

**6.7.3 Requirements for the design, construction, inspection and testing of portable tanks intended for the carriage of non-refrigerated liquefied gases**

*NOTE: These requirements also apply to portable tanks intended for the carriage of chemicals under pressure (UN Nos. 3500, 3501, 3502, 3503, 3504 and 3505).*

**6.7.3.1 Definitions**

For the purposes of this section:

*Alternative arrangement* means an approval granted by the competent authority for a portable tank or MEGC that has been designed, constructed or tested to technical requirements or testing methods other than those specified in this Chapter;

*Portable tank* means a multimodal tank having a capacity of more than 450 litres used for the carriage of non-refrigerated liquefied gases of Class 2. The portable tank includes a shell fitted with service equipment and structural equipment necessary for the carriage of gases. The portable tank shall be capable of being filled and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the shell, and shall be capable of being lifted when full. It shall be designed primarily to be loaded onto a vehicle, wagon or sea-going or inland navigation vessel and shall be equipped with skids, mountings or accessories to facilitate mechanical handling. Tank-vehicles, tank-wagons, non-metallic tanks, intermediate bulk containers (IBCs), gas cylinders and large receptacles are not considered to fall within the definition for portable tanks;

*Shell* means the part of the portable tank which retains the non-refrigerated liquefied gas intended for carriage (tank proper), including openings and their closures, but does not include service equipment or external structural equipment;

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

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

*Maximum allowable working pressure (MAWP)* means a pressure that shall be not less than the highest of the following pressures measured at the top of the shell while in operating position, but in no case less than 7 bar:

- (a) The maximum effective gauge pressure allowed in the shell during filling or discharge; or
- (b) The maximum effective gauge pressure to which the shell is designed, which shall be:
  - (i) For a non-refrigerated liquefied gas listed in the portable tank instruction T50 in 4.2.5.2.6, the MAWP (in bar) given in T50 portable tank instruction for that gas;
  - (ii) For other non-refrigerated liquefied gases, not less than the sum of:
    - The absolute vapour pressure (in bar) of the non-refrigerated liquefied gas at the design reference temperature minus 1 bar; and
    - 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 an increase of the mean bulk temperature of  $t_r - t_f$  ( $t_f$  = filling temperature, usually 15 °C,  $t_r$  = maximum mean bulk temperature, 50 °C);
  - (iii) For chemicals under pressure, the MAWP (in bar) given in T50 portable tank instruction for the liquefied gas portion of the propellants listed in T50 in 4.2.5.2.6;

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

- (a) The maximum effective gauge pressure allowed in the shell during filling or discharge; or
- (b) The sum of:

- (i) The maximum effective gauge pressure to which the shell is designed as defined in (b) of the MAWP definition (see above); and
- (ii) A head pressure determined on the basis of the static forces specified in 6.7.3.2.9, but not less than 0.35 bar;

*Test pressure* means the maximum gauge pressure at the top of the shell during the pressure test;

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

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

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

*Mild steel* means a steel with a guaranteed minimum tensile strength of 360 N/mm<sup>2</sup> to 440 N/mm<sup>2</sup> and a guaranteed minimum elongation at fracture conforming to 6.7.3.3.3.3;

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

*Design reference temperature* means the temperature at which the vapour pressure of the contents is determined for the purpose of calculating the MAWP. The design reference temperature shall be less than the critical temperature of the non-refrigerated liquefied gas or liquefied gas propellants of chemicals under pressure intended to be carried to ensure that the gas at all times is liquefied. This value for each portable tank type is as follows:

- (a) Shell with a diameter of 1.5 metres or less: 65 °C;
- (b) Shell with a diameter of more than 1.5 metres:
  - (i) Without insulation or sun shield: 60 °C;
  - (ii) With sun shield (see 6.7.3.2.12): 55 °C; and
  - (iii) With insulation (see 6.7.3.2.12) : 50 °C;

*Filling density* means the average mass of non-refrigerated liquefied gas per litre of shell capacity (kg/l). The filling density is given in portable tank instruction T50 in 4.2.5.2.6.

### 6.7.3.2

#### *General design and construction requirements*

##### 6.7.3.2.1

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

##### 6.7.3.2.2

Portable tank shells, fittings and pipework shall be constructed of materials which are:

- (a) Substantially immune to attack by the non-refrigerated liquefied gas(es) intended to be carried; or
- (b) Properly passivated or neutralized by chemical reaction.

##### 6.7.3.2.3

Gaskets shall be made of materials compatible with the non-refrigerated liquefied gas(es) intended to be carried.

- 6.7.3.2.4 Contact between dissimilar metals which could result in damage by galvanic action shall be avoided.
- 6.7.3.2.5 The materials of the portable tank, including any devices, gaskets, and accessories, shall not adversely affect the non-refrigerated liquefied gas(es) intended for carriage in the portable tank.
- 6.7.3.2.6 Portable tanks shall be designed and constructed with supports to provide a secure base during carriage and with suitable lifting and tie-down attachments.
- 6.7.3.2.7 Portable tanks shall be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads during normal conditions of handling and carriage. The design shall demonstrate that the effects of fatigue, caused by repeated application of these loads through the expected life of the portable tank, have been taken into account.
- 6.7.3.2.8 Shells shall be designed to withstand an external pressure of at least 0.4 bar (gauge pressure) above the internal pressure without permanent deformation. When the shell is to be subjected to a significant vacuum before filling or during discharge it shall be designed to withstand an external pressure of at least 0.9 bar (gauge pressure) above the internal pressure and shall be proven at that pressure.
- 6.7.3.2.9 Portable tanks and their fastenings shall, under the maximum permissible load, be capable of absorbing the following separately applied static forces:
- (a) In the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g)<sup>1</sup>;
  - (b) Horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g)<sup>1</sup>;
  - (c) Vertically upwards: the MPGM multiplied by the acceleration due to gravity (g)<sup>1</sup>; and
  - (d) Vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g)<sup>1</sup>.
- 6.7.3.2.10 Under each of the forces in 6.7.3.2.9, the safety factor to be observed shall be as follows:
- (a) For steels having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength; or
  - (b) For steels with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2 % proof strength and, for austenitic steels, the 1 % proof strength.
- 6.7.3.2.11 The values of yield strength or proof strength shall be the values according to national or international material standards. When austenitic steels are used, the specified minimum values of yield strength and proof strength according to the material standards may be increased by up to 15 % when these greater values are attested in the material inspection certificate. When no material standard exists for the steel in question, the value of yield strength or proof strength used shall be approved by the competent authority.
- 6.7.3.2.12 When the shells intended for the carriage of non-refrigerated liquefied gases are equipped with thermal insulation, the thermal insulation systems shall satisfy the following requirements:
- (a) It shall consist of a shield covering not less than the upper third but not more than the upper half of the surface of the shell and separated from the shell by an air space about 40 mm across;
  - (b) It shall consist of a complete cladding of adequate thickness of insulating materials protected so as to prevent the ingress of moisture and damage under normal conditions of carriage and so as to provide a heat transfer coefficient of not more than 0.67 (W·m<sup>-2</sup>·K<sup>-1</sup>);
  - (c) When the protective covering is so closed as to be gas-tight, a device shall be provided to prevent any dangerous pressure from developing in the insulating layer in the event of inadequate gas tightness of the shell or of its items of equipment; and
  - (d) The thermal insulation shall not inhibit access to the fittings and discharge devices.

<sup>1</sup> For calculation purposes  $g = 9.81 \text{ m/s}^2$ .

6.7.3.2.13 Portable tanks intended for the carriage of flammable non-refrigerated liquefied gases shall be capable of being electrically earthed.

**6.7.3.3** *Design criteria*

6.7.3.3.1 Shells shall be of a circular cross-section.

6.7.3.3.2 Shells shall be designed and constructed to withstand a test pressure not less than 1.3 times the design pressure. The shell design shall take into account the minimum MAWP values provided in portable tank instruction T50 in 4.2.5.2.6 for each non-refrigerated liquefied gas intended for carriage. Attention is drawn to the minimum shell thickness requirements for these shells specified in 6.7.3.4.

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

$R_e$  = yield strength in N/mm<sup>2</sup>, or 0.2 % proof strength or, for austenitic steels, 1 % proof stress;

$R_m$  = minimum tensile strength in N/mm<sup>2</sup>.

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

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

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

6.7.3.3.3.4 For the purpose of determining actual values for materials, it shall be noted that for sheet metal, the axis of the tensile test specimen shall be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture shall be measured on test specimens of rectangular cross sections in accordance with ISO 6892:1998 using a 50 mm gauge length.

**6.7.3.4** *Minimum shell thickness*

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

- (a) The minimum thickness determined in accordance with the requirements in 6.7.3.4; and
- (b) The minimum thickness determined in accordance with the recognized pressure vessel code including the requirements in 6.7.3.3.

In addition, any relevant portable tank special provision indicated in Column (11) of Table A of Chapter 3.2 and described in 4.2.5.3 shall be taken into account.

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

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

6.7.3.4.4 The equivalent thickness of a steel other than the thickness prescribed for the reference steel in 6.7.3.4.2 shall be determined using the following formula:

$$e_1 = \frac{21,4e_0}{\sqrt[3]{R_m \times A_1}}$$

where:

- $e_1$  = required equivalent thickness (in mm) of the steel to be used;  
 $e_0$  = minimum thickness (in mm) for the reference steel specified in 6.7.3.4.2;  
 $Rm_1$  = guaranteed minimum tensile strength (in N/mm<sup>2</sup>) of the steel to be used (see 6.7.3.3.3);  
 $A_1$  = guaranteed minimum elongation at fracture (in %) of the steel to be used according to national or international standards.

- 6.7.3.4.5 In no case shall the wall thickness be less than that prescribed in 6.7.3.4.1 to 6.7.3.4.3. All parts of the shell shall have a minimum thickness as determined by 6.7.3.4.1 to 6.7.3.4.3. This thickness shall be exclusive of any corrosion allowance.
- 6.7.3.4.6 When mild steel is used (see 6.7.3.1), calculation using the formula in 6.7.3.4.4 is not required.
- 6.7.3.4.7 There shall be no sudden change of plate thickness at the attachment of the ends (heads) to the cylindrical portion of the shell.
- 6.7.3.5** *Service equipment*
- 6.7.3.5.1 Service equipment shall be so arranged as to be protected against the risk of being wrenched off or damaged during handling and carriage. When the connection between the frame and the shell allows relative movement between the sub-assemblies, the equipment shall be so fastened as to permit such movement without risk of damage to working parts. The external discharge fittings (pipe sockets, shut-off devices), the internal stop-valve and its seating shall be protected against the danger of being wrenched off by external forces (for example using shear sections). The filling and discharge devices (including flanges or threaded plugs) and any protective caps shall be capable of being secured against unintended opening.
- 6.7.3.5.2 All openings with a diameter of more than 1.5 mm in shells of portable tanks, except openings for pressure-relief devices, inspection openings and closed bleed holes, shall be fitted with at least three mutually independent shut-off devices in series, the first being an internal stop-valve, excess flow valve or equivalent device, the second being an external stop-valve and the third being a blank flange or equivalent device.
- 6.7.3.5.2.1 When a portable tank is fitted with an excess flow valve, the excess flow valve shall be so fitted that its seating is inside the shell or inside a welded flange or, when fitted externally, its mountings shall be designed so that in the event of impact its effectiveness shall be maintained. The excess flow valves shall be selected and fitted so as to close automatically when the rated flow specified by the manufacturer is reached. Connections and accessories leading to or from such a valve shall have a capacity for a flow more than the rated flow of the excess flow valve.
- 6.7.3.5.3 For filling and discharge openings, the first shut-off device shall be an internal stop-valve and the second shall be a stop-valve placed in an accessible position on each discharge and filling pipe.
- 6.7.3.5.4 For filling and discharge bottom openings of portable tanks intended for the carriage of flammable and/or toxic non-refrigerated liquefied gases or chemicals under pressure the internal stop-valve shall be a quick closing safety device which closes automatically in the event of unintended movement of the portable tank during filling or discharge or fire engulfment. Except for portable tanks having a capacity of not more than 1 000 litres, it shall be possible to operate this device by remote control.
- 6.7.3.5.5 In addition to filling, discharge and gas pressure equalizing orifices, shells may have openings in which gauges, thermometers and manometers can be fitted. Connections for such instruments shall be made by suitable welded nozzles or pockets and not be screwed connections through the shell.
- 6.7.3.5.6 All portable tanks shall be fitted with manholes or other inspection openings of suitable size to allow for internal inspection and adequate access for maintenance and repair of the interior.

- 6.7.3.5.7 External fittings shall be grouped together so far as reasonably practicable.
- 6.7.3.5.8 Each connection on a portable tank shall be clearly marked to indicate its function.
- 6.7.3.5.9 Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than the MAWP of the shell taking into account the temperatures expected during carriage. All stop-valves with a screwed spindle shall close by a clockwise motion of the handwheel. For other stop-valves the position (open and closed) and direction of closure shall be clearly indicated. All stop-valves shall be designed to prevent unintentional opening.
- 6.7.3.5.10 Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration. All piping shall be of suitable metallic material. Welded pipe joints shall be used wherever possible.
- 6.7.3.5.11 Joints in copper tubing shall be brazed or have an equally strong metal union. The melting point of brazing materials shall be no lower than 525 °C. The joints shall not decrease the strength of tubing as may happen when cutting threads.
- 6.7.3.5.12 The burst pressure of all piping and pipe fittings shall be not less than the highest of four times the MAWP of the shell or four times the pressure to which it may be subjected in service by the action of a pump or other device (except pressure-relief devices).
- 6.7.3.5.13 Ductile metals shall be used in the construction of valves and accessories.
- 6.7.3.6 *Bottom openings***
- 6.7.3.6.1 Certain non-refrigerated liquefied gases shall not be carried in portable tanks with bottom openings when portable tank instruction T50 in 4.2.5.2.6 indicates that bottom openings are not allowed. There shall be no openings below the liquid level of the shell when it is filled to its maximum permissible filling limit.
- 6.7.3.7 *Pressure-relief devices***
- 6.7.3.7.1 Portable tanks shall be provided with one or more spring-loaded pressure-relief devices. The pressure-relief devices shall open automatically at a pressure not less than the MAWP and be fully open at a pressure equal to 110 % of the MAWP. These devices shall, after discharge, close at a pressure not lower than 10 % below the pressure at which discharge starts and shall remain closed at all lower pressures. The pressure-relief devices shall be of a type that will resist dynamic forces including liquid surge. Frangible discs not in series with a spring-loaded pressure-relief device are not permitted.
- 6.7.3.7.2 Pressure-relief devices shall be designed to prevent the entry of foreign matter, the leakage of gas and the development of any dangerous excess pressure.
- 6.7.3.7.3 Portable tanks intended for the carriage of certain non-refrigerated liquefied gases identified in portable tank instruction T50 in 4.2.5.2.6 shall have a pressure-relief device approved by the competent authority. Unless a portable tank in dedicated service is fitted with an approved relief device constructed of materials compatible with the load, such device shall comprise a frangible disc preceding a spring-loaded device. The space between the frangible disc and the device shall be provided with a pressure gauge or a suitable tell-tale indicator. This arrangement permits the detection of disc rupture, pinholing or leakage which could cause a malfunction of the pressure-relief device. The frangible discs shall rupture at a nominal pressure 10 % above the start-to-discharge pressure of the relief device.
- 6.7.3.7.4 In the case of multi-purpose portable tanks, the pressure-relief devices shall open at a pressure indicated in 6.7.3.7.1 for the gas having the highest maximum allowable pressure of the gases allowed to be carried in the portable tank.
- 6.7.3.8 *Capacity of relief devices***
- 6.7.3.8.1 The combined delivery capacity of the relief devices shall be sufficient that, in the event of total fire engulfment, the pressure (including accumulation) inside the shell does not exceed 120 % of the MAWP. Spring-loaded relief devices shall be used to achieve the full relief capacity prescribed. In the case of multi-purpose tanks, the combined delivery capacity of the pressure-relief devices shall be taken for the gas which requires the highest delivery capacity of the gases allowed to be carried in portable tanks.

