UNITED
NATIONS

ST

Secretariat

Distr.
GENERAL

ST/SG/AC.10/C.3/22/Add.1
30 January 1996

ENGLISH ONLY

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 ELEVENTH SESSION (Geneva, 4-15 December 1995)

Addendum 1

Report of the Working Group on Portable Tanks

(see also ST/SG/AC.10/C.3/22, paras. 11 to 44)

GE.96-20256

Report of the Working Group on Portable Tanks

1. The Working Group on Portable Tanks reconvened from 4 to 8 December 1995 during the eleventh session of the Sub-Committee of Experts on the Transport of Dangerous Goods. Dr. Schulz-Forberg (Germany) presided as Chairman. Experts from Canada, France, Germany, Norway, Netherlands, Sweden, United Kingdom, United States of America, observers from Spain and Switzerland and representatives from OCTI and TCA/EPTA attended the working group meeting. The group agreed to the following agenda:

(a) Review and implementation of the decisions of the Sub-Committee;

(b) Final reading and consideration of papers relating to portable tanks intended for the transport of liquids and solids;

(c) Continuation of the first reading of ST/SG/AC.10/C.3/R.646 (Non-refrigerated liquefied gases of Class 2);

(d) Exchange of views relative to portable tanks intended for the transport of refrigerated liquefied gases;

(e) Future work programme and timetable; and

(f) Any other business.

2. The Chairman reminded the working group of previous decisions and the terms of reference handed down by the Committee and Sub-Committee. He indicated that the goal of the portable tank harmonization effort was to establish requirements which were truly multimodal taking into account existing requirements in the UN Recommendations, the IMDG Code, RID/ADR and United States regulations (49 Code of Federal Regulations). He confirmed the need to establish grandfathering provisions for existing portable tanks since any new requirements should only apply to new portable tanks. He reported that the RID/ADR Joint Meeting had agreed to include in its programme of work an agenda item dealing with a review of the multimodal portable tank requirements for incorporation in Appendices X of RID and B.1b of ADR. The representative from OCTI reminded the group that when RID/ADR authorized the use of portable tanks in accordance with the IMDG Code this was considered an interim measure until harmonized multimodal portable tank requirements were developed.

3. The Chairman next established rules of procedure for future meetings taking into account the goal of completing the harmonization work by December 1996. The working group agreed that during future meetings no new proposals would be discussed in relation to portable tanks intended for the transport of liquids and solids unless they involve serious safety concerns and are submitted as formal proposals in accordance with the Secretariat's deadline for submission of documents. Any informal comments relative to future meetings and the discussion of the portable tanks intended for the transport of Class 2 substances should be distributed to the working group members and submitted to the Chairman for consolidation in a timely manner. The group noted the guidance provided by the Sub-Committee relevant to developing a text in accordance with the restructuring of the Recommendations. It was agreed that the expert from the United States of America could develop the restructured text when the harmonization work was complete.

4. The working group then turned to the first agenda item. The following is a summary of the discussions and actions taken by the group:

Alternate Arrangements:

5. The group adopted a text to accommodate approval of alternate arrangement portable tanks in international transport (see annex 1). The group also adopted a text to allow competent authorities to authorize transport of substances not listed in tables 12.1, 12.2 and 17.1 of the Recommendations in portable tanks (see annex 1). This provision was based on the current requirements in the IMDG Code (para. 13.1.1.4.1) and requires the competent authority to submit a proposal to the Committee or Sub-Committee upon issuing an approval.

Tank types:

6. Based on the decision of the Sub-Committee to incorporate provisions for tank types in the Recommendations, the group agreed to delete the brackets in 12.23 (previously 12.20) around "tank types" and to include a definition for tank types in the text. The group did not agree on a specific definition and deferred the matter based on the outcome of discussions relevant to ST/SG/AC.10/C.3/R.618, Rationalized Approach for the assignment of Portable Tank Requirements and the work in reformatting the Recommendations into the form of a model rule. The expert from Germany introduced an informal paper explaining the tank designations ("tank strings") under discussion by the RID/ADR Joint Meeting Restructuring Working Group. Experts agreed to consider the matter of establishing tank types and to forward any necessary proposals for the twelfth session of the Sub-Committee.

Rail impact testing:

7. The group deleted the brackets in 12.19.2.1 (renumbered 12.19.3) based on the Sub-Committee’s decision. The expert from France and the representative from OCTI suggested that the UIC leaflet which covers rail impact requirements should be considered as an additional accepted method in addition to the Canadian and Association of American Railroads standards currently referenced in 12.19.2.1 (renumbered 12.9.3). Some experts cautioned that the UIC leaflet was not specific to rail impact testing for portable tanks. The group reconfirmed its earlier decision that any acceptable standard could be added as long as it is approved by the working group. The representative from TCA/EPTA informed the group that the ISO Technical Committee Working Group (ISO TC104/SC2/WG4) responsible for ISO 1496-3 had convened a special meeting to discuss incorporation of a rail impact test in ISO 1496-3 on 1 December 1995. Group members expressed support for incorporation of a rail impact test in the ISO standard since it was felt that reference to a single international standard in the Recommendations would enhance consistency between test facilities throughout the world. The group asked the Secretariat to forward a letter to UIC and ISO TC104/SC2/WG4 requesting information with regard to the existence and supporting the development of a rail impact standard for portable tanks.

Lower capacity limit (450 L) for portable tanks intended for the transport of Class 2 substances

8. Taking into account the Sub-Committee’s decision, the group incorporated a lower capacity limit of 450 litres for portable tanks intended for the transport of refrigerated and non-refrigerated liquefied gases of Class 2. The group noted that additional amendments would be necessary to account for exceptions relevant to smaller tanks. The representative from TCA/EPTA agreed to develop a proposal to address the necessary amendments with appropriate justification.

Explosion pressure proof portable tanks:

9. The group agreed to delete the brackets in 12.3.9. The term “flame trap” was replaced by "flame arrester". The expert from Germany agreed to develop definitions for flame arresters and explosion pressure prooftanks for further consideration by the group. A late document (INF.41) submitted by the representative from TCA/EPTA raised concern relative to the adoption of the term "flame arrester" but this was not considered.

ST/SG/AC.10/C.3/R.608 Methylal:

10. The group referred this paper back to the Sub-Committee since it was considered a matter of listing and classification. The representative from OCTI indicated that the vapour pressure determination method used was not the appropriate method for vapour pressure determination.

ST/SG/AC.10/C.3/R.655 Comments by the expert from Argentina:

11. The group agreed to divide 12.19 into three parts based on the comment from the expert from Argentina including "Design approval", "Inspection and testing" (renumbered 12.20) and "Document retention" (renumbered 12.21). The proposed amendments relevant to indicating the initial inspection and test, the 2.5 year periodic and 5 year periodic inspection and tests on the data plate were not adopted. Based on a review of a typical data plate (see annex 2) and statements by various experts familiar with data plates, the group agreed that the current practice of indicating inspection and test dates on data plates was sufficient and that no new text was necessary.

ST/SG/AC.10/C.3/R.692 and ST/SG/AC.10/C.3/R.693 Comments and proposals by the expert from Belgium:

12. The decision to merge the sections covering liquid/solid portable tanks and gas portable tanks will be deferred until the harmonization work is complete.

13. The group replaced the words "a protective device" with "another form of protection".

14. The group accepted the Belgium proposal concerning Class 3 and elevated temperature substances in paragraph 12.6.7 consistent with the text in 12.3.9.

15. In response to the question concerning the definition of the letter "T" in 12.13.2.1, the expert from Sweden explained that the accumulating condition is the condition which exists once the pressure relief device starts to open up until the point when the maximum relief pressure is attained (device is fully open) due to the build up of pressure within the tank. The phrase "temperature above the pressure-relief device" relates to the temperature of the vapour being released immediately above the opening or outlet of the device (see also ISO 4126-1).

16. In 12.2.3 the words "or external structural equipment" were added at the end of the sentence.

17. The group agreed to delete the definitions for "Filling pressure" and "Discharge pressure" pending the outcome of the expert from the United States‘ search for use of the terms elsewhere in the text.

18. The comments relative to 12.2.9 were not adopted. However, paragraphs 12.19.3.1 (renumbered 12.20.2) and 12.19.3.2 (renumbered 12.20.3) were amended to ensure that portable tanks are leakproofness tested with their service equipment installed, regardless of whether the equipment was tested separately, to take account of the expert from Belgium’s concerns.

19. The group did not adopt the proposed value of 200 mm^2/s at 23 °C for the definition of highly viscous substances relative to the number of closures required for bottom openings and specifically whether an internal shut-off valve is required. Most experts considered this value unacceptable since it was consistent with the viscosity of light motor oils or thinned paints and these substances would not cause problems when being emptied through an internal shut-off valve. The representative from OCTI proposed the value 2680 mm^2/s. This value received greater support from experts and was considered more appropriate. The group made no attempt at defining the term "crystallizable" but considered that an appropriate definition should include a melting point range. The group agreed that certain substances should be permitted to be transported in portable tanks without internal shut-off valves (two means of closure without a internal shut-off device) and that future efforts should focus on developing a text defining "highly viscous" and "crystallizable". The expert from the United States of America agreed to take this on in his revision to ST/SG/AC.10/C.3/R.618 pending the outcome of the working group on the rationalized approach.

20. The comment relative to the siting of pressure relief devices was not adopted since it was considered overly restrictive. The current text was considered adequate.

