INTERNATIONAL STANDARD

ISO 20826

First edition
2006-08-15

Automotive LPG components — Containers

Composants pour véhicules au GPL — Réservoirs

Reference number
ISO 20826:2006(E)

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Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20826 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

Automotive LPG components — Containers

1 Scope

This International Standard specifies the technical requirements for the design and the testing of automotive Liquefied Petroleum Gas (LPG) containers, to be permanently attached to a motor vehicle which uses automotive LPG as a fuel.

The technical requirements cover the design criteria, the requirements on construction and workmanship, the marking and re-qualification procedures.

This International Standard also covers all tests, including their frequencies, to be carried out on autogas containers, during production and performance verification. Specific recommendations are also given on the tests to be carried out when changing the design.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 175, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals*

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 2504, *Radiography of welds and viewing conditions for films — Utilization of recommended patterns of image quality indicators (I.Q.I.)*

ISO 2768-1:1989, *General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO 4136, *Destructive tests on welds in metallic materials — Transverse tensile test*

ISO 5173, *Destructive tests on welds in metallic materials — Bend tests*

ISO 6507-1:1997, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6721 (all parts), *Plastics — Determination of dynamic mechanical properties*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 7438, *Metallic materials — Bend test*

ISO 7799, *Metallic materials — Sheet and strip 3 mm thick or less — Reverse bend test*

ISO 9328-7, *Steel flat products for pressure purposes — Technical delivery conditions — Part 7: Stainless steels*

ISO 9606 (all parts), *Approval testing of welders – Fusion welding*

ISO 12097-2:1996, *Road vehicles — Airbag components — Part 2: Testing of airbag modules*

ISO 15614-1:2004, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 17636, *Non-destructive testing of welds — Radiographic testing of fusion-welded joints*

ASTM 3039, *Fibre-resin composite*

ASTM D2343, *Standard Test Method for Tensile Properties of Glass Fiber Strands, Yarns and Rovings Used in Reinforced Plastics*

ASTM D2344, *Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates*

ASTM D4018.81 *Carbon (tens. Prop. Continuous filament)*

EN 589, *Automotive fuels — LPG — Requirements and test methods*

EN 10120, *Steel sheet and strip for welded gas cylinders*

NOTE ASTM standards are available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19424-2959, USA.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
test pressure
pressure to which the container is subjected during the test procedure

3.2
design pressure
pressure on which the calculations are based

3.3
container
vessel with all its permanent support(s) and attachment(s) installed, used for the storage of automotive LPG

3.4
cylindrical container
container with a cylindrical shell and two dished ends, either torispherical or elliptical

3.5
metal container
container made only of any suitable metal

3.6
all-composite container
container made only of composite materials without a metallic liner

3.7
batch
maximum of 200 containers of the same type produced consecutively on the same production line

3.8
type of container
container or a group of containers where the individual container does not differ significantly with respect to the following conditions:

— the manufacturer (different trade names or marks possible);

— the shape;

— the openings;

— the material;

— the welding process (if applicable);

— the heat treatment (if applicable);

— the production line;

— the diameter;

— the height (in case of a toric container — see Annex H);

— the nominal wall thickness.

3.9
longitudinal weld
weld over the full length of the shell or cylindrical part of the shell, excluding welds for fittings

3.10
re-qualification
activities such as examining and testing of the automotive LPG containers, carried out at defined intervals

3.11
parent material
material in the state after transformation necessary for the container manufacturing process

3.12
Liquefied Petroleum Gas
LPG
mixture of light hydrocarbons, gaseous under normal atmospheric conditions which can be liquefied by increased pressure or decreased temperature, the main components of which are propane, propene, butane and butene isomers

4 Symbols and abbreviated terms

a is the calculated minimum wall thickness of the cylindrical shell in mm,

b is the calculated wall thickness of the dished ends in mm,

C is the shape factor,

c.g is the centre of gravity,

D is the nominal outside diameter of the container in mm,

F is the force in N,

g is the gravity in m/s^2,

h is the height of cylindrical part of dished end in mm,

H is the outside height of dished part of container end in mm,

H_w is the height of the wedge in mm,

L_w is the length of the edge in mm,

n is the ratio between the diameter of the mandrel of the bending test machine and the thickness of the test sample,

P_b is the maximum pressure measured in the burst test in MPa,

P_h is the design pressure in MPa,

r is the inside knuckle radius of the dished end of the standard cylindrical container in mm,

R is the inside dish radius of the dished end of a standard cylindrical container in mm,

R_e is the minimum yield stress in MPa guaranteed by the manufacturer of the container, for the parent material,

R_g is the minimum tensile strength in MPa specified by the material standard,

R_m is the actual tensile strength in MPa,

T_g is the glass transition temperature of the resin matrix, in °C,

V is the velocity in km/h,

z is the welding factor,

HV is the Vickers hardness,

PRD is the pressure relief device,

PRV is the pressure relief valve,

UV is Ultra-Violet.

5 Technical requirements

5.1 General provisions

The container for vehicles using automotive LPG in their propulsion system shall function in a correct and safe way.

Any finished container, randomly chosen, shall comply with the applicable tests as prescribed in Annex A.

All necessary corrosion prevention measures shall be taken to protect the finished container.

5.2 Dimensions

For all dimensions without indication of tolerances, general tolerances of ISO 2768-1 shall apply.

5.3 Materials

All materials compatible with LPG, may be used provided that the container complies with the applicable tests of this International Standard.

For steel, EN 10120 or EN 10028-7 may be used.

The container manufacturer shall ensure that all parent materials are free from defects.

Container parts and filler materials shall be compatible when welded.

For steel welds, ISO 15614-1 shall apply.

The container manufacturer shall maintain records of the results of metallurgical and mechanical tests and analyses of parent and filler materials as described below:

— for metal containers: chemical cast analysis certificates and mechanical properties for the metal used for the construction of the parts subject to pressure;

— for all-composite containers: results of tests as prescribed in Annex G.

The container manufacturer shall maintain a system to trace all parent materials for parts subject to pressure.

5.4 Design temperature

The minimum design temperature shall be −20 °C.

The maximum design temperature shall be +65 °C.

For extremely low operating temperature, a minimum design temperature of −40 °C shall be applied. This lower design temperature shall be indicated on the marking plate.

The manufacturer shall demonstrate that the material from which the pressure-containing parts of the container are constructed shall have properties suitable for the range of temperatures down to − 40 °C.

5.5 Design pressure

The design pressure of the container shall be 3,0 MPa.

6 Construction and workmanship

6.1 General requirements

The manufacturer shall be able to demonstrate that its quality control system ensures that the containers produced meet the requirements of this International Standard.

The manufacturer shall maintain records of the processes, procedures, inspections and qualification that are carried out during production.

It is recommended that the out-of-roundness of the cylindrical shell of the metal container is not more than the difference between the maximum and minimum outside diameter of the same cross-section and is not more than 1 % of the average of those diameters.

Unless otherwise shown on the construction drawing, it is recommended that the maximum deviation of the cylindrical part of the shell from a straight line (straightness) does not exceed 0,3 % of the length of the cylindrical part.

6.2 Heat treatment

The container manufacturer shall maintain records of the heat treatment procedures on container parts and finished containers, either completely or localized, necessary to comply with the requirements of this International Standard.

6.3 Tolerances

6.3.1 Capacity

The actual water capacity of the container, shall have a tolerance of −0 % to +3 % compared to the figure shown on the marking plate.

6.3.2 Position

The tolerance on the position of the valve boss/plate in the container shall be plus or minus 1 degree in two directions, transverse and twist (see Annex D).

6.4 Openings

Openings shall be provided for filling, off-take, pressure relief and level indication.

Openings for pressure relief valves shall be in the vapour phase, when the container is in its normal mounting position.

Openings shall be taper threaded or flanged.

Openings may also be provided for power supply, pumps, etc.

Openings for valves may be either separate or combined.

An O-ring may be fitted either in the ring or in the flange, see Figure C.4.

Internal vapour off-take pipework shall be adequately supported and shall end in the vapour space of the container as high as possible above the maximum filling level.

Internal liquid off-take pipework shall end as low as possible in the container.

6.5 Accessories

Where fitted, the marking plate shall be fixed permanently on the container shell or end. Corrosion prevention measures shall be taken.

The accessories in and on the container shall be fitted under the responsibility of the holder of the bonfire test approval certificate (see I.5).

It shall be possible to securely mount a gas-tight housing or other protective device over the container accessories.

The support(s) shall be manufactured and attached to the container body in such a way as:

— not to cause dangerous concentrations of stresses or be conducive to the collection of water;

— to be strong enough to withstand forces of at least 30 g in all directions for at least 20 ms, to be demonstrated by impact test or calculation.

7 Test programme

7.1 General

This clause specifies all tests and their frequencies during production and performance verification, applicable to automotive LPG containers.

Tests methods are described in Annex A.

NOTE Performance verification means the demonstration to the competent authorities that the finished container complies with the design, construction and workmanship requirements of this International Standard.

7.2 Test programme for metal containers

Table 1 — Overview of tests to be performed on metal containers

	Test during production	Performance verification testing	Number of containers to be tested	*Subclause*
Tensile strength test	1 per batch	X[a]	2[b]	*A.1.2*
Bend test	1 per batch	X	2[b]	*A.1.3*
Burst test		X	2	*A.2*
Pressure test	Each container	X	All containers submitted for performance verification	*A.3*
Leakage test	Each container	X	Each container	*A.4*
Hardness test		X	2[b]	*A.6*
Fatigue test		X	3	*A.7*
Bonfire test		X	1	*A.8*
Radiographic examination of welds	At least 1 per batch	X	100 % of the container under test	*A.9.2*
Macroscopic examination of welds	1 per batch	X	2[b]	*A.1.4*
Visual inspection of welds	Each container	X	Each container	*A.9.1*
Visual inspection of container parts	Each container	X	Each container	
During the performance verification testing, on one of the containers to be tested, the volume of the container and the wall thickness of each part of the container shall be determined. The number of test samples for performance verification testing shall be six; they shell be produced consecutively.				
NOTE X = test required.				
[a] Test required. [b] These test pieces can be taken from one container.				

7.3 Test programme for all-composite containers

Table 2 — Overview of tests to be performed on all-composite containers

	Test during production	Performance verification testing	Number of containers to be tested	*Subclause*
Burst test	1 per batch	X[a]	3	*A.2*
Pressure tests	Each container	X	All containers submitted for performance verification	*A.3*
Leakage test	Each container	X	Each container	*A.4*
Ambient temperature pressure cycling test		X	3	*A.5.1*
High temperature pressure cycling test		X	1	*A.5.2*
Permeation test		X	2	*A.5.3*
LPG cycling test		X	1	*A.5.4*
High temperature creep test		X	1	*A.5.5*
Bonfire test		X	1	*A.8*
Impact test		X	1	*A.10*
Drop test		X	2	*A.11*
Boss torque test		X	1	*A.12*
Acid environment test		X	1	*A.13*
Ultra-violet radiation test		X	1	*A.14*

a Test required.

7.4 Tests to be performed after design changes

If the design of a container with recognised performance verification is changed, the performance verification testing shall be limited to the tests listed in the Table 3.

