series of recommendations for the revision of the provisions for the design, construction, inspection, testing, certification, retesting and use of portable tanks.

2 The revised recommendations for portable tanks represented a major overhaul of the provisions included in the Model Regulations agreed in 1970s. These recommendations reflect the introduction of a system of specifying suitable portable tank instructions for those entries in the Dangerous Goods List of the Model Regulations, where multi-modal transport should be permitted by a portable tank instruction (T-instruction). In certain instances, the T-instructions are modified and extended by portable tank special provisions (TP).

3 As a result, the recommendations for portable tanks were included in chapter 4.2 concerning their use and chapter 6.7 on their design and construction, as contained in the 10th revised edition of Model Regulations (June 1997).

4 Subsequently, the CETDG invited all dangerous goods regulators, whether for international or domestic transport, to base their legal instruments on that edition of the Model Regulations.

5 Consequently, the Maritime Safety Committee (MSC), at its seventy-second session (17 to 26 May 2000), adopted amendment 30-00 to the IMDG Code, introducing the new provisions for the construction and use of UN portable tanks, based on the 10th revised edition of the UN Model Regulations. In addition, the harmonized IMDG Code took into account further amendments included in the 11th revised edition of the Model Regulation published in 1999.

6 The Sub-Committee on Dangerous Goods, Solid Cargoes and Containers, at its fourth session (September 1999), noting the significant changes to the provisions concerning existing IMO type portable tanks as contained in amendment 29-98 of the IMDG Code, considered whether the continued use of the portable tanks should be permitted and, if so, under what provisions.

7 As a result, the Sub-Committee agreed to certain transitional arrangements for existing IMO portable tanks as follows:

.1 during the period from 2000 to 2002, manufacturers of portable tanks could continue to produce IMO portable tanks in accordance with amendment 29-98;

.2 until the end of 2009, portable tanks of an alternative technical specification (T-instruction) than that recommended in the Model Regulations could continue to be used for certain dangerous goods; and

.3 IMO tanks built prior to 2003 may be used until the end of their life if such tanks are in compliance with periodic inspection and test provisions.

8 Where an alternative specification portable tank was allowed during the period up to the end of 2009, an alternative T-instruction was given in column (12) of the Dangerous Goods List (DGL) of the provisions set out in 3.2.1 of the IMDG Code. All those alternative T-instructions were deleted from that column of the DGL in amendment 34-08 of the IMDG Code in anticipation of the end of this transitional period. From 2010 onwards, both IMO portable tanks and UN portable tanks must be offered in accordance with the T-instruction specified in column (13) of the DGL.

9 The Maritime Safety Committee, at its sixty-ninth session (11 to 20 May 1998) agreed that existing IMO type portable tanks and road tank vehicles may continue to be used until the end of their life on the condition that they successfully pass the periodic inspections and tests as described in the Code. However, the detailed provisions for such tanks, which were contained in section 13 of amendment 29-98 of the Code, were not included in subsequent amendments to the Code.

10 In this context, the DSC Sub-Committee, at its eighth session (22 to 26 September 2003), noting that the IMDG Code amendment 31-02 would attain mandatory status from 1 January 2004, developed the guidance as contained in DSC/Circ.12, reproducing the construction provisions applicable to IMO portable tanks and road tank vehicles.

11 Recognizing that IMO portable tanks, road tank vehicles and UN portable tanks should be taken out of service for the transport of dangerous goods when they are no longer capable of passing a 2.5-year intermediate inspection and test or a 5-year inspection and test. It was accepted that IMO portable tanks and road tank vehicles would continue in use for many years to come and that there was no reason to deny their continued use while they remain safe.

12 In the case that further revisions to the recommendations for the construction and use of portable tanks were to be included in future editions of the UN Model Regulations, these would have to be introduced, if applicable, in the IMDG Code, when amended. Therefore, where these provisions affect the T-instruction allocated to individual entries in 3.2.1, transitional arrangements for the continued use of the previously allocated T-instruction may be indicated by the use of additional portable tank special provisions (TP).

13 The CCC Sub-Committee, at its second session (14 to 18 September 2015), taking into account the above, in particular paragraph 12, agreed to the *Revised guidance on the continued use of existing IMO type portable tanks and road tank vehicles for the transport of dangerous goods*, as set out in the annex.

14 Member Governments are invited to bring the revised guidance to the attention of tank owners and operators, shipowners, ship operators, companies, seafarers, inspecting and certifying authorities, consignors and shippers, and all other parties concerned with the transport of dangerous goods in packaged form by sea.

15 This circular supersedes DSC/Circ.12.

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ANNEX

REVISED GUIDANCE ON THE CONTINUED USE OF EXISTING IMO TYPE PORTABLE TANKS AND ROAD TANK VEHICLES FOR THE TRANSPORT OF DANGEROUS GOODS*

Contents:

Section 1 – Introduction

The purpose of this circular is to enable tank manufacturers, owners, operators, consignors, certifying and inspection authorities, and others engaged in the transport of dangerous goods in IMO type portable tanks and road tank vehicles designed, constructed and approved before 1 January 2003 to meet their duties.

The main objective is to clarify the use of such tanks taking into account their construction provisions, which are given in section 3 of this circular.

The provisions of this circular apply to IMO Type 1, 2, 5 and 7 portable tanks and IMO Type 4, 6 and 8 road tank vehicles.

However, this circular does not apply to IMO type 4, 6 and 8 road tank vehicles that have been designed, constructed and approved in accordance with chapter 6.8 from amendment 30-00 of the Code onwards.

Definitions of the IMO tank types can be found in the **Note** to paragraph 4.2.0 of the Code.

Portable tanks designed, constructed, and approved in accordance with chapters 4.2 and 6.7 of the Code are referred to as UN portable tanks in this circular.

Section 2 – Continued use of IMO type portable tanks and road tank vehicles

2.1 Introduction

This guidance applies to IMO type portable tanks and road tank vehicles on long international voyages approved prior to the entry into force of amendment 30-00 of the Code. The provisions of chapter 6.8 of the Code as amended apply to IMO road tank vehicles approved on or after 1 January 2002.

The purpose of this section is to clarify the application of the T-instructions and the portable tank special provisions (TP) to IMO portable tanks and road tank vehicles with respect to their design and construction provisions set out in section 3.

Note: IMO portable tanks and road tank vehicles are sometimes referred to as "first generation portable tanks and road tank vehicles".

* Note: Any reference to the Code refers to the IMDG Code, as amended. All other references refer to paragraphs within this circular.

2.2 General

2.2.1 Each portable tank instruction is identified by an alphanumeric designation (T1 to T75). Column 13 in the Dangerous Goods List in 3.2.1 of the Code indicates the portable tank instruction that should be used for each substance permitted for transport in an IMO type portable tank or road tank vehicle. When no portable tank instruction appears in the Dangerous Goods List, transport of the substance in portable tanks or road tank vehicles is not permitted unless a competent authority approval is granted as set out in 6.7.1.3 of the Code.

2.2.2 Portable tank special provisions are assigned to specific dangerous goods in column 14 of the Dangerous Goods List in 3.2.1 of the Code. Each portable tank special provision is identified by an alphanumeric designation (such as TP1).

2.2.3 Full details of the portable tank instructions and the portable tank special provisions can be found in chapter 4.2 of the Code.

2.2.4 There will continue to be amendments to the UN Model Regulations concerning the construction and use of UN portable tanks as necessary on a two-year cycle. Changes to the allocated T-instructions for entries in the Dangerous Goods List, 3.2.1 of the Model Regulations will appear in each new published edition. These recommendations are likely to be adopted by the Maritime Safety Committee for inclusion in future amendment to the Code. When this occurs, a transitional period for the continued use of the existing IMO or UN portable tanks conforming to the former T-instruction will normally be included. The transitional period will be indicated by the addition of a new special portable tank provision (TP) in 3.2.1 of the Code.

2.2.5 There is no requirement to re-certify IMO type portable tanks as UN portable tanks. Although there may be some technical differences in their design and construction, for the purposes of the Code they are deemed to be equivalent to each other. IMO type portable tanks retain their original data plates. While there is no requirement to re-certify IMO type portable tanks as UN portable tanks, doing so is not prohibited and is subject to design approval by the appropriate competent authority or its authorized body in accordance with 6.7.2.18.1 of the Code.

2.3 Determination of the appropriate portable tank instructions for liquids and solids

When a specific portable tank instruction is specified in the Dangerous Goods List of the Code, portable tanks of a higher test pressure, greater shell thickness, more stringent bottom opening and pressure relief device arrangements may be used. A table is provided at 4.2.5.2.5 of the Code. This specifies the alternative T-instructions which may be applied in selecting a suitable IMO or UN portable tank.

2.4 Portable tank special provisions (TP)

Portable tank special provisions are assigned to certain substances in column 14 in the Dangerous Goods List of the Code to indicate provisions which are in addition to those provided by the T-instruction. Portable tank provisions are identified by an alphanumeric designation beginning with the letters "TP" (tank provision). Full details concerning portable tank special provisions are contained in 4.2.5.3 of the Code.

2.5 Indicating conformance with Portable Tank Instruction on IMO portable tanks

2.5.1 Each IMO portable tank should be marked, either on the portable tank itself or on a metal plate firmly secured to the portable tank, with an indication of the portable tank instruction for which it meets the minimum test pressure, minimum shell thickness, pressure relief

requirements and bottom opening requirements as shown in 4.2.5.2.6 of the Code. The markings should conform to the provisions of 4.2.0.3. This marking is not an indication that the portable tank meets design and construction criteria for any particular UN portable tank, but is an indication that the tank complies with the requirements given in 4.2.5.2.6 of the Code for the applicable portable tank instruction marked on the portable tank.

2.5.2 The existing IMO tank-type marking required by the Code at date of manufacture should continue to be displayed.

2.5.3 IMO portable tanks not currently marked with the portable tank instruction must be marked in accordance with 4.2.0.3 of the Code.

2.6 Use of IMO type 4, 6 and 8 tanks on short international voyages

2.6.1 This guidance applies to IMO type 4, 6 and 8 portable tanks and road tank vehicles on short international voyages approved prior to the entry into force of amendment 30-00 of the Code.

2.6.2 An IMO type 4 tank should be attached to the chassis when transported on board ships and should be driven on board on its own wheels and be fitted with permanent tie-down attachments for securing on board the ship.

Section 3 – Provisions for IMO type portable tanks and road tank vehicles including design, construction, inspection and testing

3.1 Introduction

The provisions for IMO portable tanks and road tank vehicles from section 13 of amendment 29-98 of the Code are reproduced in the appendix below. The reproduced text is intended for reference purposes to ensure design and construction requirements are available to users of this circular that require such information.

The only text not reproduced from amendment 29-98 are the appendices, which list in chart format substances suitable for transport in portable tanks or road tank vehicles. These appendices were not reproduced because users are now required to consult the dangerous goods list to determine the appropriate portable tank instruction and special provisions.

Users of IMO portable tanks should be aware that all other applicable provisions of the Code apply.

3.2 Reproduction of section 13 of the IMDG Code, as amended by 29-98

The reproduced text in the attached appendix represents the provisions that were in force at the time of the 29-98 amendments, including unchanged provisions of earlier amendments 27-94 and 28-96.

APPENDIX

Reproduction of Section 13 of the IMDG Code, amendment 29-98

" GENERAL INTRODUCTION

13 PORTABLE TANKS AND ROAD TANK VEHICLES

13.1 GENERAL REQUIREMENTS FOR PORTABLE TANKS AND ROAD TANK VEHICLES FOR DANGEROUS SUBSTANCES OTHER THAN CLASS 2

13.1.1 **Preamble**

13.1.1.1 The requirements of this subsection apply to portable tanks and road tank vehicles intended for the transport of dangerous substances, except for those of class 2, by sea. In addition to these requirements, or unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC) 1972, as amended, should be fulfilled by any tank which meets the definition of a "container" within the terms of that Convention. The International Convention for Safe Containers does not apply to offshore tank-containers that are handled in open seas. The design and testing of offshore tank-containers should take into account the dynamic lifting and impact forces that may occur when a tank is handled in open seas in adverse weather and sea conditions. The requirements for such tanks should be determined by the approving competent authority (see also MSC/Circ.613 in the annex at the end of this section). Such requirements should be based on MSC/Circ.860 Guidelines for the approval of offshore containers handled in open seas.

13.1.1.2 Attention is drawn to the fact that no requirements have been included in respect of any additional fire-fighting equipment which may be necessary on ships transporting these tanks.

13.1.1.3 In order to take into account progress in science and technology, the use of alternative arrangements may be considered where these offer at least equivalent safety in use in respect of compatibility with the properties of the substances transported and equivalent or superior resistance to impact, loading and fire.

13.1.1.4 The appendix to this subsection comprises the list of dangerous substances showing the particular requirements which modify or supplement these general requirements for each particular substance. The appendix will need updating from time to time in the light of technical progress and to include new substances.

13.1.1.4.1 In general, where a substance has not been allocated a UN Number, it should be carried under the most suitable N.O.S. entry. However, the competent authority of the country of origin may issue interim approvals for shipment of substances not listed in the appendix to this subsection to which individual UN Numbers have already been assigned. The approval should accompany the shipment concerned and contain at a minimum the information normally provided in the list of substances and the conditions under which the particular substance should be carried. The approval should contain a note to the effect that this competent authority has undertaken action to include this substance in the appendix to subsection 13.1.

13.1.1.4.2 Solid dangerous substances which do not appear on the list in the appendix to this section but which may be transported in portable tanks in accordance with paragraphs 13.1.28.2.1 and 13.1.28.2.3 are not subject to approval by the competent authority of the country of origin as provided for in paragraph 13.1.1.4.1 in general. However, in the particular case provided for in paragraph 13.1.28.2.3, it is necessary to obtain competent authority approval but it is not necessary for that approval to contain a note to the effect that the competent authority has undertaken action to include this substance in the appendix to subsection 13.1.

13.1.1.5 These requirements do not apply to rail tank-wagons (except for materials of class 7), non-metallic tanks, tanks intended for the transport of liquids having a capacity of 450 litres or less, and tanks for substances of class 2.

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13.1.2 **Definitions**

13.1.2.1 For the purposes of these requirements:

13.1.2.2 *Portable tank* means a tank having a capacity of more than 450 litres whose shell is fitted with items of service equipment and structural equipment necessary for the transport of dangerous substances whose vapour pressure is not more than 3 bar (absolute) at a temperature of 50°C. It is a tank that has stabilizing members external to the shell and is not permanently secured on board the ship. Its contents should not be loaded or discharged while the tank remains on board. It should be capable of being loaded and discharged without the need of removal of its structural equipment and be capable of being lifted on and off the ship when loaded.

NOTES:

1 Portable tanks being in conformity with the requirements of this section are not considered to be intermediate bulk containers (IBCs).

2 IBCs being in conformity with the requirements of section 26 of this General Introduction are not considered to be portable tanks.

13.1.2.3 *Shell* means the tank proper, including openings and their closures, but does not include service equipment (see 13.1.2.4).

13.1.2.4 *Service equipment of a shell* means filling and discharge, venting, safety, heating and heat-insulating devices and measuring instruments.

13.1.2.5 *Structural equipment* means the reinforcing, fastening, protective or stabilizing members of the shell.

13.1.2.6 *Maximum allowable working pressure* means a pressure that is not less than the higher of the following two pressures, measured at the top of the tank while in operating position:

.1 the highest effective pressure allowed in the shell during filling or discharge; or

.2 the maximum effective gauge pressure to which tanks for liquids should be designed, which is the sum of the following partial pressures minus 1 bar:

.2.1 the vapour pressure (in bar) at 65°C; and

.2.2 the partial pressure (in bar) of air or other gases in the ullage space being determined by a maximum ullage temperature of 65°C and a liquid expansion due to the increase of the bulk mean temperature of $t_r - t_f$ (t_f = filling temperature, usually 15°C; t_r = 50°C; the maximum mean bulk temperature).

13.1.2.7 *Test pressure* means the maximum gauge pressure at the top of a tank during a hydraulic test.

13.1.2.8 *Design pressure* means the pressure used, according to a recognized pressure vessel code, as mentioned in 13.1.3.11 for the design of every element of the tank.

The design pressure should never be less than the highest of the following three pressures:

.1 the working pressure as given in 13.1.2.6.1; or

.2 the sum of the pressure as given in 13.1.2.6.2 and the dynamic head pressure, determined on the basis of the dynamic forces due to inertia specified in 13.1.4.1 minus 1.0 bar; such a dynamic head pressure should never be taken to be less than 0.35 bar; or

.3 the required test pressure divided by 1.5.

13.1.2.9 *Discharge pressure* means the highest pressure actually built up in the shell when it is being discharged by pressure.

13.1.2.10 *Leakage test* means a test which consists of subjecting the shell to an effective internal pressure equivalent to the maximum allowable working pressure, but not less than 0.2 bar (gauge).

13.1.2.11 *Total mass* means the mass of the shell, its service equipment and structural equipment, and the heaviest load authorized to be transported.