21. The comment relative to 12.19.3.3 (renumbered 12.20.4) was not adopted since it was considered that the authorized body should be able to waive the inspection if this authority was delegated to him by the competent authority.

22. The group adopted the units of kilopascals (kPa) as an alternative to bar in the marking section (previously 12.20.1).

23. The group did not agree to require the actual thickness on the data plate because not all shell sections are of equivalent thickness. Thicknesses vary in the heads, manhole covers, at the knuckles and in the circumferential wall. The group felt that shell repairs should not be

conducted without referencing the design certificate or, if necessary, without attempting to contact the tank owner.

24. The group agreed to reorder the text under "Construction requirements...". Some of the text was moved to 12.18 "Tank supports, frameworks..." to enhance cohesiveness and clarity.

25. The group did not find it necessary to revise the formula for determination of the coefficient of cubical expansion. However, exchange of technical views resulted in an amendment to the section on filling. The Belgian proposal was considered inadequate because it did not account for changes in the lower temperature density value. The group agreed to adopt a new text based on the existing IMDG Code text and recommendations by the expert from Sweden (see annex 1).

26. This concluded the review and consideration of ST/SG/AC.10/C.3/R.655, ST/SG/AC.10/C.3/R.692 and ST/SG/AC.10/C.3/R.693. The group considered it necessary for the Sub-Committee to discourage submission of additional papers proposing editorial amendments or posing questions relative to the liquid/solid portable tanks during the current biennium if it is to complete the harmonization work by December 1996. It was agreed that only proposals involving serious safety concerns should be considered.

Consideration of additional papers relative to portable tanks intended for the transport of liquids and solids (ST/SG/AC.10/.3/R.621, ST/SG/AC.10/C.3/R.624, ST/SG/AC.10/C.3/R.671 and ST/SG/AC.10/C.3/R.690):

27. Amendments were adopted relative to the equivalent thickness formula and the definitions for "reference steel" and "mild steel" based on a proposal from Germany (ST/SG/AC.10/C.3/R.690) and recommendations by the expert from the Netherlands (see annex 1).

28. The Canadian proposal to increase the design temperature range to take account of climatic conditions in certain parts of the world was adopted. The group agreed to increase the design temperature range to -40 °C to 50 °C in the definition of the design temperature range (para. 12.2.14). The group considered this to apply only to the design of the shell and not to the external structural equipment.

29. The representative from OCTI expressed regret that the working group did not consider the engineering aspects of INF.25.

30. The group confirmed that it was not their intention to require a list of substances or groups of substances on the design certificate. Some experts expressed concern that compatibility between the tank and its contents needed to be ensured. It was pointed out that 12.3.2 through 12.3.6 and 12.19 provide provisions for compatibility. The group, however, agreed to add a statement concerning the shipper‘s responsibility in the filling section (para. 12.22). The words in brackets in 12.19.2.1 (renumbered 12.19.3) were deleted and replaced by "the tank type, the tank material and lining material, if applicable" (see annex 1) and the brackets were removed. Based on a proposal from the expert from Germany the following was added after the shipper‘s responsibility in the filling section:

"The shipper may consult the manufacturer of the substance in conjunction with the Competent Authority for guidance on the compatibility of the substance with the tank materials".

31. The group agreed to consider a minimum thickness of 5 mm regardless of the tank diameter for dedicated portable tanks intended for the transport of powdered and granular solids of PG II and III. The representative from TCA/EPTA agreed to draft a proposal for consideration during the twelfth session of the Sub-Committee.

32. The group did not accept the proposal submitted by the expert from France in INF.36 relative to amendment of the equivalent thickness formula to delete the diameter factor for tanks with a diameter greater than 1.8 metres. The expert from France and the representative from TCA/EPTA agreed to develop a compromise proposal for the twelfth session of the Sub-Committee.

<u>Continuation of the first reading of ST/SG/AC.10/C.3/R.646 (Non-refrigerated liquefied gases of Class 2)</u>

33. The group next focused on the requirements for non-refrigerated liquefied gases of Class 2 as proposed in ST/SG/AC.10/C.3/R.646 (France), paras. 12.28 through 12.40.3. The following is a summary of the amendments agreed on based on the proposed text:

<u>12.28.1</u> Adopted consistent with 12.6.2. The word "lateral" was deleted in both paras.

<u>12.28.2</u> The group considered whether tanks with a capacity less than 1000 litres need to have internal shut-off devices. The group acknowledged that there may be a need to incorporate exceptions for small tanks. The group agreed to defer detailed discussion on the requirements for small tanks pending a proposal by the representative from TCA/EPTA. The term "orifices" was changed to "openings".

12.28.3 Adopted.

12.28.4 Adopted with the understanding that some exceptions may be necessary.

12.28.5 Adopted.

12.28.6 Replaced the text with the first sentence of 12.6.3.

12.28.7 The following was adopted: "Service equipment excluding inspection openings and pressure relief devices should be grouped together whenever practicable."

12.28.8 Adopted.

12.28.9 Adopted. The word "stop" was inserted in the last two sentences before the word "valve". The word "must" was changed to "should". Based on a comment from the representative from TCA/EPTA the group considered prohibiting the use of valves which are attached to the shell or piping by threaded connections. The group did not take action on this matter pending more information and a proposal from TCA/EPTA.

12.28.10 The text was replaced by the text from 12.6.8.

12.28.11-12.29.1 Adopted.

12.30 The group considered whether fusible elements should be permitted on portable tanks with a capacity less than 1000 litres. It was agreed to defer this to the proposal for small tank exceptions.

12.31 The group agreed to review ISO:4126-1 "Safety Devices for Protection against Excessive Pressure - Part 1: Safety Valves" provided to the group by the TCA/EPTA representative. If found acceptable the group may decide to replace the current formula by a reference to the ISO standard. The group agreed to amend 12.31.1.1 consistent with the text in 12.13.2.1 while maintaining the footnote at the bottom of page 11 of ST/SG/AC.10/C.3/R.646.

12.31.1.2 The value 649 °C was replaced by 700 °C to definitely prohibit the use of aluminium jackets when taking advantage of reduced relief capacities. This was also changed in 12.13.2.1. The word "his" was changed to "its".

12.31.1-12.32.2 The words "Relief devices" were changed to "Pressure relief devices" in 12.31.1 and 12.31.2. The text in 12.32.2 was changed to "The rated flow capacity marked on pressure relief valves.

12.33 Adopted.

12.34 Adopted minor editorial amendments ("impige" to "impinge" and "valves" to "devices").

12.35 - 12.36 Adopted.

12.36.1 Amended consistent with 12.18.1.

12.36.1.1 Deleted.

12.36.2-12.36.3 Amended consistent with 12.18.2.

12.37.1 Amended consistent with 12.19 except the mandatory weld inspection requirements were placed in brackets pending concerns raised by the expert from the United States of America that some pressure vessel codes authorize exceptions for NDE inspection of all welds based on alternative measures (e.g. greater shell thicknesses).

The words "heating and cooling devices" and "lining" were placed in brackets since these were not thought to be relevant to gas tanks.

12.37.2 The expert from the United States of America agreed to provide the latest revision date for the AAR standard.

12.37.3 Adopted.

12.37.4 A new section "Document retention" was added consistent with the change adopted in the liquid/solid tank requirements.

12.38 This section was amended consistent with the liquid/solid tank marking requirements with exceptions specific to gases (e.g. Name of gas or gases permitted for transport, Maximum permissible load mass for each gas permitted, deletion of lining material).

12.39 The transport requirements were made consistent with those adopted for liquid/solid tanks.

12.40 "Weight" changed to "Mass" in 12.40.3.

34. This concluded the first reading of the requirements applicable to portable tanks intended for the transport of non-refrigerated liquefied gases of Class 2. The expert from France agreed to incorporate the agreed amendments for the final report. The expert from France also agreed to take into account the decisions from the discussions of the liquid/solid portable tanks applicable to 12.24 to 12.27. A heading will be inserted between the requirements for liquid/solid tanks and the non-refrigerated liquefied gas tanks.

Exchange of views relative to portable tanks intended for the transport of refrigerated liquefied gases

35. The expert from France agreed to take into account the amendments to ST/SG/AC.10/C.3/R.646 and the liquid/solid portable tanks and to distribute a revised document to working group participants by the end of December 1995 for consideration at the informal intersessional meeting in Atlanta (25-30 March 1996). The expert from Sweden pointed out the difference between the terms shell, tank and portable tanks relative to refrigerated liquefied gases.

Future work programme and timetable

36. The Chairman asked the group to provide comments relevant to the informal intersessional meeting by no later than the end of February. The group participants agreed to distribute their comments to all participants including the Chairman who will consolidate the comments in order to ensure they are considered in an organized manner. It was agreed, based on the Chairman’s proposal, that the working hours for the informal intersessional meeting would be extended (9.00 a.m.-1.00 p.m. and 2.30-5.30 p.m.) and that the group would also meet on Saturday, 30 March 1996 to gain maximum advantage of the time available. The TCA/EPTA representative informed the group that the ISO working group chairman (ISO TC104/SC2/WG4) will hold a meeting consecutive with the informal intersessional meeting to discuss rail impact testing.

37. The expert from Germany agreed to prepare a revised version of Table 12.2 in case the work of reformatting and the development of tank types for incorporation in the new Chapter 2 is not completed in time for the December 1996 deadline. Group members expressed confidence that this would not be the case.

