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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS

Sub-Committee of Experts on the Transport of Dangerous Goods

REPORT OF THE SUB-COMMITTEE OF EXPERTS ON ITS FOURTEENTH SESSION (Geneva, 8-18 December 1997)

Addendum 2

Annex 3

Report of the Working Group on tanks for non-refrigerated gases with a critical temperature below 65 °C

General

1. The Working Group on tanks for non-refrigerated gases with a critical temperature below 65 °C met from 8 to 11 December 1997 under the chairmanship of Mr. W. Visser (OCTI) on 8 December and Mr. M. Puype (EIGA) from 9 to 11 December.

2. After general discussion, the Working Group concluded that the tank provisions for gases with a critical temperature below 65 °C should be the subject of separate sections. It was agreed that the existing sections on portable tanks should remain unmodified.

3. The Working Group felt that the use of the name “portable tank” was not adequate for constructions with elements in a frame. A new description (name) was adopted: multiple-element gas container (MEGC).

4. The Group recognised the level of risk involved in transporting high pressure gases in elements.

5. The Working Group identified the need for a series of definitive formula or standards to determine the capacity of the relief devices. CGA, ISO and CEN documents, will be considered for review.

6. The Working Group recommended to list all gases in the instructions T50, T51, T60 and T75 to enhance user-friendliness. It was also agreed to include gases that would not be allowed for transport.

7. The headings of columns 10 and 11 of the Dangerous Goods List in Chapter 3.2 should be amended to include multiple-element gas containers.

8. A number of relevant provisions of existing Chapter 4.2 and Chapter 6.6 would need to be included in the new sections.

Consideration on the basic proposal ST/SG/AC.10/C.3/1997/50 (EIGA)

9. The Working Group concluded that multiple-element gas containers would only be composed from cylinders, tubes and bundles of cylinders. Pressure drums and shells were deleted. As the considered receptacles are always bare and have no bottom openings, all references to insulation and bottom openings were deleted.

10. Taking into account climatic conditions, it became obvious that the gases should be subdivided according to their critical temperature: i.e.:

- gases with a critical temperature below -50 °C;
- gases with a critical temperature between -50 °C and 65 °C; and
- gases with a critical temperature above 65 °C.

11. Non-refrigerated liquefied gases with a critical temperature above 65 °C should also be allowed for transport in multiple-element gas containers.

12. The Working Group decided to allocate a “not allowed” status for dissolved acetylene in multimodal transport because of widely diverging national regulations.

13. The Working Group decided that toxic gases and gas mixtures with [a LC_{50} < 200 ppm] should not be authorised for transport in multiple-element gas containers. A remark should be added in the relevant table for the entries concerned.

14. The Federal Institute for Materials Research and Testing (B.A.M.) (Germany) offered to review and revise the data for instruction T51.

15. The Group discussed extensively the definition for the Maximum Allowable Working Pressure (MAWP) and the filling limits for gases with a critical temperature below -50 °C. It was agreed to keep the definition and related provisions between square brackets until various element design standards have been considered. It was also recognised that a comparison between UN

terminology and terminology used in the element design standards should be completed to ensure a harmonized approach.

16. It was agreed that the members of the Working Group should review the relevant standards prior to the next meeting.

17. The Working Group deemed it necessary to refer to dated ISO standards in the UN Recommendations on the Transport of Dangerous Goods.

18. During the discussions about the minimum wall thickness it was recognised that seamless cylinders and tubes have wall thicknesses of more than 5 mm. Therefore, the paragraphs concerning minimum wall thicknesses were superfluous and could be deleted.

19. The Working Group agreed that each element or group of elements in a multiple-element gas container that can be isolated should be fitted with one or more pressure relief-devices.

20. It was decided to leave the discussion on the subject of the capacity of relief devices until the use of formulae in standards has been clarified.

21. The Working Group agreed that the prototype test report should include a new item (d) for certification covering the elements in accordance with the applicable standards.

22. For the 4g impact test, the Working Group requested guidance from the Sub-Committee on the applicability of the listed standards for multiple-element gas containers.

23. The Working Group agreed to consider the requirements for periodic inspection and testing of the elements according to ISO standards (i.e. ISO NP 11624).

24. Outstanding issues and matters which could not be resolved during the session are indicated by provisions between square brackets in the annex hereto.

