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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS

Sub-Committee of Experts on the Transport of Dangerous Goods
(Fourteenth session,
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agenda item 2 (a))

DRAFT AMENDMENTS TO THE MODEL REGULATIONS ON THE TRANSPORT OF DANGEROUS GOODS

Tanks (Part 3, Chapters 4.2 and 6.6)

Provisions for gases with critical temperatures below 65 °C

Transmitted by the Europoean Industrial Gases Association (EIGA)

Introduction

At the thirteenth session of the Sub-Committee of Experts on the transport of dangerous goods, EIGA was invited to rewrite its proposal ST/SG/AC.10/R.515 in the reformatted way having a separate section 6.6.5 devoted to the subject and to include the necessary additions in Chapter 4.2 together with new portable tank instructions.

In attachment a working document is submitted which could serve as the basis for discussion for the working group operating in tandem with the plenary.

Background

While reviewing the original Chapter 12 of the UN recommendations the inclusion of an additional qualification with regard to the design reference temperature, requiring the gas to be liquefied at all times, eliminated de facto gases with critical temperatures below 65 °C. Transportation of these gases in portable tanks is not new and the demand for using this kind of packaging is on the increase. The matter was referred to the plenary session, where it was decided that EIGA would develop a comprehensive proposal to cover excluded gases with critical temperatures below the design temperatures specified in paragraph 6.6.3.1.

Structure of the working document

The UN recommendations in their actual structure of Chapters 4.2 and 6.6 have been followed as closely as possible. The sections on liquefied gases have served as the basis for the working document. Paragraphs not carrying relevance have not been retained. Additions and changes are in ***bold italic***.
The additions and changes have been taken from the Annex B of the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) more specifically from the sections of Appendix B.1b dealing with the relevant provisions concerning Tank-containers for Class 2 (Marginals 212 200 to 212 279).

Additional Comments

The actual UN Recommendations omit a number of liquefied gases with critical temperatures **above** 65 °C also. This has not been dealt with in this working paper.
Mixtures or N.O.S. positions are not covered either but could be incorporated. EIGA is of the opinion that it would be more user-friendly if all UN numbers for gases could be found back in the portable tank instructions even if the message would be that they cannot be transported in that form.

EIGA also believes that the Chapters 4.2 and 6.6 could be substantially reduced by regrouping the requirements applicable to all categories of dangerous and devoting specific sections to the particularities of the classes and their divisions.

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CHAPTER 4.2

USE OF PORTABLE TANKS

4.2.X General requirements for the use of portable tanks for the transport of liquefied gases *with critical temperatures below 65 °C, compressed gases and gases in solution.*

4.2.X.1 This section provides general requirements applicable to the use of portable tanks for the transport of liquefied gases ***with critical temperatures below 65 °C, compressed gases and gases in solution*.**

4.2.X.2 Portable tanks shall conform to the design, construction, inspection and testing requirements detailed in ***6.6.5.*** Gases ***with critical temperatures between -50 °C and +65 °C*** shall be transported in portable tanks conforming to portable tank instruction ***T51 and compressed gases and gases in solution conforming to portable tank instruction T60*** as described in 4.2.4.2.6 and any portable tank special provisions assigned to specific gases in Column 11 of the Dangerous Goods List *in Chapter 3.2* and described in 4.2.4.3.

4.2.X.3 During transport, portable tanks shall be adequately protected against damage to the ***elements*** and service equipment resulting from lateral and longitudinal impact and overturning. If the ***elements*** and service equipment are so constructed as to withstand impact or overturning it need not be protected in this way. Examples of such protection are given in **6.6.5.13.5**.

4.2.X.4 Certain gases are chemically unstable. They are accepted for transport only when the necessary steps have been taken to prevent their dangerous decomposition, transformation or polymerization during transport. To this end, care shall in particular be taken to ensure that portable tanks do not contain any gases liable to promote these reactions.

4.2.X.5 Unless the name of the dangerous goods being transported appears on the metal plate described in 6.6.5.16.2, a copy of the certificate specified in 6.6.5.14.1 shall be made available upon a competent authority request and readily provided by the consignor, consignee or agent, as appropriate.

4.2.X.6 Empty portable tanks not cleaned and not gas-free shall comply with the same requirements as portable tanks filled with the previous gas.

4.2.X.7 *Filling*

4.2.X.7.1 Prior to filling the shipper shall ensure that the portable tank is approved for the gas to be transported and that the portable tank is not loaded with gases which in contact with the materials of the shell, gaskets and service equipment, are likely to react dangerously with them to form dangerous products or appreciably weaken the material. During filling, the temperature of the gas shall fall within the limits of the design temperature range.

4.2.X.7.2 ***Element(s) intended for the transport of gases having a critical temperature between -50 °C and +65 °C and for gases in solution shall be filled such that, when the element(s) is(are) filled to the maximum mass of the contents per litre of capacity, the pressure reached in the element(s) by the substance at 55 °C for element(s) with thermal insulation or 65 °C for bare element(s) does not exceed the maximum allowable working pressure.***

Element(s) intended for the transport of gases having a critical temperature below -50 °C shall be filled such that the internal pressure at 15 °C in the element(s) does not exceed two thirds of the maximum allowable working pressure.