38. The Chairman agreed to ask the Sub-Committee for authorization to hold an Editorial and Technical Group meeting during the second week of the twelfth session of the Sub-Committee in order to prepare the final text. It was agreed that, following the twelfth session of the Sub-Committee, the expert from the United States of America will develop a reformatted text for the tenth revised edition of the UN Recommendations (model rule).

Any other business

39. The expert from Germany asked the group to consider provisions for taking account of fatigue and cyclical stresses in transport vehicles including portable tanks. Several experts expressed concern that this would be difficult since transport vehicles experience extreme variations dependent on operational conditions. However, the group agreed to consider this matter further after the harmonization work was completed.

Annex 1

Draft revised Chapter 12 (paras 12.1 to 12.25)

CHAPTER 12

RECOMMENDATIONS ON MULTIMODAL TANK TRANSPORT

12.1 Preamble

12.1.1 The provisions of these Recommendations apply to portable tanks (including tank-containers) intended for the transport of dangerous goods of all Classes except for those of Classes 1 [and 2] by all modes of transport. In addition to the provisions of these Recommendations, and unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC) should be fulfilled by any portable tank which meets the definition of a "container" within the terms of that Convention.

12.1.2 In recognition of scientific and technical advances, the technical provisions of this chapter may be varied by alternate arrangements. These alternate arrangements should offer a level of safety not less than that given by the provisions of this Chapter with respect to the compatibility with substances transported and resistance to impact loading and fire. For international transport alternate arrangement portable tanks should be approved by the applicable competent authorities.

12.1.3 If a substance is not listed in Table 12.2 [12.1] interim approval for transport may be issued by the competent authority of the country of origin. The approval should be included in the documentation of the consignment and contain as a minimum the information normally provided in the list of substances in Table 12.2 and the conditions under which the substance should be carried. Appropriate measures should be initiated by the competent authority to include the substance in the list of substances in Table 12.2.

12.1.4 These provisions are presented in two parts. The first contains requirements applicable to portable tanks intended for the transport of dangerous goods of Classes [2], 3, 4, 5, 6, 7, 8 and 9. The second comprises tables of dangerous goods showing the particular requirements which modify or supplement the requirements of Part I for each particular substance. Table[s] [12.1] and 12.2 of Part II will be required to be brought up to date from time to time by the possible addition of new substances and in the light of technical progress.

12.2 Definitions for Classes [2], 3 to 9

12.2.1 For the purpose of the portable tank requirements relevant to substances in Classes [2], 3, 4, 5, 6, 7, 8 and 9:

12.2.2 Portable tank means a multimodal tank having a capacity of more than 450 litres used in the transport of dangerous substances of classes 3 through 9. The tank includes a shell fitted with service equipment and structural equipment necessary for the transport of dangerous substances. The portable tank should be capable of being loaded and discharged without the need of removal of its structural equipment. It should possess stabilizing members external to the shell, and should be capable of being lifted when full. It is designed primarily to be loaded onto a transport vehicle or ship and is equipped with skids, mountings, or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks and intermediate bulk containers (IBCs) are not considered to fall within the definition for portable tanks;

[12.2.X Tank type means .....]

12.2.3 Shell means the tank proper, including openings and their closures, but does not include service equipment or external structural equipment;

12.2.4 Service equipment of a shell means measuring instruments and filling, discharge, venting, safety, heating, cooling and insulating devices;

12.2.5 Structural equipment means the reinforcing, fastening, protective or stabilizing members external to the shell;

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

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

(b) the maximum effective gauge pressure to which tanks for liquids should be designed which is the sum of the following partial pressures minus 1 bar:

(i) the absolute vapour pressure of the substance in bar at 65 °C;

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

12.2.7 Design pressure means the pressure used, according to a recognized pressure vessel code. The design pressure should never be less than the highest of the following three pressures:

(a) the pressure in 12.2.6 (a); or

(b) the pressure in 12.2.6 (b) and the dynamic head pressure determined on the basis of the dynamic forces due to inertia specified in 12.3.10; such a dynamic head pressure should never be taken less than 0.35 bar; or

(c) the required minimum test pressure as specified in Table 12.2, divided by 1.5;

12.2.8 Test pressure means the maximum gauge pressure at the top of the tank taken during the hydraulic pressure test equal to at least 1.5 times the design pressure. The minimum test pressure for portable tanks used for specific substances is given in column 5 in Table 12.2;

12.2.9 Leakage test means a test using air or an inert gas which consists of subjecting the shell and its service equipment to an effective internal pressure equivalent to not less than 25% and not more than 50% of the maximum allowable working pressure;

12.2.10 Total mass means the mass of the shell, service equipment and structural equipment and the heaviest load authorized for transport;

12.2.11 Reference steel means a steel with a guaranteed minimum tensile strength of 370 N/mm^2 and a guaranteed minimum elongation of 27%;

12.2.12 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 conforming to 12.4.3 (b);

12.2.13 Design temperature range is considered to be -40 °C to 50 °C for substances transported under ambient conditions. For substances handled under elevated temperature conditions the design temperature should be at least equivalent to the maximum temperature of the substance during loading, discharge or transport. More severe design temperatures should be considered for portable tanks subjected to severe climatic conditions.

12.3 [General requirements for the design and construction of portable tanks for substances of Classes 3 to 9]

12.3.1 Shells should be designed and constructed in accordance with the provisions of a technical code recognized by the competent authority. Shells should be made of metallic materials suitable for shaping. The materials should in principle conform to nationally or internationally recognized material standards. For welded shells only a material whose weldability has been fully demonstrated should be used. Welds should be skillfully made and afford complete safety. In choosing the material, the design temperature range should be taken into account with respect to risk of brittle fracture, to stress corrosion cracking and to resistance to impact. Aluminium may only be used as a construction material when indicated in Table 12.2 of Part II for the substance to be transported. Tank materials should be suitable for the external environment in which they may be carried.

12.3.2 Portable tank shells, fittings, and pipework should be constructed of material which is:

(a) substantially immune to attack by the substance(s) intended to be transported; or

(b) properly passivated or neutralized by chemical reaction; or

(c) lined with corrosion-resistant material directly bonded to the material of the tank shell or attached by equivalent means.

12.3.3 Gaskets should be made of materials not subject to attack by the substance(s) intended to be transported.

12.3.4 The lining of a portable tank should meet the following:

(a) The material used to line the tank should:

(i) be substantially immune to attack by the substances to be transported;

(ii) be homogeneous;

(iii) be non porous;

(iv) be free from perforations;

(v) be sufficiently elastic; and

(vi) have thermal expansion characteristics compatible with the tank shell.

(b) The lining of the tank, tank fittings and piping should be:

(i) attached by bonding or other satisfactory means;

(ii) continuous; and

(iii) extended around the face of any flange.

(c) Joints and seams in the lining should be made by fusing the material together or by other equally effective means.

12.3.5 Contact between dissimilar metals which could result in damage by galvanic action should be avoided.

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

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

12.3.8 Shells, their attachments and their service and structural equipment should be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads in normal handling and transport.

12.3.9 Portable tanks without vacuum-relief valves should be designed to withstand without permanent deformation an external pressure at least 0.4 bar above the internal pressure. Tanks equipped with vacuum-relief valves should be designed to withstand, without permanent deformation, an external over-pressure of 0.21 bar gauge or greater and should have their vacuum-relief valve set to relieve at minus (-) 0.21 bar gauge. A greater negative setting may be used provided the external design pressure is not exceeded. All vacuum-relief devices used on tanks for the transport of liquids meeting the flashpoint criteria of Class 3, or elevated temperature materials transported above their flashpoint, should be equipped with a flame arrester or the tank should be explosion pressure proof.

12.3.10 Portable tanks and their fastenings should, under the maximum permissible load, be capable of absorbing the following forces:

(a) in the direction of travel: twice the total mass;

(b) horizontally at right angles to the direction of travel: the total mass (where the direction of travel is not clearly determined, the forces should be equal to twice the total mass);

(c) vertically upwards: the total mass; and

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

12.3.10.1 Under each of these loads, the safety factors to be observed should be as follows:

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

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

The value of yield stress or proof stress should be the value according to the material standard. If no material standard exists for the metal or alloy in question, the value of yield stress or proof stress used shall be approved by the competent authority.

When austenitic steels are used, the specified minimum values according to the material standards may be increased up to 15 % if this value is attested to in the material inspection certificate.

12.3.11 Portable tanks intended to contain certain dangerous substances listed in Table 12.2 of Part II should be provided with additional protection, which may take the form of additional thickness of the shell or a higher test pressure, the additional thickness or higher test pressure being determined in light of the dangers inherent of the substances concerned, or of a protective device approved by the competent authority.

12.3.12 Portable tanks should be capable of being electrically earthed when they are used for the transport of substances meeting the flashpoint criteria of Class 3 or elevated temperature materials transported above their flashpoint. Measures should be taken to prevent a dangerous electrostatic discharge.

12.4 Design criteria

12.4.1 Portable tank shells should be of a design capable of being stress-analyzed mathematically or experimentally by resistance strain gauges, or by other methods approved by the competent authority.

12.4.2 Portable tanks should be designed and constructed to withstand a hydraulic test pressure equal to at least 1.5 times the design pressure. Specific requirements are laid down for certain substances listed in Table 12.2 of Part II. Attention is drawn to the minimum shell thickness requirements for these tanks specified in 12.5.1 to 12.5.10.

