

Transportable refillable welded steel cylinders for Liquefied Petroleum Gas (LPG) — Design and construction

The European Standard EN 1442:1998, with the incorporation of amendment A1:2002, has the status of a British Standard

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National foreword

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English version

Transportable refillable welded steel cylinders for Liquefied Petroleum Gas (LPG) — Design and construction

(includes amendment A1:2002)

Bouteilles en acier soudé transportables et rechargeables pour gaz de pétrole liquéfiés (GPL) — Conception et fabrication
(inclut l'amendement A1:2002)

Ortsbewegliche, wiederbefüllbare, geschweißte Flaschen aus Stahl für Flüssiggas (LPG) — Gestaltung und Konstruktion
(enthält Änderung A1:2002)

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European Committee for Standardization
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Central Secretariat: rue de Stassart 36, B-1050 Brussels

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Foreword

This has been prepared by Technical Committee CEN/TC 286, Liquefied petroleum gas equipment and accessories, the Secretariat of which is held by NSAI.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the Free Trade Association, and supports the objectives of the framework Directives on Transport of Dangerous Goods.

The standard has been submitted for reference into the RID and/or in the technical annexes of the ADR.

Therefore the standards listed in the normative references and covering basic requirements of the RID/ADR not addressed within the present standard are normative only when the standards themselves are referred to in the RID and/or in the technical annexes of the ADR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 1998, and conflicting national standards shall be withdrawn at the latest by August 1998.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Foreword to amendment A1

This amendment EN 1442:1998/A1:2002 to the EN 1442:1998 has been prepared by Technical Committee CEN/TC 286, Liquefied petroleum gas equipment and accessories, the Secretariat of which is held by NSAI.

This amendment to the European Standard EN 1442:1998 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2002, and conflicting national standards shall be withdrawn at the latest by September 2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports the objectives of the framework Directives on Transport of Dangerous Goods.

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Introduction

This European Standard calls for the use of substances and procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage. It has been assumed in the drafting of this European Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

1 Scope

This European Standard specifies minimum requirements concerning material, design, construction and workmanship, procedure and test at manufacture of transportable refillable welded steel Liquefied Petroleum Gas (LPG) cylinders of water capacity from 0,5 l up to and including 150 l exposed to ambient temperatures.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 287-1, *Approval testing of welders — Fusion Welding — Part 1: Steels.*

EN 288-3, *Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels.*

EN 876, *Destructive test on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints.*

EN 895, *Destructive tests on welds in metallic materials — Transverse tensile test.*

EN 910, *Destructive tests on welds in metallic materials — Bend tests.*

EN 1321, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds.*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test.*

EN 25817, *Arc-welded joints in steel — Guidance on quality levels for imperfections.*
(ISO 5817:1992)

EN 970, *Non-destructive examination of fusion welds — Visual examination.*

EN 1435, *Non-destructive examination of welds — Radiographic examination of welded joints.*

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

Euronorm 6-55, *Essai de pliage pour l'acier (Bend tests for steel).*

Euronorm 12-55, *Bend tests for steel sheet and strip less than 3 mm thick.*

Euronorm 103-71, *Détermination micrographique de la grosseur du grain ferritique ou austénitique des aciers (Micrographic determination of the ferritic or austenitic grain size of steels).*

ISO 2504:1973, *Radiography of welds and viewing conditions for films — Utilization of the recommended patterns of image quality indications (I.Q.I.).*

3 Definitions and symbols

3.1 Definitions

For the purposes of this standard the following definitions apply.

3.1.1

yield stress

the upper yield strength, R_{eh} , or, for steels that do not exhibit a defined yield, the 0,2 % proof stress (non-proportional elongation), R_p (see EN 10002-1)

3.1.2

normalizing

heat treatment in which a finished cylinder is heated to a uniform temperature above the upper critical point (AC_3) of the steel and then cooled in a controlled atmosphere

3.1.3

stress relieving

heat treatment given to the finished cylinder, the object of which is to reduce the residual stresses without altering the metallurgical structure of the steel, by heating to a uniform temperature below the lower critical point (AC_1) of the steel and cooling in a still atmosphere

3.1.4

competent body

a person or corporate body defined by a national authority, which by combination of appropriate qualifications, training, experience and resources is able to make objective judgements on the subject