Table 3 — Overview of tests to be performed after design changes

Design change	Burst test	Tensile strength test	Bend test	Ambient temperature pressure cycling test	High temperature cycling test	Fatigue	Hardness test	Permeation test	LPG cycling test	High temperature creep test	Bonfire test	Impact test	Drop test	Boss torque test	Acid environment	UV
Fibre manufacturer	X_C [a]			X_C												
Fibre material	X_C			X_C	X_C	X_C					X_C	X_C	X_C	X_C	X_C	X_C
Resin material	X_C			X_C	X_C	X_C		X_C	X_C	X_C	X_C	X_C	X_C	X_C	X_C	X_C
Metallic cylinder and/or filler material	X [b]	X	X			X	X				X					
Plastic liner material				X_C	X_C			X_C	X_C	X_C	X_C	X_C	X_C	X_C		
Nominal wall thickness	X		X	X_C	X_C	X	X	X_C	X_C	X_C	X	X_C	X_C	X_C	X_C	X_C
Diameter change $\leqslant$ [20%] for toric and cylindrical containers	X			X_C				X_C [c]			X					
Diameter change >[20%] for toric and cylindrical containers	X			X_C		X		X_C [c]			X	X_C	X_C			
Length change $\leqslant$ [50%] for cylindrical containers	X			X_C				X_C [c]			X					
Length change >[50%] for cylindrical containers	X			X_C		X		X_C [c]			X	X_C	X_C			
Height change $\leqslant$ [50%] for toric containers	X			X_C				X_C [c]			X			X_C		
Height change > [50%] for toric containers	X			X_C		X		X_C [c]			X	X_C	X_C	X_C		
Change of container shapes	X_C			X_C	X_C	X		c			X	X_C	X_C	X_C		
Dome shape	X			X_C		X					X			X_C		
Opening size	X			X_C		X					X					
Coating change											X				X	X
End boss design	X			X_C		X					X			X_C		
Change in manuf. process	X			X_C	X_C	X	X	X_C	X_C		X			X_C		

Note X = test required on all types of containers.

Note X_C = test required only for all-composite containers.

[a] X_C = test required only for all-composite containers.

[b] X = test required on all types of containers.

[c] Compliance with the permeation test requirements shall be checked by direct measure or calculation.

8 Marking

The following data shall be marked on the fitting plate or ring or marking plate:

— a serial number;

— the water capacity in litres;

— the marking “LPG”;

— hydraulic test pressure in bar: “xx bar” or MPa: “xx MPa”;

— the wording: “maximum filling: 80 %”;

— year and month of hydraulic testing (e.g. 2002/01);

— approval mark of the country of approval and reference to this International Standard, “ISO 20826:yyyy”;

— diameter (for cylindrical containers) or height (for special containers) or width x length;

NOTE 1 An example of an approval mark is shown in I.5.

— the name or trade mark of the manufacturer (if not permanently marked on the container elsewhere);

— when a pump is mounted in the container, the marking “pump inside” and a marking identifying the pump;

— when a container is designed for temperatures lower than −40 °C, the marking “−40 °C”.

The marking plate shall have enough space to accommodate the re-qualification marks.

A reference mark shall be affixed on the container to ensure its correct orientation when installed.

9 Periodic inspection and re-qualification

9.1 Periodic inspection

The container, permanently attached to a motor vehicle, shall be externally visually inspected during each periodic inspection of the vehicle, with specific attention to damage, deterioration and corrosion.

The inspection does not require removal of the container from the vehicle unless the inspection authority decides that the container needs to be externally inspected or hydraulically tested (re-qualified).

9.2 Re-qualification

9.2.1 Re-qualification criteria

Each container shall be re-qualified according to the following criteria:

— not more than 20 years after the year and month of the initial hydraulic test, unless a shorter time specified by the manufacturer;

— not more than 10 years after the previous re-qualification, unless a shorter time specified by the manufacturer;

— before re-installing a used container in a vehicle;

— after defects detected during the periodic inspection.

Containers fitted in a vehicle involved in a collision shall be visually inspected for damage by a competent person.

Containers that have been subject or exposed to fire shall be removed from further service.

9.2.2 Re-qualification procedure

The re-qualification procedure shall consist of an external visual inspection and at least one of the following test procedures:

— a hydraulic test;

— an internal visual inspection.

After each re-qualification, the accessories to the container shall be replaced by new or replacement components or officially reconditioned accessories.

The re-qualification shall be performed by a competent body, in accordance with the manufacturer's instructions related to the accessories.

The competent body shall keep records of the container re-qualifications in relation to the serial number of the container.

9.2.3 Re-qualification tests

9.2.3.1 External visual inspection

9.2.3.1.1 Test procedure

The container shall be cleaned and have all loose foreign matter removed from its external surface.

The entire surface of the container shall be inspected for damage, deterioration, corrosion and readability of the markings.

9.2.3.1.2 Interpretation

Containers showing defects shall be removed from further service.

Containers, of which the data cannot be traced, shall be removed from service.

9.2.3.2 Pressure test

The container shall be tested according to A.3.

9.2.3.3 Internal visual inspection

9.2.3.3.1 Test procedure

The containers shall be emptied of liquid and depressurized in a safe and controlled way.

At least one component fitted in or on the container shall be removed.

The container shall be inspected for any sign of corrosion or other defects.

9.2.3.3.2 Interpretation

Containers showing sign(s) of internal corrosion that may affect their integrity shall be removed from further service.

9.2.4 Re-qualification marking

After the successful completion of the re-qualification, the container shall be legibly and durably marked with the following information:

— the symbol of the competent body that has carried out the re-qualification;

— the year and month of re-qualification.

Symbols and characters shall not be less than 4 mm in height.

Annex A
(normative)

Test methods

All tests shall be performed at ambient temperature of 20 °C ± 5 °C, unless otherwise stated.

A.1 Destructive testing

A.1.1 General requirements

All tests for checking the properties of the parent material and welds, if any, of the container shall be carried out on test samples taken from finished containers.

Test samples which are not flat shall be flattened by a cold process.

In test samples containing a weld, the weld shall be machined to trim the surplus.

The number and location of the test samples for the destructive tests shall be in accordance with Annex E.

A.1.2 Tensile strength test

A.1.2.1 Tensile strength test on parent material

The tensile strength test shall be carried out in accordance with ISO 6892.

The two faces of the test samples, representing the inside and the outside walls of the container respectively, shall not be machined.

The values determined for yield stress, tensile strength and elongation during the tensile strength test of the parent material shall comply with EN 10120 or ISO 9328-7 depending on the characteristics of the material used.

A.1.2.2 Tensile strength test on welds

The tensile strength test perpendicular to the weld shall be carried out in accordance with ISO 4136. Test samples shall have the dimensions as shown on Figure F.1.

The tensile strength value obtained shall meet the minimum levels required by EN 10120 or ISO 9328-7.

A.1.2.3 Retesting for a tensile strength test

If the first test fails, a second test shall be carried out on two test samples from the same container.

If both samples pass the retest, the first test shall be ignored.

Where one or both of the retests fail, the batch shall be rejected.

A.1.3 Bend test

A.1.3.1 Test procedure

The bend test shall be carried out in accordance with ISO 5173 or ISO 7438 and ISO 7799.

All bend tests shall be carried out on the inner surface in tension and the outer surface in tension.

The bend test shall be carried out transversely to the weld on test samples, with a width of 25 mm, as shown in Figure F.2. The mandrel shall be placed in the centre of the weld.

The ratio (n) between the diameter of the mandrel and the thickness of the test sample depends on the tensile strength of the parent material and shall not exceed the values in Table A.1.

Table A.1 — Maximum value of ratio n

Actual Tensile strength R_m MPa	**value of n**
Up to 440 inclusive	2
above 440 to 520 inclusive	3
above 520 to 600 inclusive	4
above 600 to 700 inclusive	5
above 700 to 800 inclusive	6
above 800 to 900 inclusive	7
R_m > 900	8

A.1.3.2 Test interpretation

Cracks shall not appear in any of the test samples when they are bent around a mandrel, as long as the inside edges are separated by a distance not greater than the diameter of the mandrel +3*a*, as shown in Figure F.3

A.1.3.3 Retesting for the bend test

If the first test fails, a second test shall be carried out on two test samples from the same container.

If both test samples pass the test, the first test shall be ignored.

Where one or both of the retests fail, the batch shall be rejected.

A.1.4 Macroscopic examination on the cross section of a weld

The macroscopic examination on a cross section of a weld to verify the properties of the parent material and welds of the pressure containing shell of the container shall be carried out on test samples taken from finished containers. For location of test samples, see Annex E.

The macroscopic examination of a full transverse section of the weld shall show a complete fusion on the surface, and shall not show any welding fault or a significant inclusion or other defects.

In case of doubt, a microscopic examination shall be made of the suspect area.

A.2 Burst test under hydraulic pressure

A.2.1 Test conditions

The pressure shall be increased at an even rate until the container bursts and the change in pressure over time shall be recorded. The maximum flow rate during the test shall not exceed 3 % of the capacity of the container per minute.

A.2.2 Interpretation of test

The criteria adopted for the interpretation of the burst test are:

— the burst pressure; and

— examination of the tear and the shape of its edges.

A.2.3 Test acceptance conditions

The measured burst pressure P_b shall be at least 2,25 times the design pressure.

The burst test shall not cause any fragmentation of the container.

The main fracture shall not be brittle, i.e. the edges of the fracture shall not be radial but shall be at an angle to a diametrical plane and display a reduction of area throughout their thickness.

For metal containers, the fracture shall not reveal any defects in the metal. The welds shall be at least as strong as the original metal.

For all-composite containers, the fracture shall not reveal any defects in the structure.

A.2.4 Retesting for burst test

If the first test fails, a second burst test shall be carried out on two containers that have been produced successively to the first container within the same batch.

If both containers pass the retest, the first test shall be ignored.

If one or both of the retests fail, the batch shall be rejected.

A.3 Hydraulic test

A.3.1 Test procedure

A finished container, without accessories but with the openings closed, shall withstand an inner pressure equal to the design pressure without leakage or becoming permanently distorted, according to the following requirements:

— The pressure in the container shall be increased at an even rate until the final test pressure is reached.

— The final test pressure shall be maintained long enough to make it possible to verify that the pressure is not falling off and that the container is not leaking.

A.3.2 Test interpretation

The container shall not show any leakage and visible signs of permanent deformation.

A.4 Leakage test

The manufacturer shall employ such manufacturing techniques and apply such tests as will demonstrate to the satisfaction of the inspector that the containers do not leak.

A.5 Additional hydraulic tests to be performed on all-composite containers

A.5.1 Ambient temperature pressure cycling test

A.5.1.1 Test procedure

A finished container shall be pressure cycled to a maximum of 20 000 cycles, according to the following procedure:

a) fill the container to be tested with a non-corrosive fluid such as oil, inhibited water or glycol;

b) cycle the pressure in the container between not more than 0,3 MPa and not less than 3,0 MPa at a rate not to exceed 10 cycles per minute. This cycle shall be performed at least 10 000 times and continued until 20 000 times unless a leak before break appears;

The number of cycles to failure shall be recorded, along with the location and description of the failure initiation.

A.5.1.2 Test interpretation

Before reaching 10 000 cycles, the container shall not fail or leak.

After completing 10 000 cycles, the container may leak before break.

A.5.1.3 Retesting

Retesting is permitted for the ambient temperature pressure cycling test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.5.2 High temperature pressure cycling test

A.5.2.1 Test procedure

A finished container shall be cycle tested, without showing evidence of rupture, leakage or fibre unravelling, as follows:

a) Fill the container to be tested with a non-corrosive fluid such as oil, inhibited water or glycol.

b) Condition for 48 hours at 0 MPa, 65 ºC, and 95 % or greater relative humidity.

c) Hydrostatically pressurize for 3 600 cycles not exceeding 10 cycles per minute, between not more than 0,3 MPa and not less than 3,0 MPa at 65 ºC and 95 % humidity.

Following the pressure cycling test at high temperature, the container shall be submitted to a pressure test and then hydrostatically pressurized to failure in accordance with the burst test procedure.

A.5.2.2 Test interpretation

The container shall comply with the hydraulic test requirements as defined in A.3.

The container shall achieve a minimum burst pressure of 85 % of the nominal burst pressure.

A.5.2.3 Retesting

Retesting is permitted for the high temperature pressure cycling test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.5.3 Permeation test

A.5.3.1 Test procedure

All the tests shall be performed at 40 °C on a container filled with commercial propane at 80 % of its water capacity.

The test shall be held during at least 8 weeks until the steady state permeation of the structure is observed during at least 500 hours.

Then, the rate of the container mass loss shall be measured.

The loss of mass as a function of time shall be recorded in a graph.

A.5.3.2 Test interpretation

The rate of mass loss shall be less than 0,15 g/hour maximum.

A.5.3.3 Retesting

Retesting is permitted for the permeation test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored. In the event where one or both of the retests fail, the batch shall be rejected.