4.2.X.7.3 Portable tanks shall not be filled above their maximum permissible gross mass and the maximum permissible load mass specified for each gas to be transported.

4.2.X.7.4 Liquefied toxic gases of division 2.3 in multiple-element portable tanks shall be filled individually per element. The isolation valve(s) shall be closed after filling and remain closed during transport.

4.2.X.8 Portable tanks shall not be offered for transport:

(a) in an ullage condition liable to produce an unacceptable hydraulic force due to surge within the portable tank;

(b) when leaking;

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

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

4.2.4 Portable tank instructions and special provisions

4.2.4.2 *Portable tank instructions*

4.2.4.2.3 bis Gases with critical temperatures between -50 °C and + 65 °C are assigned to portable tank instruction T51. T51 provides the maximum allowable working pressures, bottom opening requirements, pressure relief requirements and degree of filling requirements for gases with critical temperatures between -50 °C and +65 °C permitted for transport in portable tanks.

4.2.4.2.3 ter Compressed gases and gases in solution are assigned to portable tank instruction T60. T 60 provides the maximum allowable working pressures, pressure relief requirements and degree of filling requirements for compressed gases and gases in solution permitted for transport in portable tanks.

4.2.4.3 Portable tank special provisions

TP25 - This substance shall only be transported in multiple element portable tanks. Once equilibrium achieved at 15 °C, the filling pressure shall not exceed the value prescribed by the competent authority for the porous mass. The quantity of solvent and the quantity of acetylene shall likewise correspond to the figures specified in the approval.

4.2.4.2.6 Portable tank instructions

T51	PORTABLE TANK INSTRUCTION				T51
This portable tank instruction applies to gases with critical temperatures between -50°C and +65 °C. The general requirements of Section 4.2.X and the requirements of Section 6.6.5 shall be met.					
UN No.	**Gases**	**Max. allowable working pressure (bar) Bare; thermally insulated**	**Openings below liquid level**	**Pressure relief requirements (see 6.6.5.7)**	**Maximum filling ratio (kg/l)**
1013	**Carbon Dioxide**	**190/250** **190/225**	**Allowed**	**Normal**	**0.66/0.75** **0.73/0.78**
1022	**Chlorotrifluoromethane (Refrigerant gas R 13)**	**120/250** **120/225**	**Allowed**	**Normal**	**0.9/1.1** **0.96/1.12**
1050	**Hydrogen chloride, anhydrous**	**120/200** **120**	**Not Allowed**	**See 6.6.5.7.3**	**0.56/ 0.74** **0.69**
1035	**Ethane**	**120/300** **120**	**Allowed**	**Normal**	**0.29/0.39** **0.32**
1070	**Nitrous oxide**	**180/250** **225**	**Allowed**	**Normal**	**0.68/0.75** **0.78**
1080	**Sulphur hexafluoride**	**70/160** **120**	**Allowed**	**Normal**	**1.04/1.37** **1.34**
1860	**Vinyl fluoride, inhibited**	**250** **120/225**	**Allowed**	**Normal**	**0.64** **0.58/0.65**
1984	**Trifluoromethane (Refrigerant gas R 23)**	**190/250** **190/250**	**Allowed**	**Normal**	**0.87/0.95** **0.92/0.99**
2454	**Methyl fluoride (Refrigerant gas R 41)**	**300** **300**	**Allowed**	**Normal**	**0.36** **0.36**
2599	**Chlorotrifluoromethane and Trifluoromethane, azeotropic mixture (Refrigerant gas R 503)**	**42/100** **42/100**	**Allowed**	**Normal**	**0.2/0.66** **0.21/0.76**
1008	**Boron trifluoride, compressed**	**225/300** **225/300**	**Not Allowed**	**See 6.6.5.7.3**	**0.715/0.86** **0.715/0.86**
1962	**Ethylene, compressed**	**225/300** **120/225**	**Not Allowed**	**See 6.6.5.7.3**	**0.34/0.37** **0.25/0.36**
1859	**Silicon tetrafluoride, compressed**	**200/300** **200/300**	**Not Allowed**	**See 6.6.5.7.3**	**0.74/1.1** **0.74/1.1**
1982	**Tetrafluoromethane, compressed (Refrigerant gas R14, compressed)**	**200/300** **200/300**	**Allowed**	**Normal**	**0.62/0.94** **0.62/0.94**
2036	**Xenon, compressed**	**130** **120**	**Allowed**	**Normal**	**1.24** **1.3**
2193	**Hexafluoroethane, compressed (Refrigerant gas R116, compressed)**	**200** **160/200**	**Allowed**	**Normal**	**1.1** **1.28/1.34**

2203	**Silane, compressed**	**225/250** **225/250**	**Not Allowed**	**See 6.6.5.7.3**	**0.32/0.41** **0.32/0.41**
2417	**Carbonyl fluoride**	**200/300** **200/300**	**Not Allowed**	**See 6.6.5.7.3**	**0.47/0.7** **0.47/0.7**
2451	**Nitrogen trifluoride**	**200/300** **200/300**	**Allowed**	**Normal**	**0.5/0.75** **0.5/0.75**

T60	**PORTABLE TANK INSTRUCTION**	**T60**
This portable tank instruction applies to compressed gases,mixtures of gases,N.O.S positions and gases in solution. The general requirements of Section 4.2.X and the requirements of Section 6.6.5 shall be met.		

