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**COMMITTEE OF EXPERTS ON THE
TRANSPORT OF DANGEROUS GOODS**

**Sub-Committee of Experts on the
Transport of Dangerous Goods**

**REPORT OF THE SUB-COMMITTEE OF EXPERTS ON ITS NINTH SESSION
(Geneva, 4 - 15 July 1994)**

Addendum 4

Annex 4

**Draft revised chapter 12 (paragraphs 12.1 to 12.23.2)
(as developed by the Working Group on Portable Tanks)**

Attached is a draft consolidated text for paragraphs 12.1 to 12.23.2 which should be reviewed by the Working Group on Portable Tanks (28 November - 2 December 1994) during the 18th session of the Committee of Experts on the Transport of Dangerous Goods.

GE.94-22843

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 in 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 technological advances, the Competent Authority may approve use of alternative arrangements that offer at least the equivalent safety with respect to the compatibility with the properties of the substances transported and the equivalent or superior resistance to impact, loading and fire.

12.1.3 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. Tables [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 3 to 9**

12.2.1 For the purpose of the portable tank requirements relevant to substances in Classes 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.

[12.2.2.1 Portable tanks for dangerous goods in classes 3 through 9 are comprised of two types.

12.2.2.1A Type 1 portable tanks are tanks having a maximum allowable working pressure of at least 1.75 bar or greater [and less than 7 bar].

12.2.2.1B Type 2 portable tanks are tanks having a maximum allowable working pressure equal to or greater than or equal to 1.0 bar but below 1.75 bar, intended for the transport of certain low risk substances.]

12.2.3 Shell means the tank proper, including openings and their closures, but does not include service equipment (see 12.2.4).

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 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).

12.2.6A 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 12.2.6.1,

(b) the pressure in 12.2.6.2 and the dynamic head pressure determined on the basis of the dynamic forces due to inertia specified in 12.3.11 minus one bar; such a dynamic head pressure should never be taken less than 0.35 bar: or

(c) the required test pressure divided by 1.5.

12.2.7 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.

12.2.7A Filling pressure means the highest pressure actually built up in the shell when it is being filled.

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

12.2.9 Leakage test means the 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 75 percent 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 Mild 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 Design temperature range is considered to be -20^{0}C to 50^{0}C for substances transported under ambient conditions. For substances transported 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, construction and operation 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 and should conform to a national code. 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 resistance to impact. Aluminum 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 carried; or

(b) properly passivated or neutralized by chemical reaction ***[***with that substance***]***; or

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

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

12.3.4 The lining of each portable tank that is fitted with a lining must meet the following:

(a) the material used to line the tank must be:

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

(ii) homogeneous;

(iii) nonporous;

(iv) imperforated when applied;

(v) sufficiently elastic; and

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

(b) the lining of the tank, tank fittings and piping must 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 must be made by fusing the material together or by other equally effective means.

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

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

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

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

12.3.10 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 trap.

12.3.11 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).

12.3.11.1 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 determined 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.

12.3.13 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.

12.4 **[Cross-sectional design**]

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 hydrostatic 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 12.5.6.

[12.4.3 At the test pressure, the stress σ at the most severely stressed point of the portable tank shell should not exceed the material-dependent limitations prescribed below. Allowances should be made for any weakening due

to the welds. In addition, in choosing the material and determining wall thickness, the maximum and minimum filling and working temperatures should be taken into account.

(a) for metals and alloys, the stress at the test pressure should be the lower the smaller of the values given by the following formula:

$$\leq 0.75\ R_e \text{ or } \leq 0.5\ R_m$$

where:

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

Ratios of Re/Rm exceeding 0.85 are not allowed for steels used in the construction of welded tanks.

The values of Re and Rm to be used shall be specified minimum values according to material standards. If 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 by a body designated by that authority.

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 certificate shall be taken as a basis in determining the Re/Rm ratio in each case.**]**

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

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

$$Lo=5\ d,$$

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

12.4.4 Portable tanks should be capable of being electrically earthed when they are used for the transport of substances meeting the criteria of class 3 or elevated temperature materials transported above their flashpoint.