A.5.4 LPG cycling test

A.5.4.1 Test procedure

A container having successfully passed the permeation test shall be submitted to an ambient temperature pressure cycling test according to the requirements of A.5.1.

The container shall be sectioned and the liner/end boss interface shall be inspected.

A.5.4.2 Test interpretation

The container shall comply with the ambient temperature pressure cycling test requirements.

Inspection of the liner/end boss interface of the container shall not reveal any evidence of deterioration, such as fatigue cracking or electrostatic discharge.

A.5.4.3 Retesting

Retesting is permitted for the LPG cycling test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.5.5 High temperature creep test

A.5.5.1 General

This test shall only be performed on all-composite containers with a resin matrix having a glass transition temperature (T_G) below the maximum design temperature.

A.5.5.2 Test procedure

A finished container shall be tested as follows:

a) The container shall be pressurized to the design pressure and be held at a temperature in relation to the test duration according to Table A.2:

Table A.2 — Test temperature for the high temperature creep test

T (°C)	Exposure time (hours)
100	200
95	350
90	600
85	1000
80	1800
75	3200
70	5900
65	11000

b) The container shall be submitted to a hydraulic test.

A.5.5.3 Test interpretation

The maximum allowed volume increase is 5 %.

The container shall meet the requirements of the hydraulic test as defined in A.3 and the burst test as defined in A.2.

A.5.5.4 Retesting

Retesting is permitted for the high temperature creep test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.6 Hardness test

The hardness of the weld and the metal around the weld of a finished container shall be determined in accordance with ISO 6507-1.

For the test, the test force F shall be between 50 N and 300 N.

The Vickers hardness shall be determined on:

— the parent metal;

— the weld;

— the heat-affected zone.

The Vickers hardness shall be no more than:

— 100 HV for parent metal with carbon content less than or equal to 0,23 % and R_e less than or equal to 320 N/mm^2;

— 150 HV for parent metal with carbon content less than or equal to 0,25 % and R_e less than or equal to 320 N/mm^2.

A.7 Fatigue test

Three containers shall be subjected to the test. The containers shall be representative in respect of the minimum wall thickness according to its design and shall be marked according to the requirements shown in Clause 8.

The containers shall be filled with non-corrosive liquid and subjected to successive fluctuations of hydraulic pressure, using one of the following procedures:

Procedure 1:

— the upper test pressure shall be 2/3 of the design pressure;

— the lower test pressure shall be not more than 10 % of the upper test pressure;

— the frequency of the pressure fluctuations shall not exceed 0,25 Hz;

— the container shall be subjected to 60 000 cycles;

— the temperature on the outside surface of the container shall not exceed 50 °C during the test;

— the pressure containing parts of the container shall not burst or leak.

Procedure 2:

— the upper test pressure shall be equal to the design pressure;

— the lower test pressure shall be not more than 10 % of the upper test pressure;

— the frequency of the pressure fluctuations shall not exceed 0,25 Hz;

— the container shall be subjected to 12 000 cycles;

— the temperature on the outside surface of the container shall not exceed 50 °C during the test;

— the pressure containing parts of the container shall not burst or leak.

After the fatigue test, a burst test shall be carried out on one of the containers. The burst pressure shall be at least 1,5 times the design pressure.

A.8 Bonfire test

A.8.1 General

The bonfire test is designed to demonstrate that a container with all accessories fitted and with a fire protection system specified in the design will not burst when tested under the specified fire conditions.

The requirements of this test shall be deemed to be fulfilled for any container sharing the following characteristics with the tested container (parent container — see Table I.2):

— same type-approval owner (the holder of the trade name or mark or their duly accredited representative);

— same material;

— same shape;

— same openings;

— same or greater wall thickness;

— same or smaller diameter;

— same or smaller height;

— same or smaller external surface;

— same configuration of accessories fitted to the container (see Table I.1).

Additions, modifications and/or extensions of the accessories fitted to the container are permitted without retesting, provided the technical service, responsible for conducting the bonfire test, considers the modifications to be unlikely to have an adverse effect on the test result (see Table I.3).

A.8.2 Test procedure

Two containers, with all accessories fitted, and covered with added insulation or protective material if required by the design of the container, shall be subjected to a bonfire test.

One container shall be filled at 20 % of its volume with LPG.

One container shall be filled at 80 % of its volume with LPG.

A.8.3 Container set-up

The container shall be placed in its normal operating position with the container bottom approximately 100 mm above the fire source.

A metallic shielding shall be used to prevent direct flame impingement on container valves, fittings and/or pressure relief device. The metallic shielding shall not be in direct contact with the specified fire protection system (pressure relief device).

Any failure during the test of a valve, fitting or tubing that is not part of the intended protection system shall invalidate the result. Any failure during the test of the pressure relief device shall invalidate the result.

A.8.4 Fire source

A uniform fire source of 1,65 m shall provide direct flame impingement on the container surface across its entire diameter.

Any fuel may be used as a fire source provided it supplies sufficient uniform heat to maintain the specified test temperature until the container is vented. The selection of a fuel should take into consideration air pollution concerns. The arrangement of the fire shall be recorded in sufficient detail to ensure that the rate of heat input to the container is reproducible.

Any failure or inconsistency of the fire source during the test shall invalidate the result.

A.8.5 Temperature and pressure measurements

During the bonfire test, the following temperatures and pressure shall be measured:

— the fire temperature just below the container, at a minimum of two locations, not more than 0,75 m apart;

— the pressure inside the container.

Thermocouples may be inserted into blocks of metal measuring less than 25 mm^2. During the test, the thermocouple temperatures and the container pressure shall be recorded at intervals of 30 s or less.

A.8.6 General test requirements

Immediately after ignition, the fire shall impinge on the entire surface of the container above the fire source.

Five min after ignition, at least one thermocouple shall indicate that the temperature of the fire just below the container has reached at least 590 °C. This temperature shall be maintained for the duration of the test.

The test has ended when the pressure inside the container is equal to atmospheric pressure.

A.8.7 Acceptable results

The metal container content shall vent through the pressure relief device and the container shall not burst.

The all-composite container content shall vent through a pressure relief device and/or shall vent through the container wall and no burst shall occur.

All containers of the same family comply with the requirements of this test if the container with the largest external surface has passed the test.

A.9 Examination of welds

A.9.1 Visual inspection of welds

The manufacturer shall visually inspect all container welds.

During the inspection, the welded surface shall be well illuminated and shall be free from grease, dust and scale residue or any kind of coating.

The excess thickness of welds shall not exceed 25 % of the width of the weld (see Figure C.1).

All welds shall have an even finish without concavity and shall merge into the parent material without undercutting or abrupt irregularity.

A.9.2 Radiographic inspection of welds

A.9.2.1 Radiographic inspection procedure

Welds shall be radiographed in accordance with the requirements of this clause or ISO 17636.

When a wire-type indicator is used, the smallest diameter of the visible wire shall not exceed the value of 0,10 mm. When a stepped and holed type indicator is used, the diameter of the smallest visible hole shall not exceed 0,25 mm.

Assessment of the weld radiographs shall be based on the original films in compliance with ISO 2504.

For containers in two pieces, a radiographic inspection shall be performed on 100 mm of the circumferential butt-weld as described in Figure A.1.

Dimension in millimetres

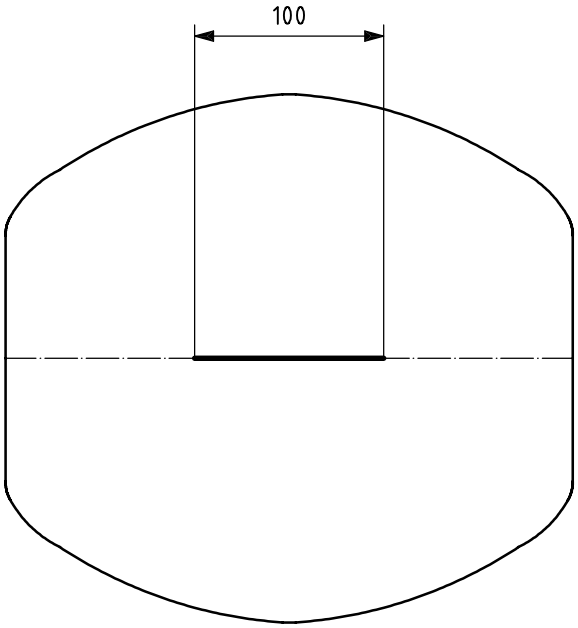


Figure A.1 — Welds radiography of container with circumferential weld only

For containers with more than two parts, a radiographic inspection shall be performed on each weld intersection, and 100 mm of the adjacent longitudinal weld. The adjacent circumferential weld of each intersection shall also be radiographed over 25 mm on each side of the intersection, in accordance with Figure A.2 below.

Dimensions in millimetres

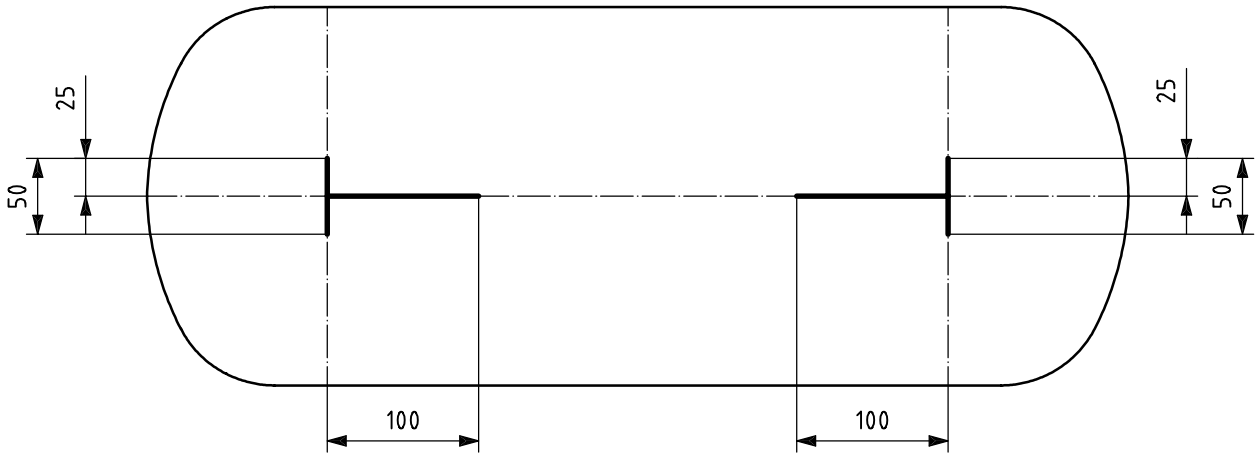


Figure A.2 — Welds radiography of a container with circumferential and longitudinal weld

A.9.2.2 Radiographic inspection frequencies

The inspections of the welds shall be performed on the first container from each shift period of a continuous production and, in the event of production being interrupted for a period of more than 16 hours, the first welded container shall be radiographed.

In addition, depending on the welding factor, the following radiographic inspection shall also be performed:

— when z = 0,85: 1 in every 200 containers for an automatic welding process;

— when z = 0,85: 1 in every 100 containers for a semi-automatic welding process;

— when z = 1: 1 in every 20 containers for an automatic welding process;

— when z = 1: 1 in every 10 containers for a semi-automatic welding process.

A.9.2.3 Test acceptance criteria

The manufacturer shall ensure that all butt welds show full penetration without any deviation of the weld seam. The fusion of the filler material with the parent material shall be smooth and free from etching.

For a container with a wall thickness greater than or equal to 4 mm, the inclusions listed below are regarded as acceptable:

— any gas inclusion measuring not more than a/4 mm;

— any gas inclusion measuring more than a/4 mm but not more than a/3 mm, which is more than 25 mm away from other gas inclusion measuring more than a/4 mm and measuring not more than a/3 mm;

— any elongated inclusion or any group of rounded inclusions in a row where the length represented, over a weld length of 12a, is not greater than 6 mm;

— gas inclusions over any 100 mm weld length where the total area of all the inclusions is not greater than 2a mm^2;

For a container with a wall thickness less than 4 mm, the inclusions listed below are regarded as acceptable:

— any gas inclusions measuring not more than a/2 mm;

— any gas inclusion measuring more than a/2 mm but not more than a/1,5 mm, which is more than 25 mm away from other gas inclusions measuring more than a/2 mm and measuring not more than a/1,5 mm;

— any elongated inclusion or any group of rounded inclusions in a row where the length represented (over a weld length of 12a) is not greater than 6 mm;

— gas inclusions over any 100 mm weld length, where the total area of all inclusions is not greater than 2a mm^2.