13.1.2.12 *Start-to-discharge pressure* means the value of increasing static pressure below which no bubbling occurs when a pressure-relief valve is tested by means of air under water seal at the outlet.

13.1.2.13 *Type 1 portable tank* means a portable tank fitted with pressure-relief devices, having a maximum allowable working pressure of 1.75 bar or above.

13.1.2.14 *Type 2 portable tank* means a portable tank fitted with pressure-relief devices, having a maximum allowable working pressure equal to or above 1.0 bar but below 1.75 bar, intended for the transport of certain dangerous liquids of low hazard.

13.1.2.15 *Type 4 tank* is a road tank vehicle with a permanently attached tank or a tank attached to a chassis, with at least four twist locks that take account of ISO standards*, having a capacity of more than 450 litres and fitted with pressure-relief devices. Such a road tank should comply with the requirements of the competent authority. It need not comply fully with the relevant requirements for type 1 or 2 portable tanks. Special requirements for type 4 tanks are given in 13.1.24.5. Type 4 tanks should only be used on short international voyages.

13.1.2.16 *Road tank vehicle* is a vehicle fitted with a tank complying with the relevant requirements for type 1 or 2 portable tanks or is a type 4 tank, intended for the transport of dangerous liquids by both road and sea modes of transport, the tank of which is permanently or rigidly attached to the vehicle during all normal operations of loading, discharging and transport and is neither filled nor discharged on board and is driven on board on its own wheels.

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

13.1.2.18 *Long international voyage* means an international voyage that is not a short international voyage.

13.1.2.19 *No bottom openings* means that the shell of the tank is not pierced below the liquid level in the tank. When existing openings are blanked off, this should be by means of suitable blank flanges welded to the shell internally and externally.

13.1.2.20 For the purposes of this subsection, *tank* means a portable tank or a road tank vehicle.

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* ISO International Standard 1161-1984.

GENERAL INTRODUCTION

13.1.3 **General requirements for the design, construction and operation of tanks**

13.1.3.1 Shells should be manufactured of ductile metallic materials suitable for shaping. For welded shells only a material whose weldability has been fully demonstrated should be used. Welds should be skillfully made and afford complete safety. Tank materials should be suitable for the marine environment.

13.1.3.2 Tanks, fittings and pipework should be manufactured of material which is either:

.1 substantially immune to attack by the substance being transported; or

.2 properly passivated or neutralized by chemical reaction with that substance; or

.3 lined with other corrosion-resistant material directly bonded to the material of the shell or attached by equivalent means.

13.1.3.3 Gaskets, where used, should be made of materials not subject to attack by the contents of the tank.

13.1.3.4 If lining is applied, the lining of the tank and its fittings and pipings should be continuous, and should extend around the face of any flanges. Where external fittings are welded to the tank, the lining should be continuous through the fittings and around the face of external flanges.

13.1.3.5 Lining material should be substantially immune to attack by the substance transported, homogeneous, non-porous, and should have thermal-expansion and elasticity characteristics that are compatible with the material of the shell and pipings.

13.1.3.6 Care should be taken to avoid damage by galvanic action due to the juxtaposition of dissimilar metals.

13.1.3.7 The materials of the tank, including any devices, gaskets and accessories, should not adversely affect the contents of the tank.

13.1.3.8 Tanks should be designed and manufactured with supports to provide a secure base during transport and with suitable lifting and tie-down attachments. Road tank vehicles should be fitted with tie-down attachments and secured on board in such a way that the suspension is not left in free play.*

13.1.3.9 Tanks intended for the transport of flammable liquids having a flashpoint of not more than 61°C c.c. should be capable of being electrically earthed, e.g. should have installed a grounding stud or other suitable device with a minimum cross-sectional area of 0.5 cm^2. Measures should be taken to prevent a dangerous electrostatic discharge, for instance, in lined tanks or in tanks with plastic components which are not electrically conductive. The aim of these measures is to assure electrical continuity.

13.1.3.10 Shells, their attachments and their service and structural equipment should be designed to withstand, without loss of contents, at least the internal pressure due to the contents and the static and dynamic stresses in normal handling and transport. For tanks that are intended for use as offshore tank-containers, the dynamic stresses imposed by handling in open seas should be taken into account.

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* Attention is drawn to the Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro-Ro Ships (resolution A.581(14)) (see the Supplement to this Code).

GENERAL INTRODUCTION

13.1.3.11 Tanks should be designed, manufactured and tested in accordance with a recognized pressure vessel code, taking into account the design pressure as defined in 13.1.2.8.

13.1.3.12 Tanks should be of a design capable of being stress-analysed mathematically or experimentally by resistance strain gauges, or by any other acceptable method.

13.1.3.13 Tanks should be designed and manufactured to withstand a test pressure equal to at least 1.5 times the maximum allowable working pressure. However, the test pressure should never be lower than 1.5 bar. Specific requirements are laid down for various substances authorized to be carried in tanks in the appendix to this subsection. Attention is also drawn to the minimum shell thickness requirements, specified in 13.1.5.1 to 13.1.5.8.

13.1.3.14 Tanks without vacuum-relief valves should be designed to withstand an external pressure at least 0.4 bar above the internal pressure. Tanks equipped with vacuum-relief valves should be designed to withstand an external overpressure of 0.21 bar or greater and should have their vacuum-relief valve set to relieve at minus (–) 0.21 bar, except that a greater negative setting may be utilized provided the external design pressure is not exceeded. All vacuum-relief valves used on tanks for the transport of liquids with flashpoints below 61°C (c.c.) should be equipped with a flame trap.

13.1.3.15 Tanks intended to contain certain dangerous substances should be provided with additional protection, which may take the form of additional thickness of the shell or a higher test pressure, the additional thickness or higher test pressure being determined in the light of the dangers inherent in the substances concerned. The requirements for each substance are given in the list in the appendix to this subsection.

13.1.4 **Design criteria**

13.1.4.1 Tanks and their fastenings should, under the maximum permissible load, be capable of absorbing the following dynamic forces:

.1 in the direction of travel: twice the total mass;

.2 horizontally at right angles to the direction of travel: the total mass (where the direction of travel is not clearly determined, the maximum permissible load should be equal to twice the total mass);

.3 vertically upwards: the total mass; and

.4 vertically downwards: twice the total mass (total loading including the effect of gravity).

13.1.4.2 Under each of these loads, the safety factors to be observed for the primary combined stress should be as follows:

.1 for metals having a clearly defined yield point, a safety factor of 1.5 in relation to the determined yield stress; or

.2 for metals with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2% (1.0% for austenitic steels) proof stress.

Note: The above loads do not give rise to an increase in the pressure in the vapour space.

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13.1.4.3 At the test pressure the membrane stress in the shell should conform to the material-dependent limitations prescribed below:

.1 for metals and alloys exhibiting a clearly defined yield point or characterized by a guaranteed conventional yield stress *R*e (generally 0.2% proof stress; for austenitic steels 1.0% proof stress), the membrane stress should not exceed 0.75*R*e or 0.50*R*m, whichever is lower.

.2 In the case of steel, the elongation at fracture, in per cent, should not be less than $\frac{10{,}000}{Rm}$, where *R*m is in N/mm^2, with an absolute minimum of 20% based on a standard gauge length of 50 mm. In the case of aluminium, the elongation at fracture, in per cent, should not be less than $\frac{10{,}000}{6Rm}$, where *R*m is in N/mm^2, with an absolute minimum of 12%.

13.1.4.4 The specimens used to determine the elongation at fracture should be taken transversely to the direction of rolling and be so secured that:

$$L_o = 5d,$$

or

$$L_o = 5.65\sqrt{A}$$

where :

L_o = gauge length of the specimen before the test;
d = diameter; and
A = cross-sectional area of the test specimen.

13.1.5 **Minimum shell thickness**

13.1.5.1 The minimum shell thickness referred to in this subsection may be used only if design criteria calculations do not indicate that a greater thickness is required.

13.1.5.2 The cylindrical portions and ends of tanks should have a thickness of not less than that determined by the following formula*:

$$e = \frac{C}{\sqrt[3]{Rm \times A}}$$

where:

e = minimum required thickness of the metal to be used, in mm;
*R*m = guaranteed minimum tensile strength of the metal to be used, in N/mm^2;
A = guaranteed minimum elongation (as a percentage) of the metal to be used on fracture under tensile stress; see 13.1.4.3;
C = 107 (equivalent to 5 mm mild steel) for tanks intended for the transport of powdery or granular solid substances and for tanks of not more than 1.80 m in diameter intended for the transport of liquids
or
C = 128 (equivalent to 6 mm mild steel) for tanks of more than 1.80 m in diameter.

* The constant C is derived from the following formula: $e\sqrt[3]{Rm \times A} = e_o\sqrt[3]{Rm_oA_o}$, where the sub-index 'o' refers to mild steel and the part of the equation without sub-index 'o' refers to the metal used. The relationship with mild steel as employed by this Code is attached to the constant C, where $C = e_o\sqrt[3]{Rm_o \times A_o}$.

13.1.5.3 Where additional thickness of the shell is required for certain dangerous substances, this thickness is given in mm mild steel in column 9 of the appendix to 13.1.

For calculation purposes the required constant *C* to be taken is given in the table below:

Where column 9 specifies:	*C* to be used for calculation is:
6 mm	128
8 mm	171
10 mm	213
12 mm	256

13.1.5.4 Except as provided in 13.1.5.5, the cylindrical portions and ends of all tanks should have a thickness of at least 3 mm regardless of the material of construction. For type 4 tanks the requirements of 13.1.24.5 may be applied.

13.1.5.5 Where additional protection of the tanks against damage is provided, the competent authority may, for a tank having a test pressure below 2.65 bar (i.e. type 2 portable tank), authorize a reduction in the minimum thickness in proportion to the protection provided.

For such protected tanks the thickness should not be less than that determined in accordance with 13.1.5.2, where:

C = 64 (equivalent to 3 mm mild steel) for tanks of not more than 1.80 m in diameter; and

C = 85 (equivalent to 4 mm mild steel) for tanks of more than 1.80 m in diameter.

13.1.5.6 The additional protection referred to in 13.1.5.5 may be provided by overall external structure protection such as a suitable "sandwich" construction with the outer shielding secured to the shell, double-wall construction or the shell supported in a complete framework with longitudinal and transverse structural members.

13.1.5.7 There should be no sudden change in plate thickness at the attachment of the head to the cylindrical portion of the shell, and after forming the head the plate thickness at the knuckle should not be less than the minimum thickness required by this subsection.

13.1.5.8 In no case should the wall thickness of any portion of the shell be less than that prescribed in this subsection.

13.1.6 **Service equipment**

13.1.6.1 Service equipment (valves, fittings, safety devices, gauging devices and the like) should be so arranged as to be protected against the risk of being wrenched off or damaged during transport and handling. If the connection between the frame and the shell allows relative movement as between the sub-assemblies, the equipment should be so fastened as to permit such movement without risk of damage to working parts. Equipment protection should offer a degree of safety

comparable to that of the shell. For offshore tank-containers, where positioning of service equipment and the design and strength of protection for such equipment is concerned, the increased danger of impact damage when handling such tanks in open seas should be taken into account.

13.1.6.2 All shell openings other than openings for pressure-relief devices and inspection openings should be provided with manually operated stop valves situated as near to the shell as is practicable.

13.1.6.3 A tank or each of its components should be provided with an opening large enough to enable the tank or compartment to be inspected.

13.1.6.4 Whenever possible, external fittings should be grouped together.

13.1.6.5 All tank connections should be clearly marked to indicate the function of each.

13.1.6.6 Stop valves with screwed spindles should close by clockwise rotation. Each valve should be designed and constructed for a rated pressure not less than the maximum allowable working pressure of the tank at the temperatures expected to be encountered.

13.1.6.7 All piping should be of suitable material. Welded pipe joints should be used wherever possible. Where copper tubing is permitted, joints should be brazed or have an equally strong metal union. The melting point of brazing material should be no lower than 525°C. Such joints should, in any event, be such as not to decrease the strength of the tubing, as may happen by cutting of threads. Ductile metals should be used in the construction of valves or accessories. The bursting strength of all piping and pipe fittings should be at least four times the strength at the maximum allowable working pressure of the tank and at least four times the strength at the pressure to which it may be subjected in service by the action of a pump or other device (except pressure-relief valves) the action of which may subject portions of the piping to pressures greater than the tank maximum allowable working pressure. Suitable provisions should be made in every case to prevent damage to piping due to thermal expansion and contraction, jarring and vibration.

13.1.7 **Bottom openings**

13.1.7.1 Certain substances listed in the appendix to this subsection should not be transported in tanks with bottom openings (bottom-discharge tanks). As an exception, for type 4 tanks, existing openings and hand inspection holes may be closed by bolted flanges mounted both internally and externally, fitted with product-compatible gaskets. Such arrangement should be approved by the competent authority.

13.1.7.2 Except as may otherwise be provided in the case of tanks intended for the transport of certain crystallizable, highly viscous or extremely hazardous substances, every bottom-discharge tank should be equipped with two serially mounted and mutually independent shutoff devices as follows:

.1 an internal stop valve; that is a stop valve within the tank or within a welded flange or its companion flange, or within a coupling which is an integral part of the tank, such that:

.1.1 the control devices are so designed as to prevent any unintended opening through impact or other inadvertent act;

.1.2 the valve may be operable from above or below; and

.1.3 if possible, the setting of the valve (open or closed) can be verified from the ground.

.2 At the end of each discharge pipe:

.2.1 a sluice valve; or

.2.2 a bolted blank flange; or

.2.3 a suitable screw cap or other liquid-tight closure.

13.1.7.3 For certain substances, as indicated by a "B" in column 8 of the appendix to this subsection, bottom-discharge tanks should be equipped with three serially mounted and mutually independent shutoff devices as follows:

.1 an internal stop valve as provided in 13.1.7.2 except that it should be possible to close the valve from an accessible position of the tank that is remote from the valve itself;

.2 an external valve; and

.3 at the end of the discharge pipe:

.3.1 a bolted blank flange; or

.3.2 a suitable screw cap or other liquid-tight closure.

13.1.7.4 The internal shutoff device should continue to be effective in the event of damage to the external control device.

13.1.7.5 In order to avoid any loss of contents in the event of damage to external discharge fittings, e.g. pipe sockets, lateral shutoff devices, the internal stop valve and its seating should be protected against the danger of being wrenched off by external stresses or should be so designed as to resist them. The filling and discharge devices, including flanges or threaded plugs and protective caps, if any, should be capable of being secured against any unintended opening.

13.1.8 **Safety relief**

13.1.8.1 All tanks should be closed and fitted with a pressure-relief device. All pressure-relief devices should be to the satisfaction of the competent authority.

13.1.9 **Pressure-relief devices**

13.1.9.1 Every tank of 1,900 litres or more, or every independent compartment of a tank of similar capacity, should be provided with one or more pressure-relief valves of the spring-loaded type and may in addition have a frangible disc or fusible element in parallel with the spring-loaded valves, except when precluded by the list in the appendix to this subsection as designated by "NF" in column 7.

13.1.9.2 Pressure-relief devices should be designed to prevent the entry of foreign matter, the leakage of liquid and the development of any dangerous excess pressure.

13.1.9.3 Tanks intended for the transport of certain highly toxic substances which are designated "NF" in column 7 of the list in the appendix to this subsection should have a pressure-relief arrangement approved by the competent authority. The arrangement should comprise a spring-loaded pressure-relief valve preceded by a frangible disc except that a tank in dedicated service may be fitted with an approved relief system offering an equivalent hermetic seal. The space between the frangible disc and the valve should be provided with a pressure gauge or suitable tell-tale

indicator. This arrangement permits the detection of disc rupture, pinholing or leakage which could cause a malfunction of the spring-loaded valve. The frangible disc in this instance should rupture at a nominal pressure that is 10% above the start-to-discharge pressure of the valve.

13.1.9.4 Every tank with a capacity of less than 1,900 litres should be fitted with a pressure-relief device which may be a frangible disc. If no spring-loaded pressure-relief valve is used, the frangible disc should be set to rupture at a nominal pressure equal to the test pressure.

13.1.9.5 If the tank is fitted with arrangements for air-pressure or inert-gas pressure discharge, the inlet line should be provided with a suitable pressure-relief device set to operate at a pressure not higher than the maximum allowable working pressure of the tank. A stop valve should be provided at the entry to the tank.

13.1.10 **Setting of pressure-relief devices**

13.1.10.1 It should be noted that the devices should operate only in conditions of excessive rise in temperature, as the tank will not during transport be subject to undue fluctuations of pressure due to operating procedures (see, however, 13.1.13.2).

13.1.10.2 The required pressure-relief valve should be set to start to discharge at a nominal pressure of five sixths of the test pressure in the case of tanks having a test pressure up to and including 4.5 bar and 110% of two thirds of the test pressure in the case of tanks having a test pressure of more than 4.5 bar. The valve should, after discharge, close at a pressure not lower than 10% below the pressure at which discharge starts, and should remain closed at all lower pressures provided that this requirement not be so construed as to prevent the use of vacuum-relief or combination pressure-relief and vacuum-relief valves.