* * * * *

Note by the Secretariat*: The original report circulated during the session has been editorially revised by the secretariat after consultation of the Chairman. In particular the proposed new Chapter 4.3 has been replaced by a new section 4.2.4 because the references to existing instructions T50 and the introduction of new instructions T51 and T60 between T50 and T75 makes it difficult to dissociate completely MEGCs provisions from existing Chapter 4.2. The necessary consequential changes to Chapter 4.2 are also listed in the annex hereto.*

* * * * *

Annex

1. Draft amendments to Chapter 4.2

Insert a new sub-section 4.2.4 as follows:

"**4.2.4 General provisions for the use of multiple-element gas containers (MEGCs)**

4.2.4.1 This section provides general requirements applicable to the use of multiple-element gas containers (MEGCs) for the transport of non-refrigerated gases.

4.2.4.2 MEGCs shall conform to the design, construction, inspection and testing requirements detailed in 6.7.5.

Gases with a critical temperature below - 50 °C shall be transported in multiple-element gas containers conforming to MEGC instruction T60.

Gases with a critical temperature between -50 °C and 65 °C shall be transported in multiple-element gas containers conforming to MEGC instruction T51.

Gases with a critical temperature above 65 °C shall be transported in multiple-element gas containers or portable tanks conforming to MEGC instruction T50.

In addition the special provisions for MEGCs assigned to specific gases in column 11 of the Dangerous Goods List and described in 4.2.5.3 shall be complied with.

***NOTE**: Gases with a critical temperature below -50 °C and which are partially liquid because of their low temperature, shall be transported in accordance with instruction T75.*

4.2.4.3 During transport, MEGCs 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 they need not be protected in this way. Examples of such protection are given in [**6.6.5.13.5**].

4.2.4.4 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 MEGCs do not contain any gases liable to promote these reactions.

4.2.4.5 Toxic gases and gas mixtures classified under N.O.S. entries of Division 2.3 with an [LC_{50} < 200 ppm] shall not be authorised for transport in MEGCs.

4.2.4.6 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.

4.2.4.7 Empty MEGCs not cleaned and not gas-free shall comply with the same requirements as MEGCs filled with the previous gas.

4.2.4.8 Filling

4.2.4.8.1 Prior to filling the shipper shall ensure that the MEGC is approved for the gas to be transported and that the MEGC is not loaded with gases which in contact with the materials of the elements, 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.

4.2.4.8.2 Elements intended for the transport of gases having a critical temperature between -50 °C and 65 °C shall be filled so that, when the elements are filled to the maximum mass of the contents per litre of capacity[, the pressure reached in the elements by the substance at 65 °C does not exceed the maximum allowable working pressure].

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

[Elements intended for the transport of gases having a critical temperature below -50 °C shall be filled so that the internal pressure at 15 °C in the elements does not exceed two thirds of the maximum allowable working pressure.]

4.2.4.8.3 Multiple-element gas containers shall not be filled above their maximum permissible gross mass. The maximum permissible load mass specified in tables T50 and T51 for each gas to be transported shall not be exceeded.

4.2.4.8.4 Toxic gases of division 2.3 shall only be transported in multiple-element gas containers where each element is equipped with an isolation valve. The isolation valves shall be closed after filling and remain closed during transport.

4.2.4.9 MEGCs shall not be offered for transport:

(a) when leaking;

(b) when damaged to such an extent that the integrity of the elements, the lifting or securing arrangements may be affected; and

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

Renumber existing section 4.2.4 as 4.2.5 and renumber accordingly sub-sections and paragraphs therein.

Amend existing 4.2.4 and 4.2.4.1 to read as follows:

"**4.2.5 Portable tank and multiple-element gas container (MEGC) instructions and special provisions**

4.2.5.1 General

This section includes the portable tank and MEGC instructions and special provisions applicable to dangerous goods authorised to be transported in portable tanks and multiple-element gas containers. Each instruction is identified by an alpha-numeric designation (T1 to T75). Column 10 of the Dangerous Goods List in Chapter 3.2 indicates the portable tank/MEGC instruction that shall be used for each substance permitted for transport in a portable tank or MEGC. When no instruction appears in column 10 for a specific dangerous goods entry then transport of the substance in portable tanks or MEGCs is not permitted unless a competent authority approval is granted as detailed in 6.6.1.3. Portable tank and MEGC special provisions are assigned to specific dangerous goods in column 11 of the Dangerous Goods List in Chapter 3.2. Each portable tank/MEGC special provision is identified by an alpha-numeric designation (TP1 to TP24). A listing of the portable tank/MEGC special provisions is provided in 4.2.5.3.