6.7.3.8.1.1 To determine the total required capacity of the relief devices, which shall be regarded as being the sum of the individual capacities of the several devices, the following formula shall 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 second ( $m^3/s$ ) at standard conditions: 1 bar and  $0^\circ C$  ( $273 K$ );

$F$  = is a coefficient with the following value:

for uninsulated shells:  $F = 1$ ;

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

where:

$U$  = heat transfer coefficient of the insulation, in  $kW \cdot m^{-2} \cdot K^{-1}$ , at  $38^\circ C$ ;

$t$  = actual temperature of the non-refrigerated liquefied gas during filling ( $^\circ C$ ); when this temperature is unknown, let  $t=15^\circ C$ ;

The value of  $F$  given above for insulated shells may be taken provided that the insulation is in accordance with 6.7.3.8.1.2;

where:

$A$  = total external surface area of shell in square metres;

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

$T$  = absolute temperature in Kelvin ( $^\circ C + 273$ ) 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 is derived from one of the following formulae as a function of the ratio  $k$  of specific heats

$$k = \frac{c_p}{c_v}$$

where

$c_p$  is the specific heat at constant pressure; and

$c_v$  is the specific heat at constant volume.

when  $k > 1$ :

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

when  $k = 1$       or       $k$  is unknown:

$$C = \frac{1}{\sqrt{e}} = 0.607$$

where  $e$  is the mathematical constant 2.7183

$C$  may also be taken from the following table:

<b><math>k</math></b>	<b><math>C</math></b>	<b><math>k</math></b>	<b><math>C</math></b>	<b><math>k</math></b>	<b><math>C</math></b>
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		

**NOTE:** This formula applies only to non-refrigerated 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 shall consider further thermodynamic properties of the gas (see, e.g. CGA S-1.2-2003 Pressure Relief Device Standards – Part 2 – Cargo and Portable Tanks for Compressed Gases).

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

- (a) Remain effective at all temperatures up to 649 °C; and
- (b) Be jacketed with a material having a melting point of 700 °C or greater.

**6.7.3.9** *Marking of pressure-relief devices*

**6.7.3.9.1** Every pressure-relief device shall be plainly and permanently marked with the following particulars:

- (a) The pressure (in bar or kPa) at which it is set to discharge;
- (b) The allowable tolerance at the discharge pressure for spring-loaded devices;
- (c) The reference temperature corresponding to the rated pressure for frangible discs;
- (d) The rated flow capacity of the device in standard cubic metres of air per second (m<sup>3</sup>/s); and
- (e) The cross sectional flow areas of the spring loaded pressure-relief devices and frangible discs in mm<sup>2</sup>.

When practicable, the following information shall also be shown:

- (f) The manufacturer's name and relevant catalogue number of the device.

**6.7.3.9.2** The rated flow capacity marked on the pressure-relief devices shall be determined according to ISO 4126-1:2004 and ISO 4126-7:2004.

**6.7.3.10** *Connections to pressure-relief devices*

6.7.3.10.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve shall be installed between the shell and the pressure-relief devices except when duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that at least one of the duplicate devices is always operable and capable of meeting the requirements of 6.7.3.8. There shall be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut-off the flow from the shell to that device. Vents from the pressure-relief devices, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

**6.7.3.11** *Siting of pressure-relief devices*

6.7.3.11.1 Each pressure-relief device inlet shall be situated on top of the shell in a position as near the longitudinal and transverse centre of the shell as reasonably practicable. All pressure relief device inlets shall under maximum filling conditions be situated in the vapour space of the shell and the devices shall be so arranged as to ensure that the escaping vapour is discharged unrestrictedly. For flammable non-refrigerated liquefied gases, the escaping vapour shall be directed away from the shell in such a manner that it cannot impinge upon the shell. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

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

**6.7.3.12** *Gauging devices*

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

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

6.7.3.13.1 Portable tanks shall be designed and constructed with a support structure to provide a secure base during carriage. The forces specified in 6.7.3.2.9 and the safety factor specified in 6.7.3.2.10 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

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

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

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

- (a) The 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.

6.7.3.13.5 When portable tanks are not protected during carriage, according to 4.2.2.3, the shells and service equipment shall be protected against damage to the shell and service equipment resulting from lateral or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the shell contents upon impact or overturning of the portable tank on its fittings. Examples of protection include:

- (a) Protection against lateral impact which may consist of longitudinal bars protecting the shell on both sides at the level of the median line;

- (b) Protection of the portable tank against overturning which may consist of reinforcement rings or bars fixed across the frame;
- (c) Protection against rear impact which may consist of a bumper or frame;
- (d) Protection of the shell against damage from impact or overturning by use of an ISO frame in accordance with ISO 1496-3:1995.

#### **6.7.3.14 *Design approval***

##### **6.7.3.14.1**

The competent authority or its authorized body shall issue a design approval certificate for any new design of a portable tank. This certificate shall attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter and where appropriate the provisions for gases provided in portable tank instruction T50 in 4.2.5.2.6. When a series of portable tanks are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the gases allowed to be carried, the materials of construction of the shell and an approval number. The approval number shall consist of the distinguishing sign or mark of the State in whose territory the approval was granted, indicated by the distinguishing sign used on vehicles in international road traffic<sup>2</sup>, and a registration number. Any alternative arrangements according to 6.7.1.2 shall be indicated on the certificate. A design approval may serve for the approval of smaller portable tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

##### **6.7.3.14.2**

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

- (a) The results of the applicable framework test specified in ISO 1496-3:1995;
- (b) The results of the initial inspection and test in 6.7.3.15.3; and
- (c) The results of the impact test in 6.7.3.15.1, when applicable.

#### **6.7.3.15 *Inspection and testing***

##### **6.7.3.15.1**

Portable tanks meeting the definition of container in the *International Convention for Safe Containers (CSC)*, 1972, as amended, shall not be used unless they are successfully qualified by subjecting a representative prototype of each design to the Dynamic, Longitudinal Impact Test prescribed in the *Manual of Tests and Criteria*, Part IV, Section 41.

##### **6.7.3.15.2**

The shell and items of equipment of each portable tank shall be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection and test (2.5 year periodic inspection and test) midway between the 5 year periodic inspections and tests. The 2.5 year inspection and test may be performed within 3 months of the specified date. An exceptional inspection and test shall be performed regardless of the last periodic inspection and test when necessary according to 6.7.3.15.7.

##### **6.7.3.15.3**

The initial inspection and test of a portable tank shall include a check of the design characteristics, an internal and external examination of the portable tank and its fittings with due regard to the non-refrigerated liquefied gases to be carried, and a pressure test referring to the test pressures according to 6.7.3.3.2. The pressure test may be performed as a hydraulic test or by using another liquid or gas with the agreement of the competent authority or its authorized body. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the shell and its fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test. All welds subject to full stress level in the shell shall be inspected during the initial test by radiographic, ultrasonic, or another suitable non-destructive test method. This does not apply to the jacket.

##### **6.7.3.15.4**

The 5 year periodic inspection and test shall include an internal and external examination and, as a general rule, a hydraulic pressure test. Sheathing, thermal insulation and the like shall be removed only

<sup>2</sup> *Distinguishing sign of the State of registration used on motor vehicles and trailers in international road traffic, e.g. in accordance with the Geneva Convention on Road Traffic of 1949 or the Vienna Convention on Road Traffic of 1968.*

to the extent required for reliable appraisal of the condition of the portable tank. When the shell and equipment have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

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

6.7.3.15.6 *Inspection and test of portable tanks and filling after the date of expiry of the last periodic inspection and test*

6.7.3.15.6.1 A portable tank may not be filled and offered for carriage after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 6.7.3.15.2. However a portable tank filled prior to the date of expiry of the last periodic inspection and test may be carried for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be carried after the date of expiry of the last periodic test and inspection:

- (a) After emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and
- (b) Unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption shall be mentioned in the transport document.

6.7.3.15.6.2 Except as provided for in 6.7.3.15.6.1, portable tanks which have missed the timeframe for their scheduled 5 year or 2.5-year periodic inspection and test may only be filled and offered for carriage if a new 5-year periodic inspection and test is performed according to 6.7.3.15.4.

6.7.3.15.7 The exceptional inspection and test is necessary when the portable tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the portable tank. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the portable tank. It shall include at least the 2.5 year inspection and test according to 6.7.3.15.5.

6.7.3.15.8 The internal and external examinations shall ensure that:

- (a) The shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the portable tank unsafe for carriage. The wall thickness shall be verified by appropriate measurement if this inspection indicates a reduction of wall thickness;
- (b) The piping, valves, and gaskets are inspected for corroded areas, defects, or any other conditions, including leakage, that might render the portable tank unsafe for filling, discharge or carriage;
- (c) Devices for tightening manhole covers are operative and there is no leakage at manhole covers or gaskets;
- (d) Missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;
- (e) All emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;
- (f) Required marks on the portable tank are legible and in accordance with the applicable requirements; and
- (g) The framework, the supports and the arrangements for lifting the portable tank are in satisfactory condition.

6.7.3.15.9 The inspections and tests in 6.7.3.15.1, 6.7.3.15.3, 6.7.3.15.4, 6.7.3.15.5 and 6.7.3.15.7 shall be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the portable tank. While under pressure, the portable tank shall be inspected for any leaks in the shell, piping or equipment.

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

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

#### **6.7.3.16 *Marking***

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

(a) Owner information

(i) Owner's registration number;

(b) Manufacturing information

(i) Country of manufacture;

(ii) Year of manufacture;

(iii) Manufacturer's name or mark;

(iv) Manufacturer's serial number;

(c) Approval information

(i) The United Nations packaging symbol  .

This symbol shall not be used for any purpose other than certifying that a packaging, a flexible bulk container, a portable tank or a MEGC complies with the relevant requirements in Chapter 6.1, 6.2, 6.3, 6.5, 6.6, 6.7 or 6.11;

(ii) Approval country;

(iii) Authorized body for the design approval;

(iv) Design approval number;

(v) Letters 'AA', if the design was approved under alternative arrangements (see 6.7.1.2);

(vi) Pressure vessel code to which the shell is designed;

(d) Pressures

(i) MAWP (in bar gauge or kPa gauge)<sup>3</sup>;

(ii) Test pressure (in bar gauge or kPa gauge)<sup>3</sup>;

(iii) Initial pressure test date (month and year);

<sup>3</sup> The unit used shall be indicated.

- (iv) Identification mark of the initial pressure test witness;
- (v) External design pressure<sup>5</sup> (in bar gauge or kPa gauge)<sup>3</sup>;
- (e) Temperatures
  - (i) Design temperature range (in °C)<sup>3</sup>;
  - (ii) Design reference temperature (in °C)<sup>3</sup>;
- (f) Materials
  - (i) Shell material(s) and material standard reference(s);
  - (ii) Equivalent thickness in reference steel (in mm)<sup>3</sup>;
- (g) Capacity
  - (i) Tank water capacity at 20 °C (in litres)<sup>3</sup>;
- (h) Periodic inspections and tests
  - (i) Type of the most recent periodic test (2.5-year, 5-year or exceptional);
  - (ii) Date of the most recent periodic test (month and year);
  - (iii) Test pressure (in bar gauge or kPa gauge)<sup>3</sup> of the most recent periodic test (if applicable);
  - (iv) Identification mark of the authorized body who performed or witnessed the most recent test.

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<sup>5</sup> See 6.7.3.2.8.

<sup>3</sup> The unit used shall be indicated.

Figure 6.7.3.16.1: Example of a plate for marking

Owner's registration number					
<b>MANUFACTURING INFORMATION</b>					
Country of manufacture					
Year of manufacture					
Manufacturer					
Manufacturer's serial number					
<b>APPROVAL INFORMATION</b>					
	Approval country				
	Authorized body for design approval				
	Design approval number	'AA' (if applicable)			
Shell design code (pressure vessel code)					
<b>PRESSURES</b>					
MAWP	bar or kPa				
Test pressure	bar or kPa				
Initial pressure test date: (mm/yyyy)	Witness stamp:				
External design pressure	bar or kPa				
<b>TEMPERATURES</b>					
Design temperature range	°C to °C				
Design reference temperature	°C				
<b>MATERIALS</b>					
Shell material(s) and material standard reference(s)					
Equivalent thickness in reference steel	mm				
<b>CAPACITY</b>					
Tank water capacity at 20 °C	litres				
<b>PERIODIC INSPECTIONS / TESTS</b>					
Test type	Test date	Witness stamp and test pressure <sup>a</sup>	Test type	Test date	Witness stamp and test pressure <sup>a</sup>
	(mm/yyyy)	bar or kPa		(mm/yyyy)	bar or kPa

<sup>a</sup> Test pressure if applicable.

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

Name of the operator

Name of non-refrigerated liquefied gas(es) permitted for carriage

Maximum permissible load mass for each non-refrigerated liquefied gas permitted \_\_\_\_\_ kg

Maximum permissible gross mass (MPGM) \_\_\_\_\_ kg

Unladen (tare) mass \_\_\_\_\_ kg

Portable tank instruction in accordance with 4.2.5.2.6

*NOTE: For the identification of the non-refrigerated liquefied gases being carried, see also Part 5.*

6.7.3.16.3 If a portable tank is designed and approved for handling in open seas, the words "OFFSHORE PORTABLE TANK" shall be marked on the identification plate.

