BRITISH STANDARD

BS EN
1442:2006

LPG equipment and accessories — Transportable refillable welded steel cylinders for LPG — Design and construction

The European Standard EN 1442:2006 has the status of a British Standard

ICS 23.020.30

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 1442:2005. It supersedes BS EN 1442:1998 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/19, LPG containers and their associated fittings, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 37 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2006

ISBN 0 580 48873 X

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1442

June 2006

ICS 23.020.30

Supersedes EN 1442:1998

English Version

LPG equipment and accessories - Transportable refillable welded steel cylinders for LPG - Design and construction

Équipements pour GPL et leurs accessoires - Bouteilles en acier soudé transportables et rechargeables pour gaz de pétrole liquéfiés (GPL) - Conception et fabrication

Flüssiggas-Geräte und Ausrüstungsteile - Ortsbewegliche, wiederbefüllbare, geschweißte Flaschen aus Stahl für Flüssiggas (LPG) - Gestaltung und Konstruktion

This European Standard was approved by CEN on 18 May 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1442:2006: E

Contents

Page

Foreword

This document (EN 1442:2006) 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 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

This document supersedes EN 1442:1998.

This European 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 has been extensively re-formatted to align with other more recent LPG cylinder standards.

The main technical changes are a widening of the range of materials permitted, reference to the latest ISO welding standards, the introduction of radioscopy as a permitted alternative to radiographic examination of welds, a reduction in the minimum required burst pressure from 50 bar to 35 bar and simplification of the marking requirements by reference to EN 14894.

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

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.

All pressures are gauge unless otherwise stated.

1 Scope

This European Standard specifies the minimum requirements for the design, construction and testing during 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.

This European Standard applies only to cylinders having a circular cross-section.

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.

EN 287–1, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 462–1, *Non-destructive testing — Image quality of radiographs — Part 1: Image quality indicators (wire type) — Determination of image quality value*

EN 462–2, *Non-destructive testing — Image quality of radiographs — Part 2: Image quality indicators (step/hole type) — Determination of image quality value*

EN 473:2000, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

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

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

EN 962:1996, *Transportable gas cylinders — Valve protection caps and valve guards for industrial and medical gas cylinders — Design, construction and tests*

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

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

EN 1418, *Welding personnel — Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*

EN 1435:1997, *Non-destructive examination of welds — Radiographic examination of welded joints*

EN 10002–1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

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

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 14894, *LPG equipment and accessories —Cylinder and drum marking*

EN ISO 643, *Steels — Micrographic determination of the apparent grain size (ISO 643:2003)*

EN ISO 5817:2003, *Welding — Fusion welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2003)*

EN ISO 6520–1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding (ISO 6520-1:1998)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15613, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test (ISO 15613:2004)*

EN ISO 15614-1, *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 15614-1:2004)*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
yield strength
upper yield strength R_{eH} or
0,2 % proof strength (non-proportional elongation), $R_{p0,2}$, for steels that do not exhibit a defined yield

3.1.2
normalised
condition resulting from 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 under controlled conditions

3.1.3
stress relieved
condition resulting from heat treatment in which a finished cylinder is heated to a uniform temperature below the lower critical point (Ac_1) of the steel and cooled in a still atmosphere, the object of which is to reduce the residual stresses without altering the metallurgical structure of the steel

3.1.4
weld-overrun zone
area on a circumferential weld where the weld metal deposition has carried on beyond the start point

3.2 Symbols

a calculated thickness of the cylindrical shell, in millimetres.

A percentage elongation after fracture.

b calculated thickness of the end of the cylinder, in millimetres.

C shape factor for ends (see Table 2, Figure 2 and Figure 3).

D outside diameter of the cylinder as given in the design drawing (see Figure 1), in millimetres.

D_p outside diameter of a bend test mandrel (see Figure 8), in millimetres.

e actual thickness of the material in the finished cylinder (at the point under consideration), in millimetres.

h height of the cylindrical part of the end (see Figure 1), in millimetres.

H outside height of the domed part of the end (see Figure 1), in millimetres.

J stress reduction factor.

L_o original gauge length of the test piece, in accordance with EN 10002–1, in millimetres.

n ratio of diameter of bend test former to the thickness of the test piece, (see Table 6).

P_c calculation pressure (1 bar = 10^5 Pa = 10^5 N/m$^{2)}$, used to calculate the minimum required thickness of the cylindrical shell and ends, in bar.

P_b maximum pressure attained during the burst test, in bar.

P_h actual test pressure applied to the cylinder by the manufacturer, in bar.

P_{hmin} minimum permissible test pressure, in bar.

r inside knuckle radius of the torispherical end, in millimetres.

R inside spherical radius of the torispherical end, in millimetres.

R_g minimum value of tensile strength guaranteed by the cylinder manufacturer for the finished cylinder, in newtons per square millimetre.

R_o minimum value of yield strength guaranteed by the cylinder manufacturer for the finished cylinder, in newtons per square millimetre.

R_m actual value of tensile strength determined by the tensile test specified in 7.4, in newtons per square millimetre.

R_{eH} upper yield strength, in newtons per square millimetre, as defined in EN 10002–1.

$R_{p0,2}$ Proof strength, non proportional extension in newtons per square millimetre, as defined in EN 10002–1.

4 Materials

4.1 Materials for shells and end pressings shall be in accordance with EN 10120 or other equivalent material specification or standard meeting the requirements of Table 1. Alternative material specifications shall, as a minimum, specify chemical composition, mechanical properties, heat treatment and delivery conditions.

NOTE "Materials" refers to materials in the state before any specific transformation occurring during the manufacturing process.

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

4.3 The welding consumables shall be such that they are capable of giving consistent welds.

4.4 The cylinder manufacturer shall obtain certificates showing the chemical analysis and details of the mechanical properties of the steel supplied for the construction of the pressure retaining parts. The certificates/reports shall be in accordance with EN 10204:2004, Type 3.1 for shells and ends and Type 2.2 for the valve boss.

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 their origin.

Table 1 — Material requirements

Element	Limits %
Materials, other than according to EN 10120, used for the fabrication of cylinders shall be of weldable quality and the following limits shall not be exceeded in the cast analysis:	
Carbon	0,22 max.
Silicon	0,50 max.
Manganese	0,30 min. to 1,60 max.
Phosphorus	0,025 max.
Sulphur	0,020 max.
Phosphorous plus sulphur	0,040 max.
Use of micro-alloying elements such as niobium, titanium and vanadium shall be limited to the following contents:	
Niobium	0,05 max.
Titanium	0,05 max.
Vanadium	0,05 max.
Niobium plus vanadium	0,08 max.
Where other micro-alloying elements are used, their presence and amounts shall be reported, together with the above, in the steel manufacturer's certificate. Should check analyses be required, they shall be carried out either on specimens taken during manufacture from material in the form as supplied by the steel manufacturer to the cylinder manufacturer or from finished cylinders.	

5 Design

5.1 General requirements

5.1.1 The calculation of the wall thickness of the pressure parts shall be based on the yield strength of the material.

5.1.2 For calculation purposes, the value of the yield strength R_o is limited to a maximum of 0,85 R_g.

5.1.3 The calculation pressure (P_c) shall be not less than the higher of:

— absolute developed pressure at 65 °C of the highest pressure LPG mixture to be filled minus 1 bar, or

— 10 bar.

NOTE This requirement is in accordance with RID/ADR. Test pressures for tabulated mixtures of LPG are listed in table P200 of ADR.

5.1.4 A drawing, which includes full dimensions that define the cylinder type (see 8.2) and the specification of the material, shall be produced.