12.4.3 At the test pressure, the primary membrane stress σ in the shell should conform to the material-dependent limitations prescribed below.

(a) for metals and alloys exhibiting a clearly defined yield point or characterized by a guaranteed proof stress (0.2 % proof stress generally or 1 % proof stress for austenitic steels), the membrane stress σ at the test pressure should not exceed 0.75 Re or 0.50 Rm, whichever is lower, where:

Re = yield stress, or 0.2% proof stress or,
in the case of austenitic steels, 1% proof stress.
Rm = minimum tensile strength.

The values of Re and Rm to be used shall be the specified minimum values according to the material standards. Where no material standard exists for the metal or alloy in question, the values of Re and Rm used shall be approved by the competent authority or its authorized body. When austenitic steels are used, the specified minimum values according to the material standards may be exceeded by up to 15% if these higher values are attested in the inspection certificate.

Ratios of Re/Rm exceeding 0.85 are not allowed for steels used in the construction of welded tanks. In determining the ratio Re/Rm, the values specified in the material inspection certificate should be used.

[The values specified in the material inspection certificate should be in conformity with the provisions of (b) and (c) below.]

(b) in the case of steel, the elongation at fracture, in %, should not be less than 10,000/Rm where Rm is in N/mm^2, with an absolute minimum of 20%.

(c) in the case of aluminium, the elongation at fracture, in % should not be less than 10,000/6 Rm where Rm is in N/mm^2, with an absolute minimum of 12 %.

12.4.3.1 For the purpose of determining actual values for materials, it should be noted that in the case of sheet metal, the axis of the tensile test specimen should be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture should be measured on test specimens of circular cross section as follows:

$$Lo = 5\ d$$

where:

Lo = length of the specimen before the test; and
d = diameter.

If test specimens of rectangular cross sections are used, the gauge length should be calculated by the formula:

$$Lo = 5.65\ (So)^{1/2}$$

where:

So = the initial cross section of the specimen before the test

12.5 Minimum shell thickness

12.5.1 The minimum thickness of a portable tank should be the higher of:

(a) the minimum thickness determined in accordance with the provisions of sections 12.5.2 to 12.5.10; and

(b) the minimum thickness determined in accordance with the recognized technical code including the provisions in 12.4.3.

12.5.2 The cylindrical portions of the shells, the ends and the manhole covers of tanks not more than 1.80 m in diameter should not be less than 5 mm thick <u>in the reference steel</u> or of equivalent thickness <u>in the actual metal</u>. Tanks more than 1.80 m in diameter should not be less than 6 mm thick in the reference steel or of equivalent thickness <u>in the actual metal</u>.

12.5.3 Where additional protection of the tank against damage is provided, the competent authority may authorize for a tank having a test pressure below 2.65 bar, a reduction in the minimum thickness in proportion to the protection provided. However, the cylindrical portion of the shells, the ends and the manhole covers of tanks not more than 1.80 m in diameter should not be less than 3 mm thick <u>in the reference steel</u> or of equivalent thickness in the actual metal, and those of tanks more than 1.80 m in diameter should not be less than 4 mm thick in the reference steel or of equivalent thickness in the actual metal.

12.5.4 The cylindrical portion, the ends and the manhole cover of the tanks in 12.5.2 and 12.5.3 should not be less than 3mm thick regardless of the material of construction.

12.5.5 The additional protection referred to in 12.5.3 may be provided by overall external structural protection, such as suitable "sandwich" construction with the outer shielding secured to the tank, double wall construction or by supporting the tank in a complete framework with longitudinal and transverse structural members.

12.5.6 The thickness of a metal other than the reference steel to that prescribed in 12.5.2 and 12.5.3 should be determined by using the following equation:

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

12.5.7 Where in Table 12.2 of Part II, apart from references to the requirements in 12.5.2, a greater minimum thickness is required, it should be mentioned that this given thickness is based on a tank diameter of 1.8 m and on the properties of the reference steel . For metals having other characteristics and for tanks having other diameters, these values should be changed using the following equation:

$$e_1 = \frac{21.4 e_o d_1}{1.8 \sqrt[3]{Rm_1 \times A_1}}$$

where e_1 = the required equivalent thickness of the metal to be used in mm

e_o = minimum thickness for the reference steel specified in table 12.2 of Part II

d_1 = actual diameter of the tank in metres

Rm_1 = guaranteed minimum tensile strength of the metal to be used in N/mm^2

A_1 = guaranteed minimum elongation (as a percentage) of the metal to be used on fracture under tensile stress (see 12.4.3).

12.5.8 In no case should the wall thickness be less than that prescribed in 12.5.2, 12.5.3 and 12.5.4. All parts of the shell should have a minimum thickness as determined by 12.5.2 to 12.5.5. This thickness should be exclusive of any corrosion allowance.

12.5.9 There should be no sudden change [of plate thickness at the attachment of the head] to the cylindrical portion of the shell.

12.5.10 If the mild steel conforming to the definition of 12.2.17 is used, calculation using the equations according to 12.5.6 and 12.5.7 is not required.

12.6 Service equipment

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

12.6.2 All openings in the tank-shell, intended for loading or discharging of the substance, should be fitted with a manually operated stop valve located as near as practicable to the shell. Other openings, except for openings leading to venting or pressure-relief devices, should be equipped with either a stop-valve or another suitable means of closure located as close as practicable to the shell. There should be no obstruction in an opening leading to a venting or pressure-relief device which might restrict or cut-off the flow from the tank to that device.

12.6.3 Each portable tank should be fitted with a manhole or other inspection openings of a suitable size to allow for internal inspection and adequate access for maintenance and repair of the interior. Compartmented tanks should have a manhole or other inspection openings for each compartment.

12.6.4 Whenever possible, external fittings should be grouped together. For insulated tanks, top fittings should be surrounded by a spill collection reservoir with suitable drains.

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

12.6.6 Each stop-valve or other means of closure should be designed and constructed to a rated pressure not less than the maximum allowable working pressure of the tank and to the temperature expected in transport. Each stop-valve with a screwed spindle should be closed by a clockwise motion of the handwheel. In the case of other stop-valves the position and/or direction of closure should be clearly indicated. All stop-valves should be constructed to prevent unintentional opening.

12.6.7 No moving parts, such as covers, components of closures, etc., which are liable to come into frictional or percussive contact with aluminium tank-containers intended for the transport of flammable liquids meeting the flashpoint criteria of Class 3 or elevated temperature substances transported above their flashpoint should be made of unprotected corrodible steel.

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

12.7 Bottom openings

12.7.1 Certain substances listed in Table 12.2 of Part II should not be carried in portable tanks with bottom openings. When Table 12.2 in Part II prohibits bottom openings the shell of the tank should not be pierced below the lading level in the tank. When existing openings are blanked off, this should be by means of suitable blank flanges welded internally and externally to the shell.

12.7.2 Bottom discharge outlets for tanks carrying solids, certain crystallizable or highly viscous substances should be equipped with not less than two serially mounted and mutually independent shut-off devices. The design should satisfy the competent authority, or its authorized body, and should include:

(a) an external stop-valve fitted as close to the tank shell as is practicable; and

(b) a liquid tight closure at the end of the discharge pipe, which may be a bolted blank flange or a screw cap.

12.7.3 Every bottom discharge outlet, except as provided in 12.7.2, should be equipped with three serially mounted and mutually independent shut-off devices. The design of the equipment should satisfy the competent authority, or its authorized body and conform to the following:

(a) a self-closing internal stop-valve, that is a stop-valve within the tank or within a welded flange or its companion flange, such that:

(i) the control devices are so designed as to prevent any unintended opening through impact or other inadvertent act;

(ii) the valve may be operable from above or below; and

(iii) if possible, the setting of the valve (open or closed) should be capable of being verified from the ground.

(iv) It should be possible to close the valve from an accessible position of the portable tank that is remote from the valve itself.

(b) an external stop-valve fitted as close to the tank shell as practicable; and

(c) a liquid tight closure at the end of the discharge pipe, which may be a bolted blank flange or a screw cap.

12.7.3.1 In the case of a lined shell, the internal stop-valve required by 12.7.3 may be replaced by an external stop-valve. The manufacturer should satisfy the requirements of the competent authority or its authorized body.

12.7.4 The internal shut-off device should continue to be effective in the event of damage to the external control device.

12.8 Safety relief

12.8.1 All portable tanks should be fitted with a pressure-relief device. All relief devices should be designed, constructed and marked to the satisfaction of the competent authority or its authorized body.

12.9 Pressure-relief devices

12.9.1 Every portable tank of 1,900 litres or more, or every independent compartment of a tank of similar capacity, should be provided with one or more pressure-relief valves of the spring-loaded type and may in addition have a frangible disc or fusible element in parallel with the spring-loaded devices except when prohibited by reference to 12.9.3 in Table 12.2 of Part II. The pressure-relief valves should be designed and have sufficient capacity to prevent tank rupture due to over pressurization or vacuum resulting from loading, unloading, or from heating of the lading.

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

12.9.3 Tank shells for the transport of certain substances listed in Table 12.2 of Part II should have a pressure-relief device approved by the competent authority. Unless a tank in dedicated service is fitted with an approved relief valve constructed of materials compatible with the load, such device should comprise a frangible disc preceding a spring-loaded valve. If a frangible disc is inserted in series with the required pressure-relief valve, the space between the frangible disc and the pressure-relief valve should be provided with a pressure gauge or suitable tell-tale indicator for detection of disc rupture, pin holing, or leakage which could cause a malfunction of the pressure-relief system. The frangible disc should rupture at a nominal pressure 10% above the start to discharge pressure of the relief valve.