4.2.5.2 ***Portable tank and MEGC instructions***

4.2.5.2.1 Portable tank and MEGC instructions apply to dangerous goods of Classes 2 to 9. Portable tank and MEGC instructions provide specific information relevant to portable tanks and MEGC requirements applicable to specific substances. These requirements shall be met in addition to the general requirements in this Chapter and Chapter 6.6.

4.2.5.2.2 For substances of Classes 3 to 9, the portable tank instructions (T1 - T34) indicate the applicable minimum test pressure, the minimum shell thickness (in reference steel), bottom opening requirements and pressure relief requirements. In T34, Division 5.2, organic peroxides permitted to be transported in portable tanks are listed along with applicable control and emergency temperatures.

4.2.5.2.3 Non-refrigerated liquefied gases are assigned to portable tank/MEGC instruction T50. T50 provides the maximum allowable working pressures, bottom opening requirements, pressure relief requirements and degree of filling requirements for non-refrigerated liquefied gases permitted for transport in portable tanks [and MEGCs].

4.2.5.2.4 Gases with critical temperatures between -50 °C and 65 °C are assigned to MEGC instruction T51. T51 provides the maximum allowable working pressures, pressure relief requirements and degree of filling requirements.

4.2.5.2.5 Gases with critical temperatures below 50 °C are assigned to MEGC instruction T60. [T60 provides the maximum allowable working pressures, pressure relief requirements and degree of filling requirements.]

4.2.5.2.6 Refrigerated liquefied gases are assigned to portable tank instruction T75.

4.2.5.2.7 Determination of the appropriate portable tank instructions
(Text of existing 4.2.4.2.5, unchanged)

4.2.5.2.8 Portable tank and MEGC instructions

T1-T33 (unchanged)
T34 (unchanged)
T50: Amend the heading to read:

"T50: PORTABLE TANK/MEGC INSTRUCTION T50

This instruction applies to non-refrigerated liquefied gases. For transport in portable tanks, the general provisions of section 4.2.2 and the requirements of section 6.6.3 shall be met. For transport in MEGCs, the general provisions of section 4.2.4 and the requirements of section 6.6.5 shall be met."

In the heading of the fourth column, add "(portable tanks only)" below "Openings below liquid level".

In the heading of the fifth column, replace "(see 6.6.3.7)" with "(see 6.6.3.7/6.6.5.7)".

In the fifth column, replace "See 6.6.3.7.3" with "See 6.6.3.7.3/6.6.5.7.3".

Insert the following two instructions:

T51 MULTIPLE-ELEMENT GAS CONTAINER INSTRUCTION T51

This MEGC instruction applies to non-refrigerated gases with a critical temperature between -50 °C and 65 °C. The general requirements of section 4.2.4 and the requirements of section 6.6.5 shall be met.

UN No.	Gases	[Max. allowable working pressure] (bar)	Pressure relief requirements (see 6.6.5.7)	Maximum filling ratio (kg/l)
1013	Carbon dioxide	190	Normal	0.66
		250		0.75
1022	Chlorotrifluoromethane (Refrigerant gas R 13)	120	Normal	0.9
		250		1.1
1050	Hydrogen chloride, anhydrous	120	See 6.6.5.7.3	0.56
		200		0.74
1035	Ethane	120	Normal	0.29
		300		0.39
1070	Nitrous oxide	180	Normal	0.68
		250		0.75
1080	Sulphur hexafluoride	70	Normal	1.04
		160		1.37
1860	Vinyl fluoride, inhibited	250	Normal	0.64
1984	Trifluoromethane (Refrigerant gas R 23)	190	Normal	0.87
		250		0.95
2454	Methyl fluoride (Refrigerant gas R 41)	300	Normal	0.36
2599	Chlorotrifluoromethane and trifluoromethane, azeotropic mixture (Refrigerant gas R 503)	42	Normal	0.2
		100		0.66
1008	Boron trifluoride, compressed	225	See 6.6.5.7.3	0.715
		300		0.86
1962	Ethylene, compressed	225	Normal	0.34
		300		0.37
1859	Silicon tetrafluoride, compressed	200	See 6.6.5.7.3	0.74
		300		1.1
1982	Tetrafluoromethane, compressed (Refrigerant gas R14, compressed)	200	Normal	0.62
		300		0.94
2036	Xenon, compressed	130	Normal	1.24
2193	Hexafluoroethane, compressed (Refrigerant gas R116, compressed)	200	Normal	1.1
2203	Silane, compressed	225	See 6.6.5.7.3	0.32
		300		0.41
2417	Carbonyl fluoride	200	See 6.6.5.7.3	0.47
		300		0.7
2451	Nitrogen trifluoride	200	Normal	0.5
		300		0.75