**6.7.4 Requirements for the design, construction, inspection and testing of portable tanks intended for the carriage of refrigerated liquefied gases**

**6.7.4.1 Definitions**

For the purposes of this section:

*Alternative arrangement* means an approval granted by the competent authority for a portable tank or MEGC that has been designed, constructed or tested to technical requirements or testing methods other than those specified in this Chapter;

*Portable tank* means a thermally insulated multimodal tank having a capacity of more than 450 litres fitted with service equipment and structural equipment necessary for the carriage of refrigerated liquefied gases. The portable tank shall be capable of being filled and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the tank, and shall be capable of being lifted when full. It shall be designed primarily to be loaded onto a vehicle, wagon or sea-going or inland navigation vessel and shall be equipped with skids, mountings or accessories to facilitate mechanical handling. Tank-vehicles, tank-wagons, non-metallic tanks, intermediate bulk containers (IBCs), gas cylinders and large receptacles are not considered to fall within the definition for portable tanks;

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

- (a) A jacket and one or more inner shells where the space between the shell(s) and the jacket is exhausted of air (vacuum insulation) and may incorporate a thermal insulation system; or
- (b) A jacket and an inner shell with an intermediate layer of solid thermally insulating material (e.g. solid foam);

*Shell* means the part of the portable tank which retains the refrigerated liquefied gas intended for carriage, including openings and their closures, but does not include service equipment or external structural equipment;

*Jacket* means the outer insulation cover or cladding which may be part of the insulation system;

*Service equipment* means measuring instruments and filling, discharge, venting, safety, pressurizing, cooling and thermal insulation devices;

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

*Maximum allowable working pressure (MAWP)* means the maximum effective gauge pressure permissible at the top of the shell of a loaded portable tank in its operating position including the highest effective pressure during filling and discharge;

*Test pressure* means the maximum gauge pressure at the top of the shell during the pressure test;

*Leakproofness test* means a test using gas subjecting the shell and its service equipment, to an effective internal pressure not less than 90 % of the MAWP;

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

*Holding time* means the time that will elapse from the establishment of the initial filling condition until the pressure has risen due to heat influx to the lowest set pressure of the pressure limiting device(s);

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

*Minimum design temperature* means the temperature which is used for the design and construction of the shell not higher than the lowest (coldest) temperature (service temperature) of the contents during normal conditions of filling, discharge and carriage.

**6.7.4.2 General design and construction requirements**

- 6.7.4.2.1 Shells shall be designed and constructed in accordance with the requirements of a pressure vessel code recognized by the competent authority. Shells and jackets shall be made of metallic materials suitable for forming. Jackets shall be made of steel. Non-metallic materials may be used for the attachments and supports between the shell and jacket, provided their material properties at the minimum design temperature are proven to be sufficient. The materials shall in principle conform to national or international material standards. For welded shells and jackets only materials whose weldability has been fully demonstrated shall be used. Welds shall be skilfully made and afford complete safety. When the manufacturing process or the materials make it necessary, the shell shall be suitably heat treated to guarantee adequate toughness in the weld and in the heat affected zones. In choosing the material, the minimum design temperature shall be taken into account with respect to risk of brittle fracture, to hydrogen embrittlement, to stress corrosion cracking and to resistance to impact. When fine grain steel is used, the guaranteed value of the yield strength shall be not more than 460 N/mm<sup>2</sup> and the guaranteed value of the upper limit of the tensile strength shall be not more than 725 N/mm<sup>2</sup> in accordance with the material specifications. Portable tank materials shall be suitable for the external environment in which they may be carried.
- 6.7.4.2.2 Any part of a portable tank, including fittings, gaskets and pipe-work, which can be expected normally to come into contact with the refrigerated liquefied gas carried shall be compatible with that refrigerated liquefied gas.
- 6.7.4.2.3 Contact between dissimilar metals which could result in damage by galvanic action shall be avoided.
- 6.7.4.2.4 The thermal insulation system shall include a complete covering of the shell(s) with effective insulating materials. External insulation shall be protected by a jacket so as to prevent the ingress of moisture and other damage under normal carriage conditions.
- 6.7.4.2.5 When a jacket is so closed as to be gas-tight, a device shall be provided to prevent any dangerous pressure from developing in the insulation space.
- 6.7.4.2.6 Portable tanks intended for the carriage of refrigerated liquefied gases having a boiling point below minus (-) 182 °C at atmospheric pressure shall not include materials which may react with oxygen or oxygen enriched atmospheres in a dangerous manner, when located in parts of the thermal insulation when there is a risk of contact with oxygen or with oxygen enriched fluid.
- 6.7.4.2.7 Insulating materials shall not deteriorate unduly in service.
- 6.7.4.2.8 A reference holding time shall be determined for each refrigerated liquefied gas intended for carriage in a portable tank.
- 6.7.4.2.8.1 The reference holding time shall be determined by a method recognized by the competent authority on the basis of the following:
- The effectiveness of the insulation system, determined in accordance with 6.7.4.2.8.2;
  - The lowest set pressure of the pressure limiting device(s);
  - The initial filling conditions;
  - An assumed ambient temperature of 30 °C;
  - The physical properties of the individual refrigerated liquefied gas intended to be carried.
- 6.7.4.2.8.2 The effectiveness of the insulation system (heat influx in watts) shall be determined by type testing the portable tank in accordance with a procedure recognized by the competent authority. This test shall consist of either:
- A constant pressure test (for example at atmospheric pressure) when the loss of refrigerated liquefied gas is measured over a period of time; or
  - A closed system test when the rise in pressure in the shell is measured over a period of time.

When performing the constant pressure test, variations in atmospheric pressure shall be taken into account. When performing either tests corrections shall be made for any variation of the ambient temperature from the assumed ambient temperature reference value of 30 °C.

*NOTE: For the determination of the actual holding time before each journey, refer to 4.2.3.7.*

**6.7.4.2.9** The jacket of a vacuum-insulated double-wall tank shall have either an external design pressure not less than 100 kPa (1 bar) (gauge pressure) calculated in accordance with a recognized technical code or a calculated critical collapsing pressure of not less than 200 kPa (2 bar) (gauge pressure). Internal and external reinforcements may be included in calculating the ability of the jacket to resist the external pressure.

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

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

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

- (a) In the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g)<sup>1</sup>;
- (b) Horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g)<sup>1</sup>;
- (c) Vertically upwards: the MPGM multiplied by the acceleration due to gravity (g)<sup>1</sup>; and
- (d) Vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g)<sup>1</sup>.

**6.7.4.2.13** Under each of the forces in 6.7.4.2.12, the safety factor to be observed shall be as follows:

- (a) For materials having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength; and
- (b) For materials with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2 % proof strength or, in case of austenitic steels, the 1 % proof strength.

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

**6.7.4.2.15** Portable tanks intended for the carriage of flammable refrigerated liquefied gases shall be capable of being electrically earthed.

### **6.7.4.3** *Design criteria*

**6.7.4.3.1** Shells shall be of a circular cross section.

**6.7.4.3.2** Shells shall be designed and constructed to withstand a test pressure not less than 1.3 times the MAWP. For shells with vacuum insulation the test pressure shall not be less than 1.3 times the sum of the MAWP and 100 kPa (1 bar). In no case shall the test pressure be less than 300 kPa (3 bar) (gauge pressure). Attention is drawn to the minimum shell thickness requirements, specified in 6.7.4.4.2 to 6.7.4.4.7.

**6.7.4.3.3** For metals exhibiting a clearly defined yield point or characterized by a guaranteed proof strength (0.2 % proof strength, generally, or 1 % proof strength for austenitic steels) the primary membrane stress

<sup>1</sup> For calculation purposes  $g = 9.81 \text{ m/s}^2$ .

$\sigma$  (sigma) in the shell shall not exceed 0.75 Re or 0.50 Rm, whichever is lower, at the test pressure, where:

Re = yield strength in N/mm<sup>2</sup>, or 0.2 % proof strength or, for austenitic steels, 1 % proof strength;

Rm = minimum tensile strength in N/mm<sup>2</sup>.

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

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

6.7.4.3.3.3 Steels used in the construction of shells shall have an elongation at fracture, in %, of not less than 10 000/Rm with an absolute minimum of 16 % for fine grain steels and 20 % for other steels. Aluminium and aluminium alloys used in the construction of shells shall have an elongation at fracture, in %, of not less than 10 000/6Rm with an absolute minimum of 12 %.

6.7.4.3.3.4 For the purpose of determining actual values for materials, it shall be noted that for sheet metal, the axis of the tensile test specimen shall be at right angles (transversely) to the direction of rolling. The permanent elongation at fracture shall be measured on test specimens of rectangular cross sections in accordance with ISO 6892:1988 using a 50 mm gauge length.

#### 6.7.4.4 *Minimum shell thickness*

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

- (a) The minimum thickness determined in accordance with the requirements in 6.7.4.4.2 to 6.7.4.4.7; or
- (b) The minimum thickness determined in accordance with the recognized pressure vessel code including the requirements in 6.7.4.3.

6.7.4.4.2 Shells of not more than 1.80 m in diameter shall be not less than 5 mm thick in the reference steel or of equivalent thickness in the metal to be used. Shells of more than 1.80 m in diameter shall be not less than 6 mm thick in the reference steel or of equivalent thickness in the metal to be used.

6.7.4.4.3 Shells of vacuum-insulated tanks of not more than 1.80 m in diameter shall be not less than 3 mm thick in the reference steel or of equivalent thickness in the metal to be used. Such shells of more than 1.80 m in diameter shall be not less than 4 mm thick in the reference steel or of equivalent thickness in the metal to be used.

6.7.4.4.4 For vacuum-insulated tanks, the aggregate thickness of the jacket and the shell shall correspond to the minimum thickness prescribed in 6.7.4.4.2, the thickness of the shell itself being not less than the minimum thickness prescribed in 6.7.4.4.3.

6.7.4.4.5 Shells shall be not less than 3 mm thick regardless of the material of construction.

6.7.4.4.6 The equivalent thickness of a metal other than the thickness prescribed for the reference steel in 6.7.4.4.2 and 6.7.4.4.3 shall be determined using the following formula:

$$e_1 = \frac{21.4e_0}{\sqrt[3]{Rm_1 \times A_1}}$$

where:

$e_1$  = required equivalent thickness (in mm) of the metal to be used;

$e_0$  = minimum thickness (in mm) of the reference steel specified in 6.7.4.4.2 and 6.7.4.4.3;

$Rm_1$  = guaranteed minimum tensile strength (in N/mm<sup>2</sup>) of the metal to be used (see 6.7.4.3.3);

$A_1$  = guaranteed minimum elongation at fracture (in %) of the metal to be used according to national or international standards.

**6.7.4.4.7** In no case shall the wall thickness be less than that prescribed in 6.7.4.4.1 to 6.7.4.4.5. All parts of the shell shall have a minimum thickness as determined by 6.7.4.4.1 to 6.7.4.4.6. This thickness shall be exclusive of any corrosion allowance.

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

**6.7.4.5** *Service equipment*

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

**6.7.4.5.2** Each filling and discharge opening in portable tanks used for the carriage of flammable refrigerated liquefied gases shall be fitted with at least three mutually independent shut-off devices in series, the first being a stop-valve situated as close as reasonably practicable to the jacket, the second being a stop-valve and the third being a blank flange or equivalent device. The shut-off device closest to the jacket shall be a quick closing device, which closes automatically in the event of unintended movement of the portable tank during filling or discharge or fire engulfment. This device shall also be possible to operate by remote control.

**6.7.4.5.3** Each filling and discharge opening in portable tanks used for the carriage of non-flammable refrigerated liquefied gases shall be fitted with at least two mutually independent shut-off devices in series, the first being a stop-valve situated as close as reasonably practicable to the jacket, the second a blank flange or equivalent device.

**6.7.4.5.4** For sections of piping which can be closed at both ends and where liquid product can be trapped, a method of automatic pressure relief shall be provided to prevent excess pressure build-up within the piping.

**6.7.4.5.5** Vacuum insulated tanks need not have an opening for inspection.

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

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

**6.7.4.5.8** Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than the MAWP of the shell taking into account the temperature expected during carriage. All stop-valves with a screwed spindle shall be closed by a clockwise motion of the handwheel. In the case of other stop-valves the position (open and closed) and direction of closure shall be clearly indicated. All stop-valves shall be designed to prevent unintentional opening.

**6.7.4.5.9** When pressure-building units are used, the liquid and vapour connections to that unit shall be provided with a valve as close to the jacket as reasonably practicable to prevent the loss of contents in case of damage to the pressure-building unit.

**6.7.4.5.10** Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration. All piping shall be of a suitable material. To prevent leakage due to fire, only steel piping and welded joints shall be used between the jacket and the connection to the first closure of any outlet. The method of attaching the closure to this connection shall be to the satisfaction of the competent authority or its authorized body. Elsewhere pipe joints shall be welded when necessary.

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

6.7.4.5.12 The materials of construction of valves and accessories shall have satisfactory properties at the lowest operating temperature of the portable tank.

6.7.4.5.13 The burst pressure of all piping and pipe fittings shall be not less than the highest of four times the MAWP of the shell or four times the pressure to which it may be subjected in service by the action of a pump or other device (except pressure-relief devices).

#### **6.7.4.6 *Pressure-relief devices***

6.7.4.6.1 Every shell shall be provided with not less than two independent spring-loaded pressure-relief devices. The pressure-relief devices shall open automatically at a pressure not less than the MAWP and be fully open at a pressure equal to 110 % of the MAWP. These devices shall, after discharge, close at a pressure not lower than 10 % below the pressure at which discharge starts and shall remain closed at all lower pressures. The pressure-relief devices shall be of the type that will resist dynamic forces including surge.

6.7.4.6.2 Shells for non-flammable refrigerated liquefied gases and hydrogen may in addition have frangible discs in parallel with the spring-loaded devices as specified in 6.7.4.7.2 and 6.7.4.7.3.

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

6.7.4.6.4 Pressure-relief devices shall be approved by the competent authority or its authorized body.

#### **6.7.4.7 *Capacity and setting of pressure-relief devices***

6.7.4.7.1 In the case of the loss of vacuum in a vacuum-insulated tank or of loss of 20 % of the insulation of a tank insulated with solid materials, the combined capacity of all pressure-relief devices installed shall be sufficient so that the pressure (including accumulation) inside the shell does not exceed 120 % of the MAWP.

6.7.4.7.2 For non-flammable refrigerated liquefied gases (except oxygen) and hydrogen, this capacity may be achieved by the use of frangible discs in parallel with the required safety-relief devices. Frangible discs shall rupture at nominal pressure equal to the test pressure of the shell.

6.7.4.7.3 Under the circumstances described in 6.7.4.7.1 and 6.7.4.7.2 together with complete fire engulfment the combined capacity of all pressure-relief devices installed shall be sufficient to limit the pressure in the shell to the test pressure.

6.7.4.7.4 The required capacity of the relief devices shall be calculated in accordance with a well-established technical code recognized by the competent authority<sup>6</sup>.

#### **6.7.4.8 *Marking of pressure-relief devices***

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

- (a) The pressure (in bar or kPa) at which it is set to discharge;
- (b) The allowable tolerance at the discharge pressure for spring-loaded devices;
- (c) The reference temperature corresponding to the rated pressure for frangible discs;
- (d) The rated flow capacity of the device in standard cubic meters of air per second (m<sup>3</sup>/s); and
- (e) The cross sectional flow areas of the spring loaded pressure-relief devices and frangible discs in mm<sup>2</sup>.

When practicable, the following information shall also be shown:

<sup>6</sup> See for example CGA S-1.2-2003 "Pressure Relief Device Standards - Part 2 - Cargo and Portable Tanks for Compressed Gases".

(f) The manufacturer's name and relevant catalogue number of the device.

6.7.4.8.2 The rated flow capacity marked on the pressure-relief devices shall be determined according to ISO 4126-1:2004 and ISO 4126-7:2004.