3.2 Symbols

a	calculated minimum thickness, in millimetres, of the cylindrical shell
A	percentage elongation after fracture
b	calculated minimum thickness, in millimetres, of the end of the cylinder
C	shape factor (see Table 1 and Figure 2)
D	outside diameter, in millimetres, of the cylinder as given in the design drawing (see Figure 1)
D_p	outside diameter, in millimetres, of a bend tests former (see Figure 10)
h	height, in millimetres, of the cylindrical part of the end (see Figure 1)
H	outside height, in millimetres, of the domed part of the end (see Figure 1)
J	stress reduction factor
L	length, in millimetres of the cylinder
L_0	original gauge length of the test piece, in millimetres, in accordance with EN 10002-1
n	ratio of diameter of bend test former to the thickness of the test piece (see Table 2)
P_c	calculation pressure, in bar ($1 \text{ bar} = 10^5 \text{ Pa} = 10^5 \text{ N/m}^2$), used to calculate the minimum required thickness of the cylindrical shell and ends
P_b	maximum pressure, in bar, attained during the burst test
P_t	actual test pressure, in bar, applied to the cylinder by the manufacturer
P_{tmin}	minimum permissible test pressure, in bar
r	inside knuckle radius, in millimetres, of the end
R	inside dishing radius, in millimetres, of the end
R_g	guaranteed tensile strength
R_0	minimum value of yield stress, in newtons per square millimetre, guaranteed by the cylinder manufacturer for the finished cylinder
R_m	actual value of tensile strength, in newtons per square millimetre, determined by the tensile test specified in 7.1.2.2

4 Materials

4.1 Materials for shells and end pressings shall conform to EN 10120.

Materials refer to materials in the state before any specific transformation with regard to the manufacturing process.

4.2 All parts welded to the cylinder shall be made of compatible material.

4.3 The welding consumables shall be such that they are capable of giving consistent welds with minimum tensile strength at least equal to that specified for the parent materials in the finished cylinder.

4.4 The cylinder manufacturer shall have certificates of the ladle analysis and mechanical properties of the steel supplied for the construction of the pressure retaining parts of the cylinder.

4.5 The manufacturer shall maintain a system of identification for the materials used in the fabrication in order that all materials for pressure parts in the completed cylinder can be traced to its origin.

5 Design

5.1 General requirements

5.1.1 The calculation of the wall thickness of the pressure parts to resist the internal pressure in the gas cylinders shall be related to the yield stress of the material.

5.1.2 For calculation purposes, the value of the yield stress R_0 is limited to a maximum of $0,85R_g$.

5.1.3 The internal pressure upon which the calculation of the wall thickness of gas cylinders is based shall be the calculation pressure P_c .

a) For cylinders for commercial butane service only:

$$P_c = P_{tmin} = 15 \text{ bar.}$$

b) For all other LPG cylinders:

$$P_c = P_{tmin} = 30 \text{ bar.}$$

5.1.4 A fully dimensional drawing including the specification of the material shall be produced.

5.2 Calculation of cylindrical shell thickness.

The wall thickness of the cylindrical shell shall be not less than that calculated using the formula:

$$a = P_c D \div \left(\frac{20R_0 J}{4/3} + P_c \right)$$

— For cylinders with a longitudinal weld: $J = 0,9$.

— For cylinders without a longitudinal weld: $J = 1,0$.

In no case shall the actual thickness be less than that specified in **5.5**.

5.3 Design of ends concave to pressure

5.3.1 Except as permitted by **5.4**, the shape of ends of gas cylinders shall be such that the following conditions are fulfilled:

— for torispherical ends: $R \leq D$; $r \geq 0,1 D$; $h \geq 4b$ [see Figure 1a)];

— for semi-ellipsoidal ends: $H \geq 0,192 D$; $h \geq 4b$ [see Figure 1b)].

5.3.2 The wall thickness of the ends of gas cylinders shall be not less than that calculated using the formula:

$$b = P_c D C \div \left(\frac{20R_0}{4/3} + P_c \right)$$

In this formula, C is a shape factor, the value of which depends on the ratio H/D .

The value of C shall be obtained from Table 1 and the graphs in Figure 2 and Figure 3.