13.1.11 **Fusible elements**

13.1.11.1 Fusible elements, if allowed in the appendix to this subsection, should function at a temperature between 110°C and 149°C provided that the developed pressure in the tank at the fusing temperature of the element does not exceed the test pressure of the tank. They should be placed at the top of the tank in the vapour space and in no case should they be shielded from external heat.

13.1.12 **Frangible discs**

13.1.12.1 Except as provided in 13.1.9.3, frangible discs, if used, should rupture at a nominal pressure equal to the test pressure. Particular attention should be given to the requirements of 13.1.6.1 if frangible discs are used.

13.1.13 **Capacity of relief devices**

13.1.13.1 The spring-loaded relief valve required by 13.1.9.1 should have a minimum diameter of 31.75 mm. Vacuum-relief valves, if used, should have a minimum through area of 2.84 cm^2.

13.1.13.2 The combined delivery capacity of the relief devices in condition of complete engulfment of the tank in fire should be sufficient to limit the pressure in the tank to 20% above the start-to-discharge pressure of the relief device. Emergency pressure-relief devices may be used to achieve the full relief capacity prescribed. Emergency pressure-relief devices may be of the spring-loaded, frangible or fusible type.

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To determine the total certified capacity of the relief devices, which may be regarded as being the sum of the individual capacities of the several devices, the following formula may be used:

$$Q = 12.4 \frac{FA^{0.82}}{LC} \sqrt{\frac{ZT}{M}}$$

where:

the accumulating condition is 20% above the start-to-discharge pressure of the relief device;

Q is the minimum required rate of discharge in cubic metres of air per second at standard conditions: 1 bar and 0°C (273 K);

F is a coefficient with the following value:

.1 for uninsulated tanks $F = 1$

.2 for insulated tanks $F = U(649 - t)/13.6$ but in no case is less than 0.25

where:

U = thermal conductance of the insulation, in kW/(m^2 K), at 38°C

t = actual temperature of the substance at loading (°C); if this temperature is unknown, let t = 15°C;

The value of *F* given in .2 above may be taken provided that:

the insulation is jacketed with a material having a melting point not less than 649°C; and

the insulation system will remain effective at all temperatures up to 649°C;

A is the total external surface area of tank in square metres;

Z is the gas compressibility factor in the accumulating condition (if this factor is unknown, let *Z* equal 1.0);

T is the absolute temperature in kelvin (°C + 273) above the pressure-relief devices and in the accumulating condition;

L is the latent heat of vaporization of the liquid, in kJ/kg, in the accumulating condition;

M is the molecular mass of the discharged gas;

C is the constant which is derived from equation (2) as a function of the ratio *k* of specific heats:

$$k = \frac{C_p}{C_v} \qquad (1)$$

where:

C_p is the specific heat at constant pressure and

C_v is the specific heat at constant volume;

$$\left.\begin{array}{ll} C = \sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}} & \text{when } k > 1 \text{ In this case } C \text{ may be taken from the table at the top of the next page.} \\ C = \frac{1}{\sqrt{e}} = 0.607 & \text{when } k = 1 \text{ or } k \text{ is unknown} \end{array}\right\} \quad (2)$$

where:

e is the mathematical constant 2.7183.

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VALUES FOR THE CONSTANT C WHEN $k > 1$

k	C	k	C	k	C
1.00	0.607	1.26	0.660	1.52	0.704
1.02	0.611	1.28	0.664	1.54	0.707
1.04	0.615	1.30	0.667	1.56	0.710
1.06	0.620	1.32	0.671	1.58	0.713
1.08	0.624	1.34	0.674	1.60	0.716
1.10	0.628	1.36	0.678	1.62	0.719
1.12	0.633	1.38	0.681	1.64	0.722
1.14	0.637	1.40	0.685	1.66	0.725
1.16	0.641	1.42	0.688	1.68	0.728
1.18	0.645	1.44	0.691	1.70	0.731
1.20	0.649	1.46	0.695	2.00	0.770
1.22	0.652	1.48	0.698	2.20	0.793
1.24	0.656	1.50	0.701		

13.1.13.3 Alternatively to using the formula above, tanks designed for the transport of liquids may have their relief devices sized in accordance with the following table. This table assumes an insulation value of $F = 1$ and should be adjusted accordingly if the tank is insulated. Other values used in determining this table are:

$M = 86.7$ $T = 394$ K $L = 334.94$ kJ/kg $C = 0.607$ $Z = 1$

MINIMUM EMERGENCY VENT CAPACITY Q IN CUBIC METRES OF AIR PER SECOND AT 1 BAR AND 0°C (273 K)

A Exposed area (square metres)	Q (Cubic metres of air per second)	A Exposed area (square metres)	Q (Cubic metres of air per second)
2	0.230	37.5	2.539
3	0.320	40	2.677
4	0.405	42.5	2.814
5	0.487	45	2.949
6	0.565	47.5	3.082
7	0.641	50	3.215
8	0.715	52.5	3.346
9	0.788	55	3.476
10	0.859	57.5	3.605
12	0.998	60	3.733
14	1.132	62.5	3.860
16	1.263	65	3.987
18	1.391	67.5	4.112
20	1.517	70	4.236
22.5	1.670	75	4.483
25	1.821	80	4.726
27.5	1.969	85	4.967
30	2.115	90	5.206
32.5	2.258	95	5.442
35	2.400	100	5.676

13.1.14 **Marking of pressure-relief devices**

13.1.14.1 Every pressure-relief device should be plainly and permanently marked with the pressure or temperature at which it is set to discharge and the rated free-air delivery of the device. Where practicable, the following particulars should also be shown:

.1 the manufacturer's name and the relevant catalogue number; and

.2 allowable tolerances at start-to-discharge pressure (frangible disc) and allowable temperature tolerances (fusible elements).

13.1.15 **Connections to pressure-relief devices**

13.1.15.1 Connections to pressure-relief devices should be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop valve should be installed between the shell and the pressure-relief devices except where duplicate devices are provided for maintenance or other reasons and the stop valves serving the devices actually in use are locked open or the stop valves are interlocked so that at least one of the devices is always in use. Vents from the pressure-relief devices, where used, should deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

13.1.16 **Siting of pressure-relief devices**

13.1.16.1 Pressure-relief device inlets should be sited on top of the tank in a position as near the longitudinal and transverse centre of the tank as possible. All pressure-relief device inlets should be situated in the vapour space of the tank and the devices so arranged as to ensure that the escaping vapour is discharged unrestrictedly and in such a manner that it cannot impinge upon the shell. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

13.1.16.2 Arrangements should be made to prevent access to the devices by unauthorized persons and to protect the devices from damage caused by the tank overturning.

13.1.17 **Gauging devices**

13.1.17.1 Glass level-gauges, or gauges made of other easily destructible material, which are in direct communication with the contents of the tank should not be used.

13.1.18 **Tank support, frameworks, lifting and tie-down attachments***

13.1.18.1 Tanks should be designed and manufactured with a support structure to provide a secure base during transport. Skids, frameworks, cradles or other similar devices are acceptable. The loadings specified in 13.1.4.1 should also be considered in this aspect of design.

13.1.18.2 The design of tank mountings (e.g. cradles and frameworks) and tank lifting and tie-down attachments should not cause undue concentration of stress in any portion of the tank. Permanent lifting and tie-down attachments should be fitted to all tanks. They should preferably be fitted to the tank supports. Otherwise, these attachments should be secured to reinforcing plates located on the shell at the points of support.

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* See also IMO Assembly resolution A.581(14) of 20 November 1985, Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro–Ro Ships (see the Supplement to this Code).

13.1.18.3 In the design of supports and frameworks, due regard should be paid to the effects of environmental corrosion, and in calculations for all structural members not constructed of corrosion-resistant materials a minimum corrosion allowance, determined by the competent authority, should be provided.

13.1.18.4 Tank frameworks intended to be lifted or secured by their corner castings should be subjected to internationally accepted tests, such as those set forth in the CSC Convention. The use of such frameworks within an integrated system is generally encouraged. In addition, for road tank vehicles, tie-down attachments should be located on the tank support or vehicle structure in such a manner that the springing system is not left in free play. Offshore tank-containers should be subjected to tests that take into account the dynamic lifting and impact forces that may occur when a tank is handled on open seas.

13.1.18.5* Fork-lift pockets of tanks should be capable of being closed off. The means of closing fork-lift pockets should be a permanent part of the framework or permanently attached to the framework.

13.1.18.5.1 Single-compartment tanks with a nominal length of less than 3.65 m (12 feet) need not comply with 13.1.18.5 provided that:

.1 the tank shell and all fittings are well protected from being hit by the fork's blades; and

.2 the distance between the centres of the fork-lift pockets is at least ½ of the maximum length of the portable tank unit.

13.1.18.6 Tanks should be carried only on vehicles whose fastenings are capable, in conditions of maximum permissible loading of the tanks, of absorbing the forces specified in 13.1.4.1.

13.1.19 **Approval, testing and marking of tanks**

13.1.19.1 The competent approval authority or a body authorized by that authority should issue, in respect of every new design of a tank, a certificate attesting that the tank and its attachments surveyed by that authority or that body are suitable for the purpose for which they are intended and meet the construction and equipment requirements of this subsection and, where appropriate, the special requirements for the substances in the appendix to this subsection. The prototype test results and an approval number should be specified in a test report. If the tanks are manufactured without change in structural design, this approval should be deemed to be design approval. The approval number should consist of the distinguishing sign or mark of the State in whose territory the approval was granted and a registration number.

13.1.19.2 Design approval should be given in respect of at least one tank of each design and each size, it being, however, understood that a set of tests made on a tank of one size may serve for the approval of smaller tanks made of a material of the same kind and thickness by the same fabrication technique and with identical supports and equivalent closures and other appurtenances.

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* Existing tanks should comply with this requirement from 1 January 1996.

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13.1.19.3 The shell and items of equipment of each tank should be inspected and tested, either together or separately, first before being put into service (initial inspection and test) and thereafter at no more than five-year intervals (periodic inspection and test).The initial inspection and test should include a check of the design characteristics, an internal and external examination and a hydraulic pressure test. If the shell and equipment have been pressure-tested separately, they should together be subjected after assembly to a leakage test. The periodic inspections and tests should include an internal and external examination and, as a general rule, a pressure test.

.1 Sheathing, thermal insulation and the like should be removed only to the extent required for reliable appraisal of the tank's condition. The initial and periodic pressure tests should be carried out, by the competent authority, at the test pressure indicated on the data plate of the tank, except in cases where periodic tests at lower test pressures are authorized.

.2 The tank should be inspected for corroded areas, dents or other conditions which indicate weakness that might render the tank unsafe in transport and, while under pressure, for leakage. If any evidence of such unsafe condition is discovered, the tank should not be placed in or returned to service until it has been repaired and the test, repeated, has been passed.

13.1.19.4 Before tanks are put into service, and thereafter at intervals midway between the five-yearly inspection and tests specified in 13.1.19.3, the following tests and inspections should be performed:

.1 a leakage test, where required;

.2 a test of satisfactory operation of all service equipment; and

.3 an internal and external inspection of the tanks and their fittings with due regard to the substances transported.

13.1.19.5 The 2.5 year (midway) inspection and test may be carried out within 3 months of the specified date. The date of the 2.5 year inspection should be durably marked on, or as near as possible to, the metal identification plate required in 13.1.20.1. When marking is not done on the plate, the characters should be at least 32 mm in height and of a contrasting colour to the tank.

13.1.19.6 The 2.5 year internal inspections may be waived or substituted for by other test methods by the competent authority in the case of tanks intended for dedicated transport. A portable tank may not be filled and offered for transport after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 13.1.19.3 and 13.1.19.4/13.115.3 and 13.115.4/13.213.3 and 13.213.4. However, a portable tank filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be transported after the date of expiry of the last periodic test and inspection:

.1 After emptying but before cleaning, for purposes of performing the next required test and inspection prior to refilling; and

.2 Unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test and inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this authorization should be entered in the dangerous goods shipping document.

13.1.19.7 When the tank is damaged, it should be so repaired as to comply with these recommendations.

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13.1.19.8 In all cases where cutting, burning or welding operations on the shell of the tank have been effected, that work should be to the approval of the competent authority and a hydrostatic test to at least the original test pressure should be carried out.

13.1.19.9 The certificate and the test report required under 13.1.19.1 and the certificate showing the results of the initial hydrostatic test for each tank issued by the competent authority or its approved inspecting agency should be retained by the authority or agency and the owners during the time the tank is in service. As a minimum, the certificate issued under 13.1.19.1 should provide the information required in 13.1.20.1.

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13.1.20 **Marking**

13.1.20.1 Every tank should be fitted with a corrosion-resistant metal plate permanently attached in a place readily accessible for inspection. At least the following particulars should be marked on the plate in characters at least 3 mm in height by stamping, engraving, embossing or any similar method. If, for reasons of tank arrangements, the plate cannot be permanently attached to the shell, the shell should be marked with at least those particulars required by a recognized pressure vessel code in a manner prescribed by that code.

The plate should be kept free of paint to ensure that the markings will be legible at all times.

Country of manufacture . . . . . .

IMO tank type no. . . . . Approval country . . . . . Approval number . . . . . .

Manufacturer's name or mark . . . . . .

Registration number . . . . . .

Year of manufacture . . . . . .

Test pressure . . . . . (bar)/(MPa)*

Maximum allowable working pressure . . . . . (bar)/(MPa)*

Water capacity at 20°C . . . . . (litres)

(The water capacity should be established to within 1% by practical test rather than by calculation.)

Maximum gross mass. . . . . (kg)

Original hydrostatic test date and witness identification . . . . . .

Code to which tank is designed . . . . . .

Metallurgic design temperature (only if above +50°C or below –20°C) . . . . . .

Maximum allowable working pressure for coils (where coils used) . . . . . (bar)/(MPa)*

Tank material . . . . . .

Equivalent thickness in mild steel . . . . . (mm)

Lining material (if any) . . . . . .

Capacity of each compartment (in compartmented tanks) . . . . . (litres)

Month, year and test pressure of most recent periodic test:

. . . . . month . . . . . year . . . . . (bar)/(MPa)*

Stamp of expert who carried out most recent test . . . . . .

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* The unit used should be marked.

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13.1.20.2 Special-purpose tanks should be marked on the identification plate to indicate the substance they are permitted to transport.

13.1.20.3 If a tank is designed and approved for handling in open seas, the words OFFSHORE CONTAINER should be marked on the identification plate.

13.1.20.4 Marking and placarding of tanks containing dangerous goods should be carried out in accordance with the requirements of sections 7 and 8.

13.1.21 **Transport requirements**

13.1.21.1 The shells and service equipment of tanks should be manufactured so as to withstand impact or overturning or, alternatively, they should, during transport, be adequately protected against lateral and longitudinal impact and against overturning.

Examples of protection of shells against collision:

.1 protection against lateral impact may consist, for example, of longitudinal bars protecting the shell on both sides at the level of the median line;

.2 protection of tanks against overturning may consist, for example, of reinforcement rings or bars fixed across the frame;

.3 protection against rear impact may consist of a bumper or frame; or

.4 external fittings should be designed or protected so as to preclude the release of contents upon impact or overturning of the tank upon the fittings.

13.1.21.2 Certain substances are chemically unstable. They are to be accepted for transport only if the necessary steps have been taken to prevent their dangerous decomposition, transformation or polymerization during transport. To this end, care should in particular be taken to ensure that tanks do not contain any substances liable to promote these reactions.

13.1.22 **Filling ratios**

13.1.22.1 Tanks should be filled to the extent provided for in 13.1.22.2 to 13.1.22.6.

13.1.22.2 The degree of filling for general use is determined by the formula:

$$\text{Degree of filling} = \frac{97}{1 + \alpha(t_r - t_f)} \quad (\%)$$

13.1.22.3 Tanks to be filled with liquids of class 6.1 or 8 (packaging group I or II) or with liquids with an absolute vapour pressure in excess of 1.75 bar (175 kPa) at 65°C, or with liquids identified as being harmful to the marine environment, should be filled in accordance with the following formula:

$$\text{Degree of filling} = \frac{95}{1 + \alpha(t_r - t_f)} \quad (\%)$$

13.1.22.4 For certain dangerous substances a lower degree of filling may be required.

13.1.22.5 In these formulae α is the mean coefficient of cubical expansion of the liquid between the temperature of the liquid during filling (t_f) and the maximum mean bulk temperature (t_r) (both in °C) and is calculated by the formula:

$$\alpha = \frac{d_{15} - d_{50}}{35 d_{50}}$$

in which d_{15} and d_{50} are the density of the liquid at 15°C and 50°C, respectively.

The maximum mean bulk temperature (t_r) should be taken as 50°C except that, for journeys in temperate climatic conditions or extreme climatic conditions, the competent authority may agree to a lower or to a higher temperature, as appropriate.

13.1.22.6 The requirements of 13.1.22.2 and 13.1.22.3 do not apply to tanks whose contents are transported at elevated temperatures. For transport at elevated temperatures, the formula for the degree of filling given in 13.1.27.4 should be used.