5.2 Calculation of cylindrical shell thickness

The wall thickness, *a*, of the cylindrical shell shall be not less than:

$$a = \frac{P_c \times D}{(15 \times R_o \times J) + P_c}$$

For cylindrical shells with a longitudinal weld: $J = 0,9$

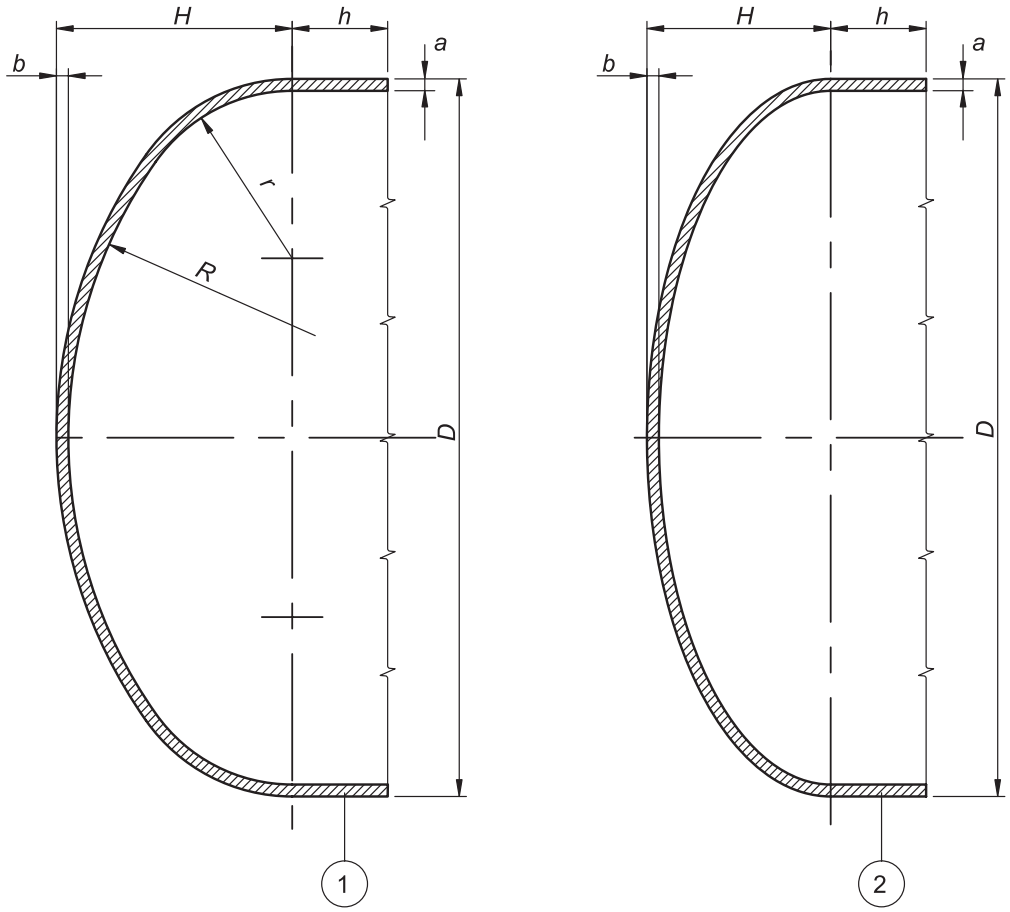
For cylindrical shells, including the cylindrical parts of ends, without a longitudinal weld: $J = 1,0$

5.3 Design of torispherical and semi-ellipsoidal ends concave to pressure

5.3.1 The shape of ends 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 1);

— for semi-ellipsoidal ends $H \geq 0,2\ D$; $h \geq 4b$ (see Figure 1).



Key

1 torispherical end
2 semi-ellipsoidal end

Figure 1 — Illustration of cylinder ends concave to pressure

NOTE For torispherical ends the height *H* can be calculated using:

$$H = (R + b) - \sqrt{[(R + b) - \frac{D}{2}] \times [(R + b) + \frac{D}{2} - 2(r + b)]}$$

5.3.2 The wall thickness, *a*, of any cylindrical part shall be calculated in accordance with 5.2.

This requirement 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.

The thickness, *b*, of the domed part shall be not less than:

$$b = \frac{P_c \times D \times C}{(15 \times R_o) + P_c}$$

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

The value of *C* shall be obtained from Figure 2 or Figure 3/Table 2.