T60	MULTIPLE-ELEMENT GAS CONTAINER INSTRUCTION	T60
This MEGC instruction applies to non-refrigerated gases with a critical temperature below -50 °C. The general requirements of section 4.2.4 and the requirements of section 6.6.5 shall be met.		

T75 unchanged

4.2.5.3 Portable tank and MEGC special provisions

Portable tank and MEGC special provisions are assigned to certain substances to indicate requirements which are in addition to or in lieu of those provided by the portable tank and MEGC instructions or the requirements in Chapter 6.6. Portable tank and MEGC special provisions are designated using the abbreviation TP (tank provision) and are assigned to specific substances in Column 11 of the Dangerous Goods List in Chapter 3.2. The following is a list of the portable tank and MEGC special provisions:

TP1 to TP24: unchanged [except for TP20 and TP21 where the word “tanks” should be replaced with “tanks or elements”]”

CHAPTER 6.6

Amend the title to read: “Requirements for the design, construction, inspection and testing of portable tanks and multiple-element gas containers”.

Amend section 6.6.1 to read as follows:

“**6.6.1 Application and general requirements**

6.6.1.1 The requirements of this Chapter apply to portable tanks intended for the transport of dangerous goods of Classes 2, 3, 4, 5, 6, 7, 8 and 9 and to multi-element gas containers (MEGCs) intended for the transport of non-refrigerated gases of Class 2, by all modes of transport. In addition to the requirements of this Chapter, unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC) 1972, as amended, shall be fulfilled by any multimodal portable tank or MEGC which meets the definition of a "container" within the terms of that Convention. Additional requirements may apply to offshore portable tanks and MEGCs that are handled in open seas.

6.6.1.2 In recognition of scientific and technological advances, the technical requirements of this Chapter may be varied by alternative arrangements. These alternative arrangements shall offer a level of safety not less than that given by the requirements of this Chapter with respect to the compatibility with substances transported and the ability of the portable tank or MEGC to withstand impact, loading and fire conditions. For international transport, alternative arrangement portable tanks and MEGCs shall be approved by the applicable competent authorities.

[6.6.1.3 When a substance is not assigned a portable tank or MEGC 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/MEGC 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.]”

Insert a new section 6.6.5 as follows:

"**6.6.5 Requirements for the design, construction, inspection and testing of multiple-element gas containers (MEGCs) intended for the transport of non-refrigerated gases**

6.6.5.1 Definitions

For the purposes of this section:

Multiple-element gas container (MEGC) means a multimodal framed assembly of elements, interconnected by a manifold used for the transport of gases of Class 2. The multiple-element gas container includes service equipment and structural equipment necessary for the transport of gases. The multiple-element gas container shall be capable of being loaded and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the elements, and shall be capable of being lifted also 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, portable tanks , non-metallic tanks, intermediate bulk containers (IBCs) and individual elements are not considered to fall within the definition for multiple-element gas container;

*Element*s means

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

Manifold means an assembly of piping and valves connecting the filling/discharge openings of the elements;

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

Structural equipment means the reinforcing, fastening, protective and stabilizing members external to the elements;

[*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 elements during filling or discharge; or

(b) the maximum effective gauge pressure to which the elements are designed, which shall be:

(i) for a gas listed in the MEGC instruction T51 in 4.2.5.2.8, the MAWP (in bar) given in that 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 element during filling or discharge; or

(b) the sum of:

(i) the maximum effective gauge pressure to which the element 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 6.6.5.2.8, but not less than 0.35 bar;]

[*Test pressure* means the maximum gauge pressure of the elements during the pressure test;]

Leakproofness test means a test using gas subjecting the elements 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 multiple-element gas container 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 6.6.5.3.2.3;]

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

[*Design reference temperature* means the temperature determined for the purpose of calculating the MAWP. This value for each MEGC type is fixed at 65 °C for bare elements];

Filling density means the average mass of liquefied gas per litre of element capacity (kg/l). The filling density is given in MEGC instructions T50 and T51 in 4.2.5.2.8.