13.1.22.7 Tanks should not be offered for transport:

.1 with a degree of filling, for liquids having a viscosity of less than 2,680 centistokes at 20°C, of more than 20% but less than 80%, unless the shell of the tank is divided by partitions or surge plates into sections of not more than 7,500 litres capacity;

.2 with residue of lading adhering to the outside of the tank or service equipment;

.3 if leaking or damaged to such an extent that the integrity of the tank or its lifting or securing arrangements may be affected; and

.4 unless the service equipment has been examined and found to be in good working order.

13.1.22.8 Empty tanks not cleaned and not gas-free should comply with the same requirements as tanks filled with the previous substance.

13.1.23 **Handling requirements**

13.1.23.1 Fork-lift pockets of tanks should be closed off when the tank is filled. This provision does not apply to tanks which, according to 13.1.18.5.1, need not be provided with means for closing off the fork-lift pockets.

13.1.24 **Road tank vehicles**

13.1.24.1 A road tank vehicle for long international voyages should be fitted with a tank complying with the requirements for type 1 or 2 portable tanks and should comply with the relative requirements for tank supports, frameworks, lifting and tie-down attachments in 13.1.18.1 to 13.1.18.4, and in addition comply with the requirements in 13.1.24.3 and 13.1.24.4.

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13.1.24.2 A road tank vehicle for short international voyages should either:

.1 comply with the requirements of 13.1.24.1; or

.2 be constructed as a type 4 tank, as defined in 13.1.2.15, complying with the requirements of 13.1.24.3, 13.1.24.4 and 13.1.24.5.

13.1.24.3 The tank supports and tie-down arrangements* of road tank vehicles should be included in the visual external inspection provided for in 13.1.19.4.

13.1.24.4 The vehicle of a road tank vehicle should be tested and inspected in accordance with the road transport requirements of the competent authority of the country in which the vehicle is operated.

13.1.24.5 *Type 4 tanks*

13.1.24.5.1 Type 4 tanks should only be authorized for short international voyages. They should comply with the requirements of 13.1.3, 13.1.4, 13.1.5 and 13.1.18 or, if they do not comply fully with these requirements, they should be certified by the competent authority for road transport of the substances to be transported by road and should at least comply with the following minimum requirements:

.1 they should have been subjected during construction to a minimum hydraulic test pressure equal to that specified in column 6 of the list of substances in the appendix to this subsection;

.2 the thickness of cylindrical portions and ends in mild steel should be:

.2.1 not more than 2 mm thinner than the thickness specified in column 9 of the above-mentioned list of substances;

.2.2 subject to an absolute minimum thickness of 4 mm of mild steel; and

.2.3 for other materials, subject to an absolute minimum thickness of 3 mm;

.3 the maximum effective gauge pressure developed by the substances to be transported should not exceed the maximum allowable working pressure of the tank; and

.4 the primary combined stresses in supports, tie-down attachments* and tank structures in way of them due to static forces and to dynamic forces as defined in 13.1.4.1 should not exceed 0.8*Re*, where *Re* is explained in 13.1.4.3. The said stresses may be calculated or measured.

13.1.24.5.2 The materials of construction of type 4 tanks, if they do not comply with the requirements of 13.1.3.1 to 13.1.3.7, should at least comply with the requirements of the competent authority for the transport by road of the substances to be transported by road.

13.1.24.5.3 Tank supports on permanently attached type 4 tanks, if they do not comply with the requirements of 13.1.18, should at least comply with the requirements of the competent authority for the transport by road of the substances to be transported by road.

13.1.24.5.4 Type 4 tanks should, as a minimum, be tested and inspected in accordance with the requirements of the competent authority for the transport by road of the substances to be transported by road.

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* See also IMO Assembly resolution A.581(14) of 20 November 1985, Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro–Ro Ships (see the Supplement to this Code).

13.1.24.5.5 The protection of valves and accessories of type 4 tanks should at least comply with the requirements of the competent authority for the transport by road of the substances to be transported by road.

13.1.24.5.6 The joints in shells of type 4 tanks should at least be made by fusion welding and comply with the requirements of the competent authority for the transport by road of the substances to be transported by road.

13.1.24.5.7 Type 4 tanks should at least be provided with manholes or other openings in the tank which comply with the requirements of the competent authority for the transport by road of the substances to be transported by road.

13.1.24.5.8 Tank nozzles and external fittings on type 4 tanks should at least comply with the requirements of the competent authority for the transport by road of the substances to be transported by road, except that, irrespective of road requirements, tanks with bottom openings should not be used for substances for which bottom openings would not be permitted for transport by sea in other types of tanks, unless exempted in accordance with 13.1.7.1.

13.1.24.5.9 All type 4 tanks should be closed tanks and, if they do not comply with the requirements of 13.1.8 to 13.1.16, they should at least be fitted with pressure-relief devices of the type required in the list of substances in the appendix to this subsection. The devices should be acceptable to the competent authority for the transport by road of the substances to be transported. The start-to-discharge pressure of such devices should in no case be less than the maximum allowable working pressure, nor greater than 25% above that pressure.

13.1.24.5.10 Type 4 tanks ▷should◁ be attached to the chassis ▷when transported on board ship. Type 4 tanks which are not permanently attached to the chassis◁ should be marked "IMO 4" in letters at least 32 mm high.

13.1.25 **Stowage**

13.1.25.1 A list of liquid substances suitable for transport in tanks is given in the appendix to this subsection. Where necessary, this list also contains additional constructional requirements or operational provisions.

13.1.25.2 Tanks should be stowed in accordance with the requirements of the individual schedules ▷, subsection 12.5◁ and section 14 of this General Introduction.

13.1.25.3 Where stowage is permitted "on deck or under deck", a tank containing a marine pollutant should be preferably stowed under deck except when a weather deck provides equivalent protection.

13.1.25.4 Where stowage is permitted "on deck only", preference should be given to the stowage of a tank containing a marine pollutant on well-protected decks or to stowage inboard in sheltered areas of exposed decks.

13.1.25.5 Portable tanks should not be overstowed unless they are designed for that purpose and transported in specially designed ships, or unless they are specially protected to the satisfaction of the competent authority.

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13.1.26 **Segregation**

13.1.26.1 Tanks containing dangerous substances should be segregated in accordance with the requirements of section 15 of this General Introduction.

13.1.27 **Special requirements relating to tanks for the transport of dangerous substances at elevated temperatures in liquid, molten or resolidified form**

13.1.27.1 The following general requirements relate particularly to tanks for the transport of dangerous substances at elevated temperatures in either liquid or molten form and of molten dangerous substances in resolidified form. Reference should also be made to the appendix to this subsection, setting out special requirements for individual substances.

13.1.27.2 The design of the tank, the choice of materials, insulation, fittings and service equipment should take into account the highest temperature reached during filling, discharge and transport and should be compatible with the substances to be transported.

13.1.27.3 The highest temperature reached during filling, discharge and transport, if it is in excess of 65°C, should be used when calculating the maximum allowable working pressure as defined in 13.1.2.6. The minimum test pressure should never be less than the pressure indicated in the appendix to this subsection.

13.1.27.4 Tanks for the transport of substances at elevated temperatures should be filled at the outset such that the tank is not more than 95% full at any time during transport, unless otherwise indicated for individual substances. The degree of filling for elevated temperature use is determined by the formula:

$$\text{Degree of filling} = \frac{95}{1 + \alpha(t_r - t_f)} \quad (\%)$$

where:

t_r is the maximum mean bulk temperature during transport.

t_f is the mean bulk temperature during filling.

α is the mean coefficient of cubical expansion of the substance between t_f and t_r and is calculated by the formula:

$$\alpha = \frac{d(t_f) - d(t_r)}{(t_r - t_f) \times d(t_r)}$$

in which $d(t_r)$ and $d(t_f)$ are the densities of the substance at the maximum transport temperature and the filling temperature respectively.

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13.1.27.5 When tanks are used for the transport of liquids at a temperature above the flashpoint, they should be capable of being electrically earthed, e.g. they should have installed a grounding stud or other suitable device with a minimum cross-sectional area of 0.5 cm^2. Measures should be taken to prevent a dangerous electrostatic discharge, for instance, in lined tanks or in tanks with plastic components which are not electrically conductive. The aim of these measures is to assure electrical continuity.

13.1.27.6 The temperature of the outer surface of the shell or of the thermal insulation should not exceed 70°C during transport.

13.1.27.7 An additional hazard during transport can be expected from flammable vapours emanating from contaminated insulation by spillage of the product during loading or unloading.

13.1.27.8 An elevated temperature mark should be displayed on the tank to indicate that it contains a substance at an elevated temperature. Substances transported at elevated temperatures may also pose additional hazards, such as explosion, fire, toxicity or corrosivity. These additional hazards may be listed in the individual schedules for these substances. In addition, the maximum temperature of the substance expected to be reached during transport should be durably marked on both sides of the tank or insulation jacket, immediately adjacent to the elevated temperature mark, in characters 100 mm high.

13.1.27.9 *Heating systems*

13.1.27.9.1 The heating system should not allow a substance to reach a temperature at which the pressure in the tank exceeds its design pressure or causes other hazards (e.g. thermal decomposition or increased corrosivity).

13.1.27.9.2 For some substances the heating system should be fitted outside the inner shell. However, a pipe used for discharging the substance may be equipped with a heating jacket. These substances are marked in column 10 with "(u)".

13.1.27.9.3 Protection against explosion

.1 In no case should the temperature at the surface of the heating element for internal heating equipment or the temperature at the tank shell for external heating equipment exceed 80% of the autoignition temperature of the substance carried. Power for internal heating elements should not be available unless the heating elements are completely submerged.

.2 If the electrical heating system is installed inside the tank, an earth leakage circuit breaker should be installed with a releasing current of < 100 mA.

.3 Electrical switch cabinets mounted to tanks should not have a direct connection to the tank interior and should provide protection of at least the equivalent of type IP 56 according to IEC 144 or IEC 529.

13.1.27.9.4 The heating system should be subject to inspection and tests, including pressure tests on heating coils or ducts as appropriate, together with the other equipment mentioned in 13.1.19.

13.1.27.10 Bottom openings should be in accordance with 13.1.7. However, all shutoff devices may be external.

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13.1.27.11 *Stowage and segregation*

13.1.27.11.1 Portable tanks transported at elevated temperatures should be stowed and segregated in accordance with 13.1.25 and 13.1.26.

13.1.28 **Special requirements relating to tanks for the transport of solid dangerous substances (e.g. powdery or granulated materials)**

13.1.28.1 Tanks used for the transport of solid dangerous substances capable of flow should comply at least with the requirements for IMO type 2 or type 4 tanks. However, the required service equipment may be in accordance with 13.1.28.4.2 and 13.1.28.4.3.

13.1.28.2 The ▷◁ solid dangerous substances ▷which may be transported◁ in portable tanks are ▷◁:

.1 solid dangerous substances ▷for which transport◁ in portable tanks ▷is◁ indicated in the individual schedules ▷for these substances◁, or ▷◁

▷.2 solid dangerous substances for which transport in portable tanks is authorized by the competent authority, or◁

▷.3◁ solid dangerous substances which are suitable for transport in metallic IBCs ▷(see section 26 of this General Introduction). However,◁ competent authority approval should be obtained where special requirement "7" or "12" applies for a particular substance, as mentioned in appendix 2 to section 26 of this General Introduction.

13.1.28.3 A number of solid materials (see 24.1.6 of this General Introduction) present no significant hazard when transported in packaged form. These materials are not covered by individual schedules in this Code and, unless otherwise specified*, there are no special requirements when transported in portable tanks.

13.1.28.4 *Special requirements for tanks dedicated to the transport of solid substances which do not liquefy during transport*

.1 The periodic hydraulic pressure tests for tanks used only in the dedicated transport of solid dangerous substances other than toxic or corrosive substances may be replaced by a suitable pressure test at 1.5 times the maximum allowable working pressure, subject to competent authority approval.

.2 Every bottom-discharge tank should be equipped with at least two serially mounted and mutually independent shutoff devices. An internal stop valve is not required.

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* No "special requirements" are currently specified.

.3 The design of the tank and the choice of materials, fittings and service equipment should be suitable for, and compatible with, the substances to be transported.

13.1.30 **Special requirements relating to tanks for the transport of flammable liquids (class 3)**

13.1.30.1 The following general requirements relate particularly to tanks intended for the transport of flammable liquids (class 3). Reference should also be made to the appendix to this subsection, setting out special requirements for individual substances of this class.

13.1.30.2 All tanks intended for the transport of flammable liquids should be closed tanks and be fitted with pressure-relief devices in accordance with 13.1.9 to 13.1.16.

13.1.30.3 In the case of liquids having a vapour pressure of more than 1.75 bar (absolute) at 50°C and a coefficient of cubical expansion of more than 150×10^{-5} the degree of filling for tanks should not exceed 90%.

13.1.40 **Special requirements relating to tanks for the transport of flammable solids, substances liable to spontaneous combustion and substances which, in contact with water, emit flammable gases (class 4)**

13.1.40.1 Reference should be made to the appendix to this subsection, setting out the special requirements for individual substances of this class. No requirements have been included for the majority of class 4.1 solids, since they can be transported quite safely in containers other than tanks.

13.1.50 **Special requirements relating to tanks for the transport of oxidizing substances (class 5.1)**

13.1.50.1 Reference should be made to the appendix to this subsection, setting out special requirements for individual substances to this class.

13.1.55 **Special requirements relating to tanks for the transport of organic peroxides (class 5.2)**

13.1.55.1 Each organic peroxide should have been tested, and a report submitted to the competent authority of the country of origin for approval and notification thereof should be sent to the competent authority of the country of destination. The notification should contain relevant transport information and the report, with test results. The tests undertaken should include those necessary:

- to prove the compatibility of all materials normally in contact with the substance during transport; and
- to provide data to enable the design of the pressure and emergency relief devices, taking into account the design characteristics of the tank.

Any special requirements necessary for the safe transport of the substance should be clearly described in the report.

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13.1.55.2 The following requirements apply to tanks intended for the transport of organic peroxides (type F) with a Self-Accelerating Decomposition Temperature (SADT) of 55°C or more. In case of conflict, these requirements prevail over 13.1 to 13.1.26. Emergencies to be taken into account are the self-accelerating decomposition of the organic peroxide and the fire engulfment as described in 13.1.55.8.

13.1.55.3 Formulations of organic peroxides transported in portable tanks with an SADT less than 55°C have to be subjected to the temperature control requirements given in section 21 of this General Introduction. The additional requirements for transport in tanks of organic peroxides with an SADT less than 55°C should be specified by the competent authority of the country of origin and notification thereof should be sent to the competent authority of the country of destination.

13.1.55.4 Tanks should be designed for a test pressure of at least 0.4 MPa (4 bar).

13.1.55.5 Tanks should be fitted with temperature-sensing devices.

13.1.55.6 Tanks should be fitted with pressure-relief devices and emergency relief devices. Vacuum-relief devices may also be used. Pressure-relief devices should operate at pressures determined according to both the properties of the organic peroxide and the construction characteristics of the tank. Fusible elements are not allowed in the shell of the tank.

13.1.55.7 The pressure-relief devices should consist of spring-loaded valves fitted to prevent significant build-up within the tank of the decomposition products and vapours released at a temperature of 50°C. The capacity and start-to-discharge pressure of the relief valves should be based on the results of the tests specified in 13.1.55.1. The start-to-discharge pressure should, however, in no case be such that liquid would escape from the valve or valves if the tank is overturned.

13.1.55.8 The emergency-relief devices may be of the spring-loaded or frangible types designed to vent all the decomposition products and vapours evolved during a period of not less than one hour of complete fire-engulfment as calculated by the following equations:

$$q = 70961\, F\, A^{0.82}$$

where:

q = heat absorption [W]

A = wetted area [m^2]

F = insulation factor [–];

F = 1 for non-insulated vessels, or

$$F = \frac{U(923 - T_{PO})}{47032} \text{ for insulated vessels}$$

where:

K = heat conductivity of insulation layer [$W \cdot m^{-1} \cdot K^{-1}$]

L = thickness of insulation layer [m]

U = K/L = heat transfer coefficient of the insulation [$W \cdot m^{-2} \cdot K^{-1}$]

T_{PO} = temperature of peroxide at relieving conditions [K]

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The start-to-discharge pressure of the emergency-relief device(s) should be higher than that specified in 13.1.55.7 and based on the results of the tests referred to in 13.1.55.1. The emergency-relief devices should be dimensioned in such a way that the maximum pressure in the tank never exceeds the test pressure of the tank.

Note: An example of a method to determine the size of emergency-relief devices is given in Appendix 5 of the United Nations *Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.*

13.1.55.9 For insulated tanks the capacity and setting of emergency relief device or devices should be determined assuming a loss of insulation of 1% of the surface area.

13.1.55.10 Vacuum-relief devices and spring-loaded valves should be provided with flame arresters. Due attention should be paid to the reduction of the relief capacity caused by the flame arrester.