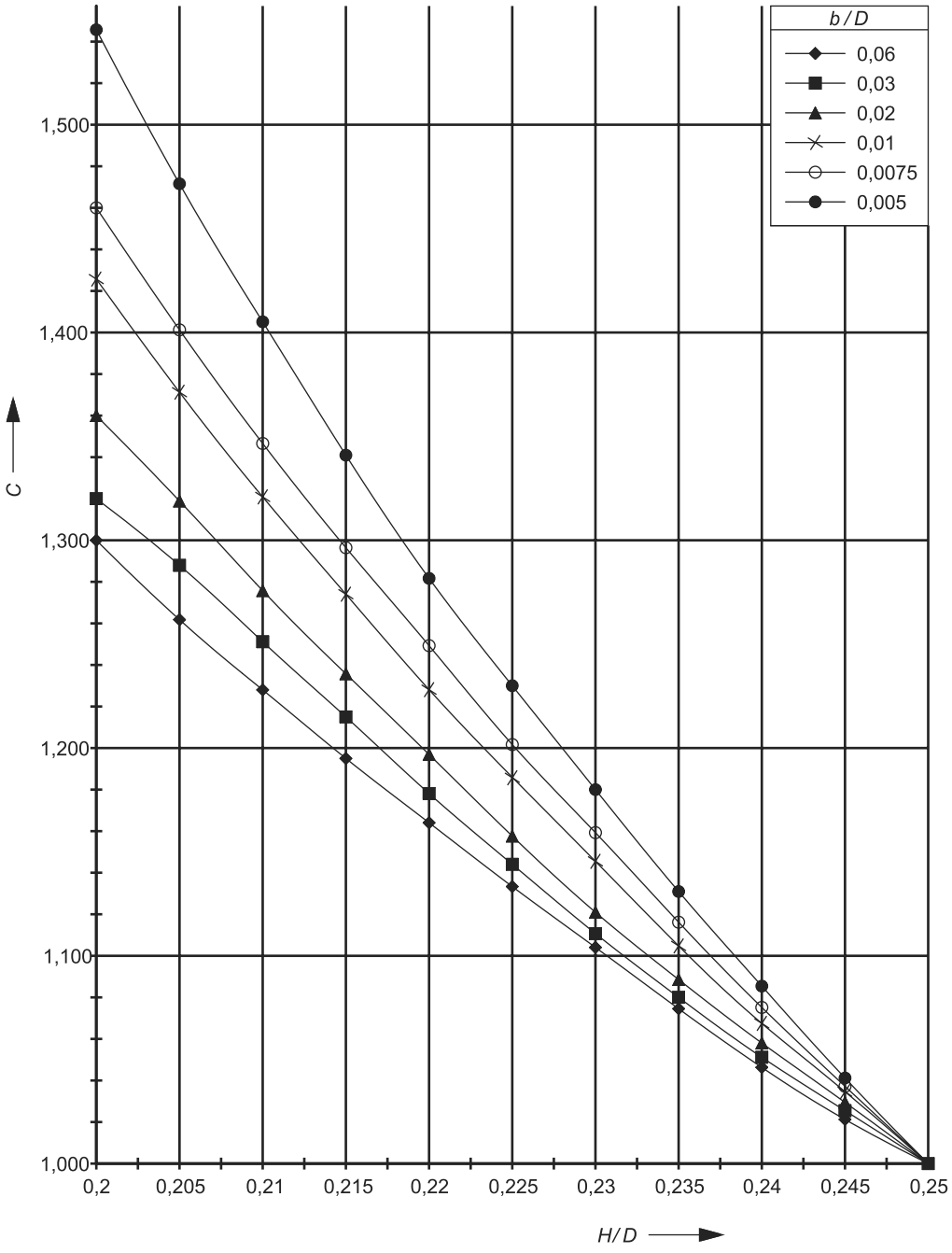


Figure 2 — Values of shape factor *C* for *H/D* between 0,2 and 0,25

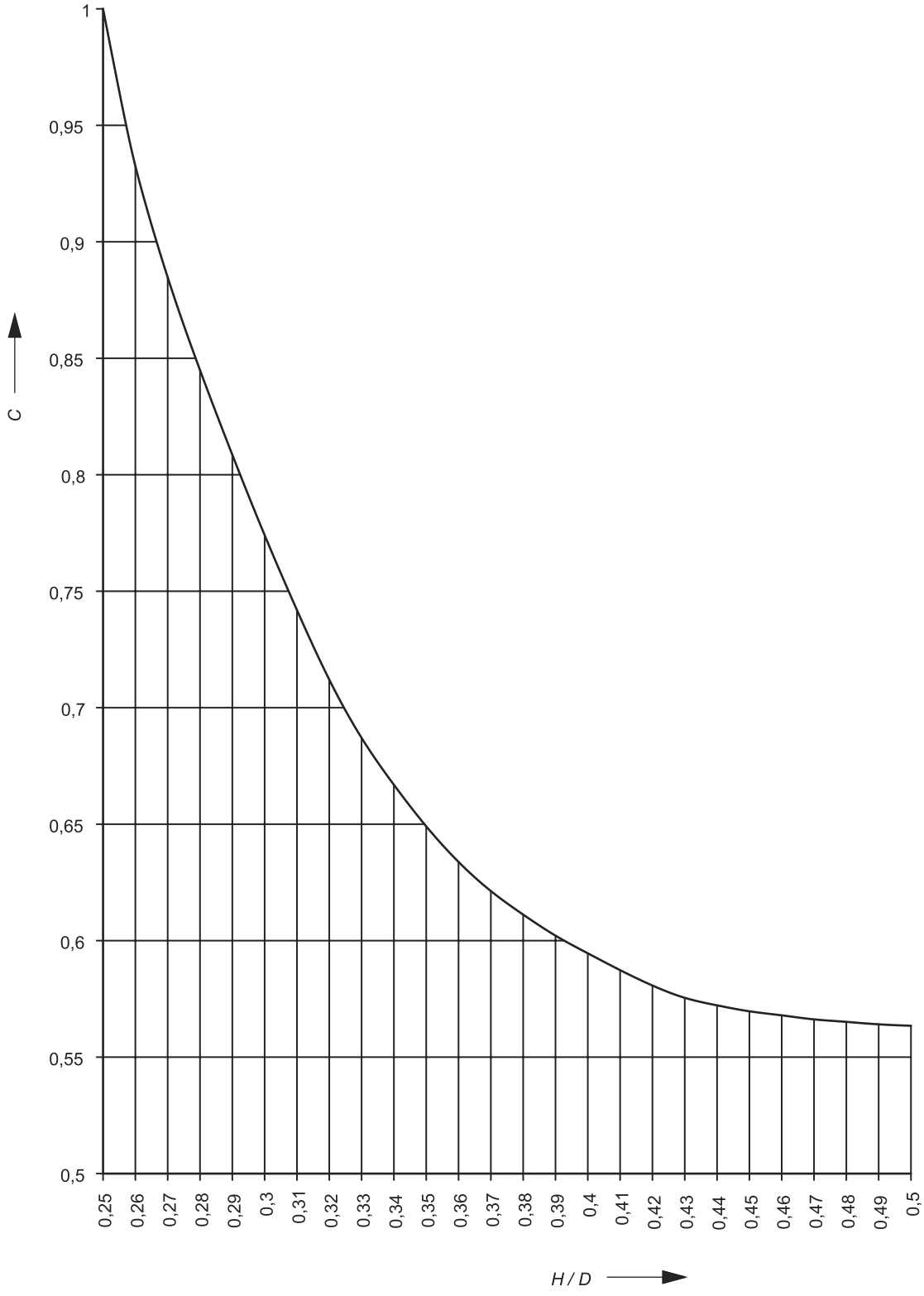


Figure 3 — Values of shape factor *C* for *H/D* between 0,25 and 0,5

Table 2 — 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 can be obtained by linear interpolation.			

5.4 Design of ends of shapes other than torispherical and semi-ellipsoidal

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 7.11 or by appropriate stress analysis. For ends convex to pressure, the minimum end thickness shall be not less than 2 times that required by 5.2.

5.5 Minimum wall thickness

The minimum wall thickness of the cylindrical shell and ends shall be not less than the greater of:

— the values of *a* and *b* determined in accordance with 5.2 and 5.3 or 5.4, as appropriate, or

— the following values, as appropriate:

for $D < 100$ mm:
1,1 mm

for 100 mm $\leq D \leq$ 150 mm:
[1,1 + 0,008 (D-100)] mm

for $D > 150$ mm:
$[\frac{D}{250} + 0,7]$ mm, but not less than 1,5 mm.

These equations 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.

5.6 Design of openings

5.6.1 All openings shall be located in one end of the cylinder.

5.6.2 Each opening in the cylinder shall be reinforced, either by a valve boss or pad securely attached by welding. The suitability of the design of the reinforcement or design changes within an approved type of cylinder shall be confirmed by design calculations or a fatigue test in accordance with 7.11.

5.6.3 The welds of the opening reinforcement shall be not less than $\sqrt{2,5bD}$ mm from any circumferential joints.

5.6.4 Unless otherwise specified, valve boss threads shall conform to an established dimensional specification.

NOTE Suitable thread specifications include ISO 10920 for 25E thread and EN ISO 11116-1 for the 17E thread.

5.7 Valve protection

The design of a cylinder shall provide protection for valves against damage in order to avoid the release of the contents, unless the valve is protected by other means.

When the valve protection is integral with the cylinder, this shall be demonstrated by drop testing in accordance with EN 962:1996, 6.7.

NOTE When the cylinder is not provided with integral valve protection, the manufacturer should specify that cylinders containing LPG should be conveyed in crates or cradles or should be provided during transportation with some other effective valve protection. Otherwise the cylinder should be fitted with valves that have demonstrated, by impact tests in accordance with EN 13152 or EN 13153, that the valve can withstand damage without leakage of the contents.

5.8 Non-pressure containing attachments

5.8.1 Attachments shall be designed so as to avoid trapping water and to permit external inspection of the attachment welds. They shall be clear of longitudinal and circumferential joints.

5.8.2 Where a foot-ring is fitted, it shall be of adequate strength to provide stability and be attached so that it does not prevent inspection of any pressure containing welds. Any foot-ring shall be suitably drained and the space enclosed by the foot-ring suitably ventilated e.g. by means of openings.

6 Construction and workmanship

6.1 Welding qualification

6.1.1 Welding associated with the pressure envelope including non pressure-containing parts shall:

— have a welding procedure specification for all joints in accordance with EN ISO 15609-1, qualified in accordance with EN ISO 15614-1 or EN ISO 15613;

— be done by welders qualified in accordance with EN 287–1 and welding personnel approved in accordance with EN 1418.

The manufacturer shall maintain records of such procedures, qualifications and approvals.

6.1.2 Welding procedure approval tests shall be on welds that are representative of those made in production.

6.1.3 Welders shall have passed the approval tests for the specific type of work and procedure to be performed.

6.2 Plates and pressed parts

The manufacturer shall ensure that the pressure parts of cylinders are of uniform quality and free from visible defects that may ultimately affect the cylinder integrity.

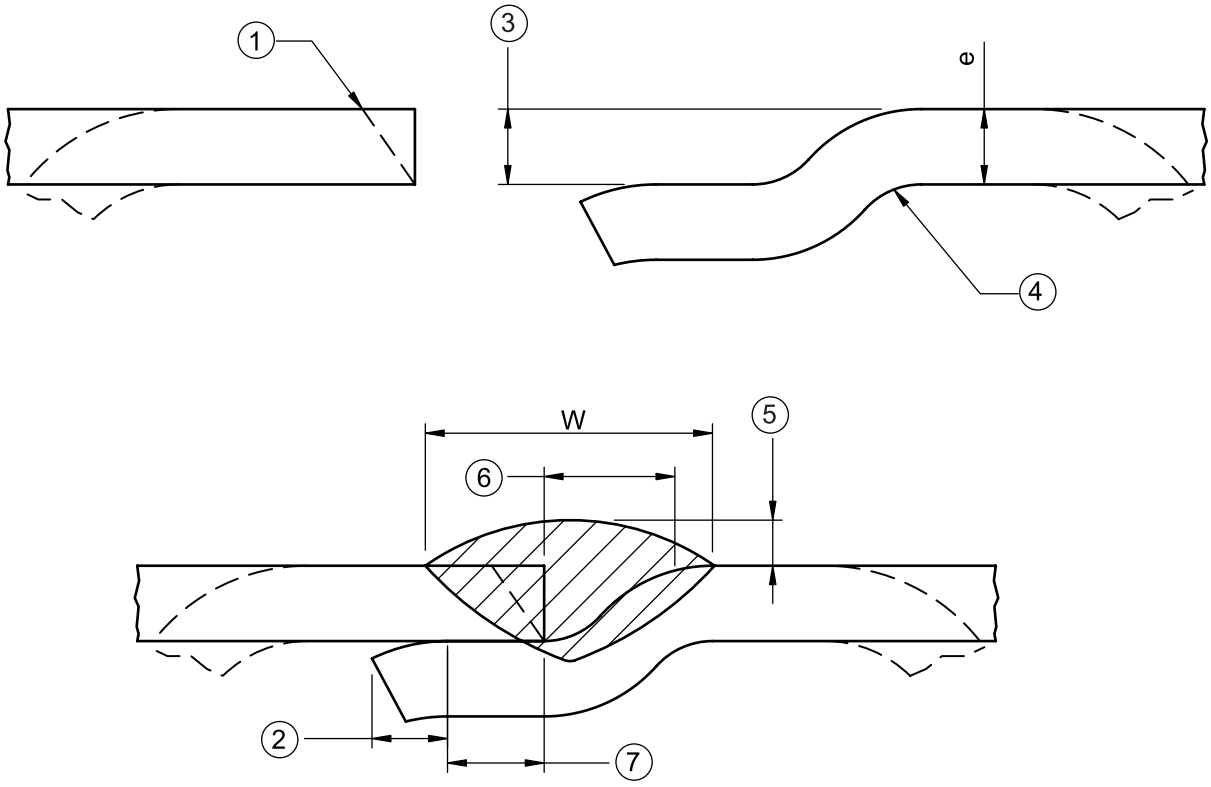
6.3 Welded joints

6.3.1 The strength characteristics of the welds in the finished cylinder shall fulfil all requirements for the design and calculation of the cylinder. Where the valve boss is welded to the cylinder by a partial penetration weld, the strength of the joint shall be demonstrated by a prototype fatigue test in accordance with 7.11.