CHAPTER 6.6

REQUIREMENTS FOR THE DESIGN, CONSTRUCTION, INSPECTION AND TESTING OF PORTABLE TANKS

6.6.1 Application and general requirements

6.6.1.3 When a substance is not assigned a portable tank instruction (T1 to T34, T50, ***T51***, ***T60*** or T75) in Column 10 of the Dangerous Goods List in Chapter 3.2, interim approval for transport may be issued by the competent authority of the country of origin. The approval shall be included in the documentation of the consignment and contain as a minimum the information normally provided in the portable tank instructions and the conditions under which the substance shall be transported. Appropriate measures shall be initiated by the competent authority to include the assignment in the Dangerous Goods List.

6.6.5 Requirements for the design, construction, inspection and testing of portable tanks intended for the transport of liquefied gases *with critical temperatures below 65 °C, compressed gases and gases in solution.*

6.6.5.1 *Definitions*

For the purposes of this section:

Portable tank means a multimodal tank having a ***total*** capacity of more than 450 litres used for the transport of gases of Class 2. The portable tank includes ***one or more element(s)*** fitted with service equipment and structural equipment necessary for the transport of gases. The portable tank shall be capable of being loaded and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the ***element(s)***, and shall be capable of being lifted when full. It shall be designed primarily to be loaded onto a transport vehicle or ship and shall be equipped with skids, mountings or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks, intermediate bulk containers (IBCs) ***and individual element(s)*** are not considered to fall within the definition for portable tanks;

Element(s) mean(s) the part of the portable tank which retain(s) the gas intended for transport, including openings and their closures, but does not include service equipment or structural equipment. ***The following are considered to be elements:***

- ***cylinders: pressure receptacles of a capacity not exceeding 150 litres***
- ***tubes: seamless pressure receptacles of a capacity exceeding 150 litres and of not more than 5000 litres***
- ***pressure drums: welded pressure receptacles of a capacity exceeding 150 litres and of not more than 1000 litres***
- ***bundles of cylinders: assemblies of cylinders which are interconnected by a manifold and held firmly together***
- ***shells: welded pressure receptacles of a capacity exceeding 1000 litres.***

A multiple-element portable tank contains elements which are linked to each other by a manifold and mounted on the frame of the portable tank;

Service equipment means measuring instruments and filling, discharge, venting, safety and insulating devices;

Structural equipment means the reinforcing, fastening, protective and stabilizing members external to the ***element(s)***;

Maximum allowable working pressure (MAWP) means a pressure that shall be not less than the highest of the following pressures, but in no case less than 7 bar:

(a) the maximum effective gauge pressure allowed in the ***element(s)*** during filling or discharge; or

(b) the maximum effective gauge pressure to which the ***element(s)*** is/***are*** designed, which shall be:

(i) for a gas listed in the portable tank instruction ***T51*** in 4.2.4.2.6, the MAWP (in bar) given in ***T51*** portable tank instruction for that gas;

(ii) for other gases, not less than the absolute pressure (in bar) of the gas at the design reference temperature minus 1 bar;

Design pressure means the pressure to be used in calculations required by a recognized pressure vessel code. The design pressure shall be not less than the highest of the following pressures:

(a) the maximum effective gauge pressure allowed in the shell during filling or discharge; or

(b) the sum of:

(i) the maximum effective gauge pressure to which the shell is designed as defined in (b) of the MAWP definition (see above); and

(ii) a head pressure determined on the basis of the dynamic forces specified in 6.6.2.2.9, but not less than 0.35 bar;

Test pressure means the maximum gauge pressure ***of the element(s)*** during the pressure test;

Leakproofness test means a test using gas subjecting the ***element(s)*** and its service equipment to an effective internal pressure of not less than 25% of the MAWP;

Maximum permissible gross mass (MPGM) means the sum of the tare mass of the portable tank and the heaviest load authorized for transport;

Reference steel means a steel with a tensile strength of 370 N/mm^2 and an elongation at fracture of 27%;

Mild steel means a steel with a guaranteed minimum tensile strength of 360 N/mm^2 to 440 N/mm^2 and a guaranteed minimum elongation at fracture conforming to 6.6.3.3.3.3;

Design temperature range for the shell shall be -40 °C to 50 °C for gases transported under ambient conditions. More severe design temperatures shall be considered for portable tanks subjected to severe climatic conditions;

Design reference temperature means the temperature determined for the purpose of calculating the MAWP. This value for each portable tank type is ***fixed at 65 °C for bare element(s)*** *and* ***at 55 °C for element(s) with thermal insulation*** ;

Filling density means the average mass of liquefied gas per litre of shell capacity (kg/l). The filling density is given in portable tank instruction ***T51*** in 4.2.4.2.6.

6.6.5.2 *General design and construction requirements*

6.6.5.2.1 ***Element(s)*** shall be designed and constructed in accordance with the requirements of a pressure vessel code recognized by the competent authority. ***Welded element(s)*** shall be made of steel suitable for forming. The materials shall in principle conform to national or international material standards. For welded ***element(s***, only a material whose weldability has been fully demonstrated shall be used. Welds shall be skilfully made and afford complete safety. When the manufacturing process or the materials make it necessary, the ***element(s)*** shall be suitably heat-treated to guarantee adequate toughness in the weld and in the heat affected zones. In choosing the material the design temperature range shall be taken into account with respect to risk of brittle fracture, to stress corrosion cracking and to resistance to impact. When fine grain steel is used ***in welded element(s)***, the guaranteed value of the yield strength shall be not more than 460 N/mm^2 and the guaranteed value of the upper limit of the tensile strength shall be not more than 725 N/mm^2 according to the material specification. Portable tank materials shall be suitable for the external environment in which they may be transported.