If these radiographic inspections reveal unacceptable defects, all necessary steps shall be taken to examine the production run in question and eliminate the defects.

A.10 Impact test

A.10.1 General

At the choice of the manufacturer, all the impact tests may be carried out on one container or each may be carried out on a different container.

A.10.2 Test procedure

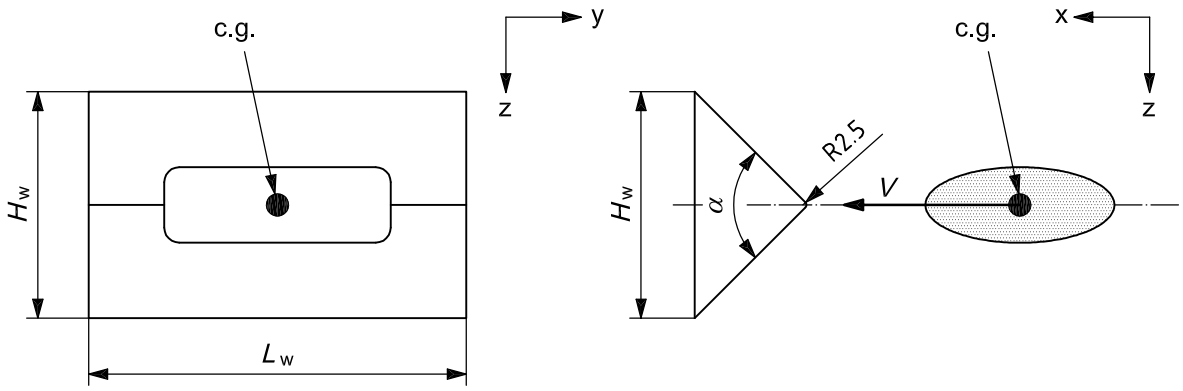
For this test, the fluid shall be a water/glycol mixture or another liquid having a low freezing point that does not change the properties of the container material.

A container filled with the fluid to the weight that equals the filling with 80 % of LPG with a reference mass of 0,568 kg/l, is projected, parallel to the length axle (x-axis in Figure A.3) of the vehicle in which it is intended to be fitted, at a velocity, V of 50 km/h, against a solid wedge, fixed horizontally, perpendicular to the movement of the container.

The centre of the wedge shall be installed in the same horizontal plane as the centre of gravity (c.g.) of the container.

The wedge shall have an angle α of 90 degrees and the point of impact shall be rounded with a maximum radius of 2,5 mm.

The length of the wedge, L_W, shall be at least equal to the width of the container in respect to its movement during the test. The height, H_W, of the wedge shall be at least 600 millimetres.



Key

c.g. centre of gravity
H_w wedge height
L_w wedge length
α wedge angle
r radius
V velocity

Figure A.3 — Set-up of the impact test procedure

In the case where a container can be installed in more than one position in the vehicle, each position shall be tested.

After this test, the container shall be submitted to a hydraulic test as defined in A.3.

A.10.3 Test interpretation

The container shall comply with the hydraulic test requirements as defined in A.3.

A.10.4 Retesting

Retesting is permitted for the impact test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.11 Drop Test

A.11.1 Test procedure

A finished container shall be drop tested at ambient temperature without internal pressurization or attached valves.

The surface onto which the containers are dropped shall be a smooth, horizontal concrete pad or flooring. The drop height shall be 2 m (measured to the lowest point of the container).

The same empty container shall be dropped:

— in a horizontal position;

— vertically on each end;

— at an angle of 45°.

Following the drop test, the container shall be submitted to an ambient temperature pressure cycling test according to the requirements of A.5.1.

A.11.2 Test interpretation

The container shall comply with the requirements of the ambient temperature pressure cycling test according to the requirements of A.5.1.

A.11.3 Retesting

Retesting is permitted for the drop test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.12 Boss torque test

A.12.1 Test procedure

The end bosses of the container shall be resistant against rotation and a torque of twice the valve or PRD installation torque specified by the manufacturer shall be applied to each end boss of the container, first in the direction to tighten a threaded connection, then in the untightening direction, and finally again in the tightening direction.

The container shall then be subjected to a hydraulic test in accordance with the requirements shown in A.3.

A.12.2 Test interpretation

The container shall comply with the requirements of the hydraulic test as shown in Clause A.3.

A.12.3 Retesting

Retesting is permitted for the boss torque test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.13 Acid environment test

A.13.1 Test procedure

A finished container shall be exposed for 100 hours to a 30 % sulphuric acid solution (battery acid with specific gravity of 1,219) while pressurized to the design pressure.

During the test, a minimum of 20 % of the total area of the container shall be covered by the sulphuric acid solution.

Then, the container shall be submitted to a burst test as defined in A.2.

A.13.2 Test interpretation

The recorded burst pressure shall be at least 85 % of the nominal container burst pressure.

A.13.3 Retesting

Retesting is permitted for the acid environment test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

A.14 Ultra-violet (UV) test

A.14.1 Test procedure

The UV exposure test shall be carried out according to the test procedure as described in 5.7 of ISO 12097-2.

If the outer layer has a load carrying function, the container shall be burst tested according to the requirements of A.2, after the UV exposure test.

A.14.2 Test interpretation

After UV exposure, no visible damage shall be observed on the outer layer.

If the outer layer has a load carrying function, the container shall comply with the burst test requirements as defined in A.2.

A.14.3 Retesting

Retesting is permitted for the ultra-violet test.

A second test shall be performed on two containers that have been produced successively to the first container within the same batch.

If the results of these tests are satisfactory, the first test shall be ignored.

In the event where one or both of the retests fail, the batch shall be rejected.

Annex B
(informative)

Example of calculations of the pressure-retaining parts of containers

B.1 Calculation of the parts under pressure for metal containers

The minimum wall thickness of the pressure-retaining parts shall be calculated using the formulas shown in B.1.1. and B.1.2 or any other recognized method (i.e. finite elements).

B.1.1 Minimum wall thickness of the cylindrical shell

The minimum wall thickness a of the cylindrical shell shall be according to the following calculation:

— Cylindrical containers without a longitudinal welds:

$$a = \frac{\mathrm{P_h} D}{1500 R_e + P_\mathrm{h}}$$

— Cylindrical containers with a longitudinal welds:

$$a = \frac{\mathrm{P_h} D}{1500 R_e z + P_\mathrm{h}}$$

where

z is 0,85 when the container manufacturer fully radiographs each weld intersection over 100 mm of the adjacent longitudinal weld, and 25 mm on each side of the intersection of the adjacent circumferential weld; and

z is 1 when the container manufacturer spot radiographs each weld intersection over 100 mm of the adjacent longitudinal weld and 25 mm on each side of the intersection of the adjacent circumferential weld (see A.9.2.1).

For the frequency of radiographic inspections of welds, taking account of the welding factor z, see A.9.2.2.

B.1.2 Minimum wall thickness of the container ends

Container ends shall be in one piece, concave to the pressure, and shall be either torispherical or semi-ellipsoidal (see examples of container ends in Figure B.3).

The wall thickness b of the ends after forming shall be:

$$b = \frac{P_\mathrm{h} D}{1500 R_\mathrm{e}} C$$

The shape factor C shall be obtained from Table B.1, Figure B.1 or Figure B.2.

The difference between the wall thickness of the cylindrical edge of the ends and the shell shall be 15 % or less of the smallest wall thickness.

The dimensions of the container ends shall fulfil the following conditions:

— Torispherical ends:

$r \geqslant 0{,}1\ D$,

$R \leqslant D$,

$r \geqslant 2\ b$,

$h \geqslant 4\ b$,

$H \geqslant 0{,}18\ D$,

$H = (R + b) - \sqrt{\left[(R + b) - D/2\right] \times \left[(R + b) + D/2 - 2(r + b)\right]}$,

$0{,}003\ D \leqslant b \leqslant 0{,}080\ D$,

$h \leqslant 0{,}15\ D$.

— Semi-ellipsoidal ends:

$H \geqslant 0{,}1\ D$,

$h \geqslant 4\ b$,

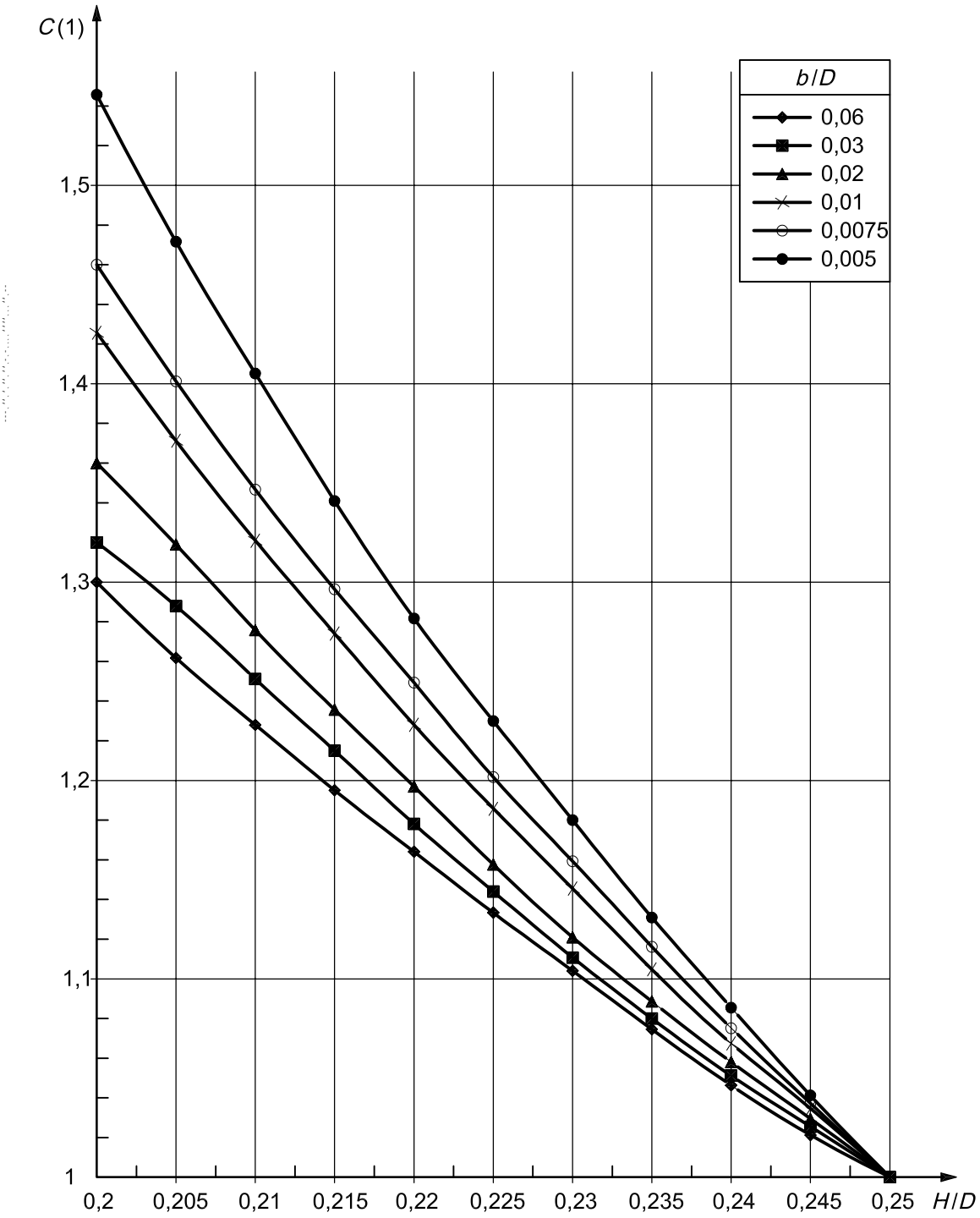
$0{,}003\ D \leqslant b \leqslant 0{,}080\ D$,

$h \leqslant 0{,}15\ D$.