6.3.2 The welding of the longitudinal and circumferential joints shall be a fully mechanised or automatic process so as to provide consistent and reproducible welds.

6.3.3 There shall be no more than one longitudinal joint, which shall be butt-welded. Joggled butt-welds and permanent backing strips shall not be used for longitudinal welds.

6.3.4 There shall be no more than two circumferential joints, excluding the valve boss weld. These shall be butt-welded. Figure 4 shows an example of a typical joggled butt-weld i.e. with one member offset to form an integral backing strip. Other geometries than that shown in Figure 4 are permitted provided satisfactory test results can be obtained in the finished cylinder.



Key
1 bevel optional
2 as desired
3 depth of offset to give a close fit on the mating part
4 inside of cylinder – (sharp break to be avoided)
5 height of weld (except in weld-overrun zone) ≤ W/4
6 width of bevel: 2,5e ≥ width of bevel ≥ e
7 minimum contact length: 1,5e
e thickness of metal which is offset
W width of weld: 8e ≥ W ≥ 3e

Figure 4 — Example of a typical circumferential joggled butt-weld

6.3.5 Unless otherwise specified, welded joints shall comply with EN ISO 5817:2003 quality level B.

6.3.6 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 (i.e. weld surface below that of the parent material). The excess thickness of the weld (bead height) shall not exceed one fourth of the width of the weld, except in the weld-overrun zone.

6.3.7 Butt-welds, including butt welded valve boss to cylinder joints, and joggled butt-welds shall have full penetration verified by macro examination, bend testing and tensile testing (see 9.3). Joggled butt-welds may have lack of penetration at the start of the weld (with a maximum length of 5 mm) if located under the overrun zone and it is demonstrated during production testing that this is not the weakest point of the cylinder. The minimum length of weld-overrun shall be 10 mm.

6.4 Tolerances

6.4.1 Out-of-roundness

The out-of-roundness of the cylindrical shell shall be limited so that the difference between the maximum and the minimum outside diameter in the same cross-section is not more than 1 % of the mean of these diameters for two piece cylinders and 1,5 % for three piece cylinders. The measurement shall not be taken over any circumferential welds.

6.4.2 Straightness

The maximum deviation of the cylindrical part of the shell from a straight line shall not exceed 0,3 % of the cylindrical length.

6.4.3 Verticality

When the cylinder is standing on its base, the cylindrical shell and the axis of the top opening shall be vertical to within 1,5° (approximately 26 mm per metre of height).

6.5 Closure of openings

Openings in finished cylinders shall be either:

— fitted with a plug of suitable non-absorbent material, or

— fitted with the appropriate valve or fitting,

to protect the thread from damage and to minimise entry of moisture into the cylinder.

6.6 Heat treatment

6.6.1 Cylinders shall be heat treated (normalised or stress relieved), unless the requirements of 6.6.4 have been satisfied.

6.6.2 The cylinder manufacturer shall maintain records of heat treatment carried out.

6.6.3 Localised heat treatment shall not be permitted.

6.6.4 Cylinders need not be heat treated provided all the following requirements are met:

— they are of three-piece construction,

— the ends are semi ellipsoidal or torispherical in accordance with Figure 1 and the depth of pressing is limited such that:

$$\frac{H-b}{D} \leq 0{,}26$$

and

$$h \leq 8b$$

— cylinders are made from a fine grain steel with maximum grain size of 8, in the delivery condition, when tested in accordance with EN ISO 643 and

— three samples of each type are subject to a fatigue test in accordance with 7.11. Any subsequent change in design, material thickness, material specification or weld procedure shall require a further set of fatigue tests.

7 Tests and examinations

7.1 General

The mechanical tests and the macro examination for checking the properties of the parent metal and welds of the pressure containing parts of the cylinders shall be carried out on test specimens taken from finished cylinders. The dimensions and positions of test specimens shall be in accordance with 7.3.

7.2 Types of test and evaluation of test results

The tests and examinations to be applied to cylinders shall be in accordance with Clause 8 and Clause 9. This is illustrated in Table 3.

Table 3 — Applicability of tests/examinations

Test/Examination		Sub-clause	Type test		Production test	
				Specified in subclause		Specified in subclause
Mechanical	Tensile	7.4	X	8.1 b)	X	9.7, 9.8
	Bend	7.5	X	8.1 b)	X	9.7, 9.8
Burst		7.6	X	8.1 c)	X	9.4, 9.7, 9.8
Pressure		7.7	-	-	X	9.1.2
Radiographic		7.8	O	8.1 b)	O X Y	9.2.2, 9.4, 9.5 9.2.1, 9.2.3 9.6.2
Macro		7.9	O	8.1 b)	O X Y	9.2.2, 9.4, 9.5 9.3.1 9.6.2
Visual		7.10	X	8.1 d)	X	9.1.1, 9.1.2
Fatigue		7.11	X	8.1 a)	-	-

O This allows for an option of a radiograph **or** macro.
X No option permitted – test to be performed.
Y Retest required under certain circumstances.

7.3 Test specimens and related tests and examinations

7.3.1 Two-piece cylinders

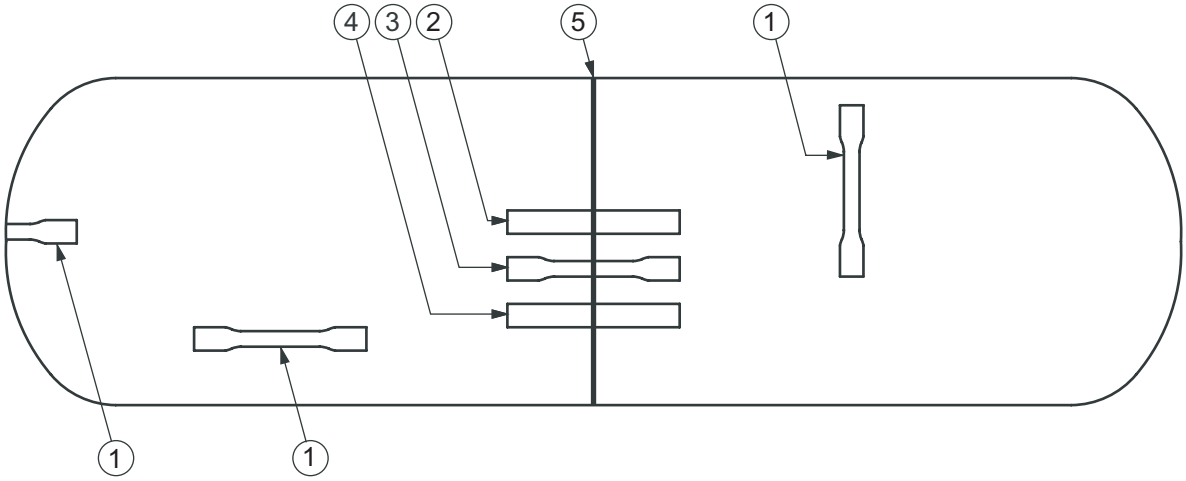
7.3.1.1 For two-piece cylinders (i.e. containing only one circumferential weld), the test specimens detailed in Table 4 shall be taken from the places shown in Figure 5.

Table 4 — Types of tests and details (two-piece cylinders)

Type	In accordance with	Key (see Figure 5)	Details
1 tensile test	EN 10002–1	1	Parent metal in the geometric longitudinal direction of the cylinder or, if it is not possible, in the circumferential direction, or the centre of one dished end.
1 bend test	EN 910	2	On the topside of the circumferential weld.
1 tensile test	EN 895	3	Perpendicular to the circumferential weld.
1 bend test	EN 910	4	On the underside of the circumferential weld.
1 macro examination	EN 1321		On a randomly selected location on the circumferential weld.