6.6.5.2.2 Portable tank ***element(s)***, fittings and pipework shall be constructed of materials which are:

(a) substantially immune to attack by the gas(es) intended to be transported; or

(b) properly passivated or neutralized by chemical reaction.

6.6.5.2.3 Gaskets shall be made of materials compatible with the gas(es) intended to be transported.

6.6.5.2.4 Contact between dissimilar metals which could result in damage by galvanic action shall be avoided.

6.6.5.2.5 The materials of the portable tank, including any devices, gaskets, and accessories, shall not adversely affect the gases intended for transport in the portable tank.

6.6.5.2.6 Portable tanks shall be designed and constructed with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

6.6.5.2.7 Portable tanks shall be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads during normal conditions of handling and transport. The design shall demonstrate that the effects of fatigue, caused by repeated application of these loads through the expected life of the portable tank, have been taken into account.

6.6.5.2.8 ***Element(s)*** shall be designed to withstand an external pressure of at least 0.4 bar gauge above the internal pressure without permanent deformation. When the ***element*** is to be subjected to a significant vacuum before filling or during discharge it shall be designed to withstand an external pressure of at least 0.9 bar gauge above the internal pressure and shall be proven at that pressure.

6.6.5.2.9 Portable tanks and their fastenings shall, under the maximum permissible load, be capable of absorbing the following separately applied static forces:

(a) in the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g) */;

(b) horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g) */;

(c) vertically upwards: the MPGM multiplied by the acceleration due to gravity (g)*/; and

(d) vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g) */.

6.6.5.2.10 Under each of the forces in 6.6.5.2.9, the safety factor to be observed shall be as follows:

(a) for steels having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength; or

(b) for steels with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2% proof strength and, for austenitic steels, the 1% proof strength.

6.6.5.2.11 The values of yield strength or proof strength shall be the value according to national or international material standards. When austenitic steels are used, the specified minimum values of yield strength and proof strength according to the material standards may be increased by up to 15% when greater values are attested in the material inspection certificate. When no material standard exists for the steel in question, the value of yield strength or proof strength used shall be approved by the competent authority.

6.6.5.2.12 When the ***element(s)*** intended for the transport of gases are equipped with thermal insulation, the thermal insulation systems shall satisfy the following requirements:

(a) It shall consist of either a shield covering not less than the upper third but not more than the upper half of the surface of the ***element(s***) and separated from the ***element(s***)by an air space about 40 mm across; or a complete cladding of adequate thickness of insulating materials protected so as to prevent the ingress of moisture and damage under normal conditions of transport and so as to provide a thermal conductance of not more than 0.67 ($W.m^{-2}.K^{-1}$);

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*/ *For calculation purposes g = 9.81 m/s^2.*

(b) When the protective covering is so closed as to be gas-tight, a device shall be provided to prevent any dangerous pressure from developing in the insulating layer in the event of inadequate gas tightness of the ***element(s)*** or of its items of equipment;

(c) The thermal insulation shall not inhibit access to the fittings and discharge devices.

6.6.5.2.13 Portable tanks intended for the transport of flammable gases shall be capable of being electrically earthed.

6.6.5.3. *Design criteria*

6.6.5.3.1 Shells shall be of a circular cross-section.

6.6.5.3.2 Shells shall be designed and constructed to withstand the test pressure or the design pressure.whichever is the higher The shell design shall take into account the minimum MAWP values provided in portable tank instruction *T51* in 4.2.4.2.6 for each gas intended for transport. Attention is drawn to the minimum shell thickness requirements for these shells specified in 6.6.5.4.

6.6.5.3.3 For steels exhibiting a clearly defined yield point or characterized by a guaranteed proof strength (0.2% proof strength, generally, or 1% proof strength for austenitic steels) the primary membrane stress σ (sigma) in the shell shall not exceed 0.75 Re or 0.50 Rm, whichever is lower, at the test pressure, where:

Re = yield strength in N/mm^2, or 0.2% proof strength or, for austenitic steels, 1% proof strength.
Rm = minimum tensile strength in N/mm^2.

6.6.5.3.3.1 The values of Re and Rm to be used shall be the specified minimum values according to national or international material standards. When austenitic steels are used, the specified minimum values for Re and Rm according to the material standards may be increased by up to 15% when greater values are attested in the material inspection certificate. When no material standard exists for the steel in question, the values of Re and Rm used shall be approved by the competent authority or its authorized body.

6.6.5.3.3.2 Steels which have a Re/Rm ratio of more than 0.85 are not allowed for the construction of shells. The values of Re and Rm to be used in determining this ratio shall be the values specified in the material inspection certificate.

6.6.5.3.3.3 Steels used in the construction of shells shall have an elongation at fracture, in %, of not less than 10 000/Rm with an absolute minimum of 16% for fine grain steels and 20% for other steels.