B.1.3 Determination of the shape factor C

Table B.1 — Relationship between H/D and Shape factor C

H/D	C	H/D	C
0,25	1,000	0,38	0,612
0,26	0,931	0,39	0,604
0,27	0,885	0,40	0,596
0,28	0,845	0,41	0,588
0,29	0,809	0,42	0,581
0,30	0,775	0,43	0,576
0,31	0,743	0,44	0,572
0,32	0,714	0,45	0,570
0,33	0,687	0,46	0,568
0,34	0,667	0,47	0,566
0,35	0,649	0,48	0,565
0,36	0,633	0,49	0,564
0,37	0,621	0,50	0,564
NOTE Intermediate values can be obtained by linear interpolation.			

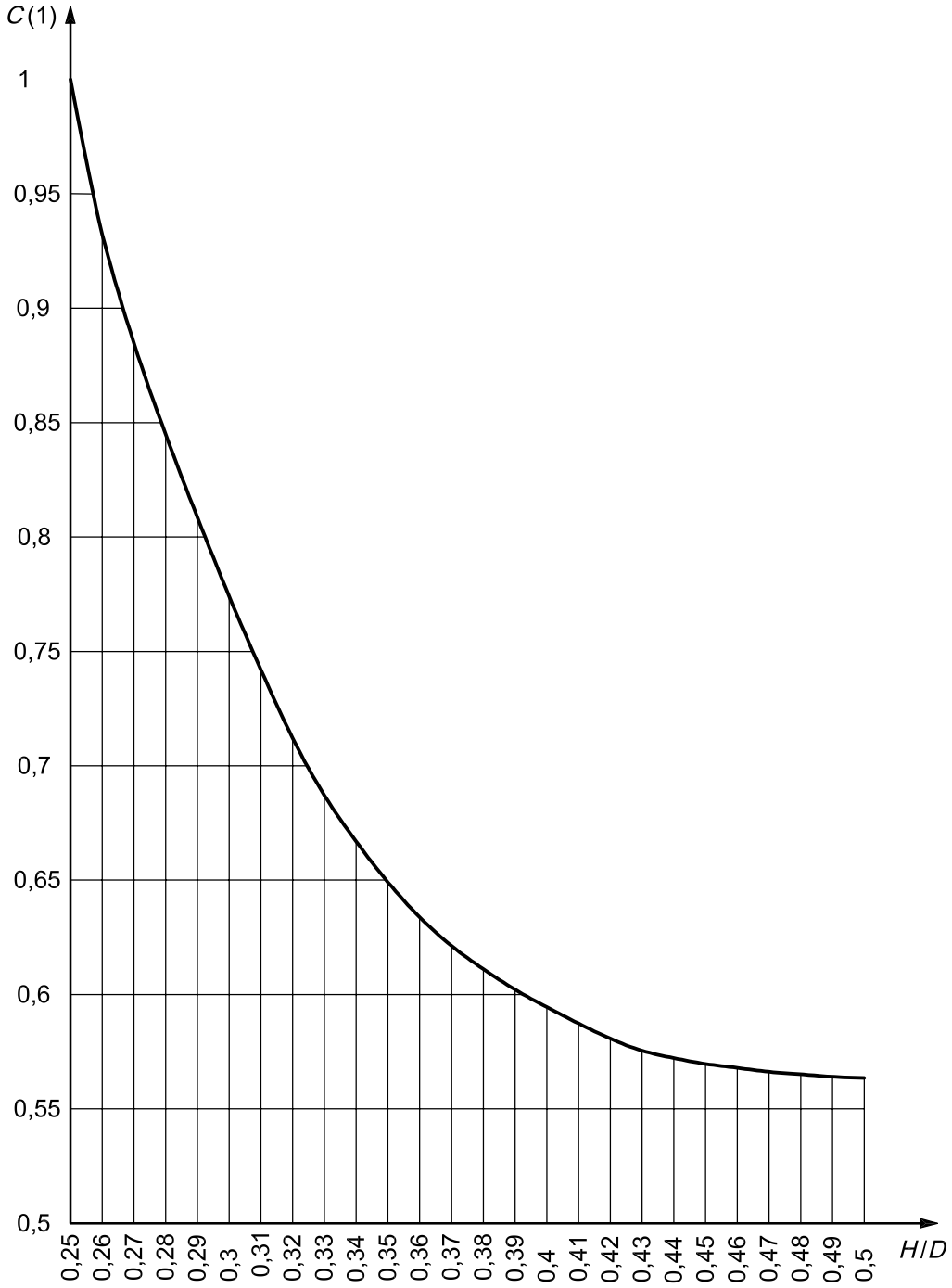


Key

1 shape factor

NOTE For symbols, see Clause 4.

Figure B.1 — Values of shape factor C for H/D between 0,20 and 0,25



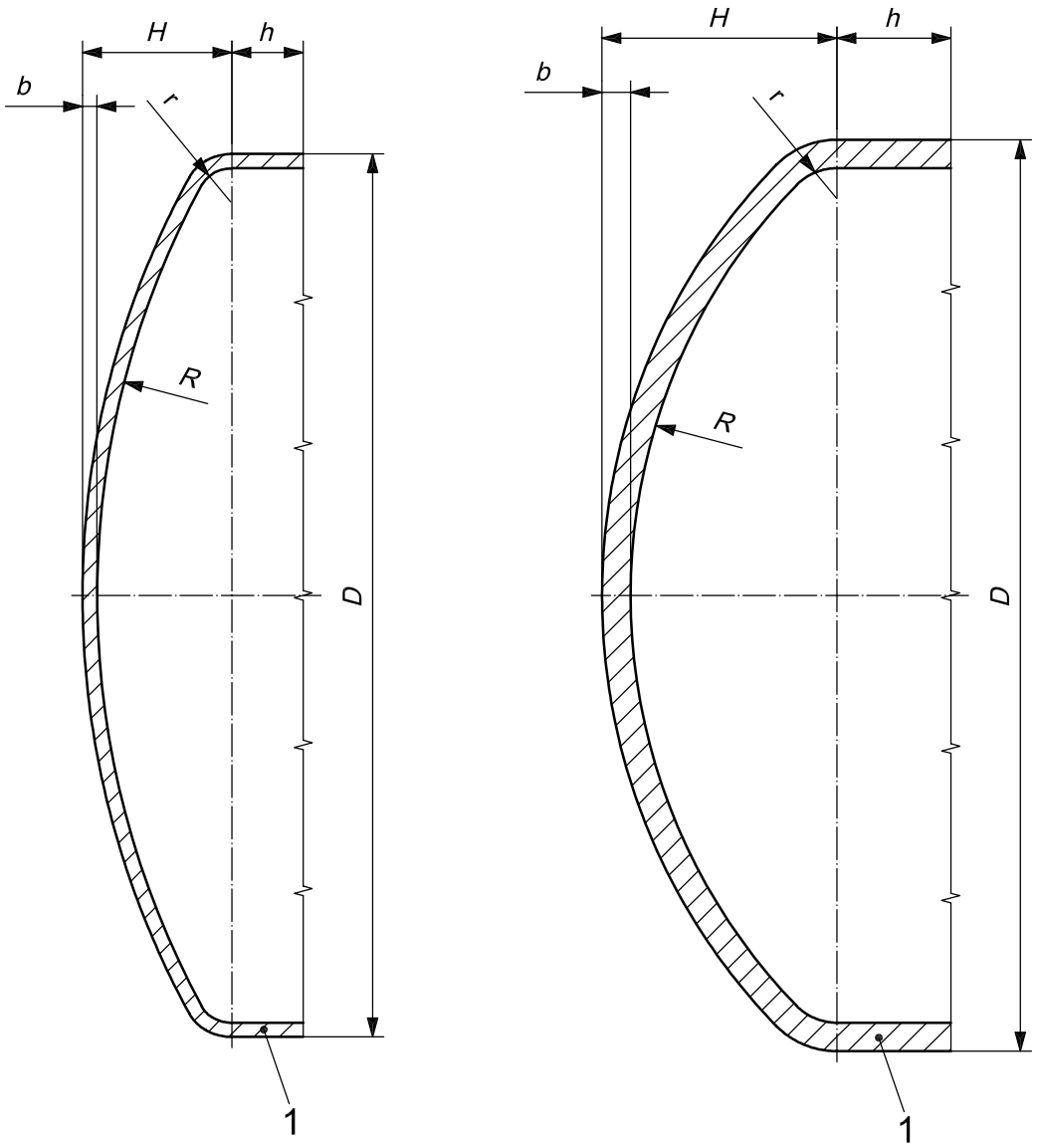
Key

1 shape factor

NOTE For symbols, see Clause 4.

Figure B.2 — Values of shape factor for H/D between 0,25 and 0,50

B.1.4 Examples of container ends for metal containers



Key

1 torispherical

2 semi-ellipsoidal

NOTE 1 For symbols, see Clause 4.

NOTE 2 See B.1 for calculation of dimensions.

Figure B.3 — Examples of container ends for metal containers

B.2 Calculation of the parts under pressure for all-composite containers

The stresses in the container shall be calculated for each container type.

The pressures used for these calculations shall be the design pressure and burst test pressure.

The calculations shall use suitable analysis techniques to establish stress distribution throughout the container.

Annex C
(informative)

Welding guidelines

C.1 Welding qualifications

The manufacturer shall qualify the welding procedures and welders according to ISO 15614-1 and ISO 9606 respectively.

C.2 Welding guidelines

Butt welds shall not be located in any areas where there are changes of profile.

Angle (fillet) welds shall be at least 10 mm away from butt welds.

Welded attachment points in the area of the small radius r of ends are permitted if the container fulfils the requirements of the burst test.

Welded mounting supports shall be welded circumferentially.

Container welds shall satisfy the following:

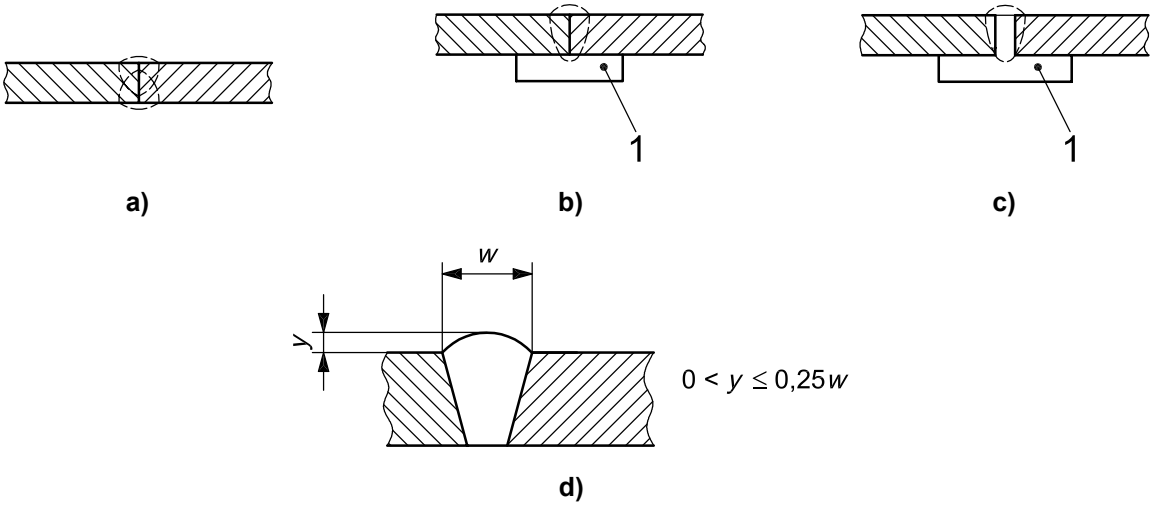
— a longitudinal weld shall be in the form of a butt weld on the full section of the wall (see Figure C.1);

— a weld attaching the valve boss/plate or ring to the container shall be in accordance with Figure C.3 and the Figure C.4;

— a weld attaching a collar or support to the container shall be either a butt or an angle weld;

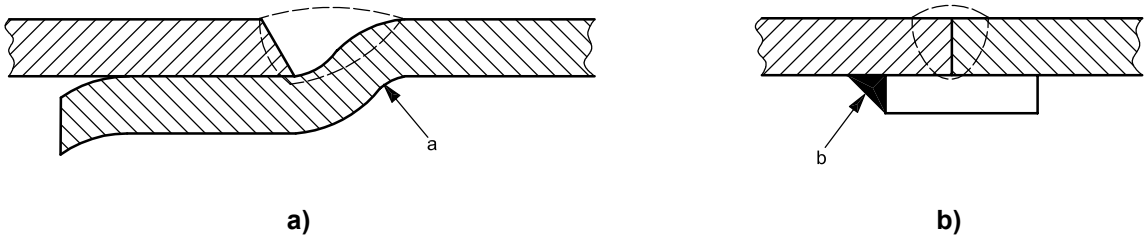
— misalignment of the joint-faces of a butt weld shall not exceed 20 % of the wall thickness;

— a circumferential weld shall be in the form of a butt weld on the full section of the wall (see Figure C.2).



