BRITISH STANDARD

BS ISO 20826:2006

Automotive LPG components — Containers

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National foreword

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A list of organizations represented on PVE/19 can be obtained on request to its secretary.

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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*.

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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*

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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

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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,

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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.

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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.

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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.

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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.				

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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.

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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 ⩽ [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 ⩽ [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 ⩽ [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.

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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.

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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.

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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.

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