#### **6.7.4.9 *Connections to pressure-relief devices***

6.7.4.9.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve shall be installed between the shell and the pressure-relief devices except when duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that the requirements of 6.7.4.7 are always fulfilled. There shall be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut-off the flow from the shell to that device. Pipework to vent the vapour or liquid from the outlet of the pressure-relief devices, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

#### **6.7.4.10 *Siting of pressure-relief devices***

6.7.4.10.1 Each pressure-relief device inlet shall be situated on top of the shell in a position as near the longitudinal and transverse centre of the shell as reasonably practicable. All pressure-relief device inlets shall under maximum filling conditions be situated in the vapour space of the shell and the devices shall be so arranged as to ensure that the escaping vapour is discharged unrestrictedly. For refrigerated liquefied gases, the escaping vapour shall be directed away from the tank and in such a manner that it cannot impinge upon the tank. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

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

#### **6.7.4.11 *Gauging devices***

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

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

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

6.7.4.12.1 Portable tanks shall be designed and constructed with a support structure to provide a secure base during carriage. The forces specified in 6.7.4.2.12 and the safety factor specified in 6.7.4.2.13 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

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

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

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

- (a) The tank and all the fittings are well protected from being hit by the forklift blades; and
- (b) The distance between the centres of the forklift pockets is at least half of the maximum length of the portable tank.

6.7.4.12.5 When portable tanks are not protected during carriage, according to 4.2.3.3, the shells and service equipment shall be protected against damage to the shell and service equipment resulting from lateral

or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the shell contents upon impact or overturning of the portable tank on its fittings. Examples of protection include:

- (a) Protection against lateral impact which may consist of longitudinal bars protecting the shell on both sides at the level of the median line;
- (b) Protection of the portable tank against overturning which may consist of reinforcement rings or bars fixed across the frame;
- (c) Protection against rear impact which may consist of a bumper or frame;
- (d) Protection of the shell against damage from impact or overturning by use of an ISO frame in accordance with ISO 1496-3:1995;
- (e) Protection of the portable tank from impact or overturning by a vacuum insulation jacket.

#### **6.7.4.13 *Design approval***

6.7.4.13.1 The competent authority or its authorized body shall issue a design approval certificate for any new design of a portable tank. This certificate shall attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter. When a series of portable tanks are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the refrigerated liquefied gases allowed to be carried, the materials of construction of the shell and jacket and an approval number. The approval number shall consist of the distinguishing sign or mark of the State in whose territory the approval was granted, indicated by the distinguishing sign for use in international road traffic<sup>2</sup>, and a registration number. Any alternative arrangements according to 6.7.1.2 shall be indicated on the certificate. A design approval may serve for the approval of smaller portable tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

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

- (a) The results of the applicable frame-work test specified in ISO 1496-3:1995;
- (b) The results of the initial inspection and test in 6.7.4.14.3; and
- (c) The results of the impact test in 6.7.4.14.1, when applicable.

#### **6.7.4.14 *Inspection and testing***

6.7.4.14.1 Portable tanks meeting the definition of container in the *International Convention for Safe Containers (CSC)*, 1972, as amended, shall not be used unless they are successfully qualified by subjecting a representative prototype of each design to the Dynamic, Longitudinal Impact Test prescribed in the *Manual of Tests and Criteria*, Part IV, Section 41.

6.7.4.14.2 The tank and items of equipment of each portable tank shall be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5 year periodic inspection and test) with an intermediate periodic inspection and test (2.5 year periodic inspection and test) midway between the 5 year periodic inspections and tests. The 2.5 year inspection and test may be performed within 3 months of the specified date. An exceptional inspection and test shall be performed regardless of the last periodic inspection and test when necessary according to 6.7.4.14.7.

6.7.4.14.3 The initial inspection and test of a portable tank shall include a check of the design characteristics, an internal and external examination of the portable tank shell and its fittings with due regard to the refrigerated liquefied gases to be carried, and a pressure test referring to the test pressures according to 6.7.4.3.2. The pressure test may be performed as a hydraulic test or by using another liquid or gas with the agreement of the competent authority or its authorized body. Before the portable tank is placed into service, a leakproofness test and a check of the satisfactory operation of all service equipment shall also

<sup>2</sup> *Distinguishing sign of the State of registration used on motor vehicles and trailers in international road traffic, e.g. in accordance with the Geneva Convention on Road Traffic of 1949 or the Vienna Convention on Road Traffic of 1968.*

be performed. When the shell and its fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test. All welds subject to full stress level shall be inspected during the initial test by radiographic, ultrasonic, or another suitable non-destructive test method. This does not apply to the jacket.

- 6.7.4.14.4 The 5 and 2.5 year periodic inspections and tests shall include an external examination of the portable tank and its fittings with due regard to the refrigerated liquefied gases carried, a leakproofness test, a check of the satisfactory operation of all service equipment and a vacuum reading, when applicable. In the case of non-vacuum insulated tanks, the jacket and insulation shall be removed during the 2.5 year and the 5 year periodic inspections and tests but only to the extent necessary for a reliable appraisal.
- 6.7.4.14.5 *(Deleted)*
- 6.7.4.14.6 *Inspection and test of portable tanks and filling after the date of expiry of the last periodic inspection and test*
- 6.7.4.14.6.1 A portable tank may not be filled and offered for carriage after the date of expiry of the last 5 year or 2.5 year periodic inspection and test as required by 6.7.4.14.2. However a portable tank filled prior to the date of expiry of the last periodic inspection and test may be carried for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be carried after the date of expiry of the last periodic test and inspection:
- After emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and
  - Unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption shall be mentioned in the transport document.
- 6.7.4.14.6.2 Except as provided for in 6.7.4.14.6.1, portable tanks which have missed the timeframe for their scheduled 5 year or 2.5-year periodic inspection and test may only be filled and offered for carriage if a new 5-year periodic inspection and test is performed according to 6.7.4.14.4.
- 6.7.4.14.7 The exceptional inspection and test is necessary when the portable tank shows evidence of damaged or corroded areas, leakage, or any other conditions that indicate a deficiency that could affect the integrity of the portable tank. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the portable tank. It shall include at least the 2.5 year inspection and test according to 6.7.4.14.4.
- 6.7.4.14.8 The internal examination during the initial inspection and test shall ensure that the shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, that might render the portable tank unsafe for carriage.
- 6.7.4.14.9 The external examination shall ensure that:
- The external piping, valves, pressurizing/cooling systems when applicable and gaskets are inspected for corroded areas, defects, or any other conditions, including leakage, that might render the portable tank unsafe for filling, discharge or carriage;
  - There is no leakage at any manhole covers or gaskets;
  - Missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;
  - All emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;
  - Required marks on the portable tank are legible and in accordance with the applicable requirements; and
  - The framework, the supports and the arrangements for lifting the portable tank are in satisfactory condition.

- 6.7.4.14.10 The inspections and tests in 6.7.4.14.1, 6.7.4.14.3, 6.7.4.14.4 and 6.7.4.14.7 shall be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the portable tank. While under pressure, the portable tank shall be inspected for any leaks in the shell, piping or equipment.
- 6.7.4.14.11 In all cases when cutting, burning or welding operations on the shell of a portable tank have been effected, that work shall be to the approval of the competent authority or its authorized body taking into account the pressure vessel code used for the construction of the shell. A pressure test to the original test pressure shall be performed after the work is completed.
- 6.7.4.14.12 When evidence of any unsafe condition is discovered, the portable tank shall not be returned to service until it has been corrected and the test is repeated and passed.

#### 6.7.4.15 *Marking*

- 6.7.4.15.1 Every portable tank shall be fitted with a corrosion-resistant metal plate permanently attached to the portable tank in a conspicuous place readily accessible for inspection. When for reasons of portable tank arrangements the plate cannot be permanently attached to the shell, the shell shall be marked with at least the information required by the pressure vessel code. As a minimum, at least the following information shall be marked on the plate by stamping or by any other similar method:
- (a) Owner information
    - (i) Owner's registration number;
  - (b) Manufacturing information
    - (i) Country of manufacture;
    - (ii) Year of manufacture;
    - (iii) Manufacturer's name or mark;
    - (iv) Manufacturer's serial number;
  - (c) Approval information
    - (i) The United Nations packaging symbol .

This symbol shall not be used for any purpose other than certifying that a packaging, a flexible bulk container, a portable tank or a MEGC complies with the relevant requirements in Chapter 6.1, 6.2, 6.3, 6.5, 6.6, 6.7 or 6.11;

    - (ii) Approval country;
    - (iii) Authorized body for the design approval;
    - (iv) Design approval number;
    - (v) Letters 'AA', if the design was approved under alternative arrangements (see 6.7.1.2);
    - (vi) Pressure vessel code to which the shell is designed;
  - (d) Pressures
    - (i) MAWP (in bar gauge or kPa gauge)<sup>3</sup>;
    - (ii) Test pressure (in bar gauge or kPa gauge)<sup>3</sup>;
    - (iii) Initial pressure test date (month and year);

<sup>3</sup> The unit used shall be indicated.

- (iv) Identification mark of the initial pressure test witness;
- (e) Temperatures
  - (i) Minimum design temperature (in °C)<sup>3</sup>;
- (f) Materials
  - (i) Shell material(s) and material standard reference(s);
  - (ii) Equivalent thickness in reference steel (in mm)<sup>3</sup>;
- (g) Capacity
  - (i) Tank water capacity at 20 °C (in litres)<sup>3</sup>;
- (h) Insulation
  - (i) Either "Thermally insulated" or "Vacuum insulated" (as applicable);
  - (ii) Effectiveness of the insulation system (heat influx) (in watts)<sup>3</sup>;
- (i) Holding times – for each refrigerated liquefied gas permitted to be carried in the portable tank
  - (i) Name, in full, of the refrigerated liquefied gas;
  - (ii) Reference holding time (in days or hours)<sup>3</sup>;
  - (iii) Initial pressure (in bar gauge or kPa gauge)<sup>3</sup>;
  - (iv) Maximum allowable mass of gas filled (in kg)<sup>3</sup>;
- (j) Periodic inspections and tests
  - (i) Type of the most recent periodic test (2.5-year, 5-year or exceptional);
  - (ii) Date of the most recent periodic test (month and year);
  - (iii) Identification mark of the authorized body who performed or witnessed the most recent test.

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<sup>3</sup> The unit used shall be indicated.

Figure 6.7.4.15.1: Example of a plate for marking

Owner's registration number					
<b>MANUFACTURING INFORMATION</b>					
Country of manufacture					
Year of manufacture					
Manufacturer					
Manufacturer's serial number					
<b>APPROVAL INFORMATION</b>					
	Approval country				
	Authorized body for design approval				
	Design approval number	'AA' (if applicable)			
Shell design code (pressure vessel code)					
<b>PRESURES</b>					
MAWP	bar or kPa				
Test pressure	bar or kPa				
Initial pressure test date: (mm/yyyy)	Witness stamp:				
<b>TEMPERATURES</b>					
Minimum design temperature	°C				
<b>MATERIALS</b>					
Shell material(s) and material standard reference(s)					
Equivalent thickness in reference steel	mm				
<b>CAPACITY</b>					
Tank water capacity at 20 °C	litres				
<b>INSULATION</b>					
'Thermally insulated' or 'Vacuum insulated' (as applicable)					
Heat influx	watts				
<b>HOLDING TIMES</b>					
Refrigerated liquefied gas(es) permitted	Reference holding time	Initial pressure	Maximum allowable mass of gas filled		
	days or hours	bar or kPa	kg		
<b>PERIODIC INSPECTIONS / TESTS</b>					
Test type	Test date (mm/yyyy)	Witness stamp	Test type	Test date (mm/yyyy)	Witness stamp

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

Name of the owner and the operator

Name of the refrigerated liquefied gas being carried (and minimum mean bulk temperature)

Maximum permissible gross mass (MPGM) kg

Unladen (tare) mass kg

Actual holding time for gas being carried days (or hours)

Portable tank instruction in accordance with 4.2.5.2.6

*NOTE: For the identification of the refrigerated liquefied gas(es) being carried, see also Part 5.*

6.7.4.15.3 If a portable tank is designed and approved for handling in open seas, the words "OFFSHORE PORTABLE TANK" shall be marked on the identification plate.

**6.7.5 Requirements for the design, construction, inspection and testing of UN multiple-element gas containers (MEGCs) intended for the carriage of non-refrigerated gases****6.7.5.1 Definitions**

For the purposes of this section:

*Alternative arrangement* means an approval granted by the competent authority for a portable tank or MEGC that has been designed, constructed or tested to technical requirements or testing methods other than those specified in this Chapter;

*Elements* are cylinders, tubes or bundles of cylinders;

*Leakproofness test* means a test using gas subjecting the elements and the service equipment of the MEGC to an effective internal pressure of not less than 20 % of the test pressure;

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

*Maximum permissible gross mass (MPGM)* means the sum of the tare mass of the MEGC and the heaviest load authorized for carriage;

*UN Multiple-element gas containers (MEGCs)* are multimodal assemblies of cylinders, tubes and bundles of cylinders which are interconnected by a manifold and which are assembled within a framework. The MEGC includes service equipment and structural equipment necessary for the carriage of gases;

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

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

**6.7.5.2 General design and construction requirements**

6.7.5.2.1 The MEGC shall be capable of being filled and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the elements to provide structural integrity for handling and carriage. MEGCs shall be designed and constructed with supports to provide a secure base during carriage and with lifting and tie-down attachments which are adequate for lifting the MEGC including when filled to its maximum permissible gross mass. The MEGC shall be designed to be loaded onto a vehicle, wagon or sea-going or inland navigation vessel and shall be equipped with skids, mountings or accessories to facilitate mechanical handling.

6.7.5.2.2 MEGCs shall be designed, manufactured and equipped in such a way as to withstand all conditions to which they will be subjected during normal conditions of handling and carriage. The design shall take into account the effects of dynamic loading and fatigue.

6.7.5.2.3 Elements of an MEGC shall be made of seamless steel or composite construction and be constructed and tested according to 6.2.1 and 6.2.2. All of the elements in an MEGC shall be of the same design type.

6.7.5.2.4 Elements of MEGCs, fittings and pipework shall be:

- (a) Compatible with the substances intended to be carried (see ISO 11114-1:2020 and ISO 11114-2:2021); or
- (b) Properly passivated or neutralized by chemical reaction.

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

6.7.5.2.6 The materials of the MEGC, including any devices, gaskets, and accessories, shall not adversely affect the gas(es) intended for carriage in the MEGC.

6.7.5.2.7 MEGCs shall be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads during normal conditions of handling and carriage.

The design shall demonstrate that the effects of fatigue, caused by repeated application of these loads through the expected life of the multiple-element gas container, have been taken into account.

6.7.5.2.8 MEGCs and their fastenings shall, under the maximum permissible load, be capable of withstanding the following separately applied static forces:

- (a) In the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g)<sup>1</sup>;
- (b) Horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g)<sup>1</sup>;
- (c) Vertically upwards: the MPGM multiplied by the acceleration due to gravity (g)<sup>1</sup>; and
- (d) Vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g)<sup>1</sup>.

6.7.5.2.9 Under the forces defined in 6.7.5.2.8, the stress at the most severely stressed point of the elements shall not exceed the values given in either the relevant standards of 6.2.2.1 or, if the elements are not designed, constructed and tested according to those standards, in the technical code or standard recognised or approved by the competent authority of the country of use (see 6.2.5).