1 removable backing strip (usually copper)

Figure C.1 — Types of main longitudinal butt welds



Key

a Avoid notch here.

b Angle weld.

NOTE 1 The angle weld can be performed as a “Spot weld”.

NOTE 2 A joggle weld is considered to be a special type of butt weld.

Figure C.2 — Circumferential butt weld

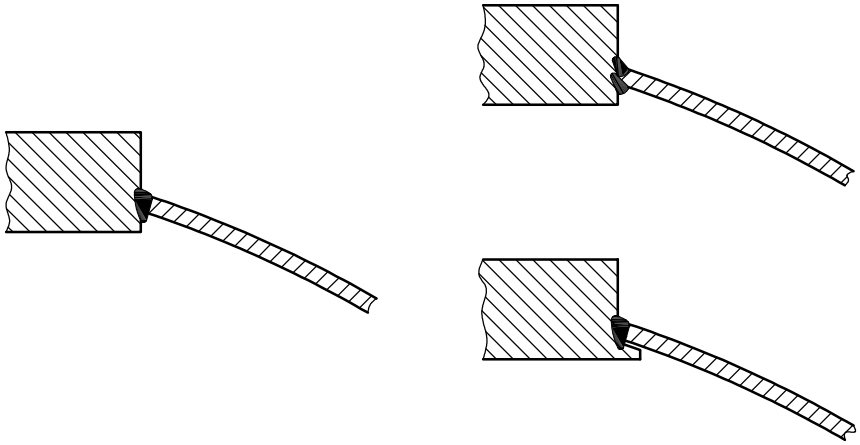
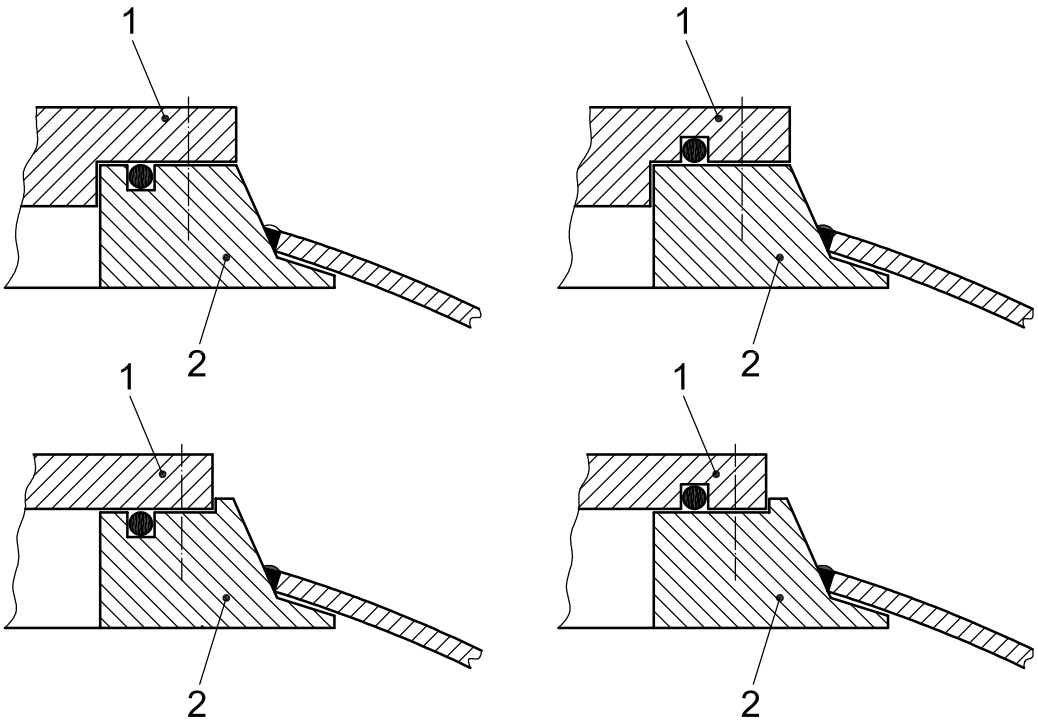


Figure C.3 — Examples of welded studded plates



Key

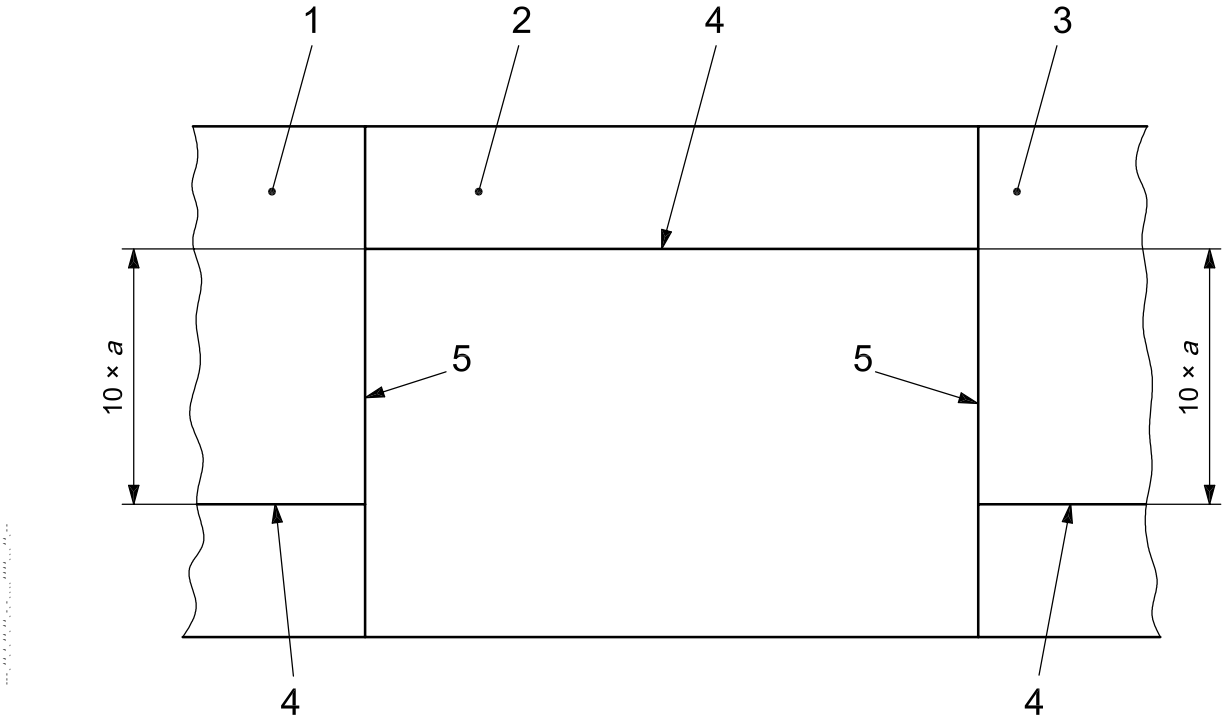
1 flange

2 ring

Figure C.4 — Examples of welded rings with flange

C.3 Shift rotating of welds

When the cylindrical part of the container is made of two or more parts, the longitudinal welds shall not be aligned and the distance between the welds shall be at least 10 times the wall thickness of the container (see Figure C.5).



Key

1 container shell part 1
2 container shell part 2
3 container shell part 3
4 longitudinal weld
5 circumferential weld

Figure C.5 — Shift rotating of welds

C.4 Weld repair

Welding imperfections shall be removed and the weld shall be repaired in accordance with an appropriate procedure. Any section repaired by welding shall be re-inspected visually and the container shall be subjected to a hydraulic test. An unacceptable imperfection found by radiography shall be re-radiographed after repair.

Internal vapour off-take pipework shall be adequately supported and shall end in the vapour space of the container as high as possible above the maximum filling level. Internal liquid off-take pipework shall end as low as possible in the container.

Annex D
(normative)

Tolerance on position of plate or ring

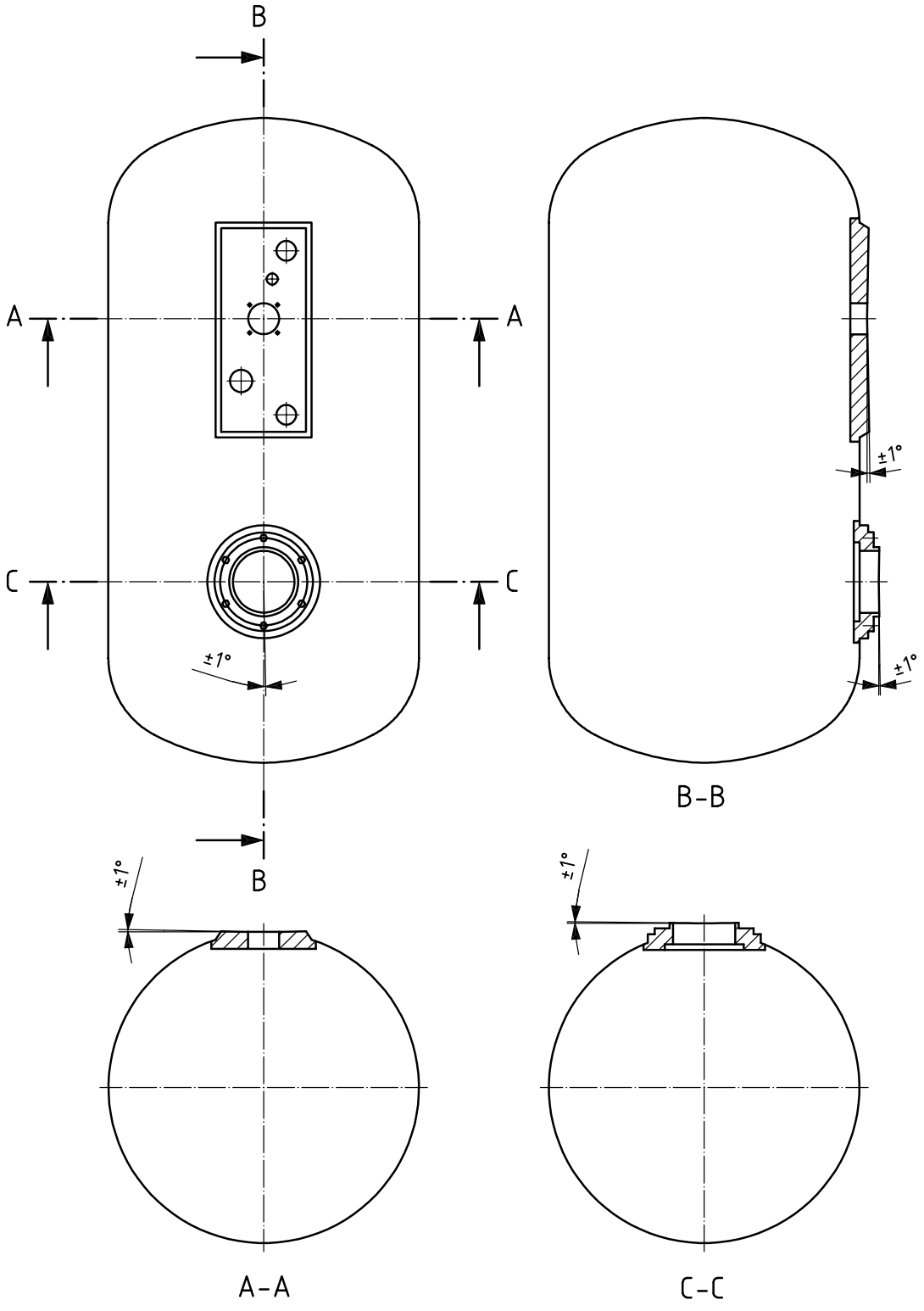
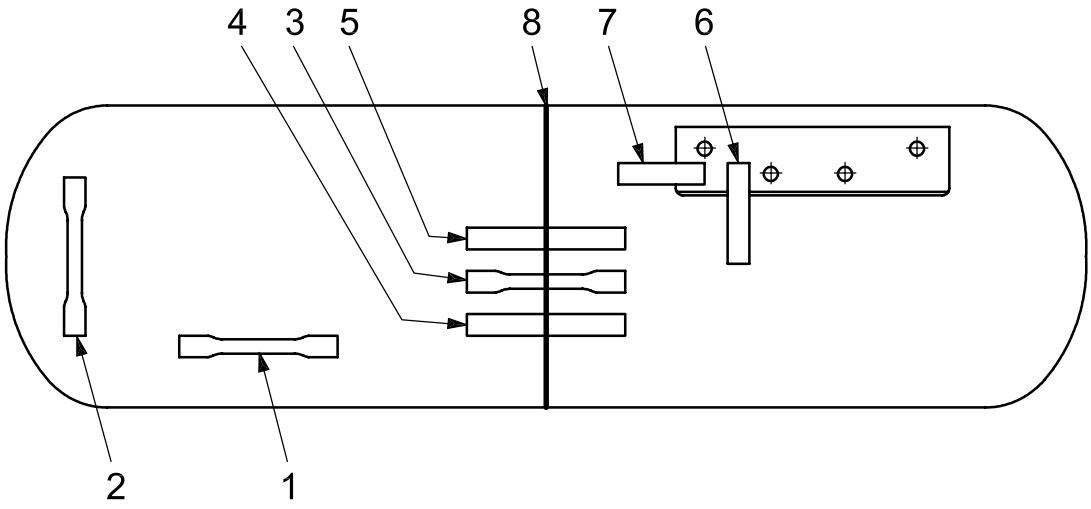