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 12.5.5.3; and

(b) the minimum thickness determined in accordance with the recognized technical code including the provisions in 12.4.3.1.

12.5.2 The cylindrical portions of the shells, the ends and the manhole covers of tanks not more than 1.80 metres in diameter should be not less than 5 mm thick if of mild steel or equivalent thickness if of other metal. In tanks more than 1.80 metres in diameter they should be not less than 6 mm thick if of mild steel or equivalent thickness if of other metal. The cylindrical portions, ends and the manhole covers of all tanks should be not less than 3 mm thick regardless of the materials of construction.

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 metres in diameter should be not less than 3 mm (1/8 inch) thick if of mild steel or of equivalent thickness if of other metal, and those of tanks more than 1.80 metres in diameter should be not less than 4 mm thick if of mild steel or of equivalent thickness if of other metal.

12.5.4 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 the tank supported in a complete framework with longitudinal and transverse structural members.

12.5.5 The thickness of a metal other than a mild steel of a guaranteed minimum tensile strength of 370 N/mm^2 and a guaranteed minimum percentage elongation of 27 equivalent to that prescribed in 12.5.2 and 12.5.3 should be determined by using the following equation:

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

12.5.5.1 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 using a mild steel of a guaranteed minimum strength of 370 N/mm^2 and a guaranteed minimum percentage elongation of 27. 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 N/mm^2

e_o = minimum thickness for mild 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).

12.5.5.2 In no case should the wall thickness be less than that prescribed in 12.5.2 and 12.5.3. 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.

12.5.5.3 There should be no sudden change of plate thickness at the attachment of the head to the cylindrical portion of the shell, and after forming the head plate thickness at the knuckle should not be less than the minimum thickness prescribed in 12.5.2 and 12.5.3. This thickness should be exclusive of any corrosion allowance.

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. Equipment protection should offer a degree of safety comparable with that of shell.

[12.6.2 All tank nozzles, except for those provided for relief devices, thermometer wells, and inspection openings, should be fitted with manually operated stop valves located as near the shell as practicable. A tank nozzle installed for a pressure relief device should not be provided with a stop valve that restricts the flow from the tank to the pressure relief device. A tank nozzle installed in the vapor space to provide a filling or cleaning opening, which is closed by a blank flange or other suitable means, need not be provided with a manually operated stop valve.]

12.6.3 [Each portable tank should be fitted with a manhole or other inspection openings sited above the maximum liquid level to allow for internal inspection and adequate access for maintenance and repair of the interior. A portable tank or each of its compartments should be provided with a large enough opening to enable the tank or compartment to be inspected.]

12.6.4 Whenever possible, external fittings should be grouped together. **[**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 valve should be designed and constructed to a rated pressure not less than the maximum allowable working pressure of the tank. Each stop valve with a screwed spindle must be closed by a clockwise motion of the handwheel. In the case of other valves the position and/or direction of closure should be clearly indicated. All valves should be constructed to prevent unintentional opening.

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, jarring 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 For solids, certain crystallizable or highly viscous substances the bottom discharge equipment may consist of two elements when indicated in Table 12.2 in Part II. The design should satisfy the competent authority. The two serially mounted and mutually independent shut-off valves should include:

(a) an external stop valve; and

(b) at the end of the discharge pipe:

(i) a bolted blank flange; or

(ii) a screw-cap, or other liquid-tight closure.**]**

12.7.3 Every bottom discharge outlet should be equipped with three serially mounted and mutually independent shut-off devices as follows:

(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; and

(c) at the end of the discharge pipe:

(i) a bolted blank flange; or

(ii) a screw-cap, or other liquid-tight closure.

For solids, certain crystallizable or highly viscous substances the bottom discharge equipment may consist of two elements only (see table 12.2 in Part II). The design should satisfy the competent authority.