7.3.1.2 Test pieces that are not sufficiently flat, shall be flattened by cold pressing.

7.3.1.3 In all bend test specimens, the weld shall be machined flush with the parent metal surface including any joggled material (see Figure 8 b)).



Key

1 alternative locations of test specimen for tensile test
2 test specimen for bend test (topside of the weld)
3 test specimen for cross-weld tensile test
4 test specimen for bend test (underside of the weld)
5 circumferential weld

Figure 5 — Test specimens taken from two-piece cylinders

7.3.2 Three-piece cylinders

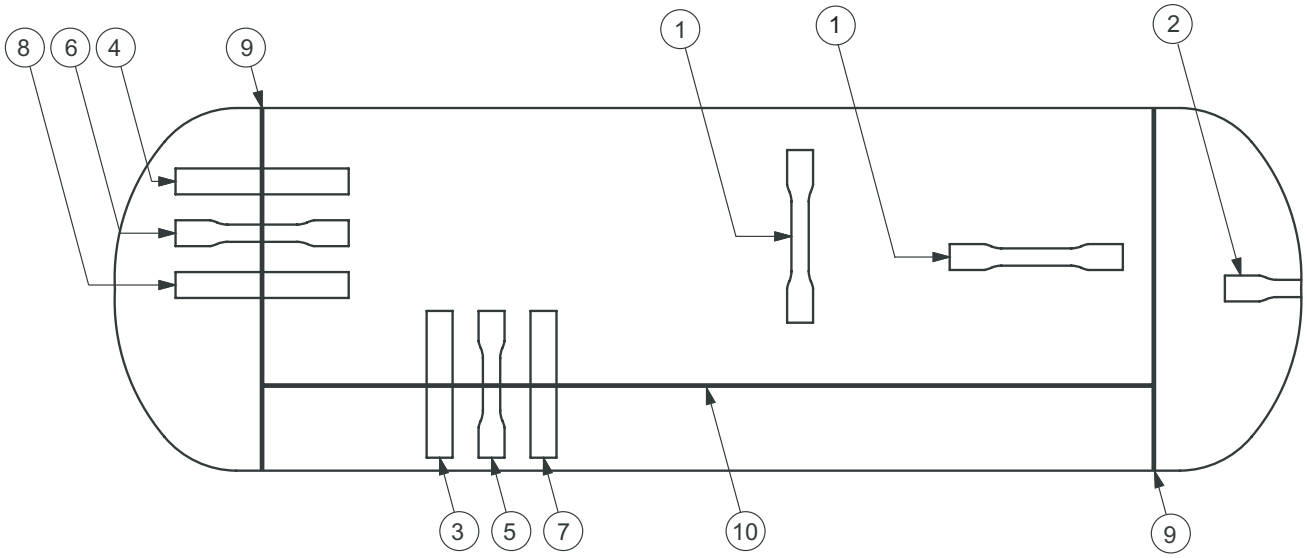
7.3.2.1 For three-piece cylinders (with longitudinal and circumferential welds), the test specimens detailed in Table 5 shall be taken from the places shown in Figure 6.

7.3.2.2 Test pieces that are not sufficiently flat, shall be flattened by cold pressing.

7.3.2.3 In all bend test specimens, the weld shall be machined flush with the parent metal surface including any joggled material (see Figure 8 b)).

Table 5 — Types of tests and details (three-piece cylinders)

Type	In accordance with	Key See Figure 6	Details
1 tensile test	EN 10002–1	1	Parent metal of cylindrical part in the longitudinal direction or, if this is not possible, in a circumferential direction.
1 tensile test	EN 10002–1	2	Parent metal from one dished end.
1 bend test	EN 910	3	On the topside of longitudinal weld.
1 bend test	EN 910	4	On the topside of a circumferential weld.
1 tensile test	EN 895	5	Perpendicular to the longitudinal weld.
1 tensile test	EN 895	6	Perpendicular to a circumferential weld.
1 bend test	EN 910	7	On the underside of the longitudinal weld.
1 bend test	EN 910	8	On the underside of a circumferential weld.
1 macro examination	EN 1321		On a randomly selected location on a circumferential weld.



Key

1 alternative locations of test specimens for tensile test
2 test specimen for tensile test
3 test specimen for bend test (topside of the weld)
4 test specimen for bend test (topside of the weld)
5 test specimen for tensile test
6 test specimen for tensile test
7 test specimen for bend test (underside of the weld)
8 test specimen for bend test (underside of the weld)
9 circumferential weld
10 longitudinal weld

Figure 6 — Test specimens taken from three-piece cylinders

7.3.3 Valve boss welds

The welding of the valve boss shall be checked by radiographic or macro examination in accordance with 7.8 or 7.9.

7.4 Tensile test

7.4.1 Parent metal

7.4.1.1 Procedure

The preparation of test specimens and procedure for carrying out the tensile test shall be in accordance with EN 10002–1.

The two faces of the test specimen representing the inside and outside walls of the cylinder respectively shall not be machined.

7.4.1.2 Requirements

The values obtained for yield strength (R_{eH} or $R_{p0,2}$), tensile strength (R_m) and elongation (A) shall be not less than those guaranteed by the cylinder manufacturer in the finished cylinder (R_o, R_g and A).

7.4.2 Welds

7.4.2.1 Procedure

The tensile test perpendicular to the weld shall be carried out in accordance with EN 895 on a test specimen having a reduced cross section of 25 mm in width for a length extending up to 15 mm beyond the edges of the weld (see Figure 7). Beyond this central part the width of the test specimen shall increase progressively.

7.4.2.2 Requirements

The tensile strength value obtained, R_m, shall not be less than that guaranteed by the cylinder manufacturer R_g, irrespective of where the fracture occurs in the cross section of the central part of the test specimen.

Dimensions in millimetres

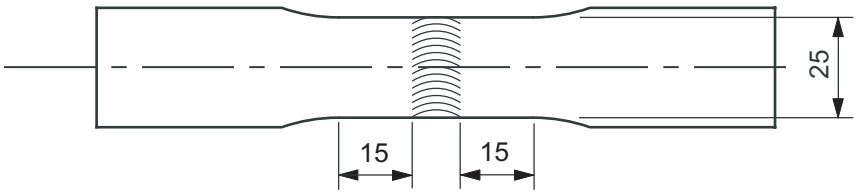


Figure 7 — Test specimen for tensile test perpendicular to the weld

7.5 Bend test

7.5.1 Procedure

7.5.1.1 The preparation of test specimens and the procedure for carrying out the bend test shall be in accordance with EN 910 and Figure 8.

7.5.1.2 The bend test specimens shall be 25 mm in width. A mandrel shall be placed in the centre of the weld while the test is being performed.

7.5.1.3 The specimen shall be fully bent round the mandrel as shown in Figure 8 c).

7.5.1.4 The ratio n between the diameter of the mandrel, D_p, and the thickness of the test specimen, e, shall not exceed the values given in Table 6.

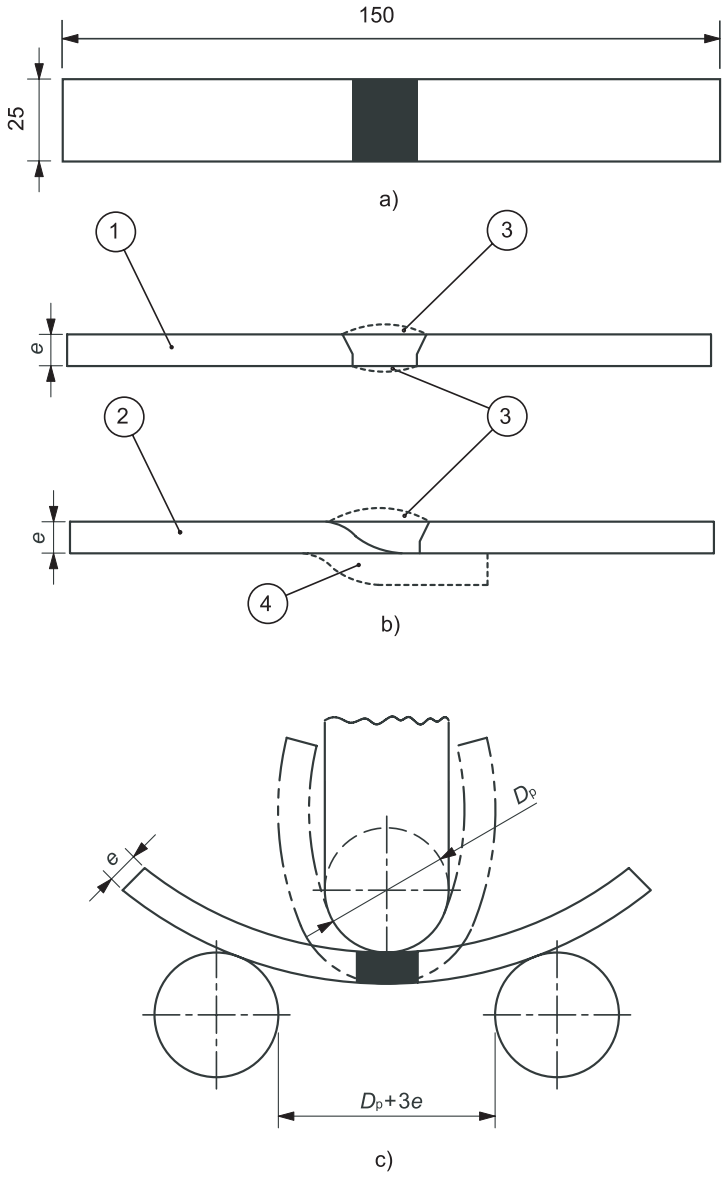
Table 6 — Ratio of mandrel diameter and test piece thickness