Figure D.1 — Tolerance on position of plate or ring

Annex E
(normative)

Location of test samples for metal containers

E.1 Location of test samples from a 2-section container

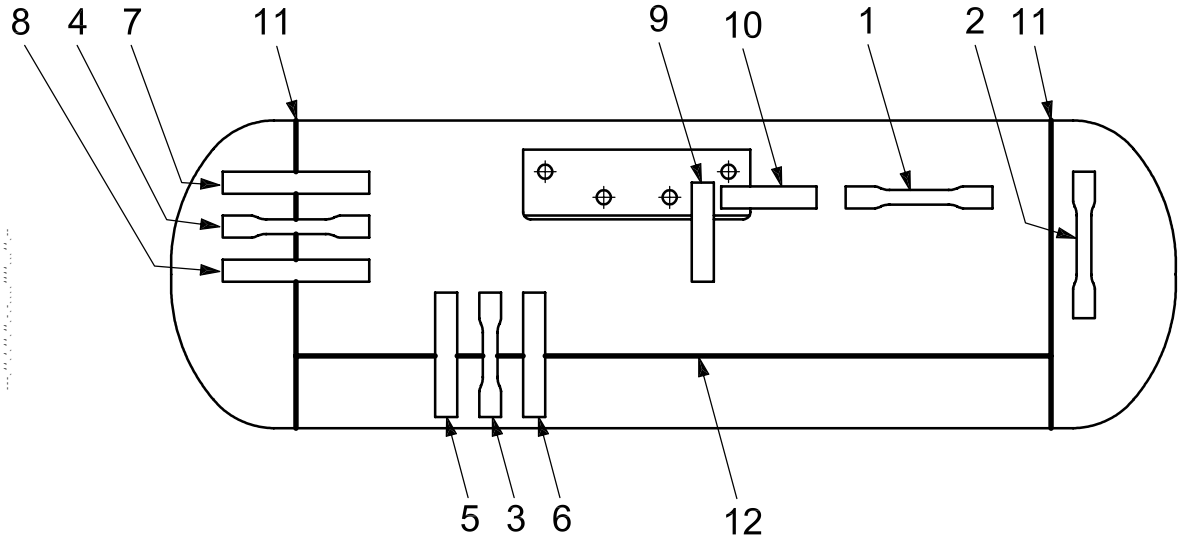


Key

1, 2 tensile strength test on parent material
3 tensile strength test on a circumferential weld
4 bend test on a circumferential weld, the inner surface in tension
5 bend test on a circumferential weld, the outer surface in tension
6,7 macrosections through valve boss/plate welds (side-mounted valve block — see Figure E.3)
8 circumferential weld

Figure E.1 — Containers with circumferential welds only and side-mounted valve blocks, location of test-samples

E.2 Location of test samples from a 3-section container

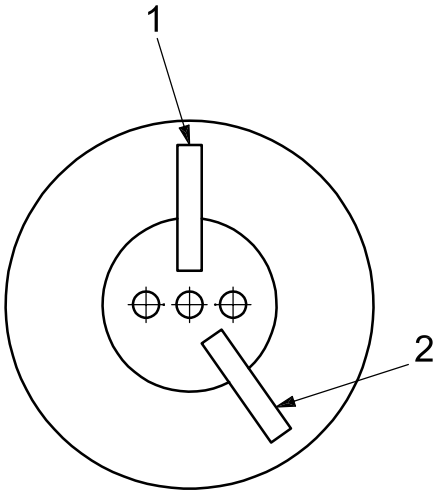


Key

1 tensile strength test on parent material
2 tensile strength test on parent material of the bottom
3 tensile strength test on a longitudinal weld
4 tensile strength test on a circumferential weld
5 bend test on a longitudinal weld, the inner surface in tension
6 bend test on a longitudinal weld, the outer surface in tension
7 bend test on a circumferential weld, the inner surface in tension
8 bend test on a circumferential weld, the outer surface in tension
9,10 macrosections through valve boss/plate welds (side-mounted valve block — see Figure E.3).
11 circumferential weld
12 longitudinal weld

Figure E.2 — Containers with longitudinal and circumferential welds, location of test-samples

E.3 Location of macrosections for valve boss/plate welds



Key

1,2 macrosections through valve boss/plate welds in the case of a side-mounted valve boss/plate

Figure E.3 — Containers with circumferential welds only and valve boss/plate fitted in the container end

Annex F
(normative)

Test sample for mechanical tests on metal containers

Dimensions in millimetres

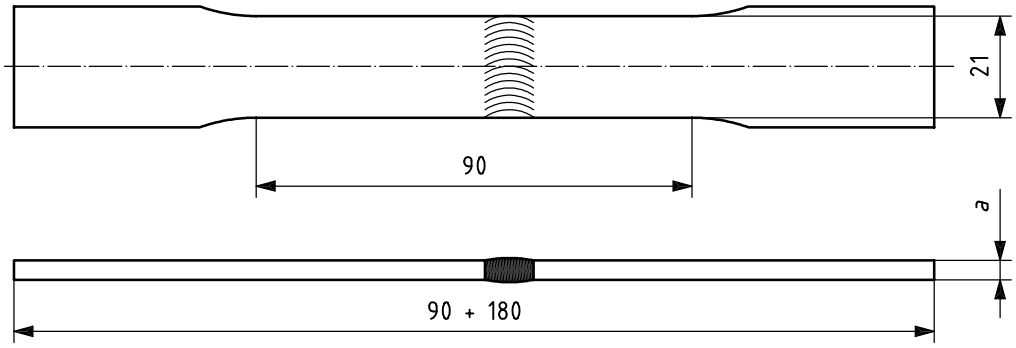


Figure F.1 — Test sample for tensile test perpendicular to the weld

Dimensions in millimetres

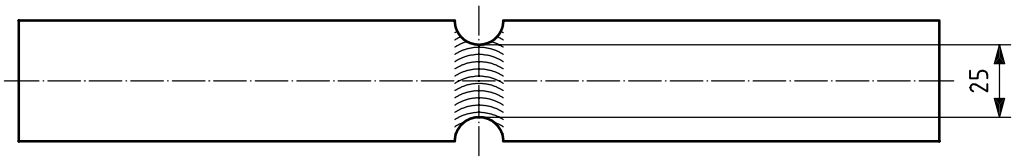
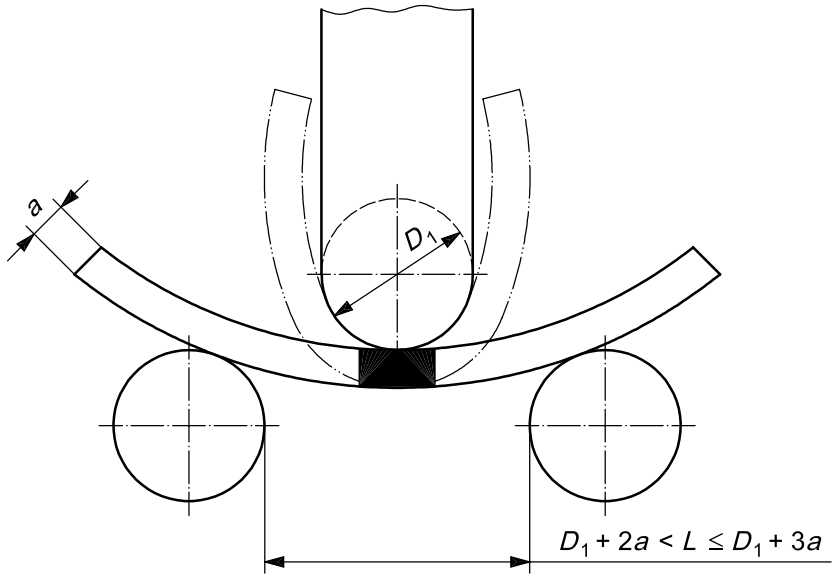


Figure F.2 — Nick break/bend test sample



NOTE For symbols, see Clause 4.

Figure F.3 — Illustration of bend test

Annex G
(normative)

Material test methods for all-composite containers

G.1 Chemical resistance

Materials used in an all-composite container shall be tested according to ISO 175 for 72 hours at room temperature.

Demonstrating the chemical resistance using data from literature is also allowed.

The material shall be compatible with the following chemical agents:

— brake fluid;

— window cleaner;

— cooling liquid;

— non-leaded petrol,

— solution of deionized water, sodium chloride 2,5 % by weight ± 0,1 %, calcium chloride 2,5 % by weight ± 0,1% and sulphuric acid sufficient to achieve a solution of pH 4,0 ± 0,2.

Test acceptance criteria:

a) Elongation: after exposure, shall be at least 85 % of the initial elongation. The elongation of an elastomer, after exposure, shall be at least equivalent to the initial elongation.

b) For structural components (e.g. fibres): the residual strength for a structural component after testing shall be at least 80 % of the original tensile strength.

c) Non-structural components (e.g. coating): there are no visual cracks allowed.

G.2 Composite structure

a) Fibres embedded in a matrix:

— Tensile properties:

— ASTM 3039 — Fibre-resin composites;

— ASTM D2343 — Glass, Aramid (tensile properties, yarns, glass);

— ASTM D4018.81 — Carbon (tensile properties continuous filament) with special remark for the matrix;

— Shear properties:

— ASTM D2344 — (Interlaminar shear strength of parallel fibre composite by short beam method);

b) Dry fibres on an isotensoid shape

— Tensile properties: ASTM D4018.81 — Carbon (continuous filament), other fibres.

G.3 Protective coating

UV-radiation degrades polymeric material when directly subjected to sunlight. Depending on the installation, the manufacturer shall proof a “safe life” for the coating.