12.9.4 Every portable tank with a capacity of less than 1,900 litres should be fitted with a pressure-relief device which may be a frangible disc if the latter complies with the requirements of 12.12.1. If no spring-loaded pressure-relief valve is used, the frangible disc should be set to rupture at a nominal pressure equal to the test pressure.

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

12.10 Setting of pressure-relief devices

12.10.1 It should be noted that the devices should operate only in conditions of excessive rise in temperature, as the tank will not during transport be subject to undue fluctuations of pressure due to operating procedures (see, however, 12.13.2).

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

12.11 Fusible elements

12.11.1 Fusible elements, if allowed in Table 12.2 of Part II, should function at a temperature between 110 °C and 149 °C provided that the developed pressure in a tank at the fusing temperature of the element does not exceed the test pressure of the tank. They should be placed at the top of the tank in the vapour space and in no case should they be shielded from external heat. Fusible elements should not be utilized on tanks with a test pressure which exceeds 2.65 bar. Special considerations meeting the satisfaction of the competent authority or its authorized body should be given to fusible elements of tanks used for substances transported at elevated temperatures.

12.12 Frangible discs

12.12.1 Except as provided in 12.9.3, frangible discs, if used should be set to rupture at a nominal pressure equal to the test pressure throughout the design temperature range. Particular attention should be given to the requirements of 12.6.1 and 12.9.3 if frangible discs are used.

12.13 Capacity of pressure-relief devices

12.13.1 The spring-loaded pressure-relief device required by 12.9.1 should have a minimum diameter of 31.75 mm. Vacuum-relief devices, if used, should have a minimum cross sectional flow area of 2.84 cm^2.

12.13.2 The combined delivery capacity of the relief devices in condition of complete engulfment of the tank in fire should be sufficient to limit the pressure in the tank to 20% above the start-to-discharge pressure of the relief device. Emergency pressure-relief devices may be used to achieve the full relief capacity prescribed. Emergency pressure-relief devices may be of the spring-loaded, frangible or fusible type. The total required capacity of the relief devices may be determined by using the formula in 12.13.2.1 or the table in 12.13.2.2.

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

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

where: **Q** = minimum required rate of discharge in cubic metres of air per hour at standard conditions: 1 bar and 0 °C (273 K);

F = is a coefficient with the following value:

for uninsulated tanks **F** = 1

for insulated tanks **F** = U(649 - t)/13.6 but in no case is less than 0.25 where:

U = thermal conductance of the insulation, in kw.m^{-2}K^{-1}, at 38 °C

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

The value of **F** given in .2 above may be taken provided that: the insulation is in conformity with 12.13.2.3.

A = total external surface area of tank in square meters

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

T = absolute temperature in Kelvin (°C + 273) above the pressure-relief devices in the accumulating condition;

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

M = molecular mass of the discharged gas;

C = a constant which may be taken from the following Table which is derived from the following equation as a function of the ratio k of specific heats:

$$k = \frac{C_p}{C_v}$$

where :

C_p = the specific heat at constant pressure and

C_v = the specific heat at constant volume;

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

when k > 1

$$C = \frac{1}{e^{0.5}} = 0.607$$

when k = 1 or k is unknown

where:

e = the mathematical constant 2.7183

VALUES FOR THE CONSTANT C WHEN k > 1

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

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

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

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

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

12.13.2.3 Insulation systems, used for the purpose of reducing the venting capacity, should be approved by the competent authority or its designated approval agency. In all cases, insulation systems approved for this purpose must:

(i) Remain effective at all temperatures up to 649 °C; and

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

12.14 Markings of pressure-relief devices

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

(a) the manufacturer's name and the relevant catalogue number;

(b) set pressure, in bar or kPa and rated flow capacity, in standard cubic metres per second;

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

12.15 Connections to pressure-relief devices

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

12.16 Siting of pressure-relief devices

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

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

12.17 Gauging devices

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

12.18 Tank support, frameworks, lifting and tie-down attachments

12.18.1 Portable tanks should be designed and fabricated with a support structure to provide a secure base during transport. The loadings specified in 12.3.10 should be considered in this aspect of design. Skids, frameworks, cradles or other similar devices are acceptable.

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

12.18.3 In the design of supports and frameworks due regard should be paid to the effects of environmental corrosion.

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

(a) the tanks shell 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 unit.

12.18.5 If portable tanks are not protected during transport, according to 12.24.1, the shells and service equipment shall be protected against collision.

Examples of protection against collision:

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

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

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

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

12.19 Design approval

12.19.1 The competent authority or a body authorized by that authority should issue a design approval certificate for any new design of a portable tank. This certificate should attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this chapter. If a series of portable tanks are manufactured without change in the design, the certificate should be valid for the entire series.

The certificate should refer to the prototype test report, <u>the tank type</u>, the <u>material of construction of the shell and of the lining, if applicable</u> and an approval number. The approval number should consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic as prescribed by the Convention on Road Traffic, Vienna 1968, and a registration number. Alternative arrangements according to 12.1.2, if any, should be indicated on the certificate. A design approval may serve for the approval of smaller tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

12.19.2 The prototype test report for the design approval should include at least the following:

- the results of the applicable frame-work test specified in ISO 1496-3: 1995;
- the results of the impact test in 12.19.3 when applicable;
- the results of the initial inspection and test in 12.20.2.

12.19.3 For portable tanks meeting the definition of container in the CSC, a prototype tank of each design should be subjected to an impact test. The prototype tank should be shown to be capable of absorbing the forces resulting from an impact equivalent to at least 4 times (4 g) the maximum gross mass of the loaded 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,
Highway Tanks and Portable Tanks for the Transportation
of Dangerous Goods
(B620-1987).

12.20 Inspection and Testing

12.20.1 The shell and items of equipment of each portable tank should be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection (2.5 year periodic inspection and test) midway in the 5 year periodic inspection and test. An exceptional inspection and test, when necessary according to 12.19.3.5, should be carried out regardless of the last periodic inspection and test.

12.20.2 The initial inspection and test of a portable tank should include a check of the design characteristics, an internal and external examination of the tank and its fittings with due regard to the substances to be transported, and a hydraulic pressure test. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment should also be conducted. If the shell and equipment have been pressure-tested separately, they should be subjected together to the leakproofness test after assembly to a leakproofness test.

12.20.3 The 5-year periodic inspection and test should include an internal and external examination and, as a general rule, a hydraulic pressure test. Sheathing, thermal insulation and the like should be removed only to the extent required for reliable appraisal of the condition of the portable tank. If the shell and equipment have been pressure-tested separately, they should be subjected together to the leakproofness test after assembly to a leakproofness test.

12.20.4 The intermediate 2.5 year periodic inspection and test should at least include:

(a) an internal and external examination of the tank and its fittings with due regard to the substances transported;

(b) a leakproofness test;

(c) a test of the satisfactory operation of all service equipment.

However, the internal examination may be waived by the competent authority concerned, or its authorized body, in the case of tanks dedicated to the transport of a single substance.

12.20.5 Portable tanks, empty and uncleaned, may be moved after the expiration of the 5 year intervals. In addition, the 2.5 year inspection and test may be carried out within 3 months before and after the specified date.

12.20.6 The exceptional inspection and test is necessary when the tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a weakness that could affect the integrity of the tank.

The extent of the exceptional inspection and test should depend on the amount of damage or deterioration of the portable tank. It should include at least the 2.5 year inspection and test according to 12.20.4.

12.20.7 The internal and external examination should ensure that:

(1) the tank shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the tank unsafe for transport;

(2) the piping, valves, heating/cooling system, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the tank unsafe for loading, discharge or transport;

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

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

(5) 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 should be operated to demonstrate proper operation;

(6) linings are inspected in accordance with criteria outlined by the lining manufacturer;

(7) required markings on the tank are legible.

12.20.8 The inspections and tests in 12.20.2, 12.20.3, 12.20.4 and 12.20.6 should be carried out or witnessed by the competent authority or its authorized body.

If the hydraulic pressure test is a part of the inspection and test, the test pressure should be the one indicated on the data plate of the portable tank. While under pressure, the tank should be inspected for any leakages on the shell, piping or equipment.

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

12.20.10 If evidence of any unsafe condition is discovered, the tank should not be placed or returned to service until it has been corrected and the test is repeated and passed.

12.21 **Document Retention**

12.21.1 The design approval certificate, the test report and the certificate showing the results of the initial inspection and test for each tank issued by the competent authority or its authorized body should be retained by the authority or body and the owner. Owners should be able to provide this documentation upon the request of any competent authority.

12.22 Filling

12.22.1 Prior to filling, the shipper should ensure that the appropriate tank type is used and that the portable tank is not loaded with substances which in contact with the materials of the shell, gaskets, service equipment and any protective linings, are likely to react dangerously with them to form dangerous products or appreciably weaken the material. The shipper may consult the manufacturer of the substance in conjunction with the Competent Authority for guidance on the compatibility of the substance with the tank materials.

12.22.1.2 Portable tanks should not be filled above the extent provided for by 12.22.3 to 12.22.6. The applicability of 12.22.3, 12.22.4 or 12.22.6 to individual substances is specified by the reference in Table 12.2 of Part II.