6.6.5.2 General design and construction requirements

6.6.5.2.1 Elements shall be designed and constructed [in accordance with ISO:11120 for tubes and ISO:9809 for cylinders or any other standard offering an equivalent level of safety]. Elements shall be made of steel suitable for forming. The materials shall in principle conform to national or international material standards. 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 elements, 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.] MEGC materials shall be suitable for the external environment in which they may be transported.

6.6.5.2.2 MEGCs, 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 (see e.g. ISO 11114).

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 MEGC, including any devices, gaskets, and accessories, shall not adversely affect the gases intended for transport in the MEGC.

6.6.5.2.6 MEGCs 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 MEGCs 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 multiple-element gas container, have been taken into account.

6.6.5.2.8 MEGCs 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) */.

6.6.5.2.9 Under each of the forces in 6.6.5.2.8, the safety factor for the framework and fastenings 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.

6.6.5.2.10 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.

6.6.5.2.11 MEGC 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 Elements shall be designed and constructed to withstand [the test pressure...] The element design shall take into account the [minimum MAWP] values provided in MEGC instruction T51 in 4.2.5.2.8 for each gas intended for transport.

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

[6.6.5.3.2 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 element 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.]

6.6.5.3.2.1 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.

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

6.6.5.3.2.3 [Steels used in the construction of elements 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.]

[6.6.5.3.2.4 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.]

6.6.5.4 Service equipment

6.6.5.4.1 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 elements 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 manifolds, the discharge fittings (pipe sockets, shut-off devices), the stop-valves [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.

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.

6.6.5.4.2 When a MEGC is fitted with an excess flow valve the excess flow valve shall be so fitted inside the frame 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.

6.6.5.4.3 [For filling and discharge openings of the MEGC two valves in series shall be placed in an accessible position on each discharge and filling pipe.] The filling and discharge devices may be fitted to a manifold. For sections of piping which can be closed at both ends and where liquid product can be trapped a pressure-relief valve shall be provided to prevent excessive pressure build-up.

[6.6.5.4.4 For filling and discharge openings of MEGC intended for the transport of flammable and/or toxic liquefied gases the stop-valve shall be a quick closing safety device which closes automatically in the event of unintended movement of the MEGC during filling or discharge or fire engulfment. Except for MEGCs having a capacity of not more than 1 000 litres, it shall be possible to operate this device by remote control.]

6.6.5.4.5 External fittings shall be grouped together at the ends so far as reasonably practicable.

6.6.5.4.6 Each valve on a multiple-element gas container shall be clearly marked to indicate its function.

6.6.5.4.7 Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than the [MAWP] of the elements 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 designed and positioned to prevent unintentional opening.

6.6.5.4.8 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.

6.6.5.4.9 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.

6.6.5.4.10 The burst pressure of all piping and pipe fittings shall be not less than [four times the nominal working pressure] of the elements (except pressure-relief devices).

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

6.6.5.5 Pressure-relief devices

6.6.5.5.1 MEGCs intended for the transport of non-refrigerated gases shall be provided with one or more [spring-loaded] pressure-relief devices. Every element or group of elements of a multiple-element gas container that can be isolated shall be fitted with one or more 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.]

6.6.5.5.2 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.

6.6.5.5.3 [MEGCs intended for the transport of certain non-refrigerated gases identified in instructions T50, T51 and T60 in 4.2.5.2.8 shall have a pressure-relief device approved by the competent authority. Unless a multiple-element gas container 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.]

6.6.5.5.4 In the case of multi-purpose MEGCs, the pressure-relief devices shall open at a pressure indicated in 6.6.5.5.1 for the gas having the highest [maximum allowable pressure of the gases] allowed to be transported in the MEGC.

6.6.5.6 Capacity of relief devices

6.6.5.6.1 [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 elements 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 elements, 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 MEGCs.]

6.6.5.6.1.1 [To determine the total required capacity of the relief devices installed on the elements for the transport of liquefied gases, the thermodynamic properties of the gas have to be considered (see for example CGA S-1.2-1995).]

6.6.5.7 Marking of pressure-relief devices

6.6.5.7.1 [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.]

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

6.6.5.8 Connections to pressure-relief devices

6.6.5.8.1 [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 element 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 6.6.5.6. 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 element 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.]

6.6.5.9 Siting of pressure-relief devices

[6.6.5.9.1 Each pressure-relief device inlet shall be situated on top of the elements 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.]