13.1.55.11 Service equipment such as valves and external piping should be so arranged that no organic peroxide remains in them after filling of the tank.

13.1.55.12 Tanks may be either insulated or protected by a sun shield. If the SADT of the organic peroxide in the tank is 55°C or less, or the tank is constructed of aluminium, the tank should be completely insulated. The outer surface should be finished in white or bright metal.

13.1.55.13 The degree of filling should not exceed 90% at 15°C.

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13.1.55.14 The marking as required in 13.1.20.2 should include the UN Number (UN No.) and the correct technical name with the approved concentration of the organic peroxide concerned.

13.1.60 **Special requirements relating to tanks for the transport of toxic substances (class 6.1)**

13.1.60.1 Reference should be made to the appendix to this subsection setting out the special requirements for individual substances of this class.

13.1.70 **Special requirements relating to tanks for the transport of radioactive materials (class 7)**

13.1.70.1 With the approval of the competent authority of the country of origin, tanks may be used for the transport of radioactive materials listed in section 12 of the introduction to class 7 under the provisions of schedules 1, 5, 6, 9, 10 and 11, except uranium hexafluoride.

13.1.70.2 In addition to the requirements of this section, the provisions of the appropriate class 7 schedule should be applied.

13.1.70.3 The degree of filling for tanks should not exceed 90% or, alternatively, any other value approved by the competent authority.

13.1.70.4 Tanks used for the transport of radioactive material should not be used for the transport of other goods.

13.1.80 **Special requirements relating to tanks for the transport of corrosive substances (class 8)**

13.1.80.1 The following general requirements relate particularly to tanks for the transport of corrosive substances (class 8).

13.1.80.2 The pressure-relief devices of tanks used for the transport of class 8 substances should be inspected at intervals not exceeding one year.

13.1.80.3 Reference should be made to the appendix to this subsection, setting out special requirements for individual substances of this class.

13.1.90 **Special requirements relating to tanks for the transport of marine pollutants included in class 9**

13.1.90.1 A tank used for the transport of an ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S., MARINE POLLUTANT, UN No. 3082, should be at least a type 2 tank as defined in 13.1.2.14.

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13.100 GENERAL REQUIREMENTS FOR PORTABLE TANKS AND ROAD TANK VEHICLES FOR NON-REFRIGERATED LIQUEFIED GASES OF CLASS 2

13.101 **Preamble**

13.101.1 The requirements of this subsection apply to portable tanks (type 5 tanks) and road tank vehicles (type 6 tanks) intended for the transport of non-refrigerated liquefied gases of class 2. In addition to these requirements and unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC), 1972, as amended, should be fulfilled by any portable tank which meets the definition of a "container" within the terms of that Convention. The International Convention for Safe Containers does not apply to offshore tank-containers that are handled in open seas. The design and testing of offshore tank-containers should take into account the dynamic lifting and impact forces that may occur when a tank is handled in open seas in adverse weather and sea conditions. The requirements for such tanks should be determined by the approving competent authority (see MSC/Circ.613 in the annex at the end of this section). Such requirements should be based on MSC/Circ.860 Guidelines for the approval of offshore containers handled in open seas.

13.101.2 In order to take into account progress in science and technology, the use of alternative arrangements which offer at least equivalent safety in use in respect of compatibility with the properties of the gases transported and equivalent or superior resistance to impact, loading and fire may be considered by the national competent authority.

13.101.3 The requirements of this subsection are presented in two parts. The first contains general requirements applicable to portable tanks and road tank vehicles intended for the transport of non-refrigerated liquefied gases of class 2. The second contains the appendix* with a table showing the particular requirements which modify or supplement the general requirements of this subsection for each particular gas.

13.101.3.1 In general, where a substance has not been allocated a UN Number, it should be carried under the most suitable N.O.S. entry. However, the competent authority of the country of origin may issue interim approvals for shipment of gases not listed in the appendix to this subsection to which individual UN Numbers have already been assigned. The approval should accompany the shipment concerned and contain at a minimum the information normally provided in the list of non-refrigerated liquefied gases and the conditions under which the particular gases should be carried. The approval should contain a note to the effect that this competent authority has undertaken action to include this gas in the appendix to subsection 13.100.

13.101.4 Construction, equipment, testing, marking and operation of portable tanks and road tank vehicles should be subject to acceptance by the competent authority of the country in which they are approved.

13.101.5 The requirements of this subsection do not apply to rail tank-wagons, non-metallic tanks or tanks having a capacity of 1,000 litres or less.

13.101.6 IMO type 5 tanks certified prior to the implementation of these revised requirements and constructed in accordance with the requirements in force at the time may be permitted for use with competent authority approval. The approval should refer to this paragraph.

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* The appendix will need updating from time to time in the light of technical progress and to include new substances.

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13.102 **Definitions**

13.102.1 For the purposes of these requirements:

13.102.2 For the purposes of this subsection, *tank* means a portable tank or the carrying tank of a road tank vehicle the shell of which is fitted with items of service equipment and structural equipment necessary for the transport of gases. A tank should be capable of being transported, loaded and discharged without the need of removal of its structural equipment.

13.102.3 *Shell* means the pressure vessel proper, including openings and their closures.

13.102.4 *Service equipment of a shell* means filling and discharge, venting, safety, heating and heat-insulating devices and measuring instruments.

13.102.5 *Structural equipment* means the reinforcing, fastening, protective and stabilizing members external to the shell and for a road tank vehicle includes fastenings to running gear or chassis.

13.102.6 *Maximum allowable working pressure (MAWP)* means the maximum gauge pressure permissible at the top of the tank in its operating position. It may be no less than the vapour pressure at the design reference temperature less one bar of any product which can be loaded and carried, and any pressure which might be used during loading or unloading. In no case should the MAWP be less than 7 bar.

13.102.7 *Test pressure* means the highest pressure which arises in the shell during the hydraulic pressure test.

13.102.8 *Discharge pressure* means the highest pressure actually built up in the shell when it is being discharged by pressure.

13.102.9 *Leakage test* is the test which submits the shell, complete with those items of service equipment necessary for filling, discharge, safety and measuring, to an effective internal pressure equivalent to the MAWP. The procedure to be adopted should be approved by the competent authority.

13.102.10 *Total mass* means the mass of the portable tank or road tank vehicle with the heaviest load authorized for transport.

13.102.11 *Design reference temperature* means the temperature at which the vapour pressure of the tank contents is determined for the purpose of calculating the MAWP.

The design reference temperature should be less than the critical temperature of the gas to be transported to ensure that the gas at all times is liquefied.

For portable tanks the temperature to be taken is as follows :

.1 for a tank with a diameter of 1.5 metres or less: 65°C;

.2 for a tank with a diameter of more than 1.5 metres:

.2.1 without insulation or sun shield: 60°C;

.2.2 with sun shield: 55°C; and

.2.3 with insulation: 50°C.*

For a road tank vehicle the temperature to be taken is to be agreed by the competent authorities.

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* This reference temperature is envisaged but dependent on the quality of the insulation system.

13.102.12 *Mild steel* means a steel with a guaranteed minimum tensile strength of 360 N/mm^2 and a guaranteed minimum percentage elongation of 27.

13.102.13 *Filling ratio* means the average mass of gas in kg per litre of tank capacity (kg/*l*).

13.102.14 *Type 5 tank* means a portable tank as defined in 13.102.2 fitted with pressure-relief devices. It should be capable of being lifted when full and its contents should not be loaded or discharged whilst the tank remains on board ship.

13.102.15 *Type 6* tank means a road tank vehicle and includes a semi-trailer with a permanently attached tank as defined in 13.102.2 fitted with pressure-relief devices. It should be fitted with permanent attachments such that it can be secured on board ship; however, its contents should not be loaded or discharged whilst the vehicle remains on board.

A road tank vehicle should be carried only on short international voyages.

13.102.16 *Short international voyage* means an international voyage in the course of which a ship is not more than 200 miles from a port or place in which the passengers and crew could be placed in safety.

Neither the distance between the last port of call in the country in which the voyage begins and the final port of destination nor the return voyage shall exceed 600 miles. The final port of destination is the last port of call in the scheduled voyage at which the ship commences its return voyage to the country in which the voyage began.

13.102.17 *Long international voyage* means an international voyage that is not a short international voyage.

13.102.18 *Competent authorities* means, in respect of those requirements solely applicable to road tank vehicles, the authority concerned with approval for transport by sea and also the authority concerned with approval for international transport by road. Where the latter authority does not exist, the relevant national authority should be substituted.

13.103 **General requirements for the construction and operation of tanks for non-refrigerated liquefied gases**

13.103.1 Shells should be made of steel suitable for shaping. For welded shells only a material whose weldability has been fully demonstrated should be used. If the manufacture-procedure or the materials make it necessary, the tanks should be heat-treated with a suitable heat treatment both after welding operations and after forming. Welds should be skilfully made and afford complete safety. Tank materials should be suitable for the external environment in which they may be carried, e.g. the marine environment. The use of aluminium as a material of construction should be specifically authorized for use in the marine mode in the appendix. In those cases where aluminium is authorized, it should be insulated to prevent significant loss of physical properties when it is subjected to a heat load of 2.60 $gcal/cm^2.s$ for a period of 30 minutes. The insulation system should remain effective at all temperatures of up to 650°C and should be jacketed with a material with a melting point of not less than 650°C. The insulation system should be approved by the competent authority. Steel should be resistant to brittle fracture and to fissuring corrosion under stress. For portable tanks the temperature range to be taken into account should be between −30°C and the design reference temperature unless more stringent conditions are specified by the competent authority. For road tank vehicles the temperature range is to be agreed by the competent authorities.

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13.103.2 Tanks, fittings and pipework should be constructed of material which is either:

.1 substantially immune to attack by the gas transported; or

.2 properly passivated or neutralized by chemical reaction with that gas.

13.103.3 Gaskets, where used, should be made of materials not subject to attack by the contents of the tank.

13.103.4 Care should be taken to avoid damage by galvanic action due to the juxtapositon of dissimilar metals.

13.103.5 The tanks, including any devices, appendages, coverings or fittings that can be expected to come into contact with the contents, should be constructed of materials that cannot be damaged by or enter into dangerous reactions with the contents.

13.103.6 Portable tanks should be designed and fabricated with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

Road tanks vehicles should be fitted with tie-down attachments and secured on board in such a way that the suspension is not left in free play.*

13.103.7 Shells, their attachments and their service and structural equipment should be designed to withstand, without loss of contents, at least the internal pressure due to the contents, plus the most severe combination of the static and dynamic stresses in normal handling and transport. For tanks that are intended for use as offshore tank-containers the dynamic stresses imposed by handling in open seas should be taken into account.

13.103.8 Tanks should be manufactured to a technical code recognized by the competent authority. Shells should be designed, manufactured and tested in accordance with a recognized pressure vessel code, taking into account corrosion, mass of contents, MAWP and, if applicable, the effect of superimposed stresses due to dynamic forces in accordance with 13.103.10.

13.103.9 Tanks should be designed to withstand an external pressure of at least 0.4 bar gauge above the internal pressure without permanent deformation.

When the tank is to be subjected to a significant vacuum before loading or during discharge, it should be designed to withstand an external pressure of at least 0.9 bar gauge and should be proven to that pressure.

13.103.10 The minimum dynamic loads to be withstood should be based on:

.1 in the direction of travel: twice the total mass;

.2 horizontally at right angles to the direction of travel: the total mass (where the direction of travel is not clearly determined, the maximum permissible load should be equal to twice the total mass);

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* Attention is drawn to the *Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro–Ro Ships* (resolution A.581(14)) (see the Supplement to this Code).

.3 vertically upwards: the total mass; and

.4 vertically downwards: twice the total mass (total loading, including the effect of gravity).

The said loads should be considered separately.

13.103.11 Where portable tanks are transported on vehicles, the fastenings of tank and vehicle should be capable of absorbing the forces specified in 13.103.10.

13.103.12 Tanks intended to contain certain gases, listed in the appendix, should be provided with additional protection, which may take the form of additional thickness of the shell or a higher test pressure, the additional thickness or higher test pressure being determined in the light of the dangers inherent in the substances concerned; or of a protective device approved by the competent authority.

13.103.13 Thermal insulation systems should satisfy the following requirements:

.1 If the shells of tanks intended for the transport of gases are equipped with thermal insulation, such insulation should either:

.1.1 consist of a shield covering not less than the upper third but not more than the upper half of the tank's surface and separated from the shell by an air space about 4 cm across; or

.1.2 consist of a complete cladding of adequate thickness of insulating materials protected so as to prevent the ingress of moisture and damage under normal transport conditions.

If the protected covering is so closed as to be gastight, a device should be provided to prevent any dangerous pressure from developing in the insulation layer in the event of inadequate gastightness of the shell or of its items of equipment.

.2 The thermal insulation should be so designed as not to hinder access to the fittings and discharge devices.

13.104 **Cross-sectional design**

13.104.1 Tanks should be of a circular cross-section.

13.104.2 Tanks should be designed and constructed to withstand a test pressure equal to at least 1.3 times the MAWP.

Specific requirements are laid down for various gases in the appendix.

Attention is also drawn to the minimum shell thickness requirements specified in 13.105.1 to 13.105.2.

13.104.3 Having regard to the risk of brittle fracture, the maximum and minimum filling and tank working temperatures should be taken into account when choosing materials and determining wall thickness. Material properties should be to the satisfaction of the competent authority.

13.104.4 At the test pressure the primary membrane stress in the shell should conform to the material-dependent limitations prescribed below:

.1 for metals and alloys exhibiting a clearly defined yield point or characterized by a guaranteed conventional yield stress *R*e (generally 0.2% residual elongation; for austenitic steels, 1% residual elongation), the stress should not exceed 0.75*R*e or 0.50*R*m, whichever is lower;

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.2 the elongation at fracture of steel, in per cent, should not be less than $\frac{10,000}{Rm}$, with an absolute minimum of 20%;

the elongation at fracture of aluminium, in per cent, should not be less than $\frac{10,000}{6Rm}$, with an absolute minimum of 12%;

.3 Rm is the guaranteed minimum tensile strength, given in N/mm^2; and

.4 when fine-grain steel is used for road tank vehicles, the minimum elongation at fracture of material used is to be agreed between the competent authorities but should not be less than 16%.

13.104.5 It should be noted that the specimens used to determine the elongation at fracture should be taken transversely to the direction of rolling and be so secured that:

$$L_o = 5d,$$

or

$$L_o = 5.65\sqrt{A}$$

where :

L_o = gauge length of the specimen before the test;

d = diameter; and

A = cross-sectional area of the test specimen.

13.105 **Minimum shell thickness**

13.105.1 The cylindrical portions and ends of all tanks should have a thickness not less than that determined by the following formula:*

$$e = \frac{C}{\sqrt[3]{Rm \times A}}$$

where:

e = minimum required thickness of the metal to be used in mm;

Rm = guaranteed minimum tensile strength of the metal to be used in N/mm^2;

A = guaranteed minimum elongation (as a percentage) of the metal to be used on fracture under tensile stress, see 13.104.4;

C = 107 (equivalent to 5 mm mild steel) for tanks of not more than 1.80 m in diameter; and

C = 128 (equivalent to 6 mm mild steel) for tanks of more than 1.80 m in diameter.

* The constant C is derived from the following formula: $e\sqrt[3]{Rm \times A} = e_o\sqrt[3]{Rm_o \times A_o}$, where the sub-index 'o' refers to mild steel and the part of the equation without sub-index 'o' refers to the metal used. The relationship with mild steel as employed by this Code is attached to the constant C, where $C = e_o\sqrt[3]{Rm_o \times A_o}$.

13.105.2 The cylindrical portions and ends of all tanks should have a thickness of at least 4 mm regardless of the materials of construction.

13.105.3 There should be no sudden change in plate thickness at the attachment of the head to the cylindrical portion of the shell, and after forming the head the plate thickness at the knuckle should not be less than the minimum thickness required by this subsection.

13.105.4 In no case should the wall thickness of any portion of the shell be less than that prescribed in this subsection.

13.106 **Service equipment**

13.106.1 Service equipment (valves, fittings, safety devices, gauging devices and the like) should be arranged so as to be protected against the risk of being wrenched off or damaged during transport and handling. If the connection between any tank and framework or any tank and running gear or chassis allows relative movement as between the sub-assemblies, the equipment should be so fastened as to permit such movement without risk of damage to working parts. Equipment protection should offer a degree of safety comparable to that of the tank shell. For offshore tank-containers, where positioning of service equipment and the design and strength of protection for such equipment is concerned, the increased danger of impact damage when handling such tanks in open seas should be taken into account.

13.106.2 All orifices in the shell more than 1.5 mm in diameter except those for safety valves, inspection openings or closed bleed holes should be provided with three mutually independent shutoff devices in series, the first being an internal stop valve, flow-restricting valve or equivalent device, the second being an external stop valve and the third being a blank flange or equivalent device.

13.106.2.1 A flow-restricting valve should be so fitted that its seating is inside the shell or inside a welded flange or if fitted externally its mountings should be designed so that in the event of impact its effectiveness should be maintained.