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

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

[12.7.6 A sacrificial device should be used to prevent damage to any lading retention part or device when piping extends beyond the surface of the shell. Sacrificial devices include elements such as shear sections, designed to fail under load. The shear section should break under strain without affecting the product retention capabilities of the tank and any attachments.**]**

12.8 **Safety relief**

12.8.1 All portable tanks tank-containers, should be closed and fitted with a pressure-relief device.

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 valve 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 pressure that is 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.

12.10 Setting of pressure-relief devices

The safety relief device should not open during normal conditions of filling, discharge and transport.

12.10.2 The required pressure-relief valve should be set to start to discharge at a nominal pressure of 125 percent of the maximum allowable working pressure for tanks having a test pressure below 4.5 bar (64 psi) and at the maximum allowable working pressure for tanks having a test pressure of 4.5 bar or more. After discharge the valve should close at a pressure not lower than 10% below the pressure at which discharge starts, and should remain closed at all lower pressures. This requirement should not be so construed as to prevent the use of vacuum-relief valves 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. Fusible elements should not be utilized on tanks with a test pressure which exceeds 2.65 bar (37.6 psi) gauge. Special considerations meeting the satisfaction of the competent authority 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 rupture at a nominal pressure equal to test pressure. Particular attention should be given to the requirements of 12.6.1 and 12.9.3 if frangible discs are used. Frangible discs should not operate within the ambient temperature range envisaged.

12.12.2 **[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.

12.13 Capacity of relief devices

12.13.1 The spring-loaded pressure relief device required by 12.9.1 should have a minimum diameter of 31.75mm. 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 equivalent formula may be used:

$$Q = 5.62 \times 10^6 \left(\frac{FA^{0.82}}{LC}\sqrt{\frac{ZT}{M}}\right)$$

where:
Q = minimum required rate of discharge in cubic metres of air per hour at standard conditions: 15.6°C and 1 atm;
A = total external surface area of tank shell
L = latent heat of vaporization in cal/g;
Z = compressibility factor for the vapour in g,m, K units (when Z is unknown the value of 1.0 should be used);
T = absolute temperature in Kelvin (°C + 273) at relieving conditions;
M = molecular weight of vapour in g units;
C = a constant depending on ratio of specific heats of vapour, to be taken as 315 in metre, g, hour and K units;

F = insulation factor; use 1 for uninsulated tanks and [(8U(650-t))/93.5E06] for insulated tanks, where t is the temperature in °C of the vapour or gas in the tank as the device is venting;
U = thermal conductivity of the insulation at 311 K in gcalories/hr·m²·K. This should be a function of the thickness of the insulation.

12.13.2.2 Alternatively to using the formulae above, tanks designed for the transport of liquids may have their relief devices sized in accordance with the following tables. These tables assume an insulation value of F = 1 and should be adjusted accordingly if the tank is insulated. Other values used in determining these tables are:

<u>In metric units</u>:

M = 86.7
T = 394 K
L = 80 kcal/kg
C = 315
Z = 1 (when unknown)

TABLE FOR METRIC UNITS.

MINIMUM EMERGENCY VENT CAPACITY, Q, IN CUBIC METERS PER AIR PER HOUR AT ATMOSPHERIC PRESSURE AND 15°C

Surface area m^2	**Minimum free air, m^3/hour**	**Surface area m^2**	**Minimum free air, m^3/hour**
2	841	37.5	9 306
3	1 172	40	9 810
4	1 485	42.5	10 308
5	1 783	45	10 806
6	2 069	47.5	11 392
7	2 348	50	11 778
8	2 621	52.5	12 258
9	2 821	55	12 732
10	3 146	57.6	13 206
12	3 665	60	13 674
14	4 146	62.5	14 142
16	4 625	65	14 604
18	5 092	67.5	15 066
20	5 556	70	15 516
22.5	6 120	75	16 422
25	6 672	80	17 316
27.5	7 212	85	18 198
30	7 746	90	19 074
32.5	8 268	95	19 938
35	8 790	100	20 790**]**

[12.13.2.3 Insulation systems, used for the purpose of reducing the venting capacity, should be approved by the competent authority or his 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 649°C or greater.]