Actual measured tensile strength R_m N/mm^2	**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
Above 900	8

7.5.2 Requirements

No cracks shall be visible in the test specimen after bending.

Dimensions in millimetres



Key

a) dimensions of test specimen
b) transverse guided bend test specimen preparation
c) illustration of bend test

1 butt-weld specimen
2 joggle butt-weld specimen
3 weld dressed flush
4 joggled portion to be removed

Figure 8 — Bend tests

7.6 Burst test under hydraulic pressure

7.6.1 Procedure

7.6.1.1 If it is intended to apply markings (see Clause 10) on a section of the cylinder subjected to pressure, then the cylinders to be tested shall be similarly marked before testing.

7.6.1.2 The burst test under hydraulic pressure shall be carried out with equipment that:

— enables the pressure to be monitored and increased gradually until the cylinder bursts;

— records the volume of the test fluid used;

— records the pressure at which the cylinder bursts.

7.6.1.3 The cylinder shall be pressurised until it bursts and the volumetric expansion of the cylinder shall be measured as:

— the volume of test fluid used between the time when the pressure starts to rise and at the time of bursting, or

— the difference between the volume of the cylinder at the beginning and the end of the test.

7.6.1.4 After the cylinder has burst the rupture surface shall be subject to examination of the tear and the shape of its edges (see 7.6.2.3).

7.6.2 Requirements

7.6.2.1 Bursting pressure

The measured bursting pressure P_b shall not be less than 2,25 times the calculation pressure P_c and at least 35 bar.

7.6.2.2 Volumetric expansion

The ratio of the volumetric expansion of the cylinder to its initial volume shall be greater than or equal to the following values.

For $R_g < 480$ N/mm^2

— 20 % if the length of the cylinder is greater than the diameter, *D*;

— 17 % if the length of the cylinder is equal to or less than the diameter, *D*.

For $R_g \geq 480$ N/mm^2

— 17 % if the length of the cylinder is greater than the diameter, *D*;

— 15 % if the length of the cylinder is equal to or less than the diameter, *D*.

NOTE Length of the cylinder is the length of the pressure envelope including the valve boss.

7.6.2.3 Type of fracture

The examination of the fracture shall show that:

— the fracture did not initiate in a weld;

— the main fracture does not indicate any brittleness, 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;

— the fracture does not reveal a visible defect in the metal, e.g. lamination;

— the burst test does not cause any fragmentation of the cylinder.

7.7 Pressure test

7.7.1 Procedure

7.7.1.1 The test fluid shall normally be a liquid. A gas may be used provided that appropriate safety precautions are taken.

7.7.1.2 The minimum test pressure (P_h) to be applied shall be not less than the calculation pressure specified in 5.1.3. For butane cylinders only the test pressure may be higher than the one shown in 5.1.3. In any case, the membrane stress within the wall of the cylinder shall not exceed 90 % of the minimum guaranteed yield strength of the material in the cylinder R_o, during the test.

NOTE This can be demonstrated by the following equation: $\frac{P_h(D-e)}{20e} \leq 0{,}9 \times R_o$

7.7.1.3 The pressure in the cylinder shall be increased gradually until the test pressure is reached.

7.7.1.4 The cylinder shall remain under pressure long enough to establish that no leaks can be observed, but not less than 30 s.

7.7.2 Requirements

7.7.2.1 There shall be no leaks from the cylinder.

7.7.2.2 After the test the cylinder shall show no signs of permanent deformation.

7.8 Radiographic examination

7.8.1 Procedure

Radiography of welds shall be carried out in accordance with EN 1435:1997, class B. Radiography personnel shall be qualified to EN 473:2000, level 1, and shall be supervised by personnel qualified to EN 473:2000, level 2.

The extent of radiography shall be as shown in Figure 9 or Figure 10 as appropriate.

The radiographic examination may be replaced by radioscopy provided it is carried out according to a process that provides the same quality of examination, imperfection detection and the same level of records as the radiographic examination.

Dimensions in millimetres

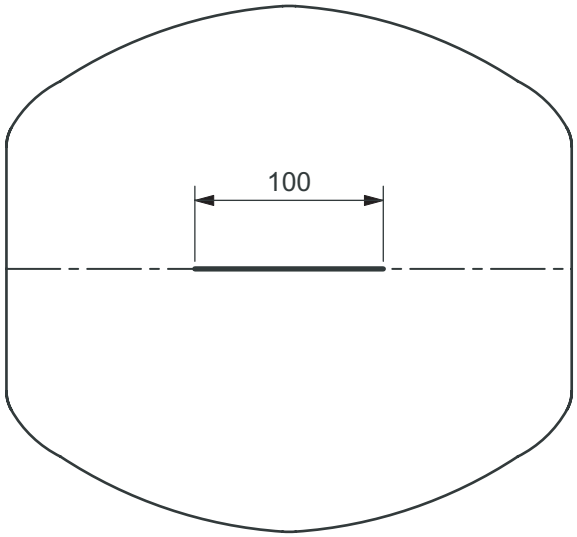


Figure 9 — Extent of radiography of welds – Cylinders with circumferential welds only

Dimensions in millimetres

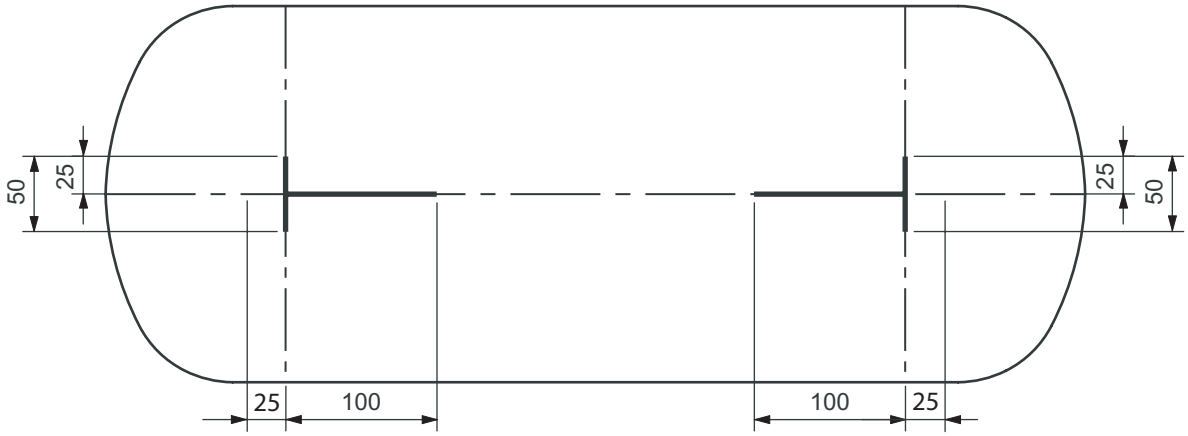


Figure 10 — Extent of radiography of welds – Cylinders with circumferential and longitudinal welds

7.8.2 Assessment

Assessment of the radiographic films shall be based on the original films in accordance with EN 462–1 and EN 462–2.

7.8.3 Requirements

The following imperfections as defined in EN ISO 6520–1 are not permitted:

— cracks;

— lack of penetration;

— lack of fusion of the weld;

— incompletely filled groove;

— root concavity;

— overlap;

— any elongated inclusion or any group of rounded inclusions in a row where the length represented over a weld length of 12*e* is greater than 6 mm;

— any gas pore measuring more than *e*/3 mm;

— any gas pore measuring more than *e*/4 mm, which is 25 mm or less from any other gas pore;

— gas pores over any 100 mm length, where the total area, in mm^2, of all the pores is greater than 2*e*.