13.106.2.2 Flow-restricting valves should be selected and fitted so as to close automatically when the rated flow specified by the manufacturer is reached.

Connections and accessories leading to or from such a valve should have the capacity for a flow greater than the rated flow of the flow-restricting valve.

13.106.3 For filling and discharge openings the first shutoff device should be an internal stop valve and the second should be a stop valve placed in an accessible position on each discharge or filling pipe.

13.106.4 For filling and discharge openings of tanks intended for the transport of flammable or toxic gases, the internal stop valve should be an instant-closing safety device which closes automatically in the event of unintended movement of the tank or fire engulfment. It should also be possible to operate this device by remote control.

13.106.5 The shells of tanks may be equipped, in addition to filling, discharge and gas pressure equalizing orifices, with openings in which gauges, thermometers and manometers can be fitted.

Connections for such instruments must be made by suitably welded nozzles or pockets and not be screwed connections through the shell.

13.106.6 A tank should be provided with an opening large enough for the tank to be inspected internally.

13.106.7 For portable tanks, external fittings should be grouped together.

13.106.8 All tank connections should be clearly marked to indicate the function of each.

13.106.9 Stop valves with screwed spindles should close by clockwise rotation.

13.106.10 All piping should be of suitable material. Welded pipe joints should be used. Non-malleable metals should not be used in the construction of valves or accessories. The bursting strength of all piping and pipe fittings should be at least four times the strength at the MAWP of the tank and at least four times the strength at the pressure to which the tank may be subjected in service by the action of a pump or other device (except pressure-relief valves), the action of which may subject portions of the piping to pressures greater than the tank MAWP. Suitable provisions should be made in every case to prevent damage to piping due to thermal expansion and contraction, jarring and vibration.

13.106.11 Tanks intended for the transport of flammable gases should be capable of being electrically earthed.

13.107 **Bottom openings**

13.107.1 For certain gases listed in the appendix, shell openings in portable tanks below the liquid level are not allowed for any purpose.

Openings in the shell of a road tank vehicle should be subject to the agreement of the competent authorities.

13.108 **Pressure-relief devices**

13.108.1 Tanks should be provided with one or more spring-loaded pressure-relief devices of a type that will resist dynamic forces, including surge. Frangible discs not in series with a spring-loaded pressure-relief device are not permitted.

For portable tanks the devices should open at a pressure not less than 1.0 times the MAWP and be fully open at a pressure of 1.1 times the MAWP.

For road tank vehicles the devices should open at a pressure not less than 1.0 times the MAWP and be fully open at a pressure not exceeding the test pressure.

The devices should, after discharge, close at a pressure not lower than 10% below the pressure at which discharge starts and should remain closed at all lower pressures.

13.108.2 Pressure-relief devices should be designed to prevent the entry of foreign matter, the leakage of gas and the development of any dangerous excess pressure.

13.108.3 Tanks for the transport of certain gases listed in the appendix should have a pressure-relief device approved by the competent authority. The pressure-relief device arrangement should comprise a spring-loaded pressure-relief valve preceded by a frangible disc, except that a tank in dedicated service may be fitted with an approved relief system offering an equivalent hermetic seal. The space between the frangible disc and the valve should be provided with a pressure

gauge or a suitable tell-tale indicator. This arrangement permits the detection of disc rupture, pinholing or leakage which could cause a malfunction of the device. The frangible disc, in this instance, should rupture at the start-to-discharge pressure of the relief valve.

13.108.4 It should be noted that the safety device should operate only in conditions of excessive rise in temperature, as the tank will not, during transport, be subject to undue fluctuations of pressure due to operating procedures (see, however, 13.109.1).

13.109 **Capacity of pressure-relief devices**

13.109.1 For portable tanks the combined delivery capacity of the devices should be such that, in the event of total fire engulfment, the pressure (including accumulation) inside the shell does not exceed 1.1 times the MAWP. Spring-loaded pressure-relief devices should be used to achieve the full relief capacity prescribed.

13.109.1.1 To determine the total required capacity of the devices, which may be regarded as being the sum of the individual capacities of the several devices, the following formula* may be used:

$$Q = 12.4 \frac{FA^{0.82}}{LC} \sqrt{\frac{ZT}{M}}$$

where:

the accumulating condition is 20% above the start-to-discharge pressure of the relief device;

Q is the minimum required rate of discharge in cubic metres of air per second at standard conditions: 1 bar and 0°C (273 K);

F is a coefficient with the following value:

.1 for uninsulated tanks $F = 1$

.2 for insulated tanks $F = U(649 - t)/13.6$ but in no case is less than 0.25

where:

U = thermal conductance of the insulation, in kW/(m^2 K), at 38°C

t = actual temperature of the substance at loading (°C); if this temperature is unknown, let t = 15°C;

The value of F given in .2 above may be taken provided that:

the insulation is jacketed with a material having a melting point not less than 649°C; and

the insulation system will remain effective at all temperatures up to 649°C;

A is the total external surface area of tank in square metres;

Z is the gas compressibility factor in the accumulating condition (if this factor is unknown, let Z equal 1.0);

T is the absolute temperature in kelvin (°C + 273) above the pressure-relief devices and in the accumulating condition;

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* This formula applies only to liquefied gases which have critical temperatures well above the temperature at the accumulating condition. For gases which have critical temperatures near or below the temperature at the accumulating condition, the calculation of the pressure-relief device delivery capacity should consider further thermodynamic properties of the gas.

L is the latent heat of vaporization of the liquid, in kJ/kg, in the accumulating condition;

M is the molecular mass of the discharged gas;

C is the constant which is derived from equation (2) as a function of the ratio k of specific heats:

$$k = \frac{C_p}{C_v} \qquad (1)$$

where:

C_p is the specific heat at constant pressure and

C_v is the specific heat at constant volume;

$$\left.\begin{array}{ll} C = \sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}} & \text{when } k > 1 \text{ In this case } C \text{ may be taken from the table below.} \\ C = \frac{1}{\sqrt{e}} = 0.607 & \text{when } k = 1 \text{ or } k \text{ is unknown} \end{array}\right\} \quad (2)$$

where:

e is the mathematical constant 2.7183.

VALUES FOR THE CONSTANT C WHEN $k > 1$

k	C	k	C	k	C
1.00	0.607	1.26	0.660	1.52	0.704
1.02	0.611	1.28	0.664	1.54	0.707
1.04	0.615	1.30	0.667	1.56	0.710
1.06	0.620	1.32	0.671	1.58	0.713
1.08	0.624	1.34	0.674	1.60	0.716
1.10	0.628	1.36	0.678	1.62	0.719
1.12	0.633	1.38	0.681	1.64	0.722
1.14	0.637	1.40	0.685	1.66	0.725
1.16	0.641	1.42	0.688	1.68	0.728
1.18	0.645	1.44	0.691	1.70	0.731
1.20	0.649	1.46	0.695	2.00	0.770
1.22	0.652	1.48	0.698	2.20	0.793
1.24	0.656	1.50	0.701		

13.109.2 For road tank vehicles the delivery capacity of the pressure-relief devices should be subject to the agreement of the competent authorities.

13.110 **Marking of pressure-relief devices**

13.110.1 Every pressure-relief device of a portable tank should be plainly and permanently marked with the pressure at which it is set to discharge and the rated free-air delivery of the device at 15°C and one bar. Capacity marked on devices should be as rated at a pressure not greater than 110% of the set pressure.

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13.111 **Connections to pressure-relief devices**

13.111.1 Connections to pressure-relief devices should be of sufficient size to enable the required discharge to pass unrestricted to the device. No stop valve should be installed between the tank shell and the pressure-relief devices except where duplicate equivalent devices are provided for maintenance and the stop valves serving the devices actually in use are locked open or the stop valves are interlocked so that at least one of the duplicate devices is always in use. Vents from the pressure-relief devices, where used, should deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the device.

13.112 **Siting of pressure-relief devices**

13.112.1 Pressure-relief device inlets should be sited on top of any portable tank in a position as near the longitudinal and transverse centre of the tank as possible.

All pressure-relief device inlets should be situated in the vapour space of the tanks and the devices so arranged as to ensure that the escaping vapour is discharged unrestricted and in such a manner that it cannot impinge upon the tank shell. Protective devices which deflect the flow of vapour are permissible provided the required valve capacity is not reduced.

13.112.2 Arrangements should be made to prevent access to the devices by unauthorized persons and to protect the devices from damage caused by the tank overturning.

13.113 **Gauging devices**

13.113.1 Glass level-gauges, or gauges made of other easily destructible material, which are in direct communication with the contents of the tank should not be used.

13.114 **Tank support, frameworks, lifting and tie-down attachments***

13.114.1 Tanks should be designed and fabricated with a support structure to provide a secure base during transport. Skids, frameworks, cradles or other similar devices are acceptable. Cradles or other devices attaching a tank to the chassis or running gear of a road tank vehicle are acceptable.

The loads specified in 13.103.10 should be taken into account in this aspect of design.

13.114.1.1 Under each of these loads for portable tanks, the safety factors to be observed should be as follows:

.1 for metals having a clearly defined yield point, a safety factor of 1.5 in relation to the determined yield stress; or

.2 for metals with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2% proof stress.

13.114.2 For road tank vehicles, the stress levels due to each load should not exceed those permitted in 13.104.4.1.

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* See also IMO Assembly resolution A.581(14) of 20 November 1985, *Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro–Ro Ships* (see the Supplement to this Code).

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13.114.3 If the landing legs of a road tank vehicle are to be used as support structure, the loads specified in 13.103.10 should be taken into account in their design and method of attachment. Any bending stress induced in the shell as a result of this manner of support should also be included in the design calculations.

13.114.4 The combined stresses caused by tank mountings (e.g. cradles, frameworks, etc.) and tank lifting and tie-down attachments should not cause excessive stress in any portion of the tank shell.

13.114.4.1 Permanent lifting and permanent tie-down attachments should be fitted to all portable tanks. Permanent tie-down attachments should be fitted to all road tank vehicles. Lifting and tie-down attachments should preferably be fitted to the tank support structure but they may be secured to the reinforcing plates located on the shell at the points of support, bearing in mind the provisions of 13.115.7.

13.114.5 Securing arrangements (tie-down attachments) should be fitted to the tank support structure and the towing vehicle of a road tank vehicle. Semi-trailers unaccompanied by a towing vehicle should be accepted for shipment only if the trailer supports and the securing arrangements and the position of stowage are agreed with the competent authority.

13.114.6 In the design of supports and frameworks, due regard should be paid to the effects of environmental corrosion, and in calculations for all structural members not constructed of corrosion-resistant materials a minimum corrosion allowance, determined by the competent authority, should be provided.

13.114.7 Portable tank frameworks intended to be lifted or secured by their corner castings should be subjected to internationally accepted special tests, for example the ISO system. The use of such frameworks within an integrated system is generally encouraged. Offshore tank-containers should be subjected to tests that take into account the dynamic lifting and impact forces that may occur when a tank is handled in open seas.

13.114.8 Fork-lift pockets of portable tanks should be capable of being closed off.

13.115 **Approval, testing and marking of type 5 tanks**

13.115.1 The competent approval authority or a body authorized by that authority should issue, in respect of every new design of a tank, a certificate attesting that the tank and its attachments surveyed by that authority or that body are suitable for the purpose for which they are intended and meet the construction and equipment requirements of this subsection and, where appropriate, the particular requirements for the gases in the appendix to this subsection. Such certificate should show the gases or group of gases allowed to be transported in the tank. The prototype test results, the gases for whose transport the tank is approved and an approval number should be specified in a test report. If a series of tanks are manufactured without change in structural design, this approval should be deemed to be a design approval. The approval number should consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic, as prescribed by the Convention on Road Traffic, Vienna, 1968, and a registration number.

13.115.2 Design approval should be given in respect of at least one tank of each design and each size, it being, however, understood that a set of tests made on a tank of one size may serve for the approval of smaller tanks made of a material of the same kind and thickness by the same fabrication technique and with identical supports and equivalent closures and other appurtenances.

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13.115.3 The shell and items of equipment of each tank should be inspected and tested, either together or separately, first before being put into service (initial inspection and test) and thereafter at not more than five-year intervals (periodic inspection and test).

13.115.3.1 The initial inspection and test should include a check of the design characteristics, and internal and external examination and a hydraulic pressure test. If the shell and equipment have been pressure-tested separately, they should together be subjected after assembly to a leakage test. All welds in the shell should be tested in the initial inspection by radiographic, ultrasonic or another suitable non-destructive method. This does not apply to the metal sheathing of an insulation.

13.115.3.2 The periodic inspections and tests should include an internal and external examination and, as a general rule, a pressure test.

13.115.3.2.1 Sheathing thermal insulation and the like should be removed only to the extent required for reliable appraisal of the tank's condition.

13.115.3.3 The initial and periodic pressure tests should be carried out by an expert approved by the competent authority, at the test pressure indicated on the data plate of the tank except in cases where periodic tests at lower test pressures are authorized.

13.115.3.4 While under pressure, the tank should be inspected for leakage or other conditions which indicate weaknesses that might render the tank unsafe in transport, and if any evidence of such unsafe condition is discovered, the tank should not be placed in or returned to service until it has been repaired and the test, repeated, has been passed.

13.115.4 Before tanks are put into service, and thereafter at intervals midway between the inspections and tests specified in 13.115.3, the following tests and inspections should be performed:

.1 a leakage test, where required;

.2 a test of satisfactory operation of all service equipment; and

.3 an internal and external inspection of the tanks and their fittings with due regard to the gases transported.

13.115.5 The 2.5 year (midway) inspection and test may be carried out within 3 months of the specified date. The date of the 2.5 year inspection should be durably marked on or as near as possible to the metal identification plate required in 13.117.1. When marking is not done on the plate, the characters should be at least 32 mm in height and of a contrasting colour to the tank.

13.115.6 The 2.5 year internal inspections may be waived or substituted by other test methods by the competent authority in the case of tanks intended for the transport of one substance. A portable tank may not be filled and offered for transport after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 13.1.19.3 and 13.1.19.4/13.115.3 and 13.115.4/13.213.3 and 13.213.4. However, a portable tank filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be transported after the date of expiry of the last periodic test and inspection:

.1 After emptying but before cleaning, for purposes of performing the next required test and inspection prior to refilling; and

.2 Unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test and inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this authorization should be entered in the dangerous goods shipping document.

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13.115.7 When a tank, other than its shell, is damaged it should not be allowed for use unless it has been repaired, so as to comply with these requirements. When the shell is damaged, it should be repaired and retested in conformity with 13.115.8.

13.115.8 In all cases where cutting, burning or welding operations on the shell of a tank have been effected, that work should be to the approval of the competent authority and a hydrostatic test to at least the original test pressure should be carried out.

13.115.9 A certificate from the competent authority or its approved inspecting agency affirming that the tank complies with the requirements of this Code should be issued and should be retained by the authority and the owners during the time the tank is in service. All information required in 13.117.1 and 13.117.2 should also be included in this certificate.

13.116 **Approval, testing and marking of type 6 tanks**

13.116.1 Road tank vehicles are to be authorized for short international voyages only.

13.116.2 For any road tank vehicles intended for transport of a substance listed in the appendix to this subsection, there should be in existence a valid certificate issued by or on behalf of the competent authority for road transport authorizing transport of that substance by road.

13.116.3 The competent authority for sea transport or a body authorized by that authority should issue additionally in respect of a road tank vehicle a certificate attesting compliance with the relevant design, construction and equipment requirements of this subsection and, where appropriate, the special requirements for the gases listed in the appendix to this subsection. The certificate should list the gases allowed to be transported.

13.116.4 A road tank vehicle should be periodically tested and inspected in accordance with the requirements of the competent authority for road transport.

13.116.5 Road tank vehicles should be marked in accordance with 13.117. However, where the marking required by the competent authority for road transport is substantially in agreement with that of 13.117.1, it will be sufficient to endorse the plate attached to the road tank vehicle with "IMO type 6".

13.117 **Marking**

13.117.1 Every tank should be fitted with a corrosion-resistant metal plate permanently attached in a place readily accessible for inspection. At least the following particulars should be marked on the plate in characters at least 3 mm in height by stamping, engraving, embossing or any similar method. If, for reasons of tank arrangements, the plate cannot be permanently attached to the shell, the shell should be marked with at least those particulars required by a recognized pressure vessel code in a manner prescribed by that code.

The plate should be kept free of any paint to ensure that the markings will be legible at all times.

Country of manufacture . . . . . .

IMO tank type no. . . . . Approval country . . . . . Approval number . . . . . .

Manufacturer's name or mark . . . . . .

Registration number . . . . . .

Year of manufacture . . . . . .

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Test pressure ..... (bar)/(MPa)* gauge

Maximum allowable working pressure ..... (bar)/(MPa)* gauge

Water capacity at 20°C ..... (litres)

(The water capacity should be established to within 1% by practical test rather than by calculation.)

Original hydrostatic test date and witness identification .....

Code to which tank is designed .....

Design reference temperature ..... (°C)

Metallurgic design temperature (only if below –30°C) .....