6.6.5.3.3.4 For the purpose of determining actual values for materials, it shall be noted that for sheet metal, the axis of the tensile test specimen shall be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture shall be measured on test specimens of rectangular cross sections in accordance with ISO 6892:1984 using a 50 mm gauge length.

6.6.5.3.3.5 Cylinders and tubes shall be designed and constructed in accordance with the requirements of a pressure vessel code recognized by the competent authority. (See 6.2.1)

6.6.5.4 *Minimum shell thickness*

6.6.5.4.1 The minimum shell thickness shall be the greater thickness based on:

(a) the minimum thickness determined in accordance with the requirements in 6.6.5.4.4; and

(b) the minimum thickness determined in accordance with the recognized pressure vessel code including the requirements in 6.6.5.3.

6.6.5.4.2 The cylindrical portions, ends (heads) and manhole covers of shells of not more than 1.80 m in diameter shall be not less than 5 mm thick in the reference steel or of equivalent thickness in the steel to be used. Shells of more than 1.80 m in diameter shall be not less than 6 mm thick in the reference steel or of equivalent thickness in the steel to be used.

6.6.5.4.3 The cylindrical portions, ends (heads) and manhole covers of all shells shall be not less than 4 mm thick regardless of the material of construction.

6.6.5.4.4 The equivalent thickness of a steel other than the thickness prescribed for the reference steel in 6.6.3.4.2 shall be determined using the following formula:

$$e_1 = \frac{21.4 \quad e_o}{\sqrt[3]{Rm_1 \times A_1}}$$

where:

e_1 = required equivalent thickness (in mm) of the steel to be used;
e_o = minimum thickness (in mm) for the reference steel specified in 6.6.5.4.2;
Rm_1 = guaranteed minimum tensile strength (in N/mm^2) of the steel to be used (see 6.6.5.3.3);
A_1 = guaranteed minimum elongation at fracture (in %) of the steel to be used according to national or international standards.

6.6.5.4.5 In no case shall the wall thickness be less than that prescribed in 6.6.5.4.1 to 6.6.5.4.3. All parts of the shell shall have a minimum thickness as determined by 6.6.5.4.1 to 6.6.5.4.3. This thickness shall be exclusive of any corrosion allowance.

6.6.*5*.4.6 When mild steel is used (see 6.6.*5*.1), calculation using the equation in 6.6.*5*.4.4 is not required.

6.6.*5*.4.7 There shall be no sudden change of plate thickness at the attachment of the ends (heads) to the cylindrical portion of the shell.

6.6.*5*.5 *Service equipment*

6.6. 5.1 Service equipment shall be so arranged as to be protected against the risk of being wrenched off or damaged during handling and transport. When the connection between the frame and the ***element(s)*** allows relative movement between the sub-assemblies, the equipment shall be so fastened as to permit such movement without risk of damage to working parts. The external discharge fittings (pipe sockets, shut-off devices), the internal stop-valve ***or its equivalent external stop-valve*** and its seating shall be protected against the danger of being wrenched off by external forces (for example using shear sections). The filling and discharge devices (including flanges or threaded plugs) and any protective caps shall be capable of being secured against unintended opening.

6.6.5.5.2 All openings with a diameter of more than 1.5 mm in shells of portable tanks, except openings for pressure-relief devices, inspection openings and closed bleed holes, shall be fitted with at least three mutually independent shut-off devices in series, the first being an internal stop-valve, excess flow valve or equivalent device, the second being an external stop-valve and the third being a blank flange or equivalent device. ***The internal stop-valve may be replaced by an external stop-valve with a protection against damage from external forces at least equivalent to that afforded by the wall of the shell.***
In the case of multiple-element portable tanks, each element intended for the transport of toxic gases division 2.3 shall be capable of being isolated by a valve. The manifold for liquefied toxic gases division 2.3 shall be so designed that the elements can be filled separately and be kept isolated by a valve capable of being sealed. The element(s) intended for the transport of flammable gases of division 2.1 shall be combined to groups of not more than 5000 litres which are capable of being isolated by a shut-off valve.

6.6.*5*.5.2.1 When a portable tank is fitted with an excess flow valve the excess flow valve shall be so fitted that its seating is inside the shell or inside a welded flange or, when fitted externally, its mountings shall be designed so that in the event of impact its effectiveness shall be maintained. The excess flow valves shall 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 shall have a capacity for a flow more than the rated flow of the excess flow valve.

6.6.*5*.5.3 For filling and discharge openings ***of shells*** the first shut-off device shall be an internal stop-valve ***or equivalent external stop-valve*** and the second shall be a stop-valve placed in an accessible position on each discharge and filling pipe. ***In the case of multiple-element portable tanks, the filling and discharge devices may be fitted to a manifold.***

6.6.5.5.4 For filling and discharge bottom openings of portable tanks intended for the transport of flammable and/or toxic liquefied gases the internal stop-valve ***or equivalent external stop-valve*** shall be a quick closing safety device which closes automatically in the event of unintended movement of the portable tank during filling or discharge or fire engulfment. Except for portable tanks having a capacity of not more than 1 000 litres, it shall be possible to operate this device by remote control.