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

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

12.22.3 The maximum degree of filling for liquids of Division 6.1 and Class 8, in

Packing Groups I and II, and liquids with an absolute vapour pressure of more than 1.75 bar at 65 ºC, is determined by the formula:

$$Degree\ of\ filling = \left(\frac{95}{1 + \alpha\ (t_r - t_f)} \right)$$

12.22.4 In these formulae α is the mean coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (t_f) and the maximum mean bulk temperature during transport (t_r). For liquids transported under ambient conditions α could be calculated by the formula:

$$\alpha = \left(\frac{d_{15} - d_{50}}{35 \times d_{50}} \right)$$

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

12.22.4.1 The maximum mean bulk temperature (t_r) should be taken as 50 ºC except that, for journeys under temperate or extreme climatic conditions, the competent authorities concerned may agree to a lower or require a higher temperature, as appropriate.

12.22.5 The provisions of 12.22.3 to 12.22.4 should not apply to portable tanks the contents of which are maintained at a temperature above 50 ºC during transport for instance by means of a heating device. For portable tanks equipped with a heating device, a temperature regulator should be used to ensure the maximum degree of filling is not more than 95 % full at any time during transport.

12.22.5.1 The maximum degree of filling for liquids transported under elevated temperature conditions is determined by the formula:

$$Degree\ of\ filling = 95\ .\ \frac{d_r}{d_f}$$

in which d_f and d_r are the densities of the liquid at the mean temperature of the liquid during filling and the maximum mean bulk temperature during transport respectively.

12.22.6 Portable tanks should not be offered for transport:

(a) with a degree of filling, for liquids having a viscosity of less than 2,680 mm^2/s at 20 °C, of more than 20% but less than 80% unless the shells of portable tanks are divided, by partitions or surge plates, into sections of not more than 7,500 litres capacity;

(b) with residue of goods carried adhering to the outside of the tank shell or service equipment;

(c) that are leaking or 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.

12.23 Marking

12.23.1 Every portable tank should be fitted with a corrosion-resistant plate permanently attached to the tank in a conspicuous place readily accessible for inspection. If for reasons of tank arrangements, the plate cannot be permanently attached to the shell, the shell should be marked with at least those particulars required by the pressure vessel code. At least the following particulars should be marked on the plate by stamping or by any other similar method.

Country of manufacture

U	Approval	-	Approval	-	In the case of Alternate Arrangements
N	COUNTRY		NUMBER		"AA"

Manufacturer’s name or mark.

Manufacturer’s serial number

Authorized Body for the design approval

Owner’s Registration number

Year of manufacture

Tank type

Technical Code to which tank is designed

Hydraulic Test pressure ________ bar gauge

MAWP _________ bar gauge or kilopascals (kPa)

Water capacity at 20 °C ________ litres

Water capacity of each compartment ________ litres at 20 °C.

Initial hydraulic pressure test date and witness identification

Design temperature range, ________ °C to ________ °C.

Maximum allowable working pressure for heating/cooling system bar gauge

Tank shell material and material reference

Equivalent thickness in reference steel ________ mm

Lining material (if any)

Date and type of most recent periodic test

Stamp of expert who carried out or witnessed the most recent test.

12.23.2 The following particulars should 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 substance(s) being carried (and maximum mean bulk temperature if higher than 50 °C)
- Maximum permissible gross mass ________ kg
- Unladen (tare) mass ________ kg

12.23.3 The contents should be identified as specified in Chapter 13 of the Recommendations.

12.24 Transport requirements

12.24.1 During transport, portable tanks should be adequately protected against lateral and longitudinal impact and against overturning. This protection is not required if portable tanks are constructed to withstand impact or overturning examples of such protection are given in 12.18.5.

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

12.24.3 The temperature of the outer surface of the tank shell excluding openings and their closures or of the thermal insulation should not exceed 70 °C during transport. When dangerous goods are transported at elevated temperatures in either liquid or solid state, the tank must be thermally insulated to meet this condition.

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

12.25 Handling requirements

12.25.1 Fork-lift pockets of portable tanks should be closed off when the portable tank is filled.

12.25.2 Substances should not be carried in adjoining compartments of tanks if they may react dangerously with each another and cause:

(a) combustion and/or evolution of considerable heat;

(b) evolution of flammable, toxic or asphyxiant gases;

(c) the formation of corrosive substances;

(d) the formation of unstable substances;

(e) dangerous rise in pressure.

PORTABLE TANKS REQUIREMENTS FOR NON REFRIGERATED LIQUEFIED GASES OF CLASS 2

12.26 **Definitions for Class 2, [3 to 9]**

12.26.1 For the purposes of the portable tanks requirements relevant to [non refrigerated liquefied gases] [substances] in Class 2, [3, 4, 5, 6, 7, 8 and 9]:

12.26.2 *Portable tank* means a multimodal tank having a capacity of more than 450 litres used in the transport of non-refrigerated liquefied gases of class 2. The tank includes a shell fitted with service equipment and structural equipment necessary for the transport of gases. The portable tank should be capable of being loaded and discharged without the need of removal of its structural equipment. It should possess stabilizing members external to the shell, and should be capable of being lifted when full. It is designed primarily to be loaded onto a transport vehicle or ship and is equipped with skids, mountings, or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks, compressed gas cylinders and large receptacles are not considered to fall within the definition for portable tanks;

[12.26.X *Tank type* means ....]

12.26.3 *Shell* means the tank proper, including openings and their closures, but does not include service equipment or [external] structural equipment;

12.26.4 *Service equipment* of a shell means measuring instruments and filling, discharge, venting, safety, [heating, cooling] and insulating devices;

12.26.5 *Structural equipment* means the reinforcing, fastening, protective or stabilizing members external to the shell;

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

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

.2 the maximum effective gauge pressure to which tanks should be designed which is:

.2.1 for gases for which the MAWP in bar is given in column (5) in Table 12.1, the appropriate value;

.2.2 for other gases, the sum of the following partial pressures minus 1 bar:

.2.2.1 the absolute vapour pressure of the substance in bar at the design reference temperature;

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

In no case should the MAWP be less than 7 bar [and more than 50 bar];

12.26.7 *Design pressure* means the pressure used, according to a recognized pressure vessel code. The design pressure should never be less than the highest of the following two pressures:

(a) the pressure in 12.26.6.1;

(b) the pressure in 12.26.6.2 and the dynamic head pressure determined on the basis of the dynamic forces due to inertia specified in 12.27.9, such a dynamic head pressure should never be taken less than 0.35 bar.

12.26.8 *Test pressure* means the maximum gauge pressure at the top of the tank taken during the hydraulic pressure test equal to at least [1.3] times the design pressure;

12.26.9 *Leakage test* means a test using gas which consists of subjecting the shell and its service equipment to an effective internal pressure equivalent to not less than 25% but not more than 50% of the maximum allowable working pressure;

12.26.10 *Total mass* means the mass of the shell, service equipment and structural equipment and the heaviest load authorised for transport;

12.26.11 *Reference steel* means a steel with a guaranteed minimum tensile strength of 370 N/mm^2 and a guaranteed minimum elongation of 27%;

12.26.12 *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 conforming to 12.28.3 (b);

12.26.13 *Design reference temperature* means the temperature at which the vapour pressure of the contents is determined for the purpose of calculating the maximum allowable working pressure. The design reference temperature should be less than the critical temperature of the gas to be transported to ensure that the gas at all times is liquefied. This value for each tank type is as follows:

(a) tank with a diameter of 1.5 metres or less: 65°C;

(b) tank with a diameter of more than 1.5 metres:

(i) without insulation or sun shield: 60°C

(ii) with sun shield: 55°C

(iii) with insulation: 50°C */.

12.26.14 *Filling density* means the average mass of substance per litre of tank capacity (kg/l). The filling density is given in column (8) in Table 12.1.

12.27 **[General requirements for the design and construction of portable tanks for non-refrigerated liquefied gases]**

12.27.1 Shells should be designed and constructed in accordance with the provisions of a [technical code recognized by the competent authority]. Shells should be made of steel suitable for shaping. The material should in principle conform to nationally or internationally recognized materials standards. For welded shells, only a material whose weldability has been fully demonstrated should be used. If the manufacturing process or the materials make it necessary, the shells should be heat-treated with a suitable heat treatment after welding operations. Welds should be skillfully made and afford complete safety. In choosing the material the design temperature range should be taken into account with respect to risk of

*/ This reference temperature is provisional and dependent on the quality of the insulation system. [define global thermal insulation]

brittle fracture, to stress corrosion cracking and to resistance to impact. Tank materials should be suitable for the external environment in which they may be carried.

12.27.2 Portable tank shells, fittings and pipework should be constructed of material which is:

(a) substantially immune to attack by the substance(s) intended to be transported;

or

(b) properly passivated or neutralized by chemical reaction.

12.27.3 Gaskets should be made of materials not subject to attack by the substance(s) intended to be transported.

12.27.4 Contact between dissimilar metals which could result in damage by galvanic action should be avoided.

12.27.5 The materials of the tanks, including any devices, gaskets, [linings] and accessories, should not adversely affect the contents of the tank.

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

12.27.7 Shells, their attachments and their service and structural equipment should be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads in normal handling and transport.

12.27.8 Tanks should be designed to withstand an external pressure of at least 0.4 bar gauge above the internal pressure without permanent deformation. When the tank is to be subjected to a significant vacuum before loading or during discharge it should be designed to withstand an external pressure of at least 0.9 bar gauge above the internal pressure and should be proven to that pressure.