Tank material .....

Equivalent thickness in mild steel ..... (mm)

Month, year and test pressure of most recent periodic test:

..... month ..... year ..... (bar)/(MPa)* gauge

13.117.2 The following particulars should be marked either on the tank itself or on a metal plate firmly secured to the tank.

Names of owner and operator .....

Name of gas being carried (and maximum mean bulk temperature if other than 50°C) .....

.....

Date of the last inspection .....

Maximum permissible gross mass ..... (kg)

Unladen (tare) mass ..... (kg)

13.117.3 If a tank is designed and approved for handling in open seas, the words OFFSHORE CONTAINER should be marked on the identification plate.

13.117.4 The contents should be identified as specified in sections 7, 8 and 9 of the General Introduction to this Code.

13.117.5 Unless the name of the gas being transported appears on the metal plate specified in 13.117.2, a copy of the certificate specified in 13.115.1 should be made available upon request of a competent authority and readily provided by the consignor, consignee or agent, as appropriate.

* The unit used should be marked.

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13.118 **Transport requirements**

13.118.1 Tanks should not be offered for transport:

.1 in an ullage condition liable to produce an unacceptable hydraulic force due to surge within the tank;

.2 when leaking;

.3 when damaged to such an extent that the integrity of the tank or its lifting or securing arrangements may be affected; and

.4 unless the service equipment has been examined and found to be in good working order.

13.118.2 Empty tanks not cleaned and not gas-free should comply with the same requirements as tanks filled with the substance previously carried.

13.118.3 During transport, portable tanks should be adequately protected against lateral and longitudinal impact and against overturning. If the shells and the service equipment are so constructed as to withstand impact or overturning they need not be protected in this way.

Examples of protection of shells against collision:

.1 protection against lateral impact may consist, for example, of longitudinal bars protecting the shell on both sides at the level of the median line;

.2 protection of tanks against overturning may consist, for example, of reinforcement rings or bars fixed across the frame;

.3 protection against rear impact may consist of a bumper or frame;

.4 external fittings should be designed or protected so as to preclude the release of contents upon impact or overturning of the tank upon the fittings.

13.118.4 Certain gases are chemically unstable. They are to be accepted for transport only if the necessary steps have been taken to prevent their dangerous decomposition, transformation or polymerization during transport. To this end, care should in particular be taken to ensure that tanks do not contain any substances liable to promote these reactions.

13.119 **Filling**

13.119.1 The maximum mass of liquefied gas per litre of tank capacity (kg/*l*) should not exceed the density of liquefied gas at 50°C multiplied by 0.95. Furthermore, the tank should not be liquid-full at 60°C.

13.119.2 During filling, the temperature of the liquefied gas should fall within the limits of the metallurgic design temperature.

13.119.3 Tanks should not be filled above their maximum permissible gross mass.

13.120 **Stowage and segregation**

13.120.1 Tanks should be stowed in accordance with the requirements of the individual schedules and section 14 of this General Introduction.

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13.120.2 If a tank is to be shipped containing a non-refrigerated liquefied gas for which the individual schedule shows one or more secondary labels, due consideration should be given to all properties of that gas and stowage should be arranged accordingly.

13.120.3 Portable tanks should not be overstowed unless they are designed for that purpose and transported in specially designed ships, or unless they are specially protected to the satisfaction of the competent authority.

13.120.4 Tanks containing non-refrigerated liquefied gases should be segregated in accordance with the requirements of section 15 of this General Introduction.

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13.200 GENERAL REQUIREMENTS FOR PORTABLE TANKS AND ROAD TANK VEHICLES FOR REFRIGERATED LIQUEFIED GASES OF CLASS 2

13.201 Preamble

13.201.1 The requirements of this subsection apply to portable tanks (type 7 tanks) and road tank vehicles (type 8 tanks) intended for the transport of refrigerated liquefied gases of class 2. In addition to the requirements of this subsection and unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC), 1972, as amended, should be fulfilled by any portable tank which meets the definition of a "container" within the terms of that Convention. The International Convention for Safe Containers does not apply to offshore tank-containers that are handled in open seas. The design and testing of offshore tank-containers should take into account the dynamic lifting and impact forces that may occur when a tank is handled in open seas in adverse weather and sea conditions. The requirements for such tanks should be determined by the approving competent authority (see also MSC/Circ.613 in the annex at the end of this section). Such requirements should be based on MSC/Circ.860 Guidelines for the approval of offshore containers handled in open seas.

13.201.2 In order to take into account progress in science and technology, the use of alternative arrangements which offer at least equivalent safety in use in respect of compatibility with the properties of the substances transported and equivalent or superior resistance to impact, loading and fire may be considered by the national competent authority.

13.201.3 Existing tanks and their service equipment not conforming strictly to the requirements set forth, but having acceptable alternatives, may be considered by the competent authority for approval. In the approval it should be clearly stated that the basis for the issue of the certificate is this paragraph. In the certificate the entry should read: "Approved in accordance with 13.201.3 of the IMDG Code".

13.201.4 The appendix* to this subsection comprises the list of dangerous substances and also indicates any special requirements which modify or supplement these general requirements for each particular substance.

13.201.5 Construction, equipment, testing, marking and operation of portable tanks and road tank vehicles should be subject to acceptance by the competent authority of the country in which they are approved.

13.201.6 These requirements do not apply to rail tank-wagons, non-metallic tanks or tanks having a capacity of 1,000 litres or less.

13.202 Definitions

13.202.1 For the purposes of these requirements:

13.202.2 *Type 7 tank* means a thermally insulated portable tank fitted with items of service and structural equipment necessary for the transport of refrigerated liquefied gases. The portable tank should be capable of being transported, loaded and discharged without the need of removal of its

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* The appendix will need updating from time to time in the light of technical progress and to include new substances.

structural equipment, and should be capable of being lifted when full. It should not be permanently secured on board the ship. Its contents should not be loaded or discharged while the portable tank remains on board.

13.202.2.1 *Type 8 tank* means a road tank vehicle and includes a semi-trailer with a permanently attached thermally insulated tank fitted with items of service equipment and structural equipment necessary for the transport of refrigerated liquefied gases. It should be fitted with permanent attachments such that it can be secured on board ship. However, its contents should not be loaded or discharged whilst the vehicle remains on board. A road tank vehicle should only be carried on short international voyages.

13.202.3 *Tank* means a construction which normally consists of:

.1 a jacket and one or more inner shells where the space between the shell or shells and the jacket incorporates thermal insulation and is exhausted of air (vacuum insulation); or

.2 a jacket and an inner shell with an intermediate layer of solid thermally insulating material (e.g. solid foam); or

.3 an outer shell with an inner layer of solid thermally insulating material.

13.202.4 *Shell* means a pressure vessel proper, including openings and their closures.

13.202.5 *Service equipment of a tank* means filling and discharge, venting, safety, thermal-insulating devices and measuring instruments.

13.202.6 *Structural equipment* means the reinforcing, fastening, protective and stabilizing members external to a tank and includes, for a road tank vehicle, fastenings to running gear or chassis.

13.202.7 *Maximum allowable working pressure (MAWP)* means the maximum effective gauge pressure permissible at the top of the shell of a loaded tank in its operating position.

13.202.8 *Test pressure* means the maximum gauge pressure which arises in the shell during the pressure test.

13.202.9 *Leakage test* means a test which consists of subjecting the shell, complete with its service equipment, to an effective internal pressure equivalent to the MAWP. The procedure to be adopted should be approved by the competent authority.

13.202.10 *Total mass* means the mass of the portable tank or road tank vehicle with the heaviest load authorized for transport.

13.202.11 *Holding time* means the time that will elapse from the moment the liquid starts boiling at atmospheric pressure up to the moment the pressure of the tank contents reaches the MAWP under equilibrium conditions.

13.202.12 *Minimum design temperature* means the lowest contents temperature at which the tank can be used.

13.202.13 *Short international voyage* means an international voyage in the course of which a ship is not more than 200 miles from a port or place in which the passengers and crew could be placed in safety. Neither the distance between the last port of call in the country in which the voyage begins

and the final port of destination nor the return voyage shall exceed 600 miles. The final port of destination is the last port of call in the scheduled voyage at which the ship commences its return voyage to the country in which the voyage began.

13.202.14 *Long international voyage* means an international voyage that is not a short international voyage.

13.202.15 *Competent authorities* means, in respect of those requirements solely applicable to road tank vehicles, the authority concerned with approval for transport by sea and also the authority concerned with approval for international transport by road. Where the latter does not exist, the relevant national authority should be substituted.

13.203 **General requirements for the design, construction and operation of tanks for refrigerated liquefied gases**

13.203.1 Shells should be made of steel, aluminium or aluminium alloys, suitable for shaping and of adequate ductility and toughness at the minimum design temperature, having regard to the risk of brittle fracture. Only materials whose weldability has been fully demonstrated should be used. Welds should be skillfully made and afford complete safety and, if the manufacturing procedure of the material so requires, the shell should be suitably heat-treated to guarantee adequate toughness in the weld and in the heat-affected zones.

13.203.1.1 Jackets should be made of steel. Jackets of aluminium may be used for road tank vehicles with the approval of the competent authority. Any part of a portable tank, including fittings and pipe-work, that is exposed to the environment should be compatible with the marine environment.

13.203.2 Any part of a tank, including fittings and pipe-work, which can be expected normally to come into contact with the substance transported should be compatible with that substance.

13.203.3 Care should be taken to avoid damage by galvanic action due to the juxtaposition of dissimilar metals.

13.203.4 The thermal insulation should include complete covering of the shell or shells externally or internally with effective insulating materials. External insulation should be protected (see 13.202.3.2) so as to prevent the ingress of moisture and other damage under normal transport conditions, either by a jacket or other suitable cladding.

13.203.5 If the jacket is so closed as to be gastight, a device should be provided to prevent any dangerous pressure from developing in the insulation space in the event of inadequate gastightness of the shell or of its items of equipment.

13.203.6 Tanks intended for the transport of refrigerated liquefied gases having a boiling point below −182°C at atmospheric pressure should not include material in the thermal insulation which may react with oxygen in a dangerous manner. Compact means of attachment between a shell and jacket may contain plastics materials, provided their material properties at their service temperature are proved to be sufficient.

13.203.7 Insulating materials should not deteriorate unduly in service.

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13.203.8 A holding time should be calculated at the design stage and take into account:

.1 effectiveness of the insulation system provided;

.2 MAWP;

.3 degree of filling;

.4 assumed ambient temperature of 50°C;

.5 physical properties of the individual substance to be transported.

13.203.9 The jacket of a vacuum-insulated double-wall tank should have either an external design pressure of at least 100 kPa (1 bar) gauge pressure calculated in accordance with a recognized code, or a calculated collapsing pressure of at least 200 kPa (2 bar) gauge pressure. Internal and external reinforcement devices may be included in calculating the ability of the jacket to resist the external pressure.

13.203.10 Portable tanks should be designed and manufactured with supports to provide a secure base during transport and with suitable lifting and tie-down attachments. Road tank vehicles should be fitted with tie-down attachments and secured on board in such a way that the suspension is not left in free play.*

13.203.11 Shells of portable tanks, their attachments and their service and structural equipment should be constructed to withstand, without loss of contents, at least the internal pressure and thermal loads due to the contents, taking into account the most severe combination of the static and dynamic loads under normal handling and transport conditions. For tanks that are intended for use as offshore tank-containers, the dynamic stresses imposed by handling in open seas should be taken into account.

13.203.12 Portable tanks and their fastenings should be capable of withstanding separately applied forces, based on:

.1 twice the total mass acting in the direction of travel of the tank simultaneous with the weight of the tank;

.2 the total mass acting horizontally at right angles to the direction of travel of the tank (where the direction of travel is not clearly determined, the total mass should be used) simultaneous with the weight of the tank;

.3 the total mass acting vertically upwards;

.4 twice the total mass acting vertically downwards.

13.203.13 Under each of these loads, for portable tanks, the safety factors to be observed should be:

.1 for metals having a clearly defined yield point, a safety factor of 1.5 in relation to the determined yield stress; or

.2 for metals with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2% proof stress (1.0% proof stress for austenitic steels).

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*Attention is drawn to the *Guidelines for the Securing Arrangements for the Transport of Road Vehicles on Ro–Ro Ships* (Resolution A.581(14)) (see the Supplement to this Code).

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13.203.14 The tank of a road tank vehicle and its fastenings should be capable of withstanding such separately applied static and dynamic loads as may be agreed between the competent authorities. Under the condition of each load, the stress level should not exceed that permitted in 13.203.19.1.

13.203.15 Shells should be designed and manufactured to withstand a test pressure equal to at least 1.3 times the MAWP.

13.203.16 For shells with vacuum insulation, the test pressure should not be less than 1.3 times the sum of the MAWP and 100 kPa (1 bar).

13.203.17 In no case should the test pressure be less than 300 kPa (3 bar) gauge pressure.

13.203.18 Attention is also drawn to the minimum shell thickness requirements specified in 13.204.2 to 13.204.4.

13.203.19 At the test pressure, the primary membrane stress in the shell should conform to the material-dependent limitations prescribed below:

.1 for metals and alloys exhibiting a clearly defined yield point or characterized by a guaranteed conventional yield stress *R*e (generally 0.2% proof stress; for austenitic steels 1.0% proof stress), the membrane stress should not exceed 0.75*R*e or 0.50*R*m, whichever is lower, where *R*m in N/mm^2 is the guaranteed minimum tensile strength;

.2 in the case of steel, the elongation at fracture, in per cent, should not be less than $\frac{10{,}000}{Rm}$, where *R*m is in N/mm^2, with an absolute minimum of 17%. In the case of aluminium, the elongation at fracture, in per cent, should not be less than $\frac{10{,}000}{6Rm}$, where *R*m is in N/mm^2, with an absolute minimum of 12%.

13.203.20 The specimens used to determine the elongation at fracture should be taken tranversely to the direction of rolling and be so secured that:

$$L_o = 5d,$$

or

$$L_o = 5.65\sqrt{A}$$

where :

L_o = gauge length of the specimen before the test;

d = diameter; and

A = cross-sectional area of the test specimen.

13.203.21 Shells should be of a circular cross-section.

13.203.22 Tanks should be manufactured to a technical code recognized by the competent authority. Shells should be designed, manufactured and tested in accordance with a recognized pressure vessel code, taking into account corrosion, mass of contents, MAWP and the effect of superimposed stresses due to dynamic forces in accordance with 13.203.12.

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13.204 **Minimum shell thickness**

13.204.1 The shells should have a thickness of not less than that determined by the following formula:*

$$e = \frac{C}{\sqrt[3]{Rm \times A}}$$

where:

e = minimum required thickness of the metal to be used, in mm;

Rm = guaranteed minimum tensile strength of the metal to be used, in N/mm^2;

A = guaranteed minimum elongation (as a percentage) of the metal to be used on fracture under tensile stress; see 13.203.15;

C = 107 (equivalent to 5 mm mild steel) for tanks of not more than 1.80 m in diameter;

C = 128 (equivalent to 6 mm mild steel) for tanks of more than 1.80 m in diameter.

C = 64 for shells of vacuum-insulated tanks of not more than 1.80 m in diameter; and

C = 85 for shells of vacuum-insulated tanks of more than 1.80 m in diameter.

13.204.2 Portable tanks should have a shell thickness of at least 3 mm regardless of the material of construction. Road tank vehicles may have a lesser thickness, subject to the agreement of the competent authorities.

13.204.3 There should be no sudden change in plate thickness at the attachment of the head to the cylindrical portion of the shell, and, after forming the head, the plate thickness at the knuckle should be not less than that determined by a recognized pressure vessel code or as required by 13.204.1 to 13.204.2, as applicable.

13.205 **Service equipment**

13.205.1 Service equipment (valves, fittings, safety devices, gauging devices and the like) should be so arranged as to be protected against the risk of being wrenched off or damaged during handling and transport. If the connection between a frame and a tank, a jacket and a shell, or a tank and a chassis or running gear allows relative movement, the equipment should be fastened so as to permit such movement without risk of damage to working parts. Equipment protection should offer a degree of safety comparable to that of the tank shell. For offshore tank-containers, where positioning of service equipment and the design and strength of protection for such equipment is concerned, the increased danger of impact damage when handling such tanks in open seas should be taken into account.

13.205.2 Each filling opening and each discharge opening in tanks used for the transport of flammable gases should be fitted with three independent shutoff devices in series, the first being a stop valve situated as close as possible to the jacket, the second being a stop valve and the third being a blank flange or equivalent device. Each filling opening and each discharge opening in tanks used

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* The constant C is derived from the following formula: $e\sqrt[3]{Rm \times A} = e_o\sqrt[3]{Rm_o \times A_o}$, where the sub-index 'o' refers to mild steel and the part of the equation without sub-index 'o' refers to the metal used. The relationship with mild steel as employed by this Code is attached to the constant C, where $C = e_o\sqrt[3]{Rm_o \times A_o}$.

for the transport of non-flammable gases should be provided with at least two independent shutoff devices in series, the first being a stop valve situated as close as possible to the outer jacket and the second being a blank flange or equivalent device.