[6.6.5.9.2 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 MEGC overturning.]

6.6.5.10 Gauging devices

6.6.5.10.1 Unless a MEGC 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 elements shall not be used.]

6.6.5.11 MEGC supports, frameworks, lifting and tie-down attachments

6.6.5.11.1 MEGCs shall be designed and fabricated with a support structure to provide a secure base during transport. The forces specified in 6.6.5.2.8 and the safety factor specified in 6.6.5.2.9 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

6.6.5.11.2 The combined stresses caused by element mountings (e.g. cradles, frameworks, etc.) and MEGC lifting and tie-down attachments shall not cause excessive stress in any element. Permanent lifting and tie-down attachments shall be fitted to all MEGCs. In no case shall mountings or attachments be welded onto the elements.

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

6.6.5.11.4 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. MEGCs with a length less than 3.65 m need not have closed off forklift pockets provided that:

(a) the elements 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 MEGC.

6.6.5.11.5 When MEGCs are not protected during transport, according to 4.2.4.3, the elements 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 elements contents upon impact or overturning of the MEGC on its fittings. Particular attention shall be paid to the protection of the manifold. Examples of protection include:

(a) protection against lateral impact which may consist of longitudinal bars;

(b) protection 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 elements and service equipment against damage from impact or overturning by use of an ISO frame in accordance with [ISO 1496-3:1995].

6.6.5.12 Design approval

6.6.5.12.1 The competent authority or its authorized body shall issue a design approval certificate for any new design of a MEGC. This certificate shall attest that the MEGC 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 instructions *[T50,] T51 and T60* in 4.2.5.2.8. When a series of MEGCs 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 manifold, the standards to which the elements are made 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 MEGCs made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.]

6.6.5.12.2 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 6.6.5.13.3;

(c) the results of the impact test in 6.6.5.13.1, when applicable; and

(d) certification documents covering the elements in accordance with the applicable standards.

6.6.5.13 Inspection and testing

6.6.5.13.1 For MEGCs meeting the definition of container in the CSC, a prototype representing each design shall be subjected to an impact test. The prototype MEGC 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

6.6.5.13.2 [The elements and items of equipment of each MEGC shall be inspected and tested before being put into service for the first time (initial inspection and test). Thereafter MEGC 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 6.6.5.13.7.]

6.6.5.13.3 [The initial inspection and test of a MEGC shall include a check of the design characteristics, an external examination of the MEGC and its fittings with due regard to the gases to be transported, and a pressure test referring to the test pressures according to 6.6.5.3.1. 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 MEGC is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the elements and their fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.]

6.6.5.13.4 [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. When the elements 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.]

6.6.5.13.5 [The intermediate 2.5 year periodic inspection and test shall include external examination of the MEGC 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. For MEGCs 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.]

6.6.5.13.6 A MEGC may not be filled and offered for transport after the date of expiry of the last periodic inspection and test as required by 6.6.5.13.2. However a MEGC 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 MEGC 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.

6.6.5.13.7 [The exceptional inspection and test is necessary when the MEGC shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the MEGC. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the MEGC. It shall include at least the 2.5 year inspection and test according to 6.6.5.13.5.]

6.6.5.13.8 [The internal and external examinations shall ensure that:

(a) the elements are inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the MEGC unsafe for transport;

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

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

(d) 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;

(e) required markings on the MEGC are legible and in accordance with the applicable requirements; and

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

6.6.5.13.9 [The inspections and tests in 6.6.5.13.1, 6.6.5.13.3, 6.6.5.13.4, 6.6.5.13.5 and 6.6.5.13.7 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 MEGC shall be inspected for any leaks in the elements, piping or equipment.]

6.6.5.13.10 [When evidence of any unsafe condition is discovered, the MEGC shall not be returned to service until it has been corrected and the pressure test is repeated and passed.]

6.6.5.14 Marking

6.6.5.14.1 [Every MEGC shall be fitted with a corrosion resistant metal plate permanently attached to the MEGC in a conspicuous place readily accessible for inspection. When for reasons of MEGC arrangements, the plate cannot be permanently attached to the elements, the elements 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 elements 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

Elements materials and material standard references

Equivalent thickness in reference steel for elements _____mm

Date and type of most recent periodic tests

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.]*

[6.6.5.14.2 The following information shall be marked [either on the MEGC itself or] on a metal plate firmly secured to the MEGC:

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.*]"