12.27.9 Portable tanks and their fastenings should, under the maximum permissible load, be capable of absorbing the following forces:

(a) in the direction of travel: twice the total mass;

(b) horizontally at right angles to the direction of travel: the total mass (where the direction of travel is not clearly determined, the forces should be equal to twice the total mass);

(c) vertically upwards: the total mass; and

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

12.27.9.1 Under each of these loads, the safety factors to be observed should be as follows:

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

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

The values of yield stress or proof stress should be the value according to material standard. If no material standard exists for the steel in question, the value of yield stress or proof stress used shall be approved by the competent authority. When austenitic steels are used, the specified minimum values according to the material standards may be increased up to 15% if this value is attested in the material inspection certificate.

12.27.10 Portable tanks intended to contain certain gases listed in Table 12.1 of Part II should be provided with additional protection, which may take the form of additional thickness of the shell or a higher test pressure, the additional thickness or higher test pressure being determined in the light of the dangers inherent in the substances concerned, or of a protective device approved by the competent authority.

12.27.11 Thermal insulation systems should satisfy the following requirements:

(a) If the shells of portable tanks intended for the transport of gases are equipped with thermal insulation, such insulation should either:

(i) consist of a shield covering not less than the upper third but not more than the upper half of the surface of the portable tank and separated from the shell by an air space about 4 cm across; or

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

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

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

12.28 **Design criteria**

12.28.1 Tanks should be of a circular cross-section.

12.28.2 Portable tanks should be designed and constructed to withstand a hydraulic test pressure equal to at least [1.3] times the design pressure. Specific requirements are laid down for certain substances in Table 12.1 of Part II. Attention is drawn to the minimum shell thickness requirements for these tanks specified in 12.29.

12.28.3 At the test pressure, the primary membrane stress σ in the shell should conform to the material-dependent limitations prescribed below.

(a) for steels exhibiting a clearly defined yield point or characterized by a garanteed proof stress (0.2% proof stress generally or 1% proof stress for austenitic steels), the membrane stress σ at the test pressure should not exceed 0.75 Re or 0.50 Rm, whichever is lower, where:

Re = yield stress, or 0.2% proof stress or, in the case of austenitic steels, 1% proof stress.
Rm = minimum tensile strength.

The values of Re and Rm to be used shall be specified minimum values according to material standards. Where 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. When austenitic steels are used, the specified minimum values according to the material standards may be exceeded by up to 15% if these higher values are attested in the inspection certificate. The values specified in the material inspection certificate shall be as follows:

Ratios of Re/Rm exceeding 0.85 are not allowed for steels used in the construction of welded tanks. In determining the ratio Re/Rm, the values specified in the material inspection certificate should be used.

(b) the elongation at fracture, in %, should not be less than 10,000/Rm where Rm is in N/mm^2, with an absolute minimum of [16% for fine grained steels and] 20% [for other steels].

12.28.3.1 For the purpose of determining actual values for materials, it should be noted that in the case of sheet metal, the axis of the tensile test specimen should be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture should be measured on test specimens of circular cross section as follows:

$$Lo = 5\ d,$$

where: Lo = length of the specimen before the test; and
d = diameter;

If test specimens of rectangular cross section are used, the gauge length should be calculated by the formula:

$$Lo = 5.65\ (So)^{1/2}$$

where: So = the initial cross section of the specimen before the test.

12.29 **Minimum shell thickness**

12.29.1 The minimum thickness of a portable tank, excluding any corrosion allowance, should be the higher of:

a) the minimum thickness determined in accordance with the provisions of sections 12.29.2 to 12.29.4; and

b) the minimum thickness determined in accordance with the recognized technical code including the provisions in 12.28.3.

12.29.2 The cylindrical portions of the shells, the ends and the manhole covers of tanks not more than 1.80 m in diameter should be not less than 5 mm thick in the reference steel or equivalent thickness in the actual steel. Tanks more than 1.80 m in diameter should not be less than 6 mm thick in the reference steel or of equivalent thickness in the actual steel. The cylindrical portions, the ends and the manhole covers of all tanks should be at least 4 mm thick regardless of the materials of construction.

12.29.3 The thickness of a steel other than the reference steel to that prescribed in 12.29.2 should be determined by using the following equation:

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

where: e_1 = the required equivalent thickness of the steel to be used in mm;
e_o = minimum thickness for the reference steel specified in 12.29.2;
Rm_1 = guaranteed minimum tensile strength of the steel to be used in N/mm^2;
A_1 = guaranteed minimum elongation (as a percentage) of the metal to be used on fracture under tensile stress (see 12.28.3).

12.29.5 If mild steel conforming to the definition of 12.26.12 is used, calculation using the equation according to 12.29.3 is not required.

12.29.4 There should be no sudden change [of plate thickness at the head of attachment] to the cylindrical portion of the shell.

12.30 **Service equipment**

12.30.1 Service equipment should be so arranged as to be protected against the risk of being wrenched off or damaged during transport and handling. If the connection between the frame and the tank shell allows relative movement between the sub-assemblies, the equipment should 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 and its seating should be protected against the danger of being wrenched off by external stresses (for example using shear sections). The filling and discharge devices (including flanges or
threaded plugs) and protective caps (if any) should be capable of being secured against any unintended opening.

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

12.30.2.1 Where portable tank is fitted with a flow-restricting valve:

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

(b) Flow-restricting valves should be selected and fitted so as to close automatically when the rated flow specified by the manufacturer is reached. Connections and accessories leading to or from such a valve should have the capacity for a flow greater than the rated flow of the flow-restricting valve.

12.30.3 In the case of filling and discharge openings the first shut-off device should be an internal stop-valve and the second should be a stop-valve placed in an accessible position on each discharge and/or filling pipe.

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

12.30.5 The shells may be equipped, in addition to filling, discharge and gas pressure equalizing orifices, with openings in which gauges, thermometers and manometers can be fitted. Connections for such instruments should be made by suitable welded nozzles or pockets and not be screwed connections through the shell.

12.30.6 Each portable tank should be fitted with a manhole or other inspection openings of a suitable size to allow for internal inspection and adequate access for maintenance and repair of the interior.

12.30.7 Service equipment, excluding inspection openings and pressure-relief devices, should be grouped together whenever practicable.

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

12.30.9 Each stop-valve or other means of closure should be designed and constructed to a rated pressure not less than the maximum allowable working pressure of the tank and to the temperature expected in transport. Each stop-valve with a screwed spindle should be closed by a clockwise motion of the handwheel. In the case of other stop-valves the position and/or direction of closure should be clearly indicated. All stop-valves should be constructed to prevent unintentional opening.

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

12.30.11 Portable tanks intended for the transport of flammable gases should be capable of being electrically earthed.

12.31 **Bottom openings**

12.31.1 For certain gases indicated in Table 12.1 of Part II shell openings for any purpose below the liquid level are not allowed.

12.32 **Pressure-relief devices**

12.32.1 Portable tanks should be provided with one or more spring-loaded pressure-relief devices. Frangible discs not in series with a spring-loaded pressure-relief device are not permitted. The valves should open automatically at a pressure not less than the maximum allowable working pressure and be fully open at a pressure of 1.1 times the maximum allowable working pressure. These valves should, after discharge, close at a pressure not lower than 10 % below the pressure at which discharge starts and should remain closed at all lower pressures. The pressure-relief valves should be of a type that will resist dynamic stresses including liquid surge.

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

12.32.3 Tank shells for the transport of certain gases listed in Table 12.1 of Part II should have a pressure-relief device approved by the competent authority. Unless a tank in dedicated service is fitted with an approved relief valve constructed of materials compatible with the load, such device should comprise a frangible disc preceding a spring-loaded valve. The space between the frangible disc and the valve should be provided with a pressure gauge or a suitable tell-tale indicator. This arrangement permits the detection of disc rupture, pinholing or leakage which could cause a malfunction of the pressure-relief device. In this instance, the frangible disc should rupture at the start-to-discharge pressure of the relief valve.

12.33 **Capacity of pressure-relief devices**

12.33.1 The combined delivery capacity of the relief devices should be sufficient that, in the event of total fire engulfment, the pressure (including accumulation) inside the shell does not exceed 1.1 times the maximum allowable working pressure. Spring-loaded relief devices should be used to achieve the full relief capacity prescribed.

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

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

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

where: **Q** = minimum required rate of discharge in cubic metres of air per hour at standard conditions: 1 bar and 0°C (273 K);

F = is a coefficient with the following value:

for uninsulated tanks F=1

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

where:

U = thermal conductance of the insulation, in $kw.m^{-2}K^{-1}$, at 38°C,

t = actual temperature of the substance at loading (°C);

if this temperature is unknown, let t=15°C.

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

the insulation is in conformity with 12.33.1.3.