6.7.5.2.10 Under each of the forces in 6.7.5.2.8, the safety factor for the framework and fastenings to be observed shall be as follows:

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

6.7.5.2.11 MEGCs intended for the carriage of flammable gases shall be capable of being electrically earthed.

6.7.5.2.12 The elements shall be secured in a manner that prevents undesired movement in relation to the structure and the concentration of harmful localized stresses.

### 6.7.5.3 *Service equipment*

6.7.5.3.1 Service equipment shall be configured or designed to prevent damage that could result in the release of the pressure receptacle contents during normal conditions of handling and carriage. When the connection between the frame and the elements allows relative movement between the sub-assemblies, the equipment shall be so fastened as to permit such movement without damage to working parts. The manifolds, the discharge fittings (pipe sockets, shut-off devices), and the stop-valves shall be protected from being wrenching off by external forces. Manifold piping leading to shut-off valves shall be sufficiently flexible to protect the valves and the piping from shearing, or releasing the pressure receptacle contents. The filling and discharge devices (including flanges or threaded plugs) and any protective caps shall be capable of being secured against unintended opening.

6.7.5.3.2 Each element intended for the carriage of toxic gases (gases of groups T, TF, TC, TO, TFC and TOC) shall be fitted with a valve. The manifold for liquefied toxic gases (gases of classification codes 2T, 2TF, 2TC, 2TO, 2TFC and 2TOC) shall be so designed that the elements can be filled separately and be kept isolated by a valve capable of being sealed. For the carriage of flammable gases (gases of group F), the elements shall be divided into groups of not more than 3 000 litres each isolated by a valve.

6.7.5.3.3 For filling and discharge openings of the MEGC, two valves in series shall be placed in an accessible position on each discharge and filling pipe. One of the valves may be a non-return valve. The filling and discharge devices may be fitted to a manifold. For sections of piping which can be closed at both ends and where a liquid product can be trapped, a pressure-relief valve shall be provided to prevent excessive pressure build-up. The main isolation valves on an MEGC shall be clearly marked to indicate their directions of closure. Each stop-valve or other means of closure shall be designed and constructed to withstand a pressure equal to or greater than 1.5 times the test pressure of the MEGC. All stop-valves with screwed spindles shall close by a clockwise motion of the handwheel. For other stop-valves, the

<sup>1</sup> For calculation purposes  $g = 9.81 \text{ m/s}^2$ .

position (open and closed) and direction of closure shall be clearly indicated. All stop-valves shall be designed and positioned to prevent unintentional opening. Ductile metals shall be used in the construction of valves or accessories.

**6.7.5.3.4** Piping shall be designed, constructed and installed so as to avoid damage due to expansion and contraction, mechanical shock and vibration. Joints in tubing shall be brazed or have an equally strong metal union. The melting point of brazing materials shall be no lower than 525 °C. The rated pressure of the service equipment and of the manifold shall be not less than two thirds of the test pressure of the elements.

**6.7.5.4** *Pressure-relief devices*

**6.7.5.4.1** The elements of MEGCs used for the carriage of UN No. 1013 carbon dioxide and UN No. 1070 nitrous oxide shall be divided into groups of not more than 3 000 litres each isolated by a valve. Each group shall be fitted with one or more pressure relief devices. If so required by the competent authority of the country of use, MEGCs for other gases shall be fitted with pressure relief devices as specified by that competent authority.

**6.7.5.4.2** When pressure relief devices are fitted, every element or group of elements of an MEGC that can be isolated shall then be fitted with one or more pressure relief devices. Pressure relief devices shall be of a type that will resist dynamic forces including liquid surge and shall be designed to prevent the entry of foreign matter, the leakage of gas and the development of any dangerous excess pressure.

**6.7.5.4.3** MEGCs used for the carriage of certain non-refrigerated gases identified in portable tank instruction T50 in 4.2.5.2.6 may have a pressure-relief device as required by the competent authority of the country of use. Unless an MEGC in dedicated service is fitted with an approved pressure relief device constructed of materials compatible with the gas carried, such a device shall comprise a frangible disc preceding a spring-loaded device. The space between the frangible disc and the spring-loaded device may be equipped with a pressure gauge or a suitable telltale indicator. This arrangement permits the detection of disc rupture, pinholing or leakage which could cause a malfunction of the pressure relief device. The frangible disc shall rupture at a nominal pressure 10 % above the start-to-discharge pressure of the spring-loaded device.

**6.7.5.4.4** In the case of multi-purpose MEGCs used for the carriage of low-pressure liquefied gases, the pressure-relief devices shall open at a pressure as specified in 6.7.3.7.1 for the gas having the highest maximum allowable working pressure of the gases allowed to be carried in the MEGC.

**6.7.5.5** *Capacity of pressure relief devices*

**6.7.5.5.1** The combined delivery capacity of the pressure relief devices when fitted shall be sufficient that, in the event of total fire engulfment of the MEGC, the pressure (including accumulation) inside the elements does not exceed 120 % of the set pressure of the pressure relief device. The formula provided in CGA S-1.2-2003 "Pressure Relief Device Standards - Part 2 - Cargo and Portable Tanks for Compressed Gases" shall be used to determine the minimum total flow capacity for the system of pressure relief devices. CGA S-1.1-2003 "Pressure Relief Device Standards - Part 1 - Cylinders for Compressed Gases" may be used to determine the relief capacity of individual elements. Spring-loaded pressure relief devices may be used to achieve the full relief capacity prescribed in the case of low pressure liquefied gases. In the case of multi-purpose MEGCs, the combined delivery capacity of the pressure-relief devices shall be taken for the gas which requires the highest delivery capacity of the gases allowed to be carried in the MEGC.

**6.7.5.5.2** To determine the total required capacity of the pressure relief devices installed on the elements for the carriage of liquefied gases, the thermodynamic properties of the gas shall be considered (see, for example, CGA S-1.2-2003 "Pressure Relief Device Standards - Part 2 - Cargo and Portable Tanks for Compressed Gases" for low pressure liquefied gases and CGA S-1.1-2003 "Pressure Relief Device Standards - Part 1 - Cylinders for Compressed Gases" for high pressure liquefied gases).

**6.7.5.6** *Marking of pressure-relief devices*

**6.7.5.6.1** Pressure relief devices shall be clearly and permanently marked with the following:

- (a) The manufacturer's name and relevant catalogue number;
- (b) The set pressure and/or the set temperature;

- (c) The date of the last test.
- (d) The cross sectional flow areas of the spring loaded pressure-relief devices and frangible discs in mm<sup>2</sup>.
- 6.7.5.6.2 The rated flow capacity marked on spring loaded pressure relief devices for low pressure liquefied gases shall be determined according to ISO 4126-1:2004 and ISO 4126-7:2004.
- 6.7.5.7** *Connections to pressure-relief devices*
- 6.7.5.7.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the pressure relief device. No stop-valve shall be installed between the element and the pressure-relief devices, except when duplicate devices are provided for maintenance or other reasons, and the stop-valves serving the devices actually in use are locked open, or the stop-valves are interlocked so that at least one of the duplicate devices is always operable and capable of meeting the requirements of 6.7.5.5. There shall be no obstruction in an opening leading to or leaving from a vent or pressure-relief device which might restrict or cut-off the flow from the element to that device. The opening through all piping and fittings shall have at least the same flow area as the inlet of the pressure relief device to which it is connected. The nominal size of the discharge piping shall be at least as large as that of the pressure relief device outlet. Vents from the pressure-relief devices, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.
- 6.7.5.8** *Siting of pressure-relief devices*
- 6.7.5.8.1 Each pressure relief device shall, under maximum filling conditions, be in communication with the vapour space of the elements for the carriage of liquefied gases. The devices, when fitted, shall be so arranged as to ensure that the escaping vapour is discharged upwards and unrestrictedly as to prevent any impingement of escaping gas or liquid upon the MEGC, its elements or personnel. For flammable, pyrophoric and oxidizing gases, the escaping gas shall be directed away from the element in such a manner that it cannot impinge upon the other elements. Heat-resistant protective devices which deflect the flow of gas are permissible provided the required pressure relief device capacity is not reduced.
- 6.7.5.8.2 Arrangements shall be made to prevent access to the pressure-relief devices by unauthorized persons and to protect the devices from damage caused by the MEGC overturning.
- 6.7.5.9** *Gauging devices*
- 6.7.5.9.1 When an MEGC is intended to be filled by mass, it shall be equipped with one or more gauging devices. Level-gauges made of glass or other fragile material shall not be used.
- 6.7.5.10** *MEGC supports, frameworks, lifting and tie-down attachments*
- 6.7.5.10.1 MEGCs shall be designed and constructed with a support structure to provide a secure base during carriage. The forces specified in 6.7.5.2.8 and the safety factor specified in 6.7.5.2.10 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.
- 6.7.5.10.2 The combined stresses caused by element mountings (e.g. cradles, frameworks, etc.) and MEGC lifting and tie-down attachments shall not cause excessive stress in any element. Permanent lifting and tie-down attachments shall be fitted to all MEGCs. In no case shall mountings or attachments be welded onto the elements.
- 6.7.5.10.3 In the design of supports and frameworks, the effects of environmental corrosion shall be taken into account.
- 6.7.5.10.4 When MEGCs are not protected during carriage, according to 4.2.4.3, the elements and service equipment shall be protected against damage resulting from lateral or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the elements' contents upon impact or overturning of the MEGC on its fittings. Particular attention shall be paid to the protection of the manifold. Examples of protection include:
- (a) Protection against lateral impact which may consist of longitudinal bars;
- (b) Protection against overturning which may consist of reinforcement rings or bars fixed across the frame;

- (c) Protection against rear impact which may consist of a bumper or frame;
- (d) Protection of the elements and service equipment against damage from impact or overturning by use of an ISO frame in accordance with the relevant provisions of ISO 1496-3:1995.

#### 6.7.5.11 *Design approval*

##### 6.7.5.11.1

The competent authority or its authorized body shall issue a design approval certificate for any new design of an MEGC. This certificate shall attest that the MEGC has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter, the applicable provisions for gases of Chapter 4.1 and of packing instruction P200. When a series of MEGCs are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the materials of construction of the manifold, the standards to which the elements are made and an approval number. The approval number shall consist of the distinguishing sign or mark of the country granting the approval, indicated by the distinguishing sign used on vehicles in international road traffic<sup>2</sup>, and a registration number. Any alternative arrangements according to 6.7.1.2 shall be indicated on the certificate. A design approval may serve for the approval of smaller MEGCs made of materials of the same type and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

##### 6.7.5.11.2

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

- (a) The results of the applicable framework test specified in ISO 1496-3:1995;
- (b) The results of the initial inspection and test specified in 6.7.5.12.3;
- (c) The results of the impact test specified in 6.7.5.12.1; and
- (d) Certification documents verifying that the cylinders and tubes comply with the applicable standards.

#### 6.7.5.12 *Inspection and testing*

##### 6.7.5.12.1

MEGCs meeting the definition of container in the *International Convention for Safe Containers (CSC)*, 1972, as amended, shall not be used unless they are successfully qualified by subjecting a representative prototype of each design to the Dynamic, Longitudinal Impact Test prescribed in the *Manual of Tests and Criteria*, Part IV, Section 41.

##### 6.7.5.12.2

The elements and items of equipment of each MEGC shall be inspected and tested before being put into service for the first time (initial inspection and test). Thereafter, MEGCs shall be inspected at no more than five-year intervals (5 year periodic inspection). An exceptional inspection and test shall be performed, regardless of the last periodic inspection and test, when necessary according to 6.7.5.12.5.

##### 6.7.5.12.3

The initial inspection and test of an MEGC shall include a check of the design characteristics, an external examination of the MEGC and its fittings with due regard to the gases to be carried, and a pressure test performed at the test pressures according to packing instruction P200 of 4.1.4.1. The pressure test of the manifold may be performed as a hydraulic test or by using another liquid or gas with the agreement of the competent authority or its authorized body. Before the MEGC is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the elements and their fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

##### 6.7.5.12.4

The 5-year periodic inspection and test shall include an external examination of the structure, the elements and the service equipment in accordance with 6.7.5.12.6. The elements and the piping shall be tested at the periodicity specified in packing instruction P200 and in accordance with the provisions described in 6.2.1.6. When the elements and equipment have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

##### 6.7.5.12.5

An exceptional inspection and test is necessary when the MEGC shows evidence of damaged or corroded areas, leakage, or other conditions that indicate a deficiency that could affect the integrity of

<sup>2</sup> *Distinguishing sign of the State of registration used on motor vehicles and trailers in international road traffic, e.g. in accordance with the Geneva Convention on Road Traffic of 1949 or the Vienna Convention on Road Traffic of 1968.*

the MEGC. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the MEGC. It shall include at least the examinations required under 6.7.5.12.6.

#### 6.7.5.12.6

The examinations shall ensure that:

- (a) The elements are inspected externally for pitting, corrosion, abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the MEGC unsafe for carriage;
- (b) The piping, valves, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the MEGC unsafe for filling, discharge or carriage;
- (c) Missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;
- (d) All emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;
- (e) Required marks on the MEGC are legible and in accordance with the applicable requirements; and
- (f) The framework, the supports and the arrangements for lifting the MEGC are in satisfactory condition.

#### 6.7.5.12.7

The inspections and tests in 6.7.5.12.1, 6.7.5.12.3, 6.7.5.12.4 and 6.7.5.12.5 shall be performed or witnessed by a body authorized by the competent authority. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the MEGC. While under pressure, the MEGC shall be inspected for any leaks in the elements, piping or equipment.

#### 6.7.5.12.8

When evidence of any unsafe condition is discovered, the MEGC shall not be returned to service until it has been corrected and the applicable tests and verifications are passed.

#### 6.7.5.13

##### *Marking*

###### 6.7.5.13.1

Every MEGC shall be fitted with a corrosion-resistant metal plate permanently attached to the MEGC in a conspicuous place readily accessible for inspection. The metal plate shall not be affixed to the elements. The elements shall be marked in accordance with Chapter 6.2. As a minimum, at least the following information shall be marked on the plate by stamping or by any other similar method:

- (a) Owner information
  - (i) Owner's registration number;
- (b) Manufacturing information
  - (i) Country of manufacture;
  - (ii) Year of manufacture;
  - (iii) Manufacturer's name or mark;
  - (iv) Manufacturer's serial number;
- (c) Approval information

- (i) The United Nations packaging symbol .

This symbol shall not be used for any purpose other than certifying that a packaging, a flexible bulk container, a portable tank or a MEGC complies with the relevant requirements in Chapter 6.1, 6.2, 6.3, 6.5, 6.6, 6.7 or 6.11;

- (ii) Approval country;
- (iii) Authorized body for the design approval;
- (iv) Design approval number;

- (v) Letters 'AA', if the design was approved under alternative arrangements (see 6.7.1.2);
- (d) Pressures
  - (i) Test pressure (in bar gauge)<sup>3</sup>;
  - (ii) Initial pressure test date (month and year);
  - (iii) Identification mark of the initial pressure test witness;
- (e) Temperatures
  - (i) Design temperature range (in °C)<sup>3</sup>;
- (f) Elements / Capacity
  - (i) Number of elements;
  - (ii) Total water capacity (in litres)<sup>3</sup>;
- (g) Periodic inspections and tests
  - (i) Type of the most recent periodic test (5-year or exceptional);
  - (ii) Date of the most recent periodic test (month and year);
  - (iii) Identification mark of the authorized body who performed or witnessed the most recent test.