13.205.3 For sections of piping which can be closed at both ends and where liquid product can be trapped, a method of automatic pressure relief, to prevent excess pressure, should be provided.

13.205.4 Vacuum-insulated tanks need not have an opening for inspection.

13.205.5 External fittings should preferably be grouped together.

13.205.6 All tank connections should be clearly marked to indicate the function of each.

13.205.7 Stop valves with screwed spindles should close by clockwise rotation.

13.205.8 All piping should be of a suitable material. Where tanks are subject to the fire engulfment requirement of 13.207.3, only steel piping and welded joints should be used between the shell and the connection to the first closure of any outlet. The method of attaching the closure to this connection should be to the satisfaction of the competent authority. Elsewhere pipe-joints should be welded wherever necessary.

13.205.9 Joints of copper tubing should be brazed or have an equally strong metal union. These joints should, in any event, not be such as to decrease the strength of the tubing as may happen by cutting of threads.

The melting point of brazing materials should be no lower than 525°C.

13.205.10 Only metals which are ductile at the lowest operating temperatures should be used in the construction of valves and accessories.

13.205.11 The bursting strength of all piping and pipe fittings should be at least four times the strength at the MAWP of the tank and at least four times the strength at the pressure to which it may be subjected in service by the action of a pump or other device (except pressure-relief valves).

13.205.12 Suitable provisions should be made in every case to prevent damage to piping due to thermal expansion and contraction, jarring and vibration.

13.205.13 Tanks for the transport of flammable gases should be capable of being electrically earthed.

13.206 **Pressure-relief devices**

13.206.1 Every shell should be provided with at least two independent pressure-relief valves of the spring-loaded type except that, in the case of a road tank vehicle used for non-flammable refrigerated gases, one of the valves may be replaced by a frangible disc.

13.206.2 Shells for non-flammable refrigerated liquefied gases may, in addition, have frangible discs in parallel with the spring-loaded valves as specified in 13.207.2 and 13.207.3.

13.206.3 Pressure-relief devices should be designed to prevent:

.1 accumulation of moisture and the entry of foreign matter; and

.2 the leakage of gas and the development of any dangerous excess pressure.

13.206.4 Pressure-relief devices should be approved by the competent authority.

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13.207 **Capacity and setting of pressure-relief devices**

13.207.1 The capacity of each spring-loaded pressure-relief valve should be sufficient to limit the pressure to 110% of the MAWP due to normal pressure rise. These valves should be set to start to discharge at the nominal pressure equal to the MAWP and should, after discharge, close at a pressure not lower than 90% of the MAWP and remain closed at all lower pressures.

13.207.2 In the case of loss of vacuum of a vacuum-insulated tank, or loss of 20% of the insulation of a tank insulated with solid materials, the combined capacity of all valves installed should be sufficient to limit the pressure to 110% of the MAWP. For helium, this capacity may be achieved by the use of frangible discs in combination with the required safety relief valves. These discs should rupture at a nominal pressure equal to the test pressure.

13.207.3 For portable tanks, the requirements of 13.207.2 should be considered together with complete engulfment in fire, under which circumstances the combined capacity of all pressure-relief devices installed should be sufficient to limit the pressure to the test pressure. Frangible discs, if used, should rupture at a nominal pressure equal to the test pressure.

13.207.4 With respect to complete fire engulfment, the competent authority should examine the heat input to the tank in the fire exposure condition. Having established the heat input, the required capacity of the relief devices should be calculated in accordance with a well-established technical code.

13.207.5 For a road tank vehicle, where a frangible disc is used for the purposes of 13.206.1, it should rupture at a nominal pressure equal to the test pressure.

13.208 **Markings on pressure-relief devices**

13.208.1 Every pressure-relief device of a portable tank should be plainly and permanently marked with the pressure at which it is set to discharge and the rated free-air delivery of the device at 15°C and one bar. Capacity marked on devices should be as rated at a pressure not greater than 110% of the set pressure.

13.209 **Connections to pressure-relief devices**

13.209.1 Connections to pressure-relief devices should be of sufficient size to enable the required discharge to pass unrestricted to the safety devices. No stop valve should be installed between the shell and the pressure-relief devices except where additional devices are provided for maintenance or other reasons and the stop valves serving the devices actually in use are locked open or the stop valves are interlocked so that the requirements of 13.207 are always fulfilled. Vents from the pressure-relief devices, where used, should deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

13.210 **Siting of pressure-relief devices**

13.210.1 All pressure-relief device inlets should be situated in the vapour space of the shells and the devices so arranged as to ensure that the escaping vapour is discharged unrestrictedly and in such a manner that it cannot impinge upon the portable tank. Protective devices which deflect the flow of vapour are permissible, provided the required capacity is not reduced.

13.210.2 Arrangements should be made to prevent access to the devices by unauthorized persons and to protect the devices from damage caused by the tank overturning.

13.211 **Gauging devices**

13.211.1 Glass level-gauges, or gauges made of other easily destructible material, which are in direct communication with the contents of the shell should not be used.

13.211.2 A connection for a vacuum gauge should be provided in the jacket of a vacuum-insulated portable tank.

13.212 **Tank support framework, lifting and tie-down attachments***

13.212.1 Tanks should be designed and manufactured with a support structure to provide a secure base during transport. Skids, frameworks, cradles or other similar devices are acceptable. The cradles or other devices attaching a tank to the chassis or running gear of a road tank vehicle are considered acceptable.

13.212.1.1 For portable tanks, the loads specified in 13.203.12 and safety factors in 13.203.13 should be taken into account in this aspect of design, whilst for road tank vehicles the design calculations should include loads and factors agreed as in 13.203.14.

13.212.1.2 If the landing legs of a road tank vehicle are to be used as support structure, the loads agreed as in 13.203.14 should be taken into account in their design and method of attachment. Bending stress induced in the shell as a result of this manner of support should be included in design calculations.

13.212.2 Permanent lifting and permanent tie-down attachments should be fitted to all portable tanks. Permanent tie-down attachments should be fitted to all road tank vehicles. Lifting and tie-down attachments should preferably be fitted to the tank support structure but they may be secured to the reinforcing plates located on the tank at the points of support.

13.212.2.1 Securing arrangements (tie-down attachments) should be fitted to the tank support structure and the towing vehicle of a road tank vehicle. Semi-trailers unaccompanied by a towing vehicle should be accepted for shipment only if the trailer supports and the securing arrangements and the position of stowage are agreed with the competent authority.

13.212.2.2 The combined stresses caused by tank mountings (e.g. cradles, frameworks, etc.) and tank lifting and tie-down attachments should not cause excessive stress in any portion of the tank.

13.212.3 In the design of supports and frameworks, due regard should be paid to the effects of environmental corrosion; in calculations for all structural members not constructed of corrosion-resistant materials, a minimum corrosion allowance determined by the competent authority should be provided.

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* See also IMO Assembly resolution A.581(14) of 20 November 1985, *Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro–Ro Ships* (see the Supplement to this Code).

13.212.4 Portable tank frameworks intended to be lifted or secured by their corner castings should be subjected to internationally accepted special tests, for example the ISO system. The use of such frameworks within an integrated system is generally encouraged. Offshore tank-containers should be subjected to tests that take into account the dynamic lifting and impact forces that may occur when a tank is handled in open seas.

13.213 **Approval, testing and marking of type 7 tanks**

13.213.1 The competent approval authority or a body authorized by that authority should issue, in respect of every new design of a portable tank, a certificate attesting that the portable tank and its attachments surveyed by that authority or that body are suitable for the purpose for which they are intended and meet the construction and equipment requirements of this subsection and, where appropriate, the special requirements for the gases in the appendix to this subsection. Such a certificate should include the gases or group of gases allowed to be transported in the portable tank. The results of the prototype test, the gases for whose transport the portable tank is approved and an approval number should be specified in a test report. If a series of portable tanks are manufactured without change in structural design, this approval should be deemed to be a design approval.

The approval number should consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic, as prescribed by the Convention on Road Traffic, Vienna, 1968, and a registration number.

13.213.2 Design approval should be given in respect of at least one portable tank of each design and each size, it being, however, understood that a set of tests made on a portable tank of one size may serve for the approval of smaller portable tanks made of a material of the same kind and thickness by the same fabrication technique and with equivalent support, closures and other appurtenances.

13.213.3 The shell and items of equipment of each tank should be inspected and tested, either together or separately, before being put into service (initial inspection and test) and thereafter at not more than five-year intervals (periodic inspection and test).

13.213.3.1 The initial inspection and test should include a check of the design characteristics and internal and external examination and a hydraulic pressure test. In special cases, and with the agreement of a competent authority, the hydraulic pressure test may be replaced by a pressure test using another liquid or gas. If the shell and equipment have been pressure-tested separately, they should together be subjected, after assembly, to a leakage test. All welds in the shell should be tested in the initial test by radiographic, ultrasonic or another suitable non-destructive method. This does not apply to the jacket.

13.213.3.2 The periodic inspections and tests should consist of an external examination of the portable tank and a leakage test. In the case of non-vacuum-insulated tanks, the jacket and thermal insulation and the like should be removed only to the extent required for a reliable appraisal of the portable tank's condition. In the case of a vacuum-insulated tank there should be a vacuum reading.

13.213.3.3 The initial and periodic tests should be carried out as required by the competent authority.

13.213.3.4 While under pressure, the tank should be inspected for leakage or other conditions which indicate weaknesses that might render the tank unsafe in transport; if any evidence of such unsafe condition is discovered, the portable tank should not be placed in or returned to service until it has been repaired and the test, repeated, has been passed.

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13.213.4 Before a portable tank is put into service, and thereafter at intervals midway between the inspections and tests provided in 13.213.3, the following tests and inspections should be performed:

.1 a leakage test, where required;

.2 a test of satisfactory operation of all service equipment;

.3 an external inspection of the portable tank and its fittings with due regard to the gases transported; and

.4 a vacuum reading, where applicable.

13.213.5 The 2.5 year (midway) inspection and test may be carried out within 3 months of the specified date. The date of the 2.5 year inspection should be durably marked on or as near as possible to the metal identification plate required in 13.215.1. When marking is not done on the plate, the characters should be at least 32 mm in height and of a contrasting colour to the tank. A portable tank may not be filled and offered for transport after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 13.1.19.3 and 13.1.19.4/13.115.3 and 13.115.4/13.213.3 and 13.213.4. However, a portable tank filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be transported after the date of expiry of the last periodic test and inspection:

.1 After emptying but before cleaning, for purposes of performing the next required test and inspection prior to refilling; and

.2 Unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test and inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this authorization should be entered in the dangerous goods shipping document.

13.213.6 When a portable tank is damaged it should not be allowed to be used until it has been repaired so as to comply with these requirements. When the shell is damaged, it should be repaired and retested in conformity with 13.213.7.

13.213.7 In all cases where cutting, burning or welding operations on the shell of a portable tank have been carried out, that work should be to the satisfaction of the competent authority and a pressure test to at least the original test pressure should be carried out.

13.213.8 Certificates showing the results of the test should be issued by the competent authority. All information required in 13.215.1 and 13.215.2 should also be included in this certificate.

13.214 **Approval, testing and marking of type 8 tanks**

13.214.1 Road tank vehicles are to be authorized for short international voyages only.

13.214.2 For any road tank vehicle intended for transport of a substance listed in the appendix to this subsection, there should be in existence a valid certificate issued by or on behalf of the competent authority for road transport authorizing transport of that substance by road.

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13.214.3 The competent authority for sea transport or a body authorized by that authority should issue additionally in respect of a road tank vehicle a certificate attesting compliance with the relevant design, construction and equipment requirements of this subsection and, where appropriate, the special requirements for the gases in the appendix to this subsection. The certificate should list the gases allowed to be transported.

13.214.4 A road tank vehicle should be tested and inspected in accordance with the requirements of the competent authority for road transport.

13.214.5 Road tank vehicles should be marked in accordance with 13.215. However, where the marking required by the competent authority for road transport is substantially in agreement with that of 13.215.1, it will be sufficient to endorse the metal plate attached to the road tank vehicle with "IMO type 8"; the reference to holding time may be omitted.

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13.215 **Marking**

13.215.1 Every tank should be fitted with a corrosion-resistant metal plate permanently attached in a place readily accessible for inspection. At least the following particulars should be marked on the plate in characters at least 3 mm in height by stamping, engraving, embossing or any similar method.

If, for reasons of tank arrangements, the plate cannot be permanently attached to the shell, the shell should be marked with at least those particulars required by a recognized pressure vessel code in a manner prescribed by that code.

The plate should be kept free of any paint to ensure that the markings will be legible at all times.

Country of manufacture . . . . . .

IMO tank type No. . . . . Approval country . . . . . Approval number . . . . . .

Manufacturer's name or mark . . . . . .

Registration number . . . . . .

Year of manufacture . . . . . .

Test pressure . . . . . (bar)/(MPa)* gauge

Maximum allowable working pressure . . . . . (bar)/(MPa)* gauge

Water capacity at 20°C of each compartment . . . . . (litres)

(The water capacity should be established to within 1% by practical test rather than by calculation.)

Original pressure test date and witness identification . . . . . .

Code to which the shell is designed . . . . . .

Minimum design temperature . . . . . (°C)

Maximum total mass . . . . . (kg)

Unladen (tare) mass . . . . . (kg)

Shell material . . . . . .

Month, year and test pressure of most recent periodic test:

. . . . . month . . . . . year . . . . . (bar)/(MPa)* gauge

Stamp of expert who carried out most recent test . . . . . .

The names, in full, of the gases for whose transport the tank is approved . . . . . .

. . . . . .

Either "thermally insulated" or "vacuum-insulated" . . . . . .

* The unit used should be indicated.

13.215.2 The following particulars should be durably marked either on the tank itself or on a metal plate firmly secured to the portable tank.

Names of owner and operator . . . . . .

Name of gas being transported (and minimum mean bulk temperature) . . . . . .

Date of the last inspection . . . . . .

Total mass . . . . . (kg)

Holding time . . . . . (days)

13.215.3 If a tank is designed and approved for handling in open seas, the words OFFSHORE CONTAINER should be marked on the identification plate.

13.215.4 The contents should be identified as specified in sections 7, 8 and 9 of the General Introduction to this Code.

13.215.5 Unless the name of the gas being transported appears on the metal plate specified in 13.215.1, a copy of the certificate specified in 13.213.1 should be made available if requested by a competent authority and be provided readily by the consignor, consignee or agent, as appropriate.

13.216 **Transport requirements**

13.216.1 Tanks should not be offered for sea transport:

.1 in an ullage condition liable to produce an unacceptable hydraulic force due to surge within the shell;

.2 when leaking;

.3 when damaged to such an extent that the integrity of the tank or its lifting or securing arrangements may be affected; and

.4 unless the service equipment has been examined and found to be in good working order.

13.216.2 Empty tanks not cleaned and not gas-free should comply with the same requirements as tanks filled with the substance previously carried.

13.216.3 During transport, tanks should be adequately protected against lateral and longitudinal impact and against overturning. If the tanks and the service equipment are so constructed as to withstand impact or overturning, they need not be protected in this way.

Examples of protection of shells against collision:

.1 protection against lateral impact may consist, for example, of longitudinal bars protecting the tank on both sides at the level of the median line;

.2 protection of portable tanks against overturning may consist, for example, of reinforcement rings or bars fixed across the frame;

.3 protection against rear impact may consist of a bumper or frame;

.4 external fittings should be designed or protected so as to preclude the release of contents upon impact or overturning of the tank upon the fittings.

13.216.4 Portable tanks should not normally be offered for sea transport of longer duration than the holding time. Due consideration should also be given to any delays which might be encountered.

13.216.5 Road tank vehicles should not be offered for carriage by sea in a condition that would lead to venting during the voyage under normal conditions.

13.217 **Filling**

13.217.1 In estimating the initial degree of filling, the necessary holding time for the intended voyage, including any delays which might be encountered, has to be taken into consideration. The initial degree of filling of a shell should be such that, if the contents were to be raised to a temperature at which the vapour pressure equalled the MAWP, the volume occupied by liquid would not exceed:

.1 for flammable gases, class 2.1, 95%;

.2 for non-flammable non-▷toxic◁ gases, class 2.2, 98%.

13.217.2 Provided the competent authority is satisfied with the modified tank arrangements, a higher initial degree of filling may be allowed when the intended voyage is considerably shorter than the holding time.

13.218 **Stowage and segregation**

13.218.1 Tanks should be stowed in accordance with the requirements of the individual schedules and section 14 of this General Introduction.

13.218.2 If a tank is to be shipped containing a refrigerated liquefied gas for which the individual schedule shows one or more secondary labels, due consideration should be given to all properties of that gas and stowage should be arranged accordingly.

13.218.3 Portable tanks should not be overstowed unless they are designed for that purpose and transported in specially designed ships, or unless they are specially protected to the satisfaction of the competent authority.

13.218.4 Tanks containing refrigerated liquefied gases should be segregated in accordance with the requirements of section 15 of this General Introduction.