6.6.5.5.5 In addition to filling, discharge and gas pressure equalizing orifices, ***element(s)*** may have openings in which gauges, thermometers and manometers can be fitted. Connections for such instruments shall be made by suitable welded nozzles or pockets and not be screwed connections through the ***element(s)***.

6.6.5.5.6 All portable tanks shall be fitted with inspection openings of suitable size to allow for internal inspection and adequate access for maintenance and repair of the interior.

6.6.5.5.7 External fittings shall be grouped together so far as reasonably practicable.

6.6.5.5.8 Each connection on a portable tank shall be clearly marked to indicate its function.

6.6.5.5.9 Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than the MAWP of the ***element(s)*** taking into account the temperatures expected during transport. All stop-valves with screwed spindles shall close by a clockwise motion of the handwheel. For other stop-valves the position (open or closed) and direction of closure shall be clearly indicated. All stop-valves shall be ***positioned*** to prevent unintentional opening.

6.6.5.5.10 Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration. All piping shall be of suitable metallic material. Welded pipe joints shall be used wherever possible.

6.6.5.5.11 Joints in copper tubing shall be brazed or have an equally strong metal union. The melting point of brazing materials shall be no lower than 525 °C. The joints shall not decrease the strength of tubing as may happen when cutting threads.

6.6.5.5.12 The ***test*** pressure of all piping and pipe fittings shall be not less than the ***highest test pressure of the element(s)*** (except pressure-relief devices).

6.6.5.5.13 Ductile metals shall be used in the construction of valves or accessories.

6.6.5.6 *Bottom openings*

6.6.5.6.1 Certain liquefied gases shall not be transported in portable tanks with bottom openings when portable tank instruction *T51* in 4.2.4.2.6 indicates that bottom openings are not allowed. There shall be no openings below the liquid level of the ***element(s)*** when it is filled to its maximum permissible filling limit.

6.6.5.7 *Pressure-relief devices*

6.6.5.7.1 ***Portable tanks intended for the transport of liquefied gases*** shall be provided with one or more spring-loaded pressure-relief devices. The pressure-relief devices shall open automatically at a pressure not less than the MAWP and be fully open at a pressure equal to 110% of the MAWP. These devices shall, after discharge, close at a pressure not lower than 10 % below the pressure at which discharge starts and shall remain closed at all lower pressures. The pressure-relief devices shall be of a type that will resist dynamic forces including liquid surge. Frangible discs not in series with a spring-loaded pressure-relief device are not permitted. ***If one of the elements of a multiple-element portable tank is fitted with a pressure relief device and shut-off devices are provide between the elements, every element shall be so fitted.***

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

6.6.5.7.3 Portable tanks intended for the transport of certain liquefied gases identified in portable tank instruction **T5*1*** in 4.2.4.2.6 shall have a pressure-relief device approved by the competent authority. Unless a portable tank in dedicated service is fitted with an approved relief device constructed of materials compatible with the load, such device shall comprise a frangible disc preceding a spring-loaded device. The space between the frangible disc and the device shall 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 pressure-relief device. The frangible discs shall rupture at a nominal pressure 10% above the start-to-discharge pressure of the relief device.

6.6.5.7.4 In the case of multi-purpose portable tanks, the pressure-relief devices shall open at a pressure indicated in 6.6.5.7.1 for the gas having the highest maximum allowable pressure of the gases allowed to be transported in the portable tank.

6.6.5.8 *Capacity of relief devices*

6.6.5.8.1 The combined delivery capacity of the relief devices shall be sufficient that, in the event of total fire engulfment, the pressure (including accumulation) inside the ***element(s) intended for the transport of liquefied gases*** does not exceed 120% of the MAWP. Spring-loaded relief devices shall be used to achieve the full relief capacity prescribed. In the case of multi-purpose tanks, the combined delivery capacity of the pressure-relief devices shall be taken for the gas which requires the highest delivery capacity of the gases allowed to be transported in portable tanks.

6.6.5.8.1.1 To determine the total required capacity of the relief devices ***installed on the element(s) for the transport of liquefied gases***, ***the thermodynamic properties of the gas have to be considered (see for example CGA S-1..2-1995)***.

6.6.5.8.1.2 Insulation systems, used for the purpose of reducing the venting capacity, shall be approved by the competent authority or its authorized body. In all cases, insulation systems approved for this purpose shall:

(a) remain effective at all temperatures up to 649 °C; and

(b) be jacketed with a material having a melting point of 700 °C or greater.

6.6.5.9 *Marking of pressure-relief devices*

6.6.5.9.1 Every pressure-relief device shall be plainly and permanently marked with the following:

(a) the pressure (in bar or kPa) at which it is set to discharge;

(b) the allowable tolerance at the discharge pressure for spring-loaded devices;

(c) the reference temperature corresponding to the rated pressure for frangible discs; and

(d) the rated flow capacity of the device in standard cubic metres of air per second (m^3/s).

When practicable, the following information shall also be shown:

(e) the manufacturer's name and relevant catalogue number.

6.6.5.9.2 The rated flow capacity marked on the pressure-relief devices shall be determined according to ISO 4126-1:1996.