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<sup>3</sup> The unit used shall be indicated.

Figure 6.7.5.13.1: Example of a plate for marking

Owner's registration number					
<b>MANUFACTURING INFORMATION</b>					
Country of manufacture					
Year of manufacture					
Manufacturer					
Manufacturer's serial number					
<b>APPROVAL INFORMATION</b>					
	Approval country				
	Authorized body for design approval				
	Design approval number	‘AA’ (if applicable)			
<b>PRESSES</b>					
Test pressure	bar				
Initial pressure test date: (mm/yyyy)	Witness stamp:				
<b>TEMPERATURES</b>					
Design temperature range	°C to °C				
<b>ELEMENTS / CAPACITY</b>					
Number of elements					
Total water capacity	litres				
<b>PERIODIC INSPECTIONS / TESTS</b>					
Test type	Test date (mm/yyyy)	Witness stamp	Test type	Test date (mm/yyyy)	Witness stamp

6.7.5.13.2 The following information shall be durably marked on a metal plate firmly secured to the MEGC:

Name of the operator

Maximum permissible load mass \_\_\_\_\_ kg

Working pressure at 15°C: \_\_\_\_\_ bar gauge

Maximum permissible gross mass (MPGM) \_\_\_\_\_ kg

Unladen (tare) mass \_\_\_\_\_ kg

## CHAPTER 6.8

### REQUIREMENTS FOR THE CONSTRUCTION, EQUIPMENT, TYPE APPROVAL, INSPECTIONS AND TESTS, AND MARKING OF FIXED TANKS (TANK-VEHICLES), DEMOUNTABLE TANKS AND TANK-CONTAINERS AND TANK SWAP BODIES, WITH SHELLS MADE OF METALLIC MATERIALS, AND BATTERY-VEHICLES AND MULTIPLE ELEMENT GAS CONTAINERS (MEGCs)

**NOTE 1:** For portable tanks and UN multiple-element gas containers (MEGCs) see Chapter 6.7, for fibre-reinforced plastics tanks see Chapter 6.9 or Chapter 6.13, as appropriate, for vacuum operated waste tanks see Chapter 6.10.

**NOTE 2:** For fixed tanks (tank-vehicles) and demountable tanks with additive devices, see special provision 664 of Chapter 3.3.

**NOTE 3:** In this chapter, “inspection body” means a body conforming to 1.8.6.

#### 6.8.1 Scope and general provisions

- 6.8.1.1 The requirements across the whole width of the page apply both to fixed tanks (tank-vehicles), to demountable tanks and battery-vehicles, and to tank-containers, tank swap bodies and MEGCs. Those contained in a single column apply only:
- To fixed tanks (tank-vehicles), to demountable tanks and battery-vehicles (left hand column);
  - To tank-containers, tank swap bodies and MEGCs (right hand column).

6.8.1.2 These requirements shall apply to

fixed tanks (tank-vehicles), demountable tanks and | tank-containers, tank swap bodies and MEGCs  
battery-vehicles

used for the carriage of gaseous, liquid, powdery or granular substances.

6.8.1.3 Section 6.8.2 sets out the requirements applicable to fixed tanks (tank-vehicles), to demountable tanks, tank-containers, tank swap bodies intended for the carriage of substances of all classes and battery-vehicles and MEGCs for gases of Class 2. Sections 6.8.3 to 6.8.5 contain special requirements supplementing or modifying the requirements of section 6.8.2.

6.8.1.4 For provisions concerning use of these tanks, see Chapter 4.3.

#### 6.8.1.5 Conformity assessment, type approval and inspections procedures

The following provisions describe how to apply the procedures in 1.8.7.

**NOTE:** These provisions apply, subject to the compliance of the inspection bodies with the provisions of 1.8.6, and without prejudice to rights and obligations, in particular notification and recognition, fixed for them by agreements or legal acts (e.g. Directive 2010/35/EU) otherwise binding on Contracting Parties to ADR.

For the purpose of this sub-section the term “country of registration” means:

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>- the Contracting Party to ADR of registration of the vehicle on which the tank is mounted;</li> <li>- for demountable tanks, the Contracting Party to ADR where the owner's or operator's company is registered.</li> </ul> | <ul style="list-style-type: none"> <li>- the Contracting Party to ADR where the owner's or operator's company is registered;</li> <li>- if the owner's or operator's company is not known, the Contracting Party to ADR of the competent authority that approved the inspection body which performed the initial inspection. Notwithstanding 1.6.4.57 these inspection bodies shall be accredited according to EN ISO/IEC 17020:2012 (except clause 8.1.3) Type A.</li> </ul> |
|---|---|

The conformity assessment of the tank shall verify that all its components conform to the requirements of ADR, irrespective of where they have been manufactured.

#### 6.8.1.5.1

##### *Type examination according to 1.8.7.2.1*

- (a) The manufacturer of the tank shall engage a single inspection body approved or recognized by the competent authority of either the country of manufacture or the first country of registration of the first tank manufactured according to that type to take responsibility for the type examination. If the country of manufacture is not a Contracting Party to ADR, the manufacturer shall engage a single inspection body approved or recognized by the competent authority of the country of registration of the first tank manufactured according to that type to take responsibility for the type examination.

*NOTE: Until 31 December 2028, the type examination shall be performed by an inspection body approved or recognized by the country of registration.*

- (b) If the type examination of the service equipment is performed separately from the tank according to 6.8.2.3.1, the manufacturer of the service equipment shall engage single inspection body approved or recognized by a Contracting Party to ADR to take responsibility for the type examination.

#### 6.8.1.5.2

##### *Type approval certificate issue according to 1.8.7.2.2*

Only the competent authority that approved or recognized the inspection body that performed the type examination shall issue the type approval certificate.

However, when an inspection body is designated by the competent authority to issue the type approval certificate the type examination shall be performed by that inspection body.

#### 6.8.1.5.3

##### *Supervision of manufacture according to 1.8.7.3*

- (a) For the supervision of manufacture, the manufacturer of the tank shall engage a single inspection body approved or recognized either by the competent authority of the country of registration or the country of manufacture. If the country of manufacture is not a Contracting Party to ADR, a manufacturer shall engage a single inspection body approved or recognized by the competent authority of the country of registration.
- (b) If the type examination of the service equipment is performed separately from the tank, the manufacturer of the service equipment shall engage a single inspection body approved or recognized by the competent authority of a Contracting Party to ADR. The manufacturer may use an in-house inspection service according to 1.8.7.7 to perform the procedures of 1.8.7.3.

#### 6.8.1.5.4

##### *Initial inspection and tests according to 1.8.7.4*

- (a) The manufacturer of the tank shall engage a single inspection body approved or recognized by the competent authority of the country of registration or the country of manufacture to take responsibility for the initial inspection and tests. If the country of manufacture is not a Contracting Party to ADR, a manufacturer shall engage a single inspection body approved or recognized by the competent authority of the country of registration to take responsibility for the initial inspection and tests.

*NOTE: Until 31 December 2032, the initial inspection shall be performed by an inspection body approved or recognized by the country of registration.*

- (b) If the service equipment is type approved separately from the tank, the manufacturer of the service equipment shall engage the same single inspection body engaged for the purposes of 6.8.1.5.3 (b) to take responsibility for the initial inspection and tests. The manufacturer may use an in-house inspection service according to 1.8.7.7 to perform the procedures of 1.8.7.4.

#### 6.8.1.5.5

##### *Entry into service verification according to 1.8.7.5*

The competent authority of the country of first registration may require, on an occasional basis, an

The competent authority of the country of first registration may require, on an occasional basis, an entry into service verification of the

entry into service verification of the tank to verify conformity with the applicable requirements.

When the country of registration of a tank-vehicle is changed, the competent authority of the Contracting Party to ADR to which the tank-vehicle is transferred may require, on an occasional basis, an entry into service verification of the tank.

tank to verify conformity with the applicable requirements.

When the country of registration of a tank-container is changed, the competent authority of the Contracting Party to ADR to which the tank-container is transferred may require, on an occasional basis an entry into service verification.

To perform the entry into service verification, the owner or operator of the tank shall engage a single inspection body different to the inspection bodies engaged for the type examination, supervision of manufacture or initial inspection. The inspection body engaged for the entry into service verification shall be approved by the competent authority of the country of registration or, if no such inspection body exists, the inspection body shall be recognized by the competent authority of the country of registration. The entry into service verification shall consider the condition of the tank and shall ensure that the requirements of ADR are fulfilled.

#### 6.8.1.5.6

*Intermediate, periodic or exceptional inspection according to 1.8.7.6*

The intermediate or periodic or exceptional inspection shall be performed:

in the country of registration by an inspection body approved or recognized by the competent authority of that country. Exceptional inspections may alternatively be performed in the country of manufacture by an inspection body approved or recognized by the competent authority of the country of manufacture or the country of registration.

by an inspection body approved or recognized by the competent authority of the Contracting Party to ADR where the inspection takes place or by an inspection body approved or recognized by the competent authority of the country of registration.

The owner or operator of the tank, or its authorized representative, shall engage a single inspection body for each intermediate, periodic or exceptional inspection.

### 6.8.2

**Requirements applicable to all classes**

#### 6.8.2.1

*Construction*

*Basic principles*

##### 6.8.2.1.1

Shells, their attachments and their service and structural equipment shall be designed to withstand without loss of contents (other than quantities of gas escaping through any degassing vents):

- Static and dynamic stresses in normal conditions of carriage as defined in 6.8.2.1.2 and 6.8.2.1.13;
- Prescribed minimum stresses as defined in 6.8.2.1.15.

6.8.2.1.2	<p>The tanks and their fastenings shall be capable of absorbing, under the maximum permissible load, the forces exerted by:</p> <ul style="list-style-type: none"> <li>- In the direction of travel: twice the total mass;</li> <li>- At right angles to the direction of travel: the total mass;</li> <li>- Vertically upwards: the total mass;</li> <li>- Vertically downwards: twice the total mass.</li> </ul>	<p>Tank-containers<sup>1</sup> and their fastenings shall, under the maximum permissible load be capable of absorbing the forces equal to those exerted by:</p> <ul style="list-style-type: none"> <li>- In the direction of travel: twice the total mass;</li> <li>- Horizontally at right angles to the direction of travel: the total mass; (where the direction of travel is not clearly determined, twice the total mass in each direction);</li> <li>- Vertically upwards: the total mass;</li> <li>- Vertically downwards: twice the total mass.</li> </ul>
6.8.2.1.3	<p>The walls of the shells shall have at least the thickness specified in</p>	
	6.8.2.1.17 to 6.8.2.1.21	6.8.2.1.17 to 6.8.2.1.20.
6.8.2.1.4	<p>Shells shall be designed and constructed in accordance with the requirements of standards listed in 6.8.2.6 or of a technical code recognized by the competent authority, in accordance with 6.8.2.7, in which the material is chosen and the shell thickness determined taking into account maximum and minimum filling and working temperatures, but the following minimum requirements of 6.8.2.1.6 to 6.8.2.1.26 shall be met.</p>	
6.8.2.1.5	<p>Tanks intended to contain certain dangerous substances shall be provided with additional protection. This may take the form of additional thickness of the shell (increased calculation pressure) determined in the light of the dangers inherent in the substances concerned or of a protective device (see the special provisions of 6.8.4).</p>	
6.8.2.1.6	<p>Welds shall be skilfully made and shall afford the fullest safety. The execution and checking of welds shall comply with the requirements of 6.8.2.1.23.</p>	
6.8.2.1.7	<p>Measures shall be taken to protect shells against the risk of deformation as a result of a negative internal pressure. Shells, other than shells according to 6.8.2.2.6, designed to be equipped with vacuum valves shall be able to withstand, without permanent deformation, an external pressure of not less than 21 kPa (0.21 bar) above the internal pressure. Shells used for the carriage of solid substances (powdery or granular) of packing groups II or III only, which do not liquefy during carriage, may be designed for a lower external pressure but not less than 5 kPa (0.05 bar). The vacuum valves shall be set to relieve at a vacuum setting not greater than the tank's design vacuum pressure. Shells, which are not designed to be equipped with a vacuum valve shall be able to withstand, without permanent deformation an external pressure of not less than 40 kPa (0.4 bar) above the internal pressure.</p>	
	<p><i>Materials for shells</i></p>	
6.8.2.1.8	<p>Shells shall be made of suitable metallic materials which, unless other temperature ranges are prescribed in the various classes, shall be resistant to brittle fracture and to stress corrosion cracking between - 20 °C and +50 °C.</p>	
6.8.2.1.9	<p>The materials of shells or of their protective linings which are in contact with the contents shall not contain substances liable to react dangerously (see "Dangerous reaction" in 1.2.1) with the contents, to form dangerous compounds, or appreciably to weaken the material.</p> <p>If contact between the substance carried and the material used for the construction of the shell entails a progressive decrease in the shell thickness, this thickness shall be increased at manufacture by an appropriate amount. This additional thickness to allow for corrosion shall not be taken into consideration in calculating the shell thickness.</p>	

<sup>1</sup> See also 7.1.3.

6.8.2.1.10 For welded shells only materials of faultless weldability whose adequate impact strength at an ambient temperature of  $-20^{\circ}\text{C}$  can be guaranteed, particularly in the weld seams and the zones adjacent thereto, shall be used.

If fine-grained steel is used, the guaranteed value of the yield strength  $\text{Re}$  shall not exceed  $460 \text{ N/mm}^2$  and the guaranteed value of the upper limit of tensile strength  $\text{Rm}$  shall not exceed  $725 \text{ N/mm}^2$ , in accordance with the specifications of the material.

6.8.2.1.11 Ratios of  $\text{Re}/\text{Rm}$  exceeding 0.85 are not allowed for steels used in the construction of welded shells.

$\text{Re} =$  apparent yield strength for steels having a clearly-defined yield point or  
guaranteed 0.2 % proof strength for steels with no clearly-defined yield point (1 % for austenitic steels)

$\text{Rm} =$  tensile strength.

The values specified in the inspection certificate for the material shall be taken as a basis in determining this ratio in each case.

6.8.2.1.12 For steel, the elongation at fracture, in % shall be not less than

$$\frac{10\,000}{\text{determined tensile strength in N/mm}^2}$$

but in any case for fine-grained steels it shall be not less than 16 % and not less than 20 % for other steels.

For aluminium alloys the elongation at fracture shall be not less than 12 %<sup>2</sup>.

*Calculation of the shell thickness*

6.8.2.1.13 The pressure on which the shell thickness is based shall not be less than the calculation pressure, but the stresses referred to in 6.8.2.1.1 shall also be taken into account, and, if necessary, the following stresses:

In the case of vehicles in which the tank constitutes a stressed self-supporting member, the shell shall be designed to withstand the stresses thus imposed in addition to stresses from other sources.

Under these stresses, the stress at the most severely stressed point of the shell and its fastenings shall not exceed the value  $\sigma$  defined in 6.8.2.1.16.