The graph in Figure 2 details the value of C in relation to the ratio b/D .

Table 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	0,713	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 may be obtained by linear interpolation.

5.4 Ends of other shapes

Ends of shapes other than those covered by 5.3 may be used provided that the adequacy of their design is demonstrated by a fatigue test in accordance with 7.6 or by appropriate stress analysis acceptable to a competent body.

5.5 Minimum wall thickness

5.5.1 The minimum wall thickness of the cylindrical shell a , and of the end, b , shall not be less than the value derived from any of the following formulae:

for $D < 100$ mm:

$$a_{\min} = b_{\min} = 1,1 \text{ mm} \quad (1)$$

for $100 \leq D \leq 150$ mm:

$$a_{\min} = b_{\min} = 1,1 + 0,008(D - 100) \text{ mm} \quad (2)$$

for $D < 150$ mm:

$$a_{\min} = b_{\min} = (D/250) + 0,7 \text{ mm} \quad (3)$$

(with an absolute minimum of 1,5 mm).

These formulae apply to cylindrical shells and ends irrespective of whether they are designed by calculation as specified in 5.2 and 5.3 or by testing as specified in 5.4. Apart from the requirements of 5.3, 5.4 and 5.5, any cylindrical part integral with an end shall, except as qualified by 5.5.2, also satisfy the requirements in 5.2 for the cylindrical shell.

5.5.2 The equation in 5.2 is not applicable where the length of the cylindrical portion of the cylinder, measured between the beginning of the domed parts of the two ends, is not more than $\sqrt{2bD}$. In this case the wall thickness shall be not less than that of the domed part (see 5.3.2).

5.6 Design of openings

5.6.1 The location of all openings shall be restricted to one end of the cylinder.

5.6.2 Each opening in the cylinder shall be reinforced, either by a valve boss or pad, of weldable and compatible steel, securely attached by welding and so designed as to be of adequate strength and to result in no harmful stress concentrations. This shall be confirmed by design calculations acceptable to a competent body or a fatigue test in accordance with 7.6.

5.6.3 The welds of the openings shall be clear of circumferential joints.

5.6.4 If the leak-tightness between the valve and the cylinder is assured by a metallic seal (e.g. copper), a suitable internal valve boss can be fitted to the cylinder by a method which need not independently guarantee leak-tightness.

6 Construction and workmanship

6.1 Welding qualification

6.1.1 The manufacturer shall have the technical capability, have at his disposal all appropriate means, and qualified personnel to carry out the manufacture of cylinders.

6.1.2 The manufacturer, with the agreement of a competent body, before proceeding with the production of a given design of cylinder, shall approve the welding procedures to EN 288-3 and welders to EN 287-1, for all welding associated with the pressure envelope including the non-pressure containing parts. Records of such approvals shall be retained by the manufacturer.

6.1.3 Welding procedure approval tests shall be made in such a manner that the welds shall be representative of those made in production.

6.1.4 Welders shall have passed the approval tests for the specific type of work and procedure concerned.

6.2 Plates and pressed parts

Before assembly, the pressure parts of the cylinders shall be visually examined for uniform quality and freedom from defects which may ultimately affect the cylinder integrity.

6.3 Welded joints

6.3.1 The welding of the longitudinal and circumferential joints shall be by a fully mechanized or automatic process to provide consistent and reproducible quality of welds.

6.3.2 The longitudinal joint, of which there shall be no more than one, shall be the butt welded type.

6.3.3 Circumferential joints, of which there shall be no more than two, shall be butt welded, or butt welded with one member offset to form an integral backing strip, i.e. joggled (see Figure 4).

6.3.4 Before the cylinders are closed, longitudinal welds shall be visually examined from both sides in accordance with EN 970. Permanent backing strips shall not be used with longitudinal welds.

6.3.5 The fusion of the welded metal with the parent metal shall be smooth and free from overlapping, undercutting or abrupt irregularity. There shall be no cracks, notching or porous patches in the welded surface and the surface adjacent to the weld. The welded surface shall be regular and even without concavity.

6.3.6 Butt welds and joggled butt welds shall have full penetration.

The excess thickness shall not exceed one-fourth of the width of the weld.