6.6.5.10 *Connections to pressure-relief devices*

6.6.5.10.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve shall be installed between the shell and the pressure-relief devices except when 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 duplicate devices is always operable and capable of meeting the requirements of 6.6.5.8. There shall be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut-off the flow from the shell to that device. Vents from the pressure-relief devices, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

6.6.5.11 *Siting of pressure-relief devices*

6.6.5.11.1 Each pressure-relief device inlet shall be situated on top of the ***element(s) for the transport of liquefied gases*** in a position as near the longitudinal and transverse centre of the shell as reasonably practicable. All pressure relief device inlets shall under maximum filling conditions be situated in the vapour space of the shell and the devices shall be so arranged as to ensure that the escaping vapour is discharged unrestrictedly. For flammable liquefied gases, the escaping vapour shall be directed away from the shell 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.

6.6.5.11.2 Arrangements shall be made to prevent access to the pressure-relief devices by unauthorized persons and to protect the devices from damage caused by the portable tank overturning.

6.6.5.12 *Gauging devices*

6.6.5.12.1 Unless a portable tank is intended to be filled by weight it shall be equipped with one or more gauging devices. Glass level-gauges and gauges made of other fragile material, which are in direct communication with the contents of the shell shall not be used.

6.6.5.13 *Portable tank supports, frameworks, lifting and tie-down attachments*

6.6.5.13.1 Portable tanks shall be designed and fabricated with a support structure to provide a secure base during transport. The forces specified in 6.6.5.2.9 and the safety factor specified in 6.6.5.2.10 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

6.6.5.13.2 The combined stresses caused by portable tank mountings (e.g. cradles, frameworks, etc.) and portable tank lifting and tie-down attachments shall not cause excessive stress in any portion of the shell. Permanent lifting and tie-down attachments shall be fitted to all portable tanks. Preferably they shall be fitted to the portable tank supports but may be secured to reinforcing plates located on shell*(s)* at the points of support.

6.6.5.13.3 In the design of supports and frameworks the effects of environmental corrosion shall be taken into account.

6.6.5.13.4 Forklift pockets shall be capable of being closed off. The means of closing forklift pockets shall be a permanent part of the framework or permanently attached to the framework. Portable tanks with a length less than 3.65 m need not have closed off forklift pockets provided that:

(a) the ***element(s)*** and all the fittings are well protected from being hit by the forklift blades; and

(b) the distance between the centres of the forklift pockets is at least half of the maximum length of the portable tank.

6.6.5.13.5 When portable tanks are not protected during transport, according to 4.2.2.3, the ***element(s)*** and service equipment shall be protected against damage resulting from lateral or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the ***element(s)*** contents upon impact or overturning of the portable tank on its fittings. Examples of protection include:

(a) protection against lateral impact which may consist of longitudinal bars protecting the ***element(s)*** on both sides at the level of the median line;

(b) protection of the portable tank against overturning which may consist of reinforcement rings or bars fixed across the frame;

(c) protection against rear impact which may consist of a bumper or frame;

(d) protection of the ***element(s)*** against damage from impact or overturning by use of an ISO frame in accordance with ISO 1496-3:1995.

6.6.5.14 *Design approval*

6.6.5.14.1 The competent authority or its authorized body shall issue a design approval certificate for any new design of a portable tank. This certificate shall attest that the portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter and when appropriate the provisions for gases provided in portable tank instruction *T51 and T60* in 4.2.4.2.6. When a series of portable tanks are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the gases allowed to be transported, the materials of construction of the ***element(s)*** and an approval number. The approval number shall 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. Any alternative arrangements according to 6.6.1.2 shall be indicated on the certificate. A design approval may serve for the approval of smaller portable tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

6.6.5.14.2 The prototype test report for the design approval shall include at least the following:

(a) the results of the applicable framework test specified in ISO 1496-3:1995;

(b) the results of the initial inspection and test in 6.6.5.15.3; and

(c) the results of the impact test in 6.6.5.15.1, when applicable.

6.6.5.15 *Inspection and testing*

6.6.5.15.1 For portable tanks meeting the definition of container in the CSC, a prototype representing each design shall be subjected to an impact test. The prototype portable tank shall be shown to be capable of absorbing the forces resulting from an impact not less than 4 times (4 g) the MPGM of the fully loaded portable tank at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for performing the impact test:

Association of American Railroads,
Manual of Standards and Recommended Practices,
Specifications for Acceptability of Tank Containers (AAR.600), 1992

Canadian Standards Association (CSA),
Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods
(B620-1987)

Deutsche Bahn AG
Zentralbereich Technik, Minden
Portable tanks, longitudinal dynamic impact test

Société Nationale des Chemins de Fer Français
C.N.E.S.T. 002-1966.
Tank containers, longitudinal external stresses and dynamic impact tests

Spoornet, South Africa
Engineering Development Centre (EDC)
Testing of ISO Tank Containers
Method EDC/TES/023/000/1991-06

6.6.5.15.2 The ***element(s)*** and items of equipment of each portable tank shall be inspected and tested before being put into service for the first time (initial inspection and test). Thereafter ***the portable tank shall be inspected and tested*** at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection and test (2.5 year periodic inspection and test) midway between the 5 year periodic inspections and tests. The 2.5 year inspection and test may be performed within 3 months of the specified date. An exceptional inspection and test shall be performed regardless of the last periodic inspection and test when necessary according to 6.6.5.15.7.