Under each of these stresses the safety factors to be observed shall be the following:

- For metals having a clearly-defined yield point: a safety factor of 1.5 in relation to the apparent yield strength; or
- For metals with no clearly-defined yield point: a safety factor of 1.5 in relation to the guaranteed 0.2 % proof strength (1 % maximum elongation for austenitic steels).

6.8.2.1.14 The calculation pressure is in the second part of the code (see 4.3.4.1) according to Column (12) of Table A of Chapter 3.2.

When "G" appears, the following requirements shall apply:

<sup>2</sup> In the case of sheet metal the axis of the tensile test-piece shall be at right angles to the direction of rolling. The permanent elongation at fracture shall be measured on test-pieces of circular cross-section in which the gauge length  $l$  is equal to five times the diameter  $d$  ( $l = 5d$ ); if test-pieces of rectangular section are used, the gauge length shall be calculated by the formula  $l = 5,65 \sqrt{F_0}$ , where  $F_0$  indicates the initial cross-section area of the test-piece.

- (a) Gravity-discharge shells intended for the carriage of substances having a vapour pressure not exceeding 110 kPa (1.1 bar) (absolute pressure) at 50 °C shall be designed for a calculation pressure of twice the static pressure of the substance to be carried but not less than twice the static pressure of water;
- (b) Pressure-filled or pressure-discharge shells intended for the carriage of substances having a vapour pressure not exceeding 110 kPa (1.1 bar) (absolute pressure) at 50 °C shall be designed for a calculation pressure equal to 1.3 times the filling or discharge pressure;

When the numerical value of the minimum calculation pressure is given (gauge pressure) the shell shall be designed for this pressure which shall not be less than 1.3 times the filling or discharge pressure. The following minimum requirements shall apply in these cases:

- (c) Shells intended for the carriage of substances having a vapour pressure of more than 110 kPa (1.1 bar) at 50 °C and a boiling point of more than 35 °C shall, whatever their filling or discharge system, be designed for a calculation pressure of not less than 150 kPa (1.5 bar) gauge pressure or 1.3 times the filling or discharge pressure, whichever is the higher;
- (d) Shells intended for the carriage of substances having a boiling point of not more than 35 °C shall, whatever their filling or discharge system, be designed for a calculation pressure equal to 1.3 times the filling or discharge pressure but not less than 0.4 MPa (4 bar) (gauge pressure).

6.8.2.1.15 At the test pressure, the stress  $\sigma$  at the most severely stressed point of the shell shall not exceed the material-dependent limits prescribed below. Allowance shall be made for any weakening due to the welds.

6.8.2.1.16 For all metals and alloys, the stress  $\sigma$  at the test pressure shall be lower than the smaller of the values given by the following formulae:

$$\sigma \leq 0.75 \text{ Re or } \sigma \leq 0.5 \text{ Rm}$$

where

Re = apparent yield strength for steels having a clearly-defined yield point; or  
guaranteed 0.2 % proof strength for steels with no clearly-defined yield point (1 % for austenitic steels)

Rm = tensile strength.

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.

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 minimum values shall, however, not be exceeded when the formula given in 6.8.2.1.18 is applied.

*Minimum shell thickness*

6.8.2.1.17 The shell thickness shall not be less than the greater of the values determined by the following formulae:

$$e = \frac{P_T D}{2 \sigma \lambda}$$

$$e = \frac{P_C D}{2 \sigma}$$

where:

$e$	=	minimum shell thickness in mm
$P_T$	=	test pressure in MPa
$P_C$	=	calculation pressure in MPa as specified in 6.8.2.1.14 or in the table of 4.3.3.1.1
$D$	=	internal diameter of shell in mm
$\sigma$	=	permissible stress, as defined in 6.8.2.1.16, in N/mm <sup>2</sup>
$\lambda$	=	a coefficient not exceeding 1, allowing for any weakening due to welds, and linked to the inspection methods defined in 6.8.2.1.23.

The thickness shall in no case be less than that defined in

6.8.2.1.18 to 6.8.2.1.21.

6.8.2.1.18 to 6.8.2.1.20.

6.8.2.1.18	Shells of circular cross-section <sup>3</sup> not more than 1.80 m in diameter other than those referred to in 6.8.2.1.21, shall not be less than 5 mm thick if of mild steel <sup>4</sup> , or of equivalent thickness if of another metal.	Shells shall be not less than 5 mm thick if of mild steel <sup>4</sup> (in conformity with the requirements of 6.8.2.1.11 and 6.8.2.1.12) or of equivalent thickness if of another metal.
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Where the diameter is more than 1.80 m, this thickness shall be increased to 6 mm except in the case of shells intended for the carriage of powdery or granular substances, if the shell is of mild steel<sup>4</sup>, or to an equivalent thickness if of another metal.

Where the diameter is more than 1.80 m, this thickness shall be increased to 6 mm except in the case of tanks intended for the carriage of powdery or granular substances, if the shell is of mild steel<sup>4</sup> or to an equivalent thickness if of another metal.

Whatever the metal used, the shell thickness shall in no case be less than 3 mm, or 4.5 mm if the tank is an extra-large tank-container.

"Equivalent thickness" means the thickness obtained by the following formula<sup>5</sup>:

<sup>3</sup> For shells not of a circular cross-section, for example box-shaped or elliptical shells, the indicated diameters shall correspond to those calculated on the basis of a circular cross-section of the same area. For such shapes of cross-section the radius of convexity of the shell wall shall not exceed 2 000 mm at the sides or 3 000 mm at the top and bottom. However, the cross section of shells according to 6.8.2.1.14 (a) may contain recesses or protrusions such as sumps, cut-outs or recessed manhole constructions. They may be constructed of flat or shaped (concave or convex) sheet metal. Dents and other unintended deformations shall not be regarded as recesses or protrusions. See the "Guideline for the application of footnote 3 of ADR 6.8.2.1.18" on the website of the UNECE secretariat (<https://unece.org/guidelines-telematics-application-standards-construction-and-approval-vehicles-calculation-risks>).

<sup>4</sup> For the definitions of "mild steel" and "reference steel" see 1.2.1. "Mild steel" in this case also covers a steel referred to in EN material standards as "mild steel", with a minimum tensile strength between 360 N/mm<sup>2</sup> and 490 N/mm<sup>2</sup> and a minimum elongation at fracture conforming to 6.8.2.1.12.

<sup>5</sup> This formula is derived from the general formula:

$$e_1 = e_0 \sqrt[3]{\left( \frac{R_{m0} A_0}{R_{ml} A_1} \right)^2}$$

where

$e_1$	=	minimum shell thickness for the metal chosen, in mm;
$e_0$	=	minimum shell thickness for mild steel, in mm, according to 6.8.2.1.18 and 6.8.2.1.19;
$R_{m0}$	=	370 (tensile strength for reference steel, see definition 1.2.1, in N/mm <sup>2</sup> );
$A_0$	=	27 (elongation at fracture for reference steel, in %);
$R_{ml}$	=	minimum tensile strength of the metal chosen, in N/mm <sup>2</sup> ; and
$A_1$	=	minimum elongation at fracture of the metal chosen under tensile stress, in %.

$$e_1 = \frac{464e_0}{\sqrt[3]{(R_{ml}A_1)^2}}$$

6.8.2.1.19 Where protection of the tank against damage through lateral impact or overturning is provided according to 6.8.2.1.20, the competent authority may allow the aforesaid minimum thicknesses to be reduced in proportion to the protection provided; however, the said thicknesses shall not be less than 3 mm in the case of mild steel<sup>4</sup>, or than an equivalent thickness in the case of other materials, for shells not more than 1.80 m in diameter. For shells with a diameter exceeding 1.80 m the aforesaid minimum thickness shall be increased to 4 mm in the case of mild steel<sup>4</sup> and to an equivalent thickness in the case of other metals.

Equivalent thickness means the thickness given by the formula in 6.8.2.1.18.

Except in cases for which 6.8.2.1.21 provide, the thickness of shells with protection against damage in accordance with 6.8.2.1.20 (a) or (b) shall not be less than the values given in the table below.

Where protection of the tank against damage is provided according to 6.8.2.1.20, the competent authority may allow the aforesaid minimum thicknesses to be reduced in proportion to the protection provided; however, the said thicknesses shall be not less than 3 mm in the case of mild steel<sup>4</sup>, or than an equivalent thickness in the case of other materials, for shells not more than 1.80 m in diameter. For shells of a diameter exceeding 1.80 m this minimum thickness shall be increased to 4 mm in the case of mild steel<sup>4</sup>, and to an equivalent thickness in the case of other metals.

Equivalent thickness means the thickness given by the formula in 6.8.2.1.18.

The thickness of shells with protection against damage in accordance with 6.8.2.1.20 shall not be less than the values given in the table below.

	Diameter of shell	≤ 1.80 m	> 1.80 m
Minimum thickness of shells			
Austenitic stainless steels	2.5 mm	3 mm	
Austenitic-ferritic stainless steels	3 mm	3.5 mm	
Other steels	3 mm	4 mm	
Aluminium alloys	4 mm	5 mm	
Pure aluminium of 99.80 %	6 mm	8 mm	

6.8.2.1.20 For tanks built after 1 January 1990, there is protection against damage as referred to in 6.8.2.1.19 when the following measures or equivalent<sup>6</sup> measures are adopted:

- (a) For tanks intended for the carriage of powdery or granular substances, the protection against damage shall satisfy the competent authority.
- (b) For tanks intended for the carriage of other substances, there is protection against damage when:
  1. For shells with a circular or elliptical cross-section having a maximum radius of curvature of 2 m, the shell is equipped with strengthening elements comprising partitions, surge-plates or external or internal rings, so placed that at least one of the following conditions is met:

The protection referred to in 6.8.2.1.19 may consist of:

- overall external structural protection as in "sandwich" construction where the sheathing is secured to the shell; or
- a structure in which the shell is supported by a complete skeleton including longitudinal and transverse structural members; or
- double-wall construction.

Where the tanks are made with double walls, the space between being evacuated of air, the aggregate thickness of the outer metal wall and the shell wall shall correspond to the minimum wall thickness prescribed in 6.8.2.1.18, the thickness of the wall of the shell itself being not

<sup>4</sup> For the definitions of "mild steel" and "reference steel" see 1.2.1. "Mild steel" in this case also covers a steel referred to in EN material standards as "mild steel", with a minimum tensile strength between 360 N/mm<sup>2</sup> and 490 N/mm<sup>2</sup> and a minimum elongation at fracture conforming to 6.8.2.1.12.

<sup>6</sup> Equivalent measures means measures given in standards referenced in 6.8.2.6.

<ul style="list-style-type: none"> <li>- Distance between two adjacent strengthening elements of not more than 1.75 m.</li> <li>- Capacity contained between two partitions or surge-plates of not more than 7 500 l.</li> </ul> <p>The vertical cross-section of a ring, with the associated coupling, shall have a section modulus of at least 10 cm<sup>3</sup>.</p> <p>External rings shall not have projecting edges with a radius of less than 2.5 mm.</p> <p>Partitions and surge-plates shall conform to the requirements of 6.8.2.1.22.</p> <p>The thickness of the partitions and surge-plates that are used as strengthening elements shall in no case be less than that of the shell.</p> <ol style="list-style-type: none"> <li>2. For tanks made with double walls, the space between being evacuated of air, the aggregate thickness of the outer metal wall and the shell wall corresponds to the wall thickness prescribed in 6.8.2.1.18, and the thickness of the wall of the shell itself is not less than the minimum thickness prescribed in 6.8.2.1.19.</li> <li>3. For tanks made with double walls having an intermediate layer of solid materials at least 50 mm thick, the outer wall has a thickness of at least 0.5 mm of mild steel<sup>4</sup> or at least 2 mm of a plastics material reinforced with glass fibre. Solid foam (with an impact absorption capacity like that, for example, of polyurethane foam) may be used as the intermediate layer of solid material.</li> <li>4. Shells of forms other than in 1, especially box-shaped shells, are provided, all round the mid-point of their vertical height and over at least 30 % of their height with a protection designed in such a way as to offer specific resilience at least equal to that of a shell constructed in mild steel<sup>4</sup> of a thickness of 5 mm (for a shell diameter not exceeding 1.80 m) or 6 mm (for a shell diameter exceeding 1.80 m). The protection shall be applied in a durable manner to the shell.</li> </ol>	<p>less than the minimum thickness prescribed in 6.8.2.1.19.</p> <p>Where tanks are made with double walls with an intermediate layer of solid materials at least 50 mm thick, the outer wall shall have a thickness of not less than 0.5 mm if it is made of mild steel<sup>4</sup> or at least 2 mm if it is made of a plastics material reinforced with glass fibre. Solid foam with an impact absorption capacity such as that, for example, of polyurethane foam, may be used as the intermediate layer of solid material.</p>
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<sup>4</sup> For the definitions of "mild steel" and "reference steel" see 1.2.1. "Mild steel" in this case also covers a steel referred to in EN material standards as "mild steel", with a minimum tensile strength between 360 N/mm<sup>2</sup> and 490 N/mm<sup>2</sup> and a minimum elongation at fracture conforming to 6.8.2.1.12.

This requirement shall be considered to have been met without further proof of the specific resilience when the protection involves the welding of a plate of the same material as the shell to the area to be strengthened, so that the minimum wall thickness is in accordance with 6.8.2.1.18.

This protection is dependent upon the possible stresses exerted on mild steel<sup>3</sup> shells in the event of an accident, where the ends and walls have a thickness of at least 5 mm for a diameter not exceeding 1.80 m or at least 6 mm for a diameter exceeding 1.80 m. If another metal is used, the equivalent thickness shall be obtained in accordance with the formula in 6.8.2.1.18.

For demountable tanks this protection is not required when they are protected on all sides by the drop sides of the carrying vehicle.

6.8.2.1.21 The thickness of shells designed in accordance with 6.8.2.1.14 (a) which either are of not more than 5 000 litres capacity or are divided into leakproof compartments of not more than 5 000 litres unit capacity may be adjusted to a level which, unless prescribed otherwise in 6.8.3 or 6.8.4, shall however not be less than the appropriate value shown in the following table:

<u>Maximum radius of curvature of shell (m)</u>	<u>Capacity of shell or shell compartment (m<sup>3</sup>)</u>	Minimum thickness (mm)
		Mild steel
≤ 2	≤ 5.0	3
2 - 3	≤ 3.5	3
	> 3.5 but ≤ 5.0	4

Where a metal other than mild steel<sup>4</sup> is used, the thickness shall be determined by the equivalence formula given in 6.8.2.1.18 and shall not be less than the values given in the following table:

<sup>4</sup> For the definitions of "mild steel" and "reference steel" see 1.2.1. "Mild steel" in this case also covers a steel referred to in EN material standards as "mild steel", with a minimum tensile strength between 360 N/mm<sup>2</sup> and 490 N/mm<sup>2</sup> and a minimum elongation at fracture conforming to 6.8.2.1.12.

Maximum radius of curvature of shell (m)	≤ 2	2-3	2-3
Capacity of shell or shell compartment (m <sup>3</sup> )	≤ 5.0	≤ 3.5	> 3.5 but ≤ 5.0
Minimum thickness of shell			
Austenitic stainless steels	2.5 mm	2.5 mm	3 mm
Austenitic-ferritic stainless steels	3 mm	3 mm	3.5 mm
Other steels	3 mm	3 mm	4 mm
Aluminium alloys	4 mm	4 mm	5 mm
Pure aluminium at 99.80 %	6 mm	6 mm	8 mm

The thickness of the partitions and surge-plates shall in no case be less than that of the shell.