G.4 Thermoplastic components

The Vicat softening temperature of a thermoplastic component as defined in ISO 306, shall be above 70 ºC. For structural components, the Vicat softening temperature shall be at least 75 ºC.

G.5 Thermoset components

The Vicat softening temperature of a thermo-set component shall be above 70 ºC.

G.6 Elastomeric components

The glass transition temperature (Tg) of an elastomer component shall be lower than −40ºC. The glass transition temperature shall be tested according ISO 6721.

The Tg-onset is derived from the plotted diagram storage modulus versus temperature by determining the temperature, where the two tangents, which are representing the slopes of the diagram before and after the dramatic loss of stiffness, intersect.

Annex H
(informative)

Example of toric containers

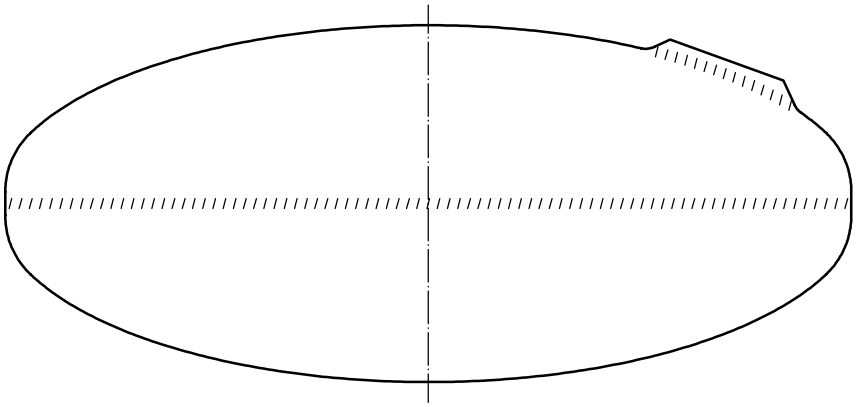


Figure H.1 — Example of an elliptical container

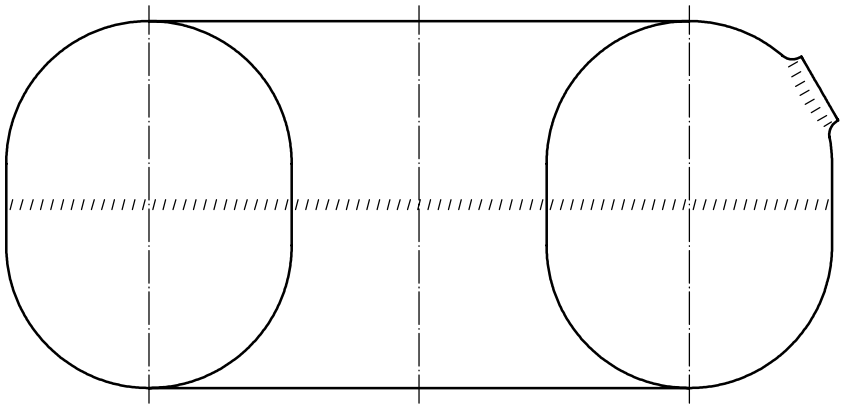


Figure H.2 — Example of a toroidal container

Annex I
(informative)

Example of requirements for performance verification

I.1 Example of application for performance verification

The application for performance verification of a container type shall be submitted by the holder of the trade name or mark or by their duly accredited representative.

It shall be accompanied by the following documents in triplicate:

— a detailed description of the type of the container (see I.6);

— a drawing of the container, sufficiently detailed and on an appropriate scale;

— verification of compliance with this International Standard;

The referred documents are the following:

- container design calculation;
- detailed description of the manufacturing of the container;
- reports of tests that have been carried out on the container;
- qualification documents of the welding procedures according to ISO 15614-1;
- documents of the qualification of the welders according to ISO 9606;
- heat treatment documents or graphics of parts of the container or the whole container, in case the parts of the container are deformed by more than 5 %.

At the request of the technical service responsible for conducting approval tests, samples of the container shall be provided. Supplementary samples shall be supplied upon request.

I.2 Modification of a container type and extension of approval

Every modification of a container type shall be notified to the administrative department, which granted the type approval.

The department may then either:

— consider that the modifications made are unlikely to have an appreciable adverse effect and that the container still complies with the requirements, or

— consider whether retesting will be partial or complete.

I.3 Conformity of production

The conformity of container production is checked according to the following requirements:

— The container shall be manufactured according to the requirements of this International Standard.

— Suitable controls of production shall be carried out.

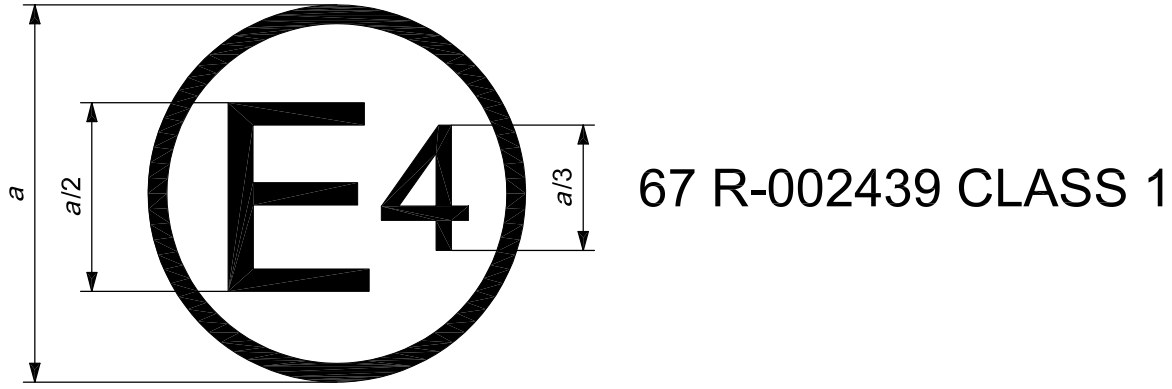
— The minimum requirements for conformity of production control tests are described in Clause 7 (see Table 1 for metal containers and Table 2 for all-composite containers).

— The authority that has granted the type approval may at any time verify the conformity of the control methods applied in each production facility; the minimum frequency of these verifications shall be once a year.

I.4 Production definitely discontinued

If the holder of the approval completely ceases the manufacturing of an approved container type in accordance with this International Standard, it shall inform the authority that granted the approval.

I.5 Example of a type approval mark according to UN/ECE Regulation 67



a diameter of circle $\geqslant$ 5 mm

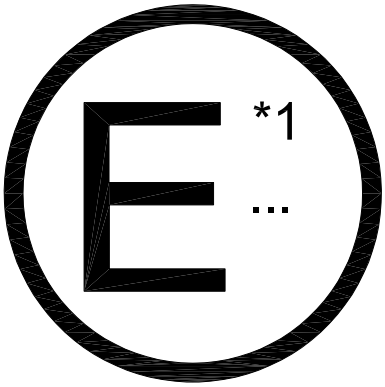
NOTE 1 The above approval mark affixed to a container shows that the container has been approved in the Netherlands pursuant to Regulation No. 67 under approval number 002439.

NOTE 2 The numeral 4 in the circle is the international country number for the Netherlands. For other international country numbers, see I.7.

NOTE 3 002439 is an example of an approval number issued to the manufacturer by the competent authority.

Figure I.1 — Example of a type approval mark according to UN/ECE Regulation 67

I.6 Example of a communication form according to UN/ECE Regulation 67



(maximum format: A4 (210 x 297 mm))

issued by: Name of administration:

……

……

……

Figure I.2 — Example of a communication form according to UN/ECE Regulation 67

Concerning: (*2) APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED
of a type of LPG equipment
Approval No.: …….. Extension No.: ……..

1. LPG equipment considered (*2):
   Container including all the accessories fitted to the container (see Table I.1):.....
   - 80 % stop valve
   - level indicator
   - pressure relief valve
   - pressure relief device
   - remotely controlled service valve with excess flow valve
   - multi-valve, including the following accessories:.....
     - gas-tight housing
     - power supply bushing (pump/actuators)
     - fuel pump
     - pressure/temperature sensor
     - filling unit
   - Shut-off valve
   - Non-return valve
2. Trade name or mark:
3. Manufacturer's name and address:
4. If applicable, name and address of manufacturer's representative:
5. Submitted for approval on:
6. Technical service responsible for conducting approval test:
7. Date of report issued by that service:
8. No. of report issued by that service:
9. Approval granted/refused/extended/withdrawn (*2)
10. Reason(s) of extension (if applicable):
11. Place:
12. Date:
13. Signature:
14. The documents filed with the application or extension of approval can be obtained upon request.

Container characteristics of the parent container (configuration 00):

a) manufacturer:

b) shape:

c) material:

d) openings:

e) wall thickness: mm

f) diameter: mm

g) height: mm

h) external surface: cm^2

i) configuration of accessories fitted to the container (see Table I.1).

Table I.1 — Control numbering of the components fitted in or on the container

No.	Item	Type	Approval No.	Extension No.
a	80 % stop valve			
b	Level indicator			
c	Pressure Relief Valve (PRV)			
d	Remotely controlled service valve with excess valve			
e	Fuel pump			
f	Multivalve			
g	Gas-tight housing			
h	Power supply bushing			
i	Non return valve			
j	Pressure relief device (PRD)			

List of containers sharing the characteristics of the parent container:

The lists of containers sharing the characteristics of the parent container indicate the diameter/height, wall thickness, external surface and the possible configuration(s) of the accessories fitted to the container.

Table I.2 — List of characteristics of the parent container

No.	Type	Diameter/height mm	Wall thickness mm	External surface cm^2	Configuration of accessories [codes] [1)]

[1] Code 00 and, if applicable, same code(s) from Table I.3

Lists of the permitted configurations of accessories fitted to the container:

Specify a list of the possible accessories, which differ from the tested configuration of accessories (code 00) and which may be fitted to the containers. Specify for all accessories, type, approval number and extension number, sharing the characteristics of the parent container.

Table I.3 — List of the permitted configurations of accessories fitted to the container

No.	Accessories	Type	Approval No.	Extension No.	Configuration of accessories [code]
a					
b					
c					
d					

(*1) Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the regulation).

(*2) Strike out what does not apply.

I.7 International country numbers in accordance with UN/ECE Regulation 67

Country number	Country
1	Germany
2	France
3	Italy
4	The Netherlands
5	Sweden
6	Belgium
7	Hungary
8	The Czech Republic
9	Spain
10	Yugoslavia
11	The United Kingdom
12	Austria
13	Luxembourg
14	Switzerland
15	(vacant)
16	Norway
17	Finland
18	Denmark
19	Romania
20	Poland
21	Portugal
22	The Russian Federation
23	Greece
24	Ireland
25	Croatia
26	Slovenia
27	Slovakia
28	Belarus
29	Estonia
30	(vacant)
31	Bosnia and Herzegovina
32	Latvia
33-36	(vacant)
37	Turkey
38-39	(vacant)
40	The Former Yugoslav Republic of Macedonia
41	(vacant)
42	The European Community (approvals are granted by its Member States using their respective ECE symbol)
43	Japan

Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the agreement concerning the adoption of Uniform Technical Prescriptions for Wheels Vehicles, Equipment and Parts.

The numbers thus assigned shall be communicated by the Secretary General of the United Nations to the Contracting Parties to the Agreement.

Bibliography

[1] EN 12806, *Automotive liquefied petroleum gas components — Other than tanks*

[2] EN 12979, *Automotive LPG systems — Installation requirements*

[3] UN ECE Regulation 67–01 series of amendments — Uniform Provisions concerning:

I: *Approval of Specific Equipment of motor vehicles using Liquefied Petroleum Gases in their Propulsion System*

II: *Approval of a Vehicle Fitted with Specific Equipment for use of Liquefied Petroleum Gases in its Propulsion System with regard to the Installation of such equipment*

[4] EN 10028-7, *Flat products made of steel for pressure purposes — Part 7: Stainless steels*

[5] EN 12085, *Automotive Liquefied Petroleum Gas components — Containers*

ICS 43.060.40

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