6.6.5.15.3 The initial inspection and test of a portable tank shall include a check of the design characteristics, an internal and external examination of the portable tank and its fittings with due regard to the gases to be transported, and a pressure test referring to the test pressures according to 6.6.5.3.2. The pressure test may be performed as a hydraulic test or by using another liquid or gas with the agreement of the competent authority or its authorized body. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the ***element(s)*** and *their* fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test. All welds subject to full stress level in the shell shall be inspected during the initial test by radiographic, ultrasonic, or another suitable non-destructive test method. This does not apply to the jacket.

6.6.5.15.4 The 5 year periodic inspection and test shall include an internal and external examination and, as a general rule, a hydraulic pressure test. ***With the agreement of the competent authority or its authorized body, the hydraulic pressure test may be replaced by equivalent methods based on ultrasound or acoustic emission.*** Sheathing, thermal insulation and the like shall be removed only to the extent required for reliable appraisal of the condition of the portable tank. When the ***element(s)*** and equipment have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

With the agreement of the competent authority or its authorized body, the periodicity of the internal inspection and the hydraulic pressure test of cylinders and tubes may be extended for gases of divisions 2.1 and 2.2 following the rules as adopted by the competent authority.

6.6.5.15.5 The intermediate 2.5 year periodic inspection and test shall include an internal and external examination of the portable tank and its fittings with due regard to the gases intended to be transported, a leakproofness test and a test of the satisfactory operation of all service equipment. Sheathing thermal insulation and the like shall be removed only to the extent required for reliable appraisal of the condition of the portable tank. For portable tanks intended for the transport of a single liquefied gas, the 2.5 year internal examination may be waived or substituted by other test methods or inspection procedures specified by the competent authority or its authorized body. ***For portable tanks intended for the transport of compressed gases, the internal examination may be waived.***

6.6.5.15.6 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 6.6.5.15.2. 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:

(a) after emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and

(b) 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 or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption shall be mentioned in the transport document.

6.6.5.15.7 The exceptional inspection and test is necessary when the portable tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the portable tank. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the portable tank. It shall include at least the 2.5 year inspection and test according to 6.6.5.15.5.

6.6.5.15.8 The internal and external examinations shall ensure that:

(a) the ***element(s)*** is***/are*** inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the portable tank unsafe for transport;

(b) the piping, valves, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the portable tank unsafe for filling, discharge or transport;

(c) devices for tightening manhole covers are operative and there is no leakage at manhole covers or gaskets;

(d) missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;

(e) all emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;

(f) required markings on the portable tank are legible and in accordance with the applicable requirements; and

(g) the framework, the supports and the arrangements for lifting the portable tank are in satisfactory condition.

6.6.*5*.15.9 The inspections and tests in 6.6.*5*.15.1, 6.6.*5*.15.3, 6.6.*5*.15.4, 6.6.*5*.15.5 and 6.6.*5*.15.7 shall be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the portable tank. While under pressure, the portable tank shall be inspected for any leaks in the shell, piping or equipment.

6.6.*5*.15.10 In all cases when cutting, burning or welding operations on the ***element(s)*** have been effected, that work shall be to the approval of the competent authority or its authorized body taking into account the pressure vessel code used for the construction of the ***element(s)***. A pressure test to the original test pressure shall be performed after the work is completed.

6.6.*5*.15.11 When evidence of any unsafe condition is discovered, the portable tank shall not be returned to service until it has been corrected and the pressure test is repeated and passed.

6.6.*5*.16 *Marking*

6.6.*5*.16.1 Every portable tank shall be fitted with a corrosion resistant metal plate permanently attached to the portable tank in a conspicuous place readily accessible for inspection. When for reasons of portable tank arrangements, the plate cannot be permanently attached to the ***element(s)***, the ***element(s)*** shall be marked with at least the information required by the pressure vessel code. As a minimum at least the following information shall be marked on the plate by stamping or by any other similar method.

Country of manufacture

U N	Approval Country	Approval Number	For Alternative Arrangements "AA"

Manufacturer's name or mark

Manufacturer's serial number

Authorized body for the design approval

Owner's registration number

Year of manufacture

Pressure vessel code to which the ***element(s)*** is***/are*** designed

Test pressure _____bar/kPa gauge */ ***of each element***

MAWP_____ bar/kPa gauge */or ***Maximum filling pressure at 15 °C--------bar/kPa gauge***

External design pressure **/ _____ bar/kPa gauge */

Design temperature range_____ °C to_____°C

Design reference temperature_____ °C

Number of elements-------

Total water capacity at 20 °C _____litres

Initial pressure test date and witness identification

Element(s) material(s) and material standard reference(s)

Equivalent thickness in reference steel ***for shell(s)*** _____mm

Date and type of most recent periodic test(s)

Month_____ Year_____ Test pressure_____bar/kPa gauge */

Stamp of expert who performed or witnessed the most recent test

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*/ *The unit used shall be marked.*

**/ *See 6.6.3.2.8.*

6.6.5.16.2 The following information shall be marked either on the portable tank itself or on a metal plate firmly secured to the portable tank:

Name of the operator

Name of gas(es) permitted for transport

Maximum permissible load mass for each gas permitted _____kg

Maximum permissible load mass per element (liquefied gas only)---------kg

Maximum permissible gross mass (MPGM)_____kg

Unladen (tare) mass_____kg

***NOTE**: For the identification of the gases being transported, see also Part 5.*

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