- 6.8.2.1.22 Surge-plates and partitions shall be dished, with a depth of dish of not less than 10 cm, or shall be corrugated, profiled or otherwise reinforced to give equivalent strength. The area of the surge plate shall be at least 70 % of the cross-sectional area of the tank in which the surge-plate is fitted.

*Welding and inspection of welds*

- 6.8.2.1.23 The inspection body performing inspections in accordance with 6.8.2.4.1 or 6.8.2.4.4, shall verify and confirm the ability of the manufacturer or the maintenance or repair shop to perform welding operations and the operation of a weld quality assurance system. Welding shall be performed by qualified welders using a qualified welding process whose effectiveness (including any heat treatments required) has been demonstrated by tests.

**NOTE:** When 6.8.5 is applicable, the impact-strength tests carried out for the qualifications of the welding processes shall comply with the requirements of 6.8.5.3.

The following checks shall be carried out for welds made by each welding process used by the manufacturer in accordance with the value of the coefficient  $\lambda$  used in determining the thickness of the shell in 6.8.2.1.17:

$\lambda = 0.8$ : All weld beads shall so far as possible be inspected visually on both faces and shall be subjected to non-destructive checks. The non-destructive checks shall include all weld "Tee" junctions, all inserts used to avoid welds crossing and all welds in the knuckle area of the tank ends. The total length of welds to be examined shall not be less than:

10 % of the length of all the longitudinal welds,

10 % of the length of all the circumferential welds,

10 % of the length of all the circumferential welds in the tank ends, and

10 % of the length of all the radial welds in the tank ends.

$\lambda = 0.9$ : All weld beads shall so far as possible be inspected visually on both faces and shall be subjected to non-destructive checks. The non-destructive checks shall include all connections, all inserts used to avoid welds crossing, all welds in the knuckle area of the tank ends and all welds for the assembly of large-diameter items of equipment. The total length of welds to be examined shall not be less than:

100 % of the length of all the longitudinal welds,

25 % of the length of all the circumferential welds,

25 % of the length of all the circumferential welds in the tank ends, and

25 % of the length of all the radial welds in the tank ends.

$\lambda = 1$ : All weld beads throughout their length shall be subjected to non-destructive checks and shall so far as possible be inspected visually on both faces. A weld test-piece shall be taken.

The non-destructive checks of the circumferential, longitudinal and radial welds shall be carried out by radiography or by ultrasound. Other welds allowed in the appropriate design and construction standard shall be tested using alternative methods in accordance with the relevant standard(s) referenced in 6.8.2.6.2. The checks shall confirm that the quality of the welding is appropriate to the stresses.

In the cases of either  $\lambda = 0.8$  or  $\lambda = 0.9$ , when the presence of an unacceptable defect is detected in a portion of a weld, the non-destructive checks shall be extended to a portion of equal length on both sides of the portion that contains the defect. If the non-destructive checks detect an additional defect that is unacceptable, non-destructive checks shall be extended to all remaining welds of the same type of welding process.

Welds made during repairs or alterations shall be assessed as above and in accordance with the non-destructive tests specified in the relevant standard(s) referenced in 6.8.2.6.2.

Where there are doubts regarding the quality of welds, including the welds made to repair any defects revealed by the non-destructive checks, additional checks of the welds may be required.

#### *Other construction requirements*

6.8.2.1.24 The protective lining shall be so designed that its leakproofness remains intact, whatever the deformation liable to occur in normal conditions of carriage (see 6.8.2.1.2).

6.8.2.1.25 The thermal insulation shall be so designed as not to hinder access to, or the operation of, filling and discharge devices and safety valves.

6.8.2.1.26 If shells intended for the carriage of flammable liquids having a flash-point of not more than 60 °C are fitted with non-metallic protective linings (inner layers), the shells and the protective linings shall be so designed that no danger of ignition from electrostatic charges can occur.

6.8.2.1.27	<p>Shells intended for the carriage of liquids having a flash-point of not more than 60 °C or for the carriage of flammable gases, or of UN No.1361 carbon or UN No.1361 carbon black, packing group II, shall be linked to the chassis by means of at least one good electrical connection. Any metal contact capable of causing electrochemical corrosion shall be avoided. Shells shall be provided with at least one earth fitting clearly marked with the symbol " <math>\frac{1}{2}</math> ", capable of being electrically connected.</p>	<p>All parts of a tank-container intended for the carriage of liquids having a flash-point of not more than 60 °C, flammable gases, or UN No.1361 carbon or UN No.1361 carbon black, packing group II, shall be capable of being electrically earthed. Any metal contact capable of causing electrochemical corrosion shall be avoided.</p>
6.8.2.1.28	<p><i>Protection of fittings mounted on the upper part of the tank</i></p> <p>The fittings and accessories mounted on the upper part of the tank shall be protected against damage caused by overturning. This protection may take the form of strengthening rings, protective canopies or transverse or longitudinal members so shaped that effective protection is given.</p>	
6.8.2.1.29	<p><i>(Reserved)</i></p>	
<b>6.8.2.2</b>	<p><b><i>Items of equipment</i></b></p>	
6.8.2.2.1	<p>Suitable non-metallic materials may be used to manufacture service and structural equipment. Welded elements shall be attached to the shell in such a way that tearing of the shell is prevented.</p> <p>The items of equipment shall be so arranged as to be protected against the risk of being wrenched off or damaged during carriage or handling. They shall exhibit a suitable degree of safety comparable to that of the shells themselves, and shall in particular:</p> <ul style="list-style-type: none"> <li>- Be compatible with the substances carried; and</li> <li>- Meet the requirements of 6.8.2.1.1.</li> </ul> <p>Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration.</p>	<p>As many operating parts as possible shall be served by the smallest possible number of openings in the shell. The leakproofness of the service equipment including the closure (cover) of the inspection openings shall be ensured even in the event of overturning of the tank, taking into account the forces generated by an impact (such as acceleration and dynamic pressure). Limited release of the tank contents due to a pressure peak during the impact is however allowed.</p>
		<p>The leakproofness of the service equipment shall be ensured even in the event of the overturning of the tank-container.</p>
	<p>The gaskets shall be made of a material compatible with the substance carried and shall be replaced as soon as their effectiveness is impaired, for example as a result of ageing.</p> <p>Gaskets ensuring the leakproofness of fittings requiring manipulation during normal use of tanks shall be so designed and arranged that manipulation of the fittings incorporating them does not damage them.</p>	

6.8.2.2.2 Each bottom-filling or bottom-discharge opening in tanks which are referred to, in Column (12) of Table A of Chapter 3.2, with a tank code including the letter "A" in its third part (see 4.3.4.1.1) shall be equipped with at least two mutually independent closures, mounted in series, comprising

- An external stop-valve with piping made of a malleable metal material and
- A closing device at the end of each pipe which may be a screw-threaded plug, a blank flange or an equivalent device. This closing device shall be sufficiently tight so that the substance is contained without loss. Measures shall be taken to enable the safe release of pressure in the discharge pipe before the closing device is completely removed.

Each bottom-filling or bottom-discharge opening in tanks which are referred to, in Column (12) of Table A of Chapter 3.2, with a tank code including the letter "B" in its third part (see 4.3.3.1.1 or 4.3.4.1.1) shall be equipped with at least three mutually independent closures, mounted in series, comprising

- An internal stop-valve, i.e. a stop-valve mounted inside the shell or in a welded flange or companion flange;
- An external stop-valve or an equivalent device<sup>7</sup>

one at the end of each pipe

| as near as possible to the shell

and

- A closing device at the end of each pipe which may be a screw-threaded plug, a blank flange or an equivalent device. This closing device shall be sufficiently tight so that the substance is contained without loss. Measures shall be taken to enable the safe release of pressure in the discharge pipe before the closing device is completely removed.

However, in the case of tanks intended for the carriage of certain crystallizable or highly viscous substances and shells fitted with a protective lining, the internal stop-valve may be replaced by an external stop-valve provided with additional protection.

The internal stop-valve shall be operable either from above or from below. Its setting - open or closed - shall so far as possible in each case be capable of being verified from the ground. Internal stop-valve control devices shall be so designed as to prevent any unintended opening through impact or an inadvertent act.

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

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

The position and/or direction of closure of shut-off devices shall be clearly apparent<sup>8</sup>.

All openings of tanks which are referred to in Column (12) of Table A of Chapter 3.2, by a tank code including letter "C" or "D" in its third part (see 4.3.3.1.1 and 4.3.4.1.1) shall be situated above the surface level of the liquid. These tanks shall have no pipes or pipe connections below the surface level of the liquid. The cleaning openings (fist-holes) are, however, permitted in the lower part of the shell for tanks referred to by a tank code including letter "C" in its third part. This opening shall be capable of being sealed by a flange so closed as to be leakproof and whose design shall be approved by the competent authority.

<sup>7</sup> In the case of tank-containers of less than 1 m<sup>3</sup> capacity, the external stop-valve or other equivalent device may be replaced by a blank flange.

<sup>8</sup> The mode of operation of dry break couplings is self-closing. Consequently, an open/closed indicator is not necessary. This type of closure shall only be used as a second or third closure.

6.8.2.2.3 Tanks that are not hermetically closed may be fitted with vacuum valves to avoid an unacceptable negative internal pressure; these vacuum-relief valves shall be set to relieve at a vacuum setting not greater than the vacuum pressure for which the tank has been designed (see 6.8.2.1.7). Hermetically closed tanks shall not be fitted with vacuum valves. However, tanks of the tank code SGAH, S4AH or L4BH, fitted with vacuum valves which open at a negative pressure of not less than 21 kPa (0.21 bar) shall be considered as being hermetically closed. For tanks intended for the carriage of solid substances (powdery or granular) of packing groups II or III only, which do not liquefy during transport, the negative pressure may be reduced to not less than 5 kPa (0.05 bar).

Vacuum valves and breather devices (see 6.8.2.2.6) used on tanks intended for the carriage of substances meeting the flash-point criteria of Class 3, shall prevent the immediate passage of flame into the shell by means of a suitable protective device, or the shell of the tank shall be explosion pressure shock resistant, which means being capable of withstanding without leakage, but allowing deformation, an explosion resulting from the passage of the flame.

If the protective device consists of a suitable flame trap or flame arrester, it shall be positioned as close as possible to the shell or the shell compartment. For multi-compartment tanks, each compartment shall be protected separately.

Flame arresters for breather devices shall be suitable for the vapour emitted by the substances carried (maximum experimental safety gap – MESG), temperature range and application. They shall meet the requirements and tests of EN ISO 16852:2016 (Flame arresters - Performance requirements, test methods and limits for use) for the situations given in the table below:

Application/Installation	Testing requirements
Direct communication with atmosphere	EN ISO 16852:2016, 7.3.2.1
Communication to pipe work system	EN ISO 16852:2016, 7.3.3.2 (applies to valve/flame arrester combinations when tested together)
	EN ISO 16852:2016, 7.3.3.3 (applies to flame arresters tested independently of the valves)

6.8.2.2.4 The shell or each of its compartments shall be provided with an opening large enough to permit inspection.

These openings for extra-large tank-containers intended for the carriage of substances in the liquid state which are not divided by partitions or surge plates into sections of not more than 7 500 litres capacity shall be provided with closures designed for a test pressure of at least 0.4 MPa (4 bar).

Hinged dome covers shall not be permitted for extra-large tank-containers with a test pressure of more than 0.6 MPa (6 bar).

6.8.2.2.5 *(Reserved)*

6.8.2.2.6 Tanks intended for the carriage of liquids having a vapour pressure of not more than 110 kPa (1.1 bar) (absolute) at 50 °C shall have a breather device and a safety device to prevent the contents from spilling out if the tank overturns; otherwise they shall conform to 6.8.2.2.7 or 6.8.2.2.8.

6.8.2.2.7 Tanks intended for the carriage of liquids having a vapour pressure of more than 110 kPa (1.1 bar) at 50 °C and a boiling point of more than 35 °C shall have a safety valve set at not less than 150 kPa (1.5 bar) (gauge pressure) and which shall be fully open at a pressure not exceeding the test pressure; otherwise they shall conform to 6.8.2.2.8.

6.8.2.2.8 Tanks intended for the carriage of liquids having a boiling point of not more than 35 °C shall have a safety valve set at not less than 300 kPa (3 bar) gauge pressure and which shall be fully open at a pressure not exceeding the test pressure; otherwise they shall be hermetically closed<sup>9</sup>.

6.8.2.2.9 Movable parts such as covers, closures, etc., which are liable to come into frictional or percussive contact with aluminium shells intended for the carriage of flammable liquids having a flash-point of not more than 60 °C or for the carriage of flammable gases shall not be made of unprotected corrodible steel.

6.8.2.2.10 If tanks required to be hermetically closed are equipped with safety valves, these shall be preceded by a bursting disc and the following conditions shall be observed:

Except for tanks intended for the carriage of compressed, liquefied or dissolved gases where the arrangement of the bursting disc and safety valve satisfy the requirements of 6.8.3.2.9, burst pressures of the bursting disc shall satisfy the following requirements:

- the minimum burst pressure at 20 °C, tolerances included, shall be greater than or equal to 0.8 times the test pressure;
- the maximum burst pressure at 20 °C, tolerances included, shall be less than or equal to 1.1 times the test pressure; and
- the burst pressure at the maximum service temperature shall be greater than the maximum working pressure.

A pressure gauge or another suitable indicator shall be provided in the space between the bursting disc and the safety valve, to enable detection of any rupture, perforation or leakage of the disc.

6.8.2.2.11 Level-gauges shall neither be part of, nor fitted to shells, if they incorporate transparent material which can, at any time, come into direct contact with the substance carried in the shell.

#### 6.8.2.3 *Type examination and type approval*

##### 6.8.2.3.1 *Type examination*

The provisions in 1.8.7.2.1 shall be applied.

A manufacturer of service equipment for which a standard is listed in the table in 6.8.2.6.1 or 6.8.3.6 may request a separate type examination. This separate type examination shall be taken into account during the type examination of the tank.

##### 6.8.2.3.2 *Type approval*

The competent authority shall issue in respect of each new type of tank-vehicle, demountable tank, tank-container, tank swap body, battery-vehicle or MEGC a certificate attesting that the type, including fastenings, which has been examined, is suitable for the purpose for which it is intended and meets the construction requirements of 6.8.2.1, the equipment requirements of 6.8.2.2 and the special conditions for the classes of substances carried.

The certificate shall show in addition to the items listed in 1.8.7.2.2.1:

- An approval number for the type which shall consist of the distinguishing sign used on vehicles in international road traffic<sup>10</sup> of the State in whose territory the approval was granted and a registration number;
- The tank code in accordance with 4.3.3.1.1 or 4.3.4.1.1;

<sup>9</sup> For the definition of "hermetically closed tank" see 1.2.1.

<sup>10</sup> Distinguishing sign of the State of registration used on motor vehicles and trailers in international road traffic, e.g. in accordance with the Geneva Convention on Road Traffic of 1949 or the Vienna Convention on Road Traffic of 1968.