12.14 Markings on relief devices

[12.14.1 Every pressure-relief device should be plainly and permanently marked at 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: and tolerances (fusible elements).

(b) 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 valves

[12.16.1 Each pressure relief device inlet should be situated in the vapor space of the tank assuming that the tank is filled to the maximum degree of filling allowed in section 12.22. The discharge from any device should be unrestricted and directed to prevent impingement upon the tank shell or structural framework. Protective devices which deflect the flow of vapor are permissible provided the required vent capacity is maintained. Pressure and vacuum relief devices including their inlets should be sited on the top of the tank in a position as near as possible to the longitudinal and transverse center of the tank.**]**

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 and lifting 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 12.3.11 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 nominal length of less than 3.65 meters need not have closed off pockets provided that:

(a) the tanks shell and all the fittings are well protected from being hit by the Fork’s 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.

12.19 **Design approval, inspection and testing of portable tanks**

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 and 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 substances or groups of substances allowed to be transported] 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: 1991;

[- the results of the impact test in 12.19;]

- the results of the initial inspection and test in 12.19.3.1

12.19.3 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.

12.19.3.1 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.

12.19.3.2 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 seperately, they should be subjected together after assembly to a leakproofness test.

12.19.3.3 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.

12.19.3.4 Portable tanks, empty and uncleaned, may be moved after the expiration of the 2.5 year and 5 year intervals for the purpose of undergoing the testing. In addition, the 2.5 year inspection and test may be carried out within 3 months before and after the specified date [provided that the tank is not filled after the specified date].

12.19.3.5 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 12.19.3.3.

12.19.3.6 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.

12.19.3.7 The inspections and tests in 12.19.3.1, 12.1.9.3.2, 12.19.3.3 and 12.19.3.5 should be carried out or witnessed by an expert approved by the competent authority.

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.

12.19.3.8 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 at least the original test pressure should be carried out.

12.19.3.9 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.

12.19.7 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.

12.20 **Marking**

12.20.1 Every portable tank should be fitted with a corrosion-resistant plate permanently attached to the tank in a conspicuous plate 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

Owner’s Registration number

Year of manufacture

Tank type

Technical Code to which tank is designed

Hydraulic Test pressure .... bar gauge

MAWP..................... bar gauge

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, _______ ^{0}C to ______ ^{0}C.

Maximum allowable working pressure for heating/cooling system bar gauge

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.

12.20.2 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 being carried (and maximum mean bulk temperature if higher than 50°C)
- Maximum permissible gross mass ... kg
- Unladen (tare) mass .... kg

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

12.21 **Transport requirement**s

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

(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.

12.21.2 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.

12.21.3 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.

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

12.22 **Filling Ratios**

12.22.1 Portable tanks, should be filled to the extent provided for by 12.22.2 to 12.22.5. The applicability of 12.22.2, 12.22.3 or 12.22.5 to individual substances is specified by the reference in Table 12.2 of Part II.

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

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

12.22.3 Liquids of Division 6.1 or Class 8, in Packing Groups I or II, and also liquids with absolute saturated vapour pressure of more than 1.75/bar at 65°C, should be filled according to the formula:

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

12.22.4 In these formulae α is the mean of coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (t_f) and the maximum mean bulk temperature (t_r), and is calculated by the formula:

$$\alpha = (d_{15} - d_{50})/(35d_{50})$$

in which d_{15} and d_{50} are the density 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°C except that, for journeys in temperate or extreme climatic conditions, the competent authorities concerned may agree to a lower or to a higher temperature, as appropriate.

12.22.5 The provisions of 12.22.1 to 12.22.3 should not apply to portable tanks whose contents are maintained by means of a heating device at a temperature above 50°C during transport. In such a case the degree of filling should be such that, through the action of a temperature regulator, the portable tank is not full to more than 95 % of its capacity at any time during transport.

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 centistokes 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 **Handling requirements**

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

12.23.2 **[**Substances should not be carried in the same or 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.]