7.9 Macro examination

7.9.1 Procedure

The macro examination shall be carried out in accordance with EN 1321.

7.9.2 Requirement

Full transverse sections of longitudinal and circumferential welds and any butt welded valve boss to cylinder joints shall show complete fusion and complete penetration as specified in 7.8.3. If there is a doubt, a microscopic examination shall be made of the suspect area.

In the case of partial penetration welds of the valve boss to cylinder, the depth of penetration shall be not less than that in the cylinders subject to prototype fatigue tests, refer to 6.3.1.

In the case of non-pressure containing attachments the weld penetration shall not exceed 40 % of the wall thickness of the pressure-containing part.

7.10 Visual examination of the surface of the weld

7.10.1 Procedure

The weld shall be examined in accordance with EN 970 after the weld has been completed. The welded surface to be examined shall be well illuminated, and shall be free from grease, dust, scale residue or protective coating of any kind.

7.10.2 Requirements

The welds shall comply with 6.3.5 and 6.3.6.

7.11 Fatigue test

7.11.1 Procedure

7.11.1.1 The cylinders shall be filled with a non-corrosive liquid, e.g. water with a corrosion inhibitor, and subjected to successive applications of hydraulic pressure.

7.11.1.2 The test shall be carried out at an upper cyclic pressure either:

— equal to two thirds of the test pressure, in which case the cylinder shall be subjected to 80 000 cycles, or

— equal to the test pressure, in which case the cylinder shall be subjected to 12 000 cycles.

7.11.1.3 The value of the lower cyclic pressure shall not exceed 10 % of the upper cyclic pressure.

7.11.1.4 The frequency of pressure cycling shall not exceed 0,25 Hz (15 cycles/min). The temperature measured on the outside surface of the cylinder shall not exceed 50 °C during the test.

7.11.2 Requirements

There shall be no leakage from the cylinder.

8 Technical requirements for type approval

8.1 Extent of testing

The manufacturer shall make available a batch of at least 50 cylinders of each type, which shall be guaranteed as being representative of the production cylinders. The material shall be of the same specification and have the same nominal thickness and the same manufacturing processes as the production cylinders.

Cylinders shall be selected for test as follows:

a) 3 cylinders for a fatigue test in accordance with 7.11 when so required by 5.4, 5.6.2, 6.3.1, 6.6.4 or Clause 10;

b) 2 cylinders for mechanical tests in accordance with 7.4 and 7.5 and radiographic/macro tests in accordance with 7.8 and 7.9;

c) 2 cylinders for a burst test in accordance with 7.6;

d) 2 cylinders shall be subject to:

— dimensional and wall thickness checks to confirm compliance with the design;

— tolerance checks to confirm compliance with the requirements of 6.4;

— visual examination of the surface of the welds, in accordance with 7.10;

NOTE These can be the same cylinders used for the mechanical tests.

8.2 Cylinder types

Different designs of cylinder shall be considered to be of the same type within the following limitations:

a) two piece cylinders which have the same:

— nominal diameter;

— nominal length of the pressure envelope, excluding the valve boss;

— nominal end profile;

— minimum thickness;

— material specifications;

and which are:

— equipped with the same openings (see 5.6.2);

— manufactured using the same manufacturing techniques;

— subject to the same heat treatment conditions;

— manufactured using the same type of mechanised or automatic welding machines;

b) three piece cylinders complying with the limitations of 8.2 a) except they can differ in length within the following limits:

— the length of the pressure envelope is not less than 3*D*;

— the length of the pressure envelope is not more than 1,5 times that of the cylinders type tested.

8.3 Type approval certificate

Each type of cylinder shall be covered by a type approval certificate.

9 Production testing and examination requirements

9.1 Tests and examinations applicable to all cylinders

9.1.1 All cylinders shall be subject to a visual examination of the longitudinal weld from both sides before the cylinder is closed in accordance with EN 970.

9.1.2 All finished cylinders, prior to coating, shall be subject to the following:

— pressure test as specified in 7.7;

— visual examination of the surface of the welds as specified in 7.10;

— inspection of the markings as specified in Clause 10 and Annex A.

9.1.3 Cylinders that do not pass the tests shall be rejected and segregated for repair and reassessment or scrapping.

9.2 Radiographic examination

9.2.1 Radiography shall be carried out on the circumferential and longitudinal welds (see Figure 9 and Figure 10) of the first production cylinder in the following circumstances:

— at start of production,

— after a change in the type or size of cylinder,

— after a change in the welding procedure (including machine setting), or

— after a break in production exceeding 4 h.

9.2.2 In the case of cylinders with an outside diameter less than 250 mm, radiography of joggle butt-welds may be replaced by two macro examinations (see 7.9), one of which shall be in the weld-overrun zone and the other on the opposite side of the cylinder.

9.2.3 In addition to the requirements of 9.2.1 for cylinders with longitudinal welds, one cylinder out of every 250 production cylinders shall have the junction of the longitudinal and circumferential welds radiographed as indicated in Figure 10.

9.2.4 Where more than one welding machine is used for production, the above procedures shall apply to each machine.

9.3 Macro examination

9.3.1 Macro examination shall be carried out on the circumferential welds of sample cylinders as detailed in Table 4 and Table 5. The sample cylinders shall be selected in accordance with 9.7.

9.3.2 Macro examination shall be carried out as specified in 7.9.

9.4 Examination of valve boss weld

Radiographic or macro examination shall be carried out at sampling rates and on samples taken from cylinders selected for the mechanical/burst tests as specified in 9.7.

9.5 Examination of non-pressure containing attachment welds

Macro examinations shall be carried out as follows:

— for cylinders where the attachments are welded before closure of the cylinder and visual examination has been made to check for evidence of excess penetration: one cylinder at the commencement of each production shift;

— for cylinders where visual examination for excess penetration has not been carried out: one cylinder out of every thousand cylinders produced.

The examination may be carried out on samples taken from cylinders selected for the mechanical/burst tests specified in 9.7.

NOTE The macro examination may be supplemented by radiographic examination at the manufacturer's discretion.

9.6 Unacceptable imperfections found by the radiographic or macro examinations

9.6.1 Should any of the radiographic or macro examinations show an unacceptable imperfection, production shall be stopped.

9.6.2 Every cylinder welded since the preceding acceptable radiographic or macro examination shall be set aside until it is demonstrated that these cylinders are satisfactory either by radiographic or macro examination or other appropriate means.

9.6.3 Production shall not be restarted until the cause of the defect has been established and rectified, and the procedure as specified in 9.2 has been repeated.

9.6.4 Cylinders that do not pass the tests shall be rejected and segregated for repair and reassessment or scrapping.

9.7 Batch testing (mechanical / burst tests)

9.7.1 Batch

A batch shall consist of finished cylinders made consecutively by the same manufacturer, using the same manufacturing process, to the same design, size and material specifications, on the same type of automatic welding machines and subject to the same heat treatment conditions.

NOTE In this context, "consecutively" need not imply continuous production.

9.7.2 Inspection lots

For acceptance purposes the batch shall be divided into inspection lots not exceeding 1 000 cylinders.

For selection of sample cylinders for either burst or mechanical tests, each lot is divided into sub-lots of 250 cylinders during the first 3 000 cylinders of a batch and sub-lots of 500 or lots of 1 000 cylinders, depending on cylinder size, thereafter (see Figure 11).