A = total external surface area of tank in square meters;

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

T = absolute temperature in Kelvin (°C + 273) above the pressure-relief devices in the accumulating condition;

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

M = molecular mass of the discharged gas;

C = a constant which may be taken from the following table which is derived from the following equation as a function of the ratio k of specific heats

$$k = \frac{C_p}{C_v}$$

where:

C_p = the specific heat at constant pressure and

C_v = the specific heat at constant volume;

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

when k > 1

$$C = \frac{1}{e^{0.5}} = 0.607$$

when k = 1 or k is unknown

where: e = the mathematical constant 2.7183

VALUES FOR THE CONSTANT C WHEN k > 1

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

12.33.1.2 Insulation systems, used for the purpose of reducing the venting capacity, should be approved by the competent authority or its designated approval agency. In all cases, insulation systems approved for this purpose must:

(i) Remain effective at all temperatures up to 649°C; and

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

12.34 **Markings on pressure-relief devices**

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

(a) the manufacturer’s name and the relevant catalogue number;

(b) set pressure, in bar or kPa and rated flow capacity, in standard cubic metres per second;

(c) allowable tolerances at start-to-discharge pressure (frangible disc).

12.34.2 The rated flow capacity marked on the pressure-relief valves should be determined according to ISO.......

12.35 **Connections to pressure-relief devices**

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

12.36 **Siting of pressure-relief devices**

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

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

12.37 **Gauging devices**

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

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

12.38.1 Portable tanks should be designed and fabricated with a support structure to provide a secure base during transport. The loadings specified in 12.27.9 should be considered in this aspect of design. Skids, frameworks, cradles or other similar devices are acceptable.

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

12.38.3 In the design of supports and frameworks due regard should be paid to the effects of environmental corrosion.

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

(a) the tanks shell 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 unit.

12.38.5 If portable tanks are not protected during transport, according to 12.44.2, the shells and service equipment shall be protected against collision.

Examples of protection of shells against collision:

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

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

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

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

12.39 **Design approval**

12.39.1 The competent authority or a body authorized by that authority should issue a design approval certificate for any new design of a portable tank. This certificate should attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this chapter. If a series of portable tanks are manufactured without change in the design, the certificate should be valid for the entire series. The certificate should refer to the prototype test report, the tank type, the material of construction of the shell [and of the lining, if applicable] and an approval number. The approval number should consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic, as prescribed by the Convention on Road Traffic, Vienna 1968, and a registration number. Alternative arrangements according to 12.1.2, if any, should be indicated on the certificate. A design approval may serve for the approval of smaller tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

12.39.2 The prototype test report for the design approval should include at least the following:

- the results of the applicable frame-work test specified in ISO 1496-3: 1995;

- the results of the impact test in 12.39.3 when applicable;

- the results of the initial inspection and test in 12.40.2.

12.39.3 For portable tanks meeting the definition of container in the CSC, a prototype tank of each design should be subjected to an impact test. The prototype tank should be shown to be capable of absorbing the forces resulting from an impact equivalent to at least 4 times (4g) the maximum gross mass of the loaded 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,
Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods (B620-1987).

12.40 **Inspection and testing**

12.40.1 The shell and items of equipment of each portable tank should be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection (2.5 year periodic inspection and test) midway the 5 year periodic inspection. An exceptional inspection and test, when necessary according to 12.40.6, should be carried out regardless of the last periodic inspection and test.

12.40.2 The initial inspection and test of a portable tank should include a check of the design characteristics, an internal and external examination of the tank and its fittings with due regard to the substances to be transported, and a hydraulic pressure test. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment should also be conducted. If the shell and equipment have been pressure-tested separately, they should be subjected together after assembly to a leakproofness test. [All welds in the shell should be tested in the initial test by radiographic, ultrasonic or another suitable non destructive method. This does not apply to the metal sheating of an insulation.]

12.40.3 The 5 year periodic inspection and test should include an internal and external examination and, as a general rule, a hydraulic pressure test. Sheathing, thermal insulation and the like should be removed only to the extent required for reliable appraisal of the condition of the portable tank. If the shell and equipment have been pressure-tested separately, they should be subjected together after assembly to a leakproofness test.

12.40.4 The intermediate 2.5 year periodic inspection and test should at least include:

(a) an internal and external examination of the tank and its fittings with due regard to the substances transported;

(b) a leakproofness test;

(c) a test of the satisfactory operation of all service equipment.

However, the internal examination may be waived by the competent authority concerned, or its authorized body, in the case of tanks intended for the transport of a single substance.

12.40.5 Portable tanks, empty and uncleaned, may be moved after the expiration of the 5 year intervals. In addition, the 2.5 year inspection and test may be carried out within 3 months before and after the specified date.

12.40.6 The exceptional inspection and test is necessary when the tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a weakness that could affect the integrity of the tank.

The extent of the exceptional inspection and test should depend on the amount of damage or deterioration of the portable tank. It should include at least the 2.5 year inspection and test according to 12.40.4.

12.40.7 The internal and external examination should ensure that:

(1) the tank shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the tank unsafe for transport;

(2) the piping, valves, [heating/cooling system] and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the tank unsafe for loading, discharge or transport;

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

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

(5) 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 should be operated to demonstrate proper operation;

[(6) linings are inspected in accordance with criteria outlined by the lining manufacturer;]

(7) required markings on the tank are legible.

12.40.8 The inspections and tests in 12.40.2, 12.40.3, 12.40.4 and 12.40.6 should be carried out or witnessed by an expert approved by the competent authority or its authorized body.

If the hydraulic pressure test is a part of the inspection and test, the test pressure should be the one indicated on the data plate of the portable tank. While under pressure, the tank should be inspected for any leakages on the shell, piping or equipment

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

12.40.10 If evidence of any unsafe condition is discovered, the tank should not be placed or returned to service until it has been corrected and the test is repeated and passed.

12.41 **Document retention**

12.41.1 The design approval certificate, the test report and the certificate showing the results of the initial inspection and test for each tank issued by the competent authority or its authorized body should be retained by the authority or body and the owner. Owners should be able to provide this documentation upon the request of any competent authority.

12.42 **Filling**

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

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

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

12.43 **Marking**

12.43.1 Every portable tank should be fitted with a corrosion resistant plate permanently attached to the tank in a conspicuous place readily accessible for inspection. If for reasons of tank arrangements, the plate cannot be permanently attached to the shell, the shell should be marked with at least those particulars required by the pressure vessel code. At least the following particulars should be marked on the plate by stamping or by any other similar method.

Country of manufacture

U	Approval	Approval	In the case of Alternate Arrangements
N	COUNTRY	NUMBER	"AA"

Manufacturer's name or mark

Manufacturer's serial number

Authorized body for the design approval

Owner's Registration number

Year of manufacture

Tank type

Technical Code to which tank is designed

Hydraulic Test pressure . . . . bar gauge

Maximum allowable working pressure . . . . bar gauge or kilopascals (kPa)

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

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

Initial hydraulic pressure test date and witness identification

Design temperature range . . . . . . °C to . . . . . .°C

Tank shell material and material reference

Equivalent thickness in mild steel . . . . .mm

[Lining material (if any)]

Date and type of most recent periodic test

Stamp of expert who carried out or witnessed the most recent test

12.43.2 The following particulars should 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 gases being carried (and maximum mean bulk temperature if other than 50°C)
Maximum permissible load mass for each gas permitted . . . . .kg
Maximum permissible gross mass . . . . .kg
Unladen (tare) mass . . . . kg

12.43.3 The contents should be identified as specified in Chapter 13 of the Recommendations.

12.44 **Transport requirements**

12.44.1 Portable tanks should not be offered for transport:

(a) in an ullage condition liable to produce an unacceptable hydraulic force due to surge within the tank;
(b) that are leaking;
(c) that are 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.

12.44.2 During transport, portable tanks should be adequately protected against lateral and longitudinal impact and against overturning. This protection is not required if portable tanks are constructed to withstand impact or overturning. Examples of such protection are given in 12.38.5.

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

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

Annex 2

Example of typical data plate
(see para. 11)

ACME TANK MANUFACTURING AUSTIN, TEXAS, USA		
TECHNICAL CHARACTERISTICS		
MANUFACTURERS NAME		E
COUNTRY OF MANUFACTURE		.
YEAR OF MANUFACTURE		5
MANUFACTURERS SERIAL NO.		2
OWNERS NAME		S
OWNERS REGISTRATION NO.		3
COUNTRY OF APPROVAL		A
APPROVAL NUMBER - IMO		4 0 -
APPROVED MODES		A
CODE TO WHICH TANK IS DESIGNED		[illegible]
MAXIMUM WORKING PRESSURE		[illegible]
TEST PRESSURE		[illegible]
WATER CAPACITY		[illegible]
METALLURGICAL DESIGN TEMP		[illegible]
DESIGN REFERENCE TEMP		[illegible]
EXTERNAL DESIGN PRESSURE		[illegible]
EQUIVALENT THICKNESS IN MILD STEEL	0.794 IN	M 7 M
CORROSION ALLOWANCE		
NAME OF PRODUCT CARRIED		d e i
MAX. DESIGN SPECIFIC GRAVITY		[illegible]
SHELL MATERIAL		[illegible]
HEAD MATERIAL		[illegible]
MAXIMUM GROSS WEIGHT		[illegible]
UNLADEN (TARE) WEIGHT		B G 6 L
PRODUCT WEIGHT		B G
APPROVAL AND COMPETENT AUTHORITIES		
APPROVAL AGENCY		S
IMO TYPE		E 5
US DOT NO.		3
RMF. APPROVAL NO.		M
ADR / RID NO. / RTMD		6
ENCODED SPECIFICATIONS		0 0 D
PERIODIC INSPECTION		
DATE OF FIRST HYDRAULIC TEST:		
INSPECTION AT INTERVALS OF 2 ½ YEARS	INSPECTION AT INTERVALS OF 5 YEARS	