9.7.3 Rate of sampling

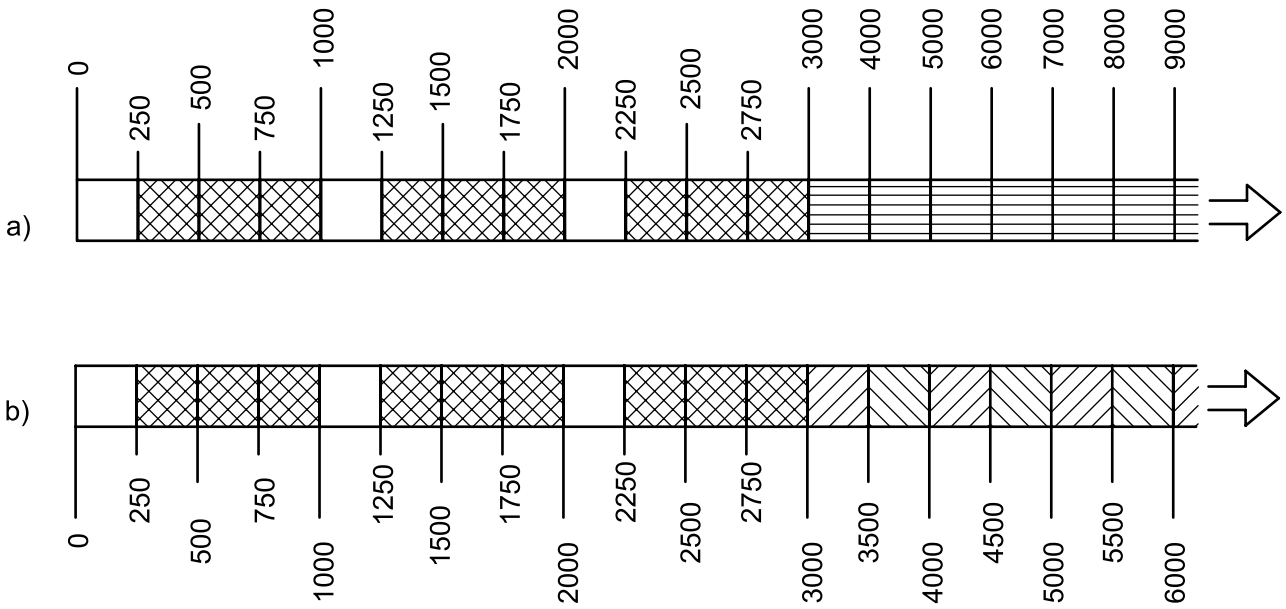
9.7.3.1 General

Where a batch contains material from more than one cast, the manufacturer shall arrange for samples tested to represent each cast of material used.

The reduced rate of sampling for large volume manufacture (above 3 000 cylinders) may only be applied once the manufacturer can demonstrate that the batch production test results and manufacturing processes are consistently reliable without any major interruption of manufacture.

Except as permitted by 9.7.3.4, the samples taken for "**B**urst tests **or M**echanical tests" shall be alternated between the mechanical and the burst tests.

A chart illustrating the rate of sampling is given in Figure 11.



Key

a) for cylinders of volume less than or equal to 35 l

b) for cylinders of volume greater than 35 l

Size of lot/sub-lot	Symbol	No. of cylinders	Type of tests
250	□	2	one subjected to a **B**urst test **and** one subjected to a **M**echanical tests.
250	▩	1	one subjected to a **B**urst test **or** a **M**echanical tests.
500	▨	2	one subjected to a **B**urst test **and** one subjected to a **M**echanical tests.
500	▨	1	one subjected to a **B**urst test **or** a **M**echanical tests.
1 000	▤	2	one subjected to a **B**urst test **and** one subjected to a **M**echanical tests.

NOTE Cylinders required by 9.7.2 to be subject to mechanical tests and which have a water capacity less than 6,5 l and a burst pressure greater than 100 bar can, at the manufacturer's discretion, be subjected to the alternative burst test.

Figure 11 — Inspection lots

9.7.3.2 Batch less than or equal to 3 000 cylinders

9.7.3.2.1 From the first 250 cylinders or less in each inspection lot, representative cylinders shall be taken at random, one for the burst test and one for mechanical tests.

9.7.3.2.2 From each subsequent group of 250 cylinders or less in the inspection lot, one representative cylinder shall be taken at random for either a burst test or mechanical tests.

9.7.3.3 Batch over 3 000 cylinders

9.7.3.3.1 Cylinders less than or equal to 35 l capacity

For the first 3 000 cylinders in the batch, representative cylinders shall be taken as specified in 9.7.3.2. For the remaining cylinders, from each inspection lot (1 000 cylinders), representative cylinders shall be taken at random, one for the burst test and one for mechanical tests.

9.7.3.3.2 Cylinders greater than 35 l capacity

9.7.3.3.2.1 For the first 3 000 cylinders in the batch, representative cylinders shall be taken as specified in 9.7.3.2.

9.7.3.3.2.2 From the first 500 cylinders or less in each inspection lot remaining, representative cylinders shall be taken at random, one for the burst test and one for mechanical tests. From the remaining 500 cylinders or less in such inspection lots, one representative cylinder shall be taken at random for either a burst test or mechanical tests.

9.7.3.4 Cylinders less than or equal to 6,5 l

For cylinders with a water capacity of less than or equal to 6,5 l and having a burst pressure greater than 100 bar, samples selected for mechanical tests may be subjected to a burst test as an alternative.

9.7.4 Additional checks

The sample cylinders selected for mechanical test shall also undergo the following checks:

— dimensional and wall thickness checks to confirm compliance with the design;

— tolerance checks to confirm compliance with the requirements of 6.4.

9.8 Failure to meet mechanical and burst test requirements

9.8.1 Mechanical

9.8.1.1 If there is evidence of a fault in carrying out the mechanical tests, or of an error of measurement, a second test on the same cylinder shall be performed. If the result of this test is satisfactory, the first test shall be ignored.

9.8.1.2 If the second test confirms the initial test result, the procedure specified in 9.8.3.1 or 9.8.3.2 shall be followed.

9.8.2 Burst

In the event of a single cylinder failing the burst test, the procedure specified in 9.8.3.1 or 9.8.3.2 shall be followed.

9.8.3 Batch retest

9.8.3.1 In the event of a single cylinder failing either the mechanical or burst test, both mechanical and burst tests shall be repeated as shown in Table 8, the retest cylinders shall be taken at random from the same lot/sub-lot.

Table 8 — Batch retest requirements

Inspection lot/sub-lot size	Failure	Retest
≤ 250	1 **M**	2 **M** + 1 **B**
≤ 250	1 **B**	2 **B** + 1 **M**
> 250	1 **M**	2 **M** + 2 **B**
> 250	1 **B**	1 **M** + 4 **B**
NOTE **M** denotes mechanical test and **B** denotes burst test.		

In the event that there is no failure from the retest the batch shall be accepted.

9.8.3.2 In the event of more than one cylinder failing the tests or one or more cylinders failing the retest specified in 9.8.3.1 the batch shall be rejected.

9.8.4 Resubmission of a batch

9.8.4.1 Heat-treated cylinders

In the case of heat treated cylinders, the manufacturer may re-heat-treat the rejected batch which shall then be resubmitted as a new batch as specified in 9.7.

9.8.4.2 Non heat-treated cylinders

In the case of non heat-treated cylinders, the batch may be heat-treated and resubmitted provided that further type approval tests are carried out and the weld procedures are qualified to establish the suitability of the heat treatment.

9.8.5 Weld repairs

Individual cylinders rejected due to local weld imperfections may, if not otherwise specified, be subjected to weld repairs without further heat-treatment provided that the cylinders are re-subjected to the tests specified in 9.1.2.

All repairs shall be carried out in accordance with an approved repair procedure by qualified personnel (see Clause 6).

10 Marking

Each cylinder shall be marked clearly and legibly with certification, manufacturing and operational information in accordance with EN 14894, together with those standard specific marks required by Annex A.

NOTE Marking in accordance with EN 14894 complies with the requirements of the RID/ADR.

Where the marking is directly on the pressure envelope, it shall be demonstrated by the fatigue and burst tests that failure does not initiate in the markings and the markings remain legible.

11 Certificate

Each batch of cylinders shall be covered by a certificate stating that the cylinders meet the requirements of this European Standard in all respects.

Annex A
(normative)

Manufacturer's marking

Table A.1 — Manufacturer's marking

Definition	Example
For a cylinder which is normalised, this symbol shall be placed immediately after this European standard number.	N
For a cylinder which is stress relieved, this symbol shall be placed immediately after this European standard number.	S
For a cylinder which is not normalised or stress relieved, this symbol shall be placed immediately after this European standard number.	U
Where the cylinder has been subject to a higher test pressure in accordance with 7.7.1.2, the grade(s) of LPG shall be marked.	"Butane" "Mixture A"

Bibliography

[1] ISO 10920, *Gas cylinders — 25E taper thread for connection of valves to gas cylinders — Specification*

[2] EN ISO 11116-1, *Gas cylinders — 17E taper thread for connection of valves to gas cylinders — Part 1: Specifications (ISO 11116-1:1999)*

[3] EN 13152, *Specification and testing of LPG cylinder valves — Self closing*

[4] EN 13153, *Specification and testing of LPG cylinder valves — Manually operated*

[5] ADR, European Agreement concerning the International Carriage of Dangerous goods by Road.

[6] RID, Regulations concerning the International Carriage of Dangerous Goods by Rail.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL