BS EN ISO 11118:2015

BSI Standards Publication

Gas cylinders — Non-refillable metallic gas cylinders — Specification and test methods

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National foreword

This British Standard is the UK implementation of EN ISO 11118:2015. It supersedes BS EN ISO 13340:2001 and BS EN 12205:2001 which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/3/3, Gas containers - Transportable gas containers - Cylinder design, construction and testing at the time of manufacture.

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

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

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European foreword

This document (EN ISO 11118:2015) has been prepared by Technical Committee ISO/TC 58 "Gas cylinders" in collaboration with the Technical Committee CEN/TC 23 “Transportable gas cylinders” the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by April 2016, and conflicting national standards shall be withdrawn at the latest by April 2016.

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

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Endorsement notice

The text of ISO 11118:2015 has been approved by CEN as EN ISO 11118:2015 without any modification.

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary Information

The committee responsible for this document is ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Cylinder design*.

This second edition cancels and replaces the first edition (ISO 11118:1999) and ISO 13340:2001, which have been technically revised with the following changes:

— removed references to dissolved gases from the Scope;

— the edition aligns ISO 11118 and EN 12205;

— incorporates ISO 13340 in ISO 11118;

— incorporated new titles of ISO referenced documents;

— incorporated definitions and use of R_{ea}, R_{eg}, R_{ma}, and R_{mg};

— clarified requirements for the processing of carbon steel to avoid strain aging;

— added pierceable metal membranes to cylinder non-refillability;

— added test requirement for aluminium materials for intercrystalline corrosion for seamless and welded aluminium cylinders;

— included alternative temperatures for artificial aging of carbon steel cylinder prior to burst testing;

— modified markings to align with UN requirements;

— clarified inspection criteria for each cylinder;

— corrected references to correct Annexes;

— modified burst pressure to align with other ISO Standards;

— aligned test pressure requirement of non-refillable sealing device to the same as the cylinder;

— modified Annex B for completeness;

— deleted existing Annex C since it was not needed and inserted a new Annex C for accuracy;

— added new informative Annex D for informational purposes on yield point elongation (YPE).

Introduction

This International Standard addresses the general requirements on design, construction, and initial inspection and testing of non-refillable metallic gas cylinders and their non-refillable sealing devices of the United Nations Recommendations on the Transport of Dangerous Goods: Model Regulations. The purpose of this International Standard is to provide a specification for the design, manufacture, inspection, and testing of non-refillable metallic gas cylinders for worldwide safe use, handling, and transport.

The objective is to balance design and economic efficiency against international acceptance and universal utility.

This International Standard aims to eliminate the concern about climate, duplicate inspections, and restrictions currently existing because of lack of definitive International Standards. This International Standard does not reflect on the suitability of the practice of any nation or region.

Gas cylinders — Non-refillable metallic gas cylinders — Specification and test methods

1 Scope

This International Standard specifies minimum requirements for the material, design, inspections, construction and workmanship, manufacturing processes, and tests at manufacture of non-refillable metallic gas cylinders of welded, brazed, or seamless construction for compressed and liquefied gases including the requirements for their non-refillable sealing devices and their methods of testing.

NOTE The specific gases permitted in cylinders constructed to this International Standard can be limited by national or international requirements.

This International Standard is applicable to cylinders where

a) the test pressure does not exceed 250 bar (i.e. $p_h \leq 250$ bar) for liquefied gases and 450 bar for compressed gases;

b) the product of the test pressure and the water capacity does not exceed 1 000 bar·litres (i.e. $p_h\, V \leq 1\ 000$ bar L);

c) the test pressure exceeds 45 bar and the water capacity does not exceed 5 l (i.e. for $p_h > 45$ bar, then $V \leq 5$ l).

2 Normative references

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

ISO 3651-2, *Determination of resistance to intergranular corrosion of stainless steels — Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid*

ISO 4706:2008, *Gas cylinders — Refillable welded steel cylinders — Test pressure 60 bar and below*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7866:2012, *Gas cylinders — Refillable seamless aluminium alloy gas cylinders — Design, construction and testing*

ISO 9329-1, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Unalloyed steels with specified room temperature properties*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 9809-1:2010, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa*

ISO 9809-4:2014, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 4: Stainless steel cylinders with an Rm value of less than 1 100 MPa*

ISO 10156, *Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets*

ISO 10297, *Gas cylinders — Cylinder valves — Specification and type testing*

ISO 11114-1, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 1: Metallic materials*

ISO 11114-2, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials*

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

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 20703:2006, *Gas cylinders — Refillable welded aluminium-alloy cylinders — Design, construction and testing*

3 Terms and definitions

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

3.1
batch
quantity of completed and pressure tested cylinders made consecutively by the same manufacturer using the same manufacturing techniques to the same design, size, and material specifications using the same type of welding machines (when applicable), welding procedures (when applicable), and to the same heat treatment conditions (when applicable)

Note 1 to entry: See Clause 10 for details.

3.2
cylindrical shell
portion of the cylinder excluding the cylinder ends which is parallel to the centreline axis of the cylinder

3.3
cylinder shell
empty cylinder before affixing the *non-refillable sealing device* (3.12), but including all other permanent attachments

3.4
material certificate
document issued by the material manufacturer which certifies the chemical analysis, mechanical properties, heat treatment, processing techniques, or other properties/features if required

3.5
burst pressure
highest pressure reached in a cylinder during the burst test

3.6
test pressure
required pressure applied during the pressure test

3.7
working pressure
settled pressure of compressed gas at a uniform reference temperature of 15 °C (288 K) in a full gas cylinder

3.8
minimum operating temperature
minimum ambient temperature to which the cylinder contents can be exposed, but not exceeding −20 °C

Note 1 to entry: See 5.1.6.

3.9
non-refillable cylinder
cylinder including a *non-refillable sealing device* (3.12) that permits the cylinder to be filled only once

Note 1 to entry: Where there is no risk of ambiguity, the short abbreviated form "cylinder" is used in this International Standard.

3.10
water capacity
volume of water required to completely fill an empty cylinder

3.11
processor
facility that anneals, rolls, slits, or otherwise, changes the material from the form received from the location where the steel was melted

3.12
non-refillable sealing device
device permanently attached to the cylinder which, once activated, prevents the cylinder from being refilled

4 Symbols

a calculated minimum thickness, in millimetres, of the cylindrical shell

D nominal outside diameter of the cylinder, in millimetres

F design stress factor (variable)

P_b burst pressure of the cylinder, in bar

p_h test pressure, in bar above atmospheric pressure

p_w working pressure, in bar above atmospheric pressure

p_{vt} non-refillable sealing device test pressure, in bar above atmospheric pressure

R_{ea} actual value of the yield strength, in megapascals, of the cylinder when tested

R_{eg} minimum guaranteed value of the yield strength, in megapascals, for the finished cylinder

R_{ma} actual value of the tensile strength, in megapascals, of the cylinder when tested

R_{mg} minimum guaranteed value of the tensile strength, in megapascals, for the finished cylinder

V water capacity of the cylinder, in litres

5 Materials

5.1 General requirements

5.1.1 Cylinder shells shall be made of carbon or low alloy steels, austenitic stainless steel, aluminium, or aluminium alloys. The materials used shall be specified by type (see 5.2) and chemical composition (see 5.3). Materials shall not contain seams, cracks, laminations, or other injurious defects. For material requirements of non-refillable sealing devices, see Annex A.

5.1.2 The cylinder manufacturer shall specify the chemical and mechanical requirements to the material supplier.

5.1.3 The cylinder manufacturer shall obtain a material certificate from the manufacturer/processor of the material certifying the chemical analysis of the cast. The certificate shall be issued by the manufacturer of the material and shall confirm compliance to the material specification.

5.1.4 The cylinder manufacturer shall verify that the materials are in accordance with the cylinder manufacturer specifications.

5.1.5 All materials used in the construction of the pressure containing parts of the cylinder shall be traceable.

5.1.6 All materials shall be suitable for use at the minimum operating temperature or at −20 °C, whichever is the lower.

5.1.7 The materials used for manufacture of the cylinder shell shall be compatible with the intended gas service as specified in ISO 11114-1 or ISO 11114-2.

5.1.8 Contact between dissimilar metals which could result in damage by galvanic corrosion shall be avoided.

5.2 Material types

5.2.1 Carbon and low-alloy steels

5.2.1.1 The steel used for the fabrication of gas cylinder shells shall be made in an electric furnace or, by the basic oxygen process, shall have non-ageing properties and shall be fully killed by aluminium and/or silicon.

5.2.1.2 Carbon steel for cold deep drawn seamless, welded, or brazed cylinder shells shall have non-ageing properties, processed free of stretcher strain, and shall be fully killed with aluminium and/or silicon. The chemical composition shall meet the requirements of 5.3.1.1.

5.2.1.3 Carbon steel for other welded cylinder shells shall have a chemical composition which meets the requirements of 5.3.1.2. The maximum tensile strength shall not exceed 700 MPa.

5.2.1.4 Carbon steel for cylinder shells made from seamless steel tubing with integrally formed ends, hot drawn, and finished shall have a chemical composition which meets the requirements of 5.3.1.3.

5.2.1.5 Low alloy steels shall conform to ISO 4706:2008, 5.9.1 or ISO 9809-1:2010, 6.1, 6.2, and 6.3

5.2.2 Aluminium and aluminium alloy

5.2.2.1 Aluminium alloys with a tensile strength greater than 500 MPa shall not be used.

5.2.2.2 Aluminium alloys used for cylinders shall conform to the material requirements of ISO 7866:2012, 6.1 and 6.2 or ISO 20703:2006, 4.1 and 4.2, as appropriate.

5.2.2.3 Pure aluminium is permitted and shall have a minimum aluminium content of 99,0 %.

5.2.3 Austenitic stainless steels

5.2.3.1 For austenitic stainless steels, the maximum tensile strength shall not exceed 800 MPa.

5.2.3.2 The cylinder manufacturer shall take into consideration the loss of material strength within the heat affected zone of any weld.

5.2.3.3 Austenitic stainless steels for all types of cylinder shells shall conform to ISO 9809-4:2014, 6.1 and 6.2.

5.2.3.4 Due to the risk of sensitization to inter-granular corrosion resulting from hot working/welding for each material specification and heat-treatment method, a corrosion test shall be carried out according to ISO 3651-2 on a specimen taken from a finished cylinder.

Some grades of stainless steels can be susceptible to environmental stress corrosion cracking. Special precautions should be taken in such cases.

5.3 Chemical compositions

5.3.1 Carbon and low-alloy steels

5.3.1.1 Carbon steels having non-aging properties for cold deep drawn welded or brazed cylinder shells shall have the following chemical composition limits in % mass fraction.

Carbon	≤0,12
Manganese	≤0,50
Phosphorus	≤0,025
Sulfur	≤0,025

5.3.1.2 Carbon steels for welded cylinder shells other than cold deep drawn shall have the following chemical composition limits in % mass fraction.

Carbon	≤0,25
Manganese	≤0,50
Phosphorus	≤0,025
Sulfur	≤0,025

5.3.1.3 Carbon steels for cylinders made of seamless steel with integrally formed ends, hot drawn, and finished shall have the following chemical composition limits in % mass fraction.

Carbon	≤0,55
Manganese	≤1,70
Phosphorus	≤0,025
Sulfur	≤0,025

5.3.2 Aluminium and aluminium alloys

Aluminium and aluminium alloys shall have a maximum lead and bismuth contents not exceeding 0,003 % each.

6 Inspection and testing

To ensure that the cylinders conform to this International Standard, they shall be subject to inspection and testing in accordance with Clauses 9 to 11 and Annex A by an inspection body (hereinafter referred to as "the inspector") authorized to do so.

Equipment used for measurements, testing, and examination during production shall be maintained and calibrated within a documented quality management system.

NOTE Evaluation of conformity can be carried out according to the regulations recognized by the country(ies) in which the cylinders are intended to be used.

7 Design

7.1 General requirements

7.1.1 The calculation of the cylindrical wall thickness of the pressure containing parts shall be related to the guaranteed minimum yield strength of the finished cylinder (R_{eg}).

7.1.2 The design of the cylinder shell shall be such that the pressure containing parts, when subjected to the test pressure (p_h), shall not show any permanent visible deformation.

7.1.3 Welded aluminium and welded aluminium alloy cylinders are limited to a maximum of 60 bar test pressure.

7.2 Calculation of pressure containing parts

The minimum thickness of the cylindrical shell of the pressure containing parts shall not be less than any of the three values determined in 7.2 a), b), or c).

a) The minimum thickness of the cylindrical shell shall be not less than that necessary for the minimum burst pressure to be greater than 1,6 times the test pressure (p_h) and such that the requirements of 9.2.4.5 and Clause 11 are met.

b) The minimum thickness of the cylindrical shell shall not be less than that calculated by the Lamé - von Mises formula as given in Formula (1).

$$a = \frac{D}{2}\left[1 - \sqrt{\left(\frac{10FR_{eg} - \sqrt{3}\,p_h}{10FR_{eg}}\right)}\right] \qquad (1)$$

where F ≤ 0,85

c) The minimum thickness of the cylindrical shell shall not be less than that calculated by using Formula (2) or Formula (3) as appropriate.

Formula (2) (for steel):

$$a = D/650 + 0{,}4 \qquad (2)$$

Formula (3) (for aluminium alloys):

$$a = D/300 + 0{,}5 \qquad (3)$$

NOTE It is generally assumed that p_h is equal to 1,5 times working pressure for compressed gases.

7.3 Design drawings

Fully dimensioned drawing(s) of the non-refillable cylinder shall be supplied which includes the following as a minimum:

a) material specifications for cylinder shells including, but not limited to R_{eg} and R_{mg} (MPa). In addition, the material specifications for the non-refillable sealing device shall be noted;

b) test pressure (bar);

c) minimum burst pressure (bar);

d) minimum thickness of the cylindrical shell (mm);

e) minimum water capacity (litre) (for cylinders ≤2 l, the water capacity may be reported in ml);

f) nominal cylinder outside diameter (mm);

g) dimensions of the cylinder ends (mm);

h) overall length of the cylinder (mm);

i) heat treatment (if any);

j) method of construction;

k) welding/brazing procedure designation (if any);

l) specifications for valve outlet connection or cylinder threaded connection for use (if applicable);

m) cylinder design identification;

n) design standard (i.e. ISO 11118);

o) date and revision identity of drawing;

p) manufacturers identity;

q) content and position of markings;

r) description of non-refillable sealing device that guarantees non-refillability and, if applicable, piercing force and energy required to pierce membranes.

8 Construction and workmanship

8.1 Construction

8.1.1 Types of construction of cylinder shell

The cylinder shells shall be of seamless, welded, or brazed construction.

8.1.1.1 Seamless construction

Seamless cylinder shells shall be produced by

a) forging or drop forging from a solid ingot or billet,

b) manufacturing from seamless tube, or

c) pressing from a flat plate (cold deep drawn).

Welding and brazing are only permitted to attach the non-refillable sealing device.

a) Welding shall be carried out only on cylinders made of weldable materials.

b) Brazing shall be carried out only on cylinders made of materials not degraded by this procedure.

8.1.1.2 Welded construction

8.1.1.2.1 General requirements

The welding of longitudinal and circumferential seams shall be by a semi-automatic or automatic process.

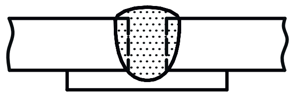
The longitudinal seam weld, if any, shall be of the butt type weld joint as illustrated in Figure 1 a).

The circumferential seam(s), if any, shall be butt-welded. The weld joint shall be as illustrated in Figure 1 a), b), c), or d).

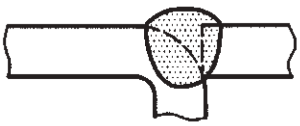
Welded joints shall have strength greater than the tensile strength of the finished cylindrical wall.

The welding procedure and operator qualifications shall include, as a minimum, welds representative of those made in production representing the variables in the materials and the process. Requalifying of the procedures and operators shall be required if there is a change in any of the essential variables as specified in 8.1.1.2.2.7.

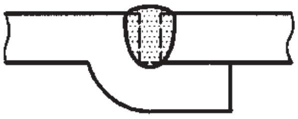
a) Butt weld joint



c) Butt weld joint with backing ring



b) Offset butt weld



d) Joggle butt weld

Figure 1 — Weld joints

8.1.1.2.2 Welding qualifications

8.1.1.2.2.1 General

a) All welding operators and welding procedures shall be approved by meeting the requirements of 8.1.1.2.2 through 8.1.1.2.2.9 or those given in ISO 9606-1, ISO 15613, and ISO 15614-1.

b) Records of welding operators and welding procedures qualifications shall be kept on file by the manufacturer.

c) Weld procedure specification approval tests shall be carried out such that the welds shall be representative of those made in production.

d) Welding operators and welding procedures shall pass the approval tests for the specific type of work and procedure specification concerned.

8.1.1.2.2.2 Materials for pressure and non-pressure containing parts

The materials used for qualification shall be the same as those specified in the procedure specification and those used for the production.

8.1.1.2.2.3 Positions of welds

For welder qualification, the position of the part for welding shall be the same as that in the actual manufacturing.

8.1.1.2.2.4 Welding consumables

The weld consumables shall be the same as those specified in the procedure specification, those tested from the welders, and those used for the production.

8.1.1.2.2.5 Retesting

Where a welder fails to meet the requirements of this International Standard,

a) an immediate retest shall be carried out of two test welds of the type failed, both of which shall meet all the requirements of the standard, or

b) a retest shall be carried out provided there is evidence that the operator has had further training and practice to the design and procedure specification.

8.1.1.2.2.6 Period of effectiveness

A welder shall be requalified on the design if the design has not been produced by the welder for a period of six months or more. Records of effectiveness shall be retained by the manufacturer.

8.1.1.2.2.7 Essential variables of the welding process

The procedure specification and welder qualification shall be tested when any of the following changes are made:

a) a change to the base materials;

b) a change to the welding material;

c) a change to the weld process;

d) a change to the weld position;

e) a decrease of 30 °C or more in the minimum specified preheating temperature;

f) the omission or addition of a backing strip in single pass welds;

g) a change from multiple pass to single pass per side;

h) a change to the shielding gas or to the composition (if greater than a 15 % change in the mixture);

i) a change from a single arc to multi arc or vice versa.

8.1.1.2.2.8 Welder qualification tests

a) For longitudinal welds:

    1) Bend test, root of weld;

2) Weld tensile test.

b) For circumferential welds:

1) Macro test;

2) Weld tensile test.

c) For threaded connections to cylinder ends: Macro tests, 180° apart.

d) For welded attachments, foot rings, collars, or lugs: Macro test.

e) For fillet welds: Macro tests, 180° apart.

8.1.1.2.2.9 Acceptance

a) For bend tests:

Upon completion of the test, the test piece (weld metal and base material) shall remain uncracked.

b) For tensile tests:

The tensile strength value obtained, R_{ma}, shall not be less than that guaranteed by the cylinder manufacturer regardless of the fracture location.

c) For macro tests:

The etched specimen shall be prepared to a resolution where visually, examination can occur to determine adequate root penetration into both members as to the established design (e.g. ISO 17639).

8.1.1.3 Brazed construction

Butt weld brazed joints shall not be used.

Three-piece cylinder designs with brazed seams shall not be permitted.

Brazing shall not be used for aluminium or aluminium alloy cylinders.

Brazing materials shall be compatible with the intended gas being placed in the cylinder.

The brazing material shall have a melting point greater than 540 °C.

Brazed seams shall be assembled such as to ensure complete penetration of the brazing material throughout the joint.

Brazed joints shall have strength greater than the tensile strength of the finished cylindrical wall.

Brazing procedures and operators shall be qualified to a written procedure (e.g. ISO 13585, EN 13134).

8.1.1.4 Attachments and openings

Attachments to the cylinder including sealing of the neck opening by welding or crimping a pierceable metal membrane shall be by means which are not detrimental to the integrity of the cylinder. Welding or brazing of attachments to the cylinder other than non-refillable sealing device shall be completed prior to the final testing of the cylinder shell (see Clause 11).

There shall be no openings or attachments in the cylindrical shell.

All openings and their reinforcements shall be within an imaginary circle concentric with the centreline axis of the cylinder. The diameter of the circle shall not exceed 80 % of the outside diameter of the cylinder. The plane of the circle shall be perpendicular to the centreline axis of the cylinder (see Figure 2).

If necessary, each opening can be reinforced by a securely attached fitting, boss, pad, collar, or other suitable means.

Material used for welded attachments and fittings shall be of weldable quality and compatible with the cylinder material.

Material used for brazed attachments and fittings shall be of brazable quality and compatible with the cylinder material. The minimum width of the brazed joints shall be at least four times the minimum design shell wall thickness.

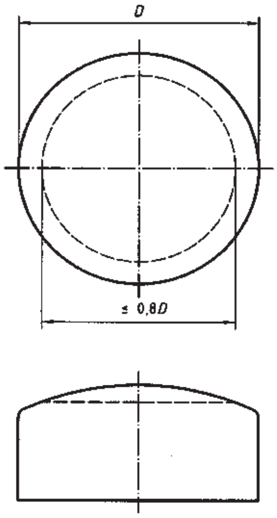


Figure 2 — Openings

8.1.2 Cylinder non-refillability

The cylinder shall be equipped with a device rendering the cylinder non-refillable. This can be accomplished by a valve or a pierceable metal membrane in accordance with Annex A that is permanently attached to the neck opening which, when in place, renders the cylinder non-refillable. Replaceable sealing devices shall not be used.

8.1.3 Pressure relief devices

Where a pressure relief device is an integral part of the cylinder, the manufacturer of the cylinder shall size the pressure relief device to have sufficient relieving capacity to prevent the rupture.

8.2 Workmanship

The quality of workmanship and construction shall be such as to ensure that cylinders are free from defects, including at least the following:

a) the pressure containing parts shall be of uniform quality and free from surface imperfections which could adversely affect the safe working of the cylinder;

b) before sealing the cylinder or after welding the longitudinal joint, if any, each cylinder shall be clean, dry, and free of any loose particles;

c) after completion of all welded/brazed joints, the weld shall not have concavity, weld under-cutting, or abrupt weld irregularity nor have any cracks or other defects;

d) if filling is part of the cylinder manufacturing process, the gas properties and filling conditions shall be in accordance with the appropriate regulations.

9 Type approval procedure

9.1 General requirements

A technical specification of each new design of cylinder [or cylinder family as defined in 9.1 f)], including design drawing, design calculations, material details, and heat treatment, shall be submitted by the manufacturer to the inspector. The results of the tests shall be summarized in a report to be kept available by the approval holder and are available for review/inspection when required.

The type approval tests detailed in 9.2 and Annex A shall be carried out on each new design under the supervision of the inspector.

A cylinder shall be considered to be of a new design when at least one of the following applies:

a) it is manufactured in a different manufacturing facility;

b) it is manufactured by a different process (this includes any major process change);

c) it is manufactured from a material of different specification;

d) it is given a different heat treatment, if applicable;

e) either the cylinder profile or the thickness of the starting material have changed relative to the cylinder diameter or calculated minimum thickness of the cylindrical shell respectively;

f) the overall length of the cylinder has increased by more than 50 % (cylinders with a length/outside diameter ratio less than three shall not be used as reference for any new design with this ratio greater than three);

g) the nominal outside diameter of the cylinder has been increased or decreased by more than 1 % or 5 mm, whichever is greater of the original design diameter;

h) an increase in the test pressure that requires a change in design cylindrical wall thickness;

i) the non-refillable sealing device design has changed.

9.2 Prototype tests

9.2.1 General

A minimum of 50 cylinder shells guaranteed by the manufacturer to be representative of the new design shall be tested as described in 9.2.2, 9.2.3, 9.2.4, and 9.2.6. Prior to subjecting the cylinder shells to prototype testing, the cylinder shells shall be subjected to a pressure equal to the test pressure (p_h) and exhibit no leakage or visible distortion. The complete non-refillable cylinders shall be tested as described in 9.2.5 and 9.2.7 (if applicable).

The non-refillable sealing device shall be tested as defined in A.3 or A.4 as applicable.

If the results of the tests conducted in accordance with 9.2.2 to 9.2.7 and Annex A are satisfactory, the inspector shall issue a new design type approval certificate, a typical example of which is given in Annex B.

9.2.2 Material tests

A check analysis shall be performed by the cylinder manufacturer on material representative of the cylinders.

Check analysis shall be carried out either on specimens taken during manufacture from the material in the form as supplied by the material manufacturer to the cylinder manufacturer or from finished cylinders. For carbon steels, the maximum permissible deviation from the limits for the cast analyses shall conform to the values specified in ISO 9329-1.

Where use is made of an aluminium alloy containing copper or where use is made of an aluminium alloy containing magnesium and manganese and the magnesium content is greater than 3,5 % or the manganese content lower than 0,5 %, possible intercrystalline corrosion shall be tested for each material specification and heat-treatment method. The test shall be carried out according to ISO 7866:2012, A.1.

9.2.3 Tensile tests

9.2.3.1 Tensile tests shall be carried out on material taken from three representative cylinders. These tensile specimens shall be located as shown in Figure 3, except that for cylinders with diameters ≤140 mm, transverse tensile specimen for testing the parent material are not necessary to be taken.

9.2.3.2 Tensile specimens shall be prepared and tested in accordance with ISO 6892-1. If due to cylinder size or configuration the specimen size cannot meet the requirements of ISO 6892-1, a smaller sample can be used following the guidelines of ISO 4706.

The cylinder manufacturer shall record the actual tensile strength (R_{ma}), actual yield strength (R_{ea}), and percentage elongation after fracture.

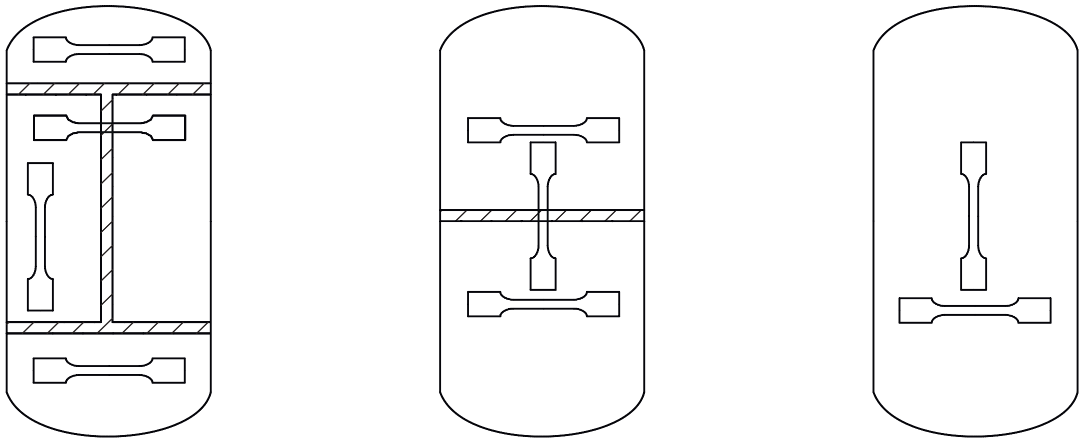
9.2.3.3 All tensile specimens shall exhibit a ductile fracture and mechanical properties for the relevant materials shall be as required in Clause 5 and 7.3. In addition,

a) for heat-treated and non-heat-treated cylinders, the tensile strength (R_{ma}) shall meet the requirements of the design criteria;

b) for heat-treated and non-heat-treated cylinders, the actual yield strength (R_{ea}) shall be ≥R_{eg};

c) for heat-treated and non-heat-treated cylinders, the percentage elongation after fracture shall be recorded. Percentage of elongation determination shall not be required on welded/brazed joint tensile specimens;

d) welded/brazed joint tensile specimens shall not fracture in the welded or brazed joint.



a) 3-piece cylinder b) 2-piece cylinder c) Seamless cylinder

Figure 3 — Location of tensile specimens

9.2.4 Burst tests

9.2.4.1 Burst tests shall be carried out on a minimum of three representative cylinders. If the markings on the cylinder are to be engraved or stamped, all prototypes shall be engraved or stamped prior to burst testing using the marking process used in production. The test can be performed with or without the non-refillable sealing device attached.

Burst testing successfully passing the requirements of 9.2.5.4 fulfils the requirement of this Clause.

9.2.4.2 Each cylinder shall be weighed to determine its tare weight. Each cylinder shall then be filled with water to the maximum volume of the cylinder to determine the cylinder water capacity. The cylinder tare weight and water capacity shall be recorded.

9.2.4.3 Tests shall be carried out at room temperature.

9.2.4.4 Non-refillable carbon steel cylinders that have not been heat-treated shall be artificially aged prior to burst testing.

Artificial ageing of the cylinder shall be accomplished by holding it at a temperature of either

a) 100 °C for a minimum of 1 h,

b) 120 °C for a minimum of 15 min, or

c) 150 °C for a minimum of 2,5 min.

After exposure to heat and prior to filling, the cylinder shall be allowed to return to room temperature by air cooling.

Where hydraulic burst testing of the cylinder is not feasible or if the valve or cylinder design prevents a hydraulic fluid from being introduced into the cylinder, a pneumatic burst test can be conducted. When a pneumatic burst test method is used, all safety precautions and considerations shall be taken to ensure the safety of personnel and property.

WARNING — Carrying out a pneumatic burst pressure test is considerably more dangerous than performing a hydraulic burst pressure test. A pneumatic burst pressure test should only be carried out after ensuring that any additional safety requirements (over and above those required for a hydraulic burst pressure test) are in place.

9.2.4.5 The procedure for burst testing cylinders is

a) for cylinder designs with p_h of <70 bar, pressurize the cylinder to the test pressure (p_h) at a rate not exceeding 14 bar/min and hold the test pressure for 30 s. There shall be no decrease in the pressure during the 30 s holding period. Once the holding period has passed, increase the pressure in the cylinder (at any convenient rate) until the cylinder bursts.

   Measurements shall be taken at discreet intervals during the test (from test start to cylinder burst) of the cylinder pressure and time so as to be able to ascertain the following:

   1) the initial cylinder pressurization rate;

   2) the holding period duration and pressure;

   3) the pressurization rate applied from the end of the holding period to cylinder burst;

   4) the cylinder burst pressure.

   NOTE A time versus cylinder pressure plot can be employed as a means of recording the necessary test parameters.

b) for cylinder designs with P_b ≥ 70 bar, pressurize the cylinder to the test pressure (p_h) at a rate not exceeding 5 bar/s to test pressure (p_h) and hold for 30 s. There shall be no decrease in the pressure during the holding period. Once the holding period has passed, increase the pressure in the cylinder at any convenient rate until the cylinder bursts.

Measurements shall be taken at discreet intervals during the test (from test start to cylinder burst) of the cylinder pressure and time so as to be able to ascertain the following:

1) the initial cylinder pressurization rate;

2) the holding period duration and pressure;

3) the pressurization rate applied from the end of the holding period to cylinder burst;

4) the cylinder burst pressure.

NOTE A time versus cylinder pressure plot can be employed as a means of recording the necessary test parameters.

9.2.4.6 The burst test acceptance criteria are the following:

a) the burst pressure shall be equal to or greater than 1,6 times the test pressure of the cylinder;

b) initiation of the failure shall not be in a weld or braze or in the heat affected zone of a weld or braze;

c) the initiation of the failure shall be in the cylindrical shell of the cylinder, except if the fracture initiation is caused by shear stress in the cylinder ends at the point of an attachment. In all cases, the fracture shall be ductile;

d) the burst cylinder shall remain in one piece under bursting;

e) the burst cylinder shall not exhibit evidence of yield point elongation (see Annex D).

9.2.5 Drop tests

9.2.5.1 Drop tests shall be carried out on a minimum of three representative cylinders. The samples for drop testing shall be representative of the final shipping package (e.g. carton, overpack, cylinder cap). The drop tests can be conducted without the final shipping package if this condition would be more severe.

9.2.5.2 The impact surface shall be a concrete block 1 m × 1 m × 0,1 m thick from a single cast composed of cement, sand, and gravel. It shall be protected by a sheet of steel 10 mm thick. The flatness of the protective sheet shall be such that the difference in level of any two points on its surface shall not exceed 2 mm.

9.2.5.3 Cylinders used for liquefied gases shall be filled with water or other inert material (i.e. sand) to the maximum water capacity of the cylinder. Cylinders used for permanent gases shall be filled with water to 40 % of the water capacity of the cylinder. In neither case, shall the cylinder be pressurized for the drop test.

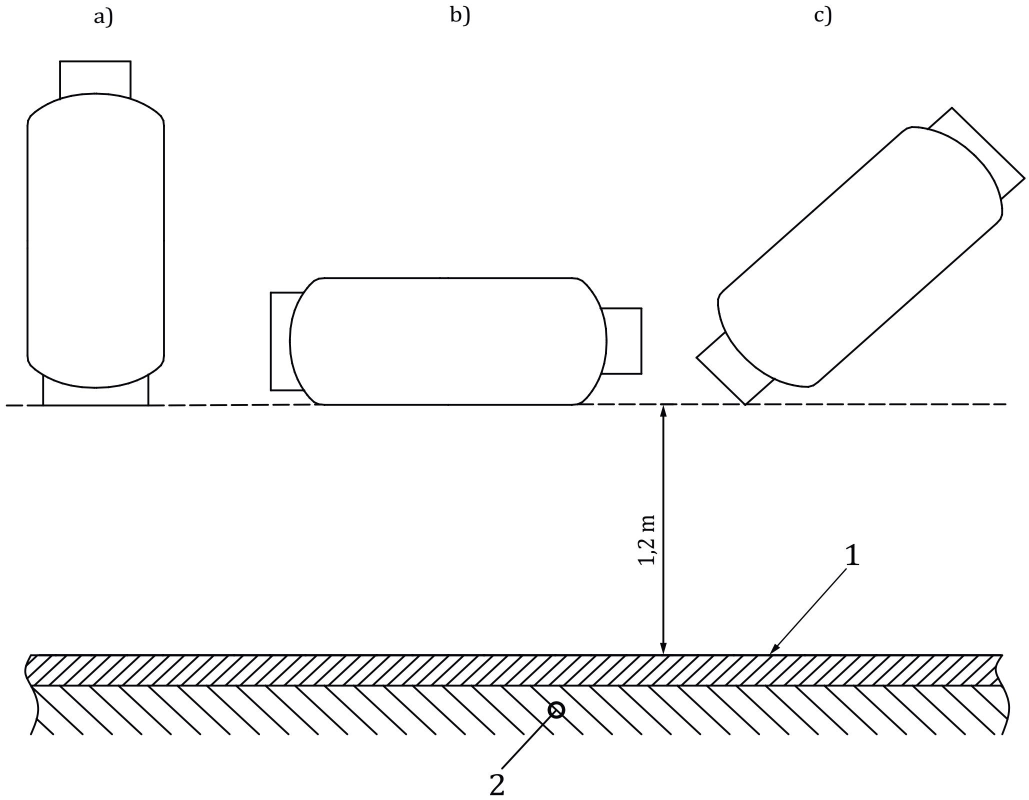
The drop test procedure are the following:

a) one cylinder shall be dropped from a height of 1,2 m with the bottom of the cylinder striking the impact surface as illustrated in Figure 4 a);

b) one cylinder shall be dropped from a height of 1,2 m with the cylinder sidewall striking the impact surface as illustrated in Figure 4 b);

c) one cylinder shall be dropped from a height of 1,2 m with the cylinder cap, collar, guard, or other valve protection device striking the impact surface at a 45° angle as illustrated in Figure 4 c).

9.2.5.4 For cylinders tested as described in 9.2.5.3, the cylinder shall exhibit no leakage at a minimum pressure of 2 bar. The non-refillable sealing device shall remain operational (e.g. capable of being opened and closed, if applicable) and the cylinder shall pass the burst test as described in 9.2.4.



Key

1 impact surface

2 concrete block

Figure 4 — Drop tests

9.2.6 Dimension checks

9.2.6.1 Dimension checks shall be carried out on a minimum of three prototype cylinders. The finished cylinder shall be longitudinally sectioned into sufficient pieces to determine the minimum thickness in the cylindrical shell. Alternatively, ultrasonic measurement or any other equally sensitive method can be used. The minimum thickness shall not be less than the minimum thickness in 7.2 and shall not be less than the minimum thickness specified on the design drawing.

9.2.6.2 The nominal outside diameter (*D*), length, and ends radii shall be measured and be in accordance with the design drawing (see 7.3).

9.2.7 Valve to cylinder interface test

One sample of each valve and cylinder design shall be subjected to a hydraulic overpressure to prove each design of valve to cylinder interface. The interface shall not fail at <1,6 times the highest test pressure (p_h) of any cylinder to be used for that design interface.

9.3 Design type approval

Once the results of the prototype tests according to 9.2 (including Annex A) are satisfactory, the inspector shall issue a type approval certificate referring to the design type test report. An example of a certificate of type approval is given in Annex B.

10 Batch tests

10.1 General requirements

A burst test in accordance with 9.2.4 shall be carried out at a frequency of at least one per batch, as specified in Table 1.

The burst tests shall be conducted on randomly selected cylinder shells. All engraved or stamped markings on the cylinder shell or cylinder ends shall be made prior to burst testing. When a cylinder design is assembled from component parts (e.g. a welded or brazed construction), the component parts may be manufactured at a time previous to manufacturing the batch.

Table 1 — Sampling frequency

p_hV	Sampling frequency
0–50	1/1 000
51–300	1/750
301–600	1/500
601–1 000	1/200

For cylinders with p_hV 0-50, the sampling frequency can be reduced to one in 1 500 after 3 000 cylinders have been successfully manufactured and passed all tests, have been manufactured consecutively by the same manufacturer using the same manufacturing techniques, to the same design, size, and material specifications using the same type of welding machines (when applicable), welding procedures (when applicable), and to the same heat treatment conditions (when applicable). The manufacturing time frame might not exceed a 12 h time period.

10.2 Failure to meet test requirements

If the cylinder shell fails to meet any of the requirements of 9.2.4.6, the batch shall be rejected. If the cause for the rejection can be determined and the affected cylinders isolated from the batch, the remainder of the batch can be requalified by retesting following the requirements given in 10.1. Any cylinder that fails to meet the requirements of 9.2.4.6 shall be rendered unserviceable (e.g. by crushing).

11 Tests on every cylinder

Each cylinder shall be inspected for the following:

a) being free of cracks, seams, laminations, or other defects;

b) weld quality;

c) proper markings.

Each non-refillable cylinder, except those used for burst tests, shall be proof pressure tested at a pressure of at least the test pressure (p_h). The cylinder shall remain at the proof test pressure long enough, at least 10 s for testing with gaseous media and 30 s for liquid media, to make it possible to validate the integrity of the cylinder and welds.

Pressure testing shall be conducted with the cylinder submerged under water or by any other method giving equal sensitivity of leak detection. As an alternative, the cylinder shall be pressure tested at test pressure (p_h) and subsequently, be leak tested at the time of filling.

Cylinders shall not exhibit leaks, visible distortion, or any other defects during the test.

Cylinders exhibiting any of these defects shall be rejected.

Cylinder weld repair are permitted. The weld operator and process shall be as defined in Clause 8. Repairs shall be followed by pressure testing as defined above.

Cylinders that cannot be repaired shall be rendered unserviceable.

WARNING — It should be noted that pneumatic pressure tests are considerably more dangerous than water pressure tests since, regardless of the size of the cylinder, any error in carrying out this test is highly likely to lead to a rupture under gas pressure. Therefore, these tests should only be carried out after ensuring that the safety measures satisfy the safety requirements.

12 Markings

12.1 General

The markings shall be durable and waterproof and shall be affixed to the cylinder.

Engraving is permitted when it does not influence the burst pressure or integrity of the cylinder. When engraving in the cylindrical shell is conducted, the remaining wall thickness after engraving shall meet the minimum design wall thickness of the cylinder.

NOTE Attention is drawn to requirements for marking in relevant regulations which might override the requirements given in this International Standard.

12.2 Manufacturing and operational markings

12.2.1 Each cylinder shall be marked with the following:

a) number of this International Standard, i.e. ISO 11118;

b) working pressure (bar) proceeded by the letters PW (for compressed gases) and test pressure (bar) proceeded by the letters PH and followed by the letters BAR;

c) water capacity (litre);

d) the character(s) identifying the country of manufacture as indicated by the distinguishing signs for motor vehicles in international traffic followed by the registration number or symbol of the cylinder manufacturing facility. This country mark is not required if it is the same as that in 12.2.1 e);

e) the character(s) identifying the country which approved the inspector as indicated by the distinguishing signs for motor vehicles in the international traffic followed by mark of the inspector

f) date of manufacture, the year (two digits), followed by the month (two digits) separated by a forward slash;

g) batch serial number;

h) UN identification number of the gas prefixed by the letters UN.

12.2.2 The markings specified in 12.2.1 a) to e) inclusive, shall be in numbers and letters at least 3 mm in height and sequentially displayed. For cylinders ≤0,2 l or ≤40 mm, external diameter markings shall not be less than 1,5 mm in height.

Example for liquefied gases:

ISO 11118	PH22BAR	15L	F MF	USA IB
12.2.1 a)	12.2.1 b)	12.2.1 c)	12.2.1 d)	12.2.1 e)

Example for compressed gases:

ISO 11118	PW150PH225BAR	15L	F MF	USA IB
12.2.1 a)	12.2.1 b)	12.2.1 c)	12.2.1 d)	12.2.1 e)

12.2.3 Date codes and batch markings as required by 12.2.1 f) and g) shall be numbers at least 3 mm in height and sequentially displayed. For example:

91/06-0000

12.2.1 f) 12.2.1 g)

12.2.4 The UN identification number of the gas, as required by 12.2.1 h), shall be in characters at least 3 mm in height. For example:

UN1013

12.2.1 h)

12.3 Other markings

In addition to the marking requirements given in 12.2, the cylinder shall also be marked “DO NOT REFILL”. This marking shall be a minimum of 5 mm in height.

Additional markings might be required by the country of origin or use.

13 Test reports and certificate of compliance

Each batch of non-refillable cylinders, including the non-refillable sealing devices, shall be certified to state that they conform to ISO 11118. The certificate shall be signed by the inspector. An example of a certificate is given in Annex C.

The test reports shall be prepared summarizing all the tests carried out and the results obtained.

These reports shall be signed by the responsible person(s) of the testing organization and shall include drawings, parts, lists, material certificates, etc.

Annex A
(normative)

Non-refillable sealing devices — Specifications and prototype testing

A.1 General

This annex specifies requirements of non-refillable sealing devices, valves, or pierceable metal membranes to be used with non-refillable cylinders and the method of testing for prototype approval.

A.2 Requirements

A.2.1 General

Non-refillable sealing devices shall operate satisfactorily over the full range of operating temperatures normally from –20 °C to 65 °C. The range can be extended for short periods (e.g. during filling).

Non-refillable sealing devices shall be capable of withstanding the mechanical stresses and chemicals they may experience during normal operation.

A.2.2 Requirements for non-refillable valves

A.2.2.1 General

A.2.2.1.1 Valve description

Valves for non-refillable cylinders are typically comprised of the following:

a) a body;

b) a valve operating mechanism including the sealing device;

c) connection(s) for use (fill and discharge);

d) a connection system between the valve and cylinder shell.

Also, it can occasionally incorporate the following:

a) a safety device against over pressurization;

b) a dip tube ;

c) a screw plug or cap on the outlet connection to ensure leak tightness or protection;

d) an excess flow limiting device.

A.2.2.1.2 Materials

Metallic and non-metallic materials in contact with the gas shall be chemically and/or physically compatible with the gas under all intended operating conditions (as specified in ISO 11114-1 and ISO 11114-2).

For oxygen or other oxidizing gases, the compatibility of the material with these gases and ignition resistance of materials and lubricants should be considered by an appropriate test procedure (e.g. ISO 11114-3).

A.2.2.2 Design and construction

A.2.2.2.1 Valve body

The valve body shall be manufactured by a process that will ensure the reproducibility of the mechanical characteristics necessary to meet the requirements.

A threaded valve shall not be able to be removed without destruction of the original cylinder thread.

The valve body shall be capable of withstanding a hydraulic burst pressure test in accordance with A.3.2.2.

A.2.2.2.2 Valve operating mechanism

The valve operating mechanism shall be manufactured from materials capable of withstanding the mechanical stresses including possible dynamic loads (for example, pressure shocks or cyclic changes) and the extremes of service temperature to which it may be subjected.

The valve operating mechanism shall

a) be designed in such a way that the cylinders cannot be refilled;

b) not be dependent on the pressure in the cylinder;

c) under normal conditions, operate without difficulty throughout its service life;

d) be designed in such a way that the setting of the operating position of the valve can only be changed by a positive action;

e) be designed to ensure that lubricants that are not oxygen compatible do not come into contact with oxidizing gases as defined in ISO 10156.

A.2.2.2.3 Leak Tightness

External and internal leak tightness shall be achieved over the full range of operating pressures and temperatures.

The leak tightness test is normally carried out with air or nitrogen. Valves designated for use with gases lighter than air shall be subjected to a test using helium or hydrogen. The leak tightness test shall be carried out at room temperature, at –20 °C and at +65 °C.

A.2.2.2.4 Leakage rate

The internal or external leakage rate shall not exceed 6 cm^3/h corrected to normal temperature and pressure (20 °C and 1 013 m bar).

The specified rate can be amended by agreement and subject to special applications, for example, for valves for highly toxic or high purity gas service, a lower leakage rate may be specified.

A.2.3 Requirements for pierceable metal sealing membranes

A.2.3.1 General

Pierceable metal sealing membranes shall retain their sealing properties and piercing force requirements throughout the full range of operating temperatures normally from –20 °C to 65 °C. Pierceable metal sealing membranes shall be capable of withstanding the mechanical stresses and contents they may experience during normal operation.

A.2.3.2 Materials

The membrane material in contact with the gas shall be chemically and/or physically compatible with the gas according to ISO 11114-1 and ISO 11114-2 under all intended operating conditions.

For oxygen or other oxidizing gases, the compatibility of the membrane material with these gases and ignition resistance of materials and lubricants shall be verified by an appropriate test procedure (e.g. ISO 11114-3).

A.2.3.3 Design and construction

The membrane shall be designed so that it can be used only once. The membrane can incorporate a separate seal and/or a central pierceable area. It shall be constructed so that the force required to open the membrane shall meet the specified limits for piercing force and energy required to pierce. Where the membrane is attached to the neck opening by welding, the material shall be of weldable quality, shall be conducted using compatible welding consumables (if applicable), and shall be compatible with the cylinder material.

A.2.3.4 Leak tightness

External and internal leak tightness shall be achieved over the full range of service pressures and temperatures.

The leak tightness test is normally carried out by differential weighing of the filled cylinder after a suitable storage period or by an appropriate gas leak detection systems with a sensitivity to meet the requirements of A.2.3.5.

A.2.3.5 Leakage rate

The leak rate for the membrane and the associated welded areas shall not exceed = 0,355 2 cm^3/h at test temperature (see A.4.4).

The specified rate can be amended by agreement and subject to special applications, for example, for membranes for highly toxic or high purity gas service, a lower leakage rate may be specified.

A.3 Prototype tests of permanently attached non-refillable valves

A.3.1 General

A minimum of 50 cylinder valves guaranteed by the manufacturer to be representative of the new design shall be made available for prototype testing.

Before valves are introduced into service, they shall be submitted for prototype testing which shall be carried out separately from the prototype testing of the cylinder shell. The manufacturer shall make available to the inspector a set of drawings consisting of the general arrangement, parts list, and material specifications. Any type variant within the given family shall be clearly identified.

a) Description of valve and method of operation.

b) Information on the field of application of the valve (e.g. gases and gas mixtures, pressures, use with or without valve protection device). It shall be clearly indicated which gases and gas mixtures can be used with each type variant.

c) Certificates of material compatibility as required.

A.3.2 Test valves

A.3.2.1 Schedule of tests

A minimum of nine sample valves shall be selected from the batch of 50 valves presented to the inspector.

a) One sample (n°1) for the hydraulic burst pressure test (see A.3.2.2).

b) Five samples (n°2 through n°6) for the tightness test (see A.3.2.3).

c) One sample (n°7) for the non-refillability test (see A.3.2.4).

d) One sample (n°8) for the valve to cylinder interface test (see A.3.2.6).

e) One sample (n°9) for any additional test which may be required.

f) For oxygen service three additional samples (n°10 through n°12) shall be subjected to the oxygen pressure surge valve test (see A.3.2.5).

A.3.2.2 Hydraulic burst pressure test

For safety reasons, this test shall be carried out prior to all other tests. The hydraulic burst pressure test shall be carried out with the following:

a) the valve seat in open position;

b) the valve outlet connection sealed;

c) any safety relief devices (where fitted) removed and the opening sealed;

d) the test medium is water or any other suitable fluid;

e) the hydraulic burst test pressure minimum is 1,6 times the test pressure of the cylinder;

f) the test temperature is the ambient temperature;

g) the pressure holding time is 2 min minimum.

The pressure shall be raised continuously and gradually. The prototype valve shall withstand the test pressure without permanent deformation or rupture.

A.3.2.3 Leak tightness test

Five samples shall be tested. Both internal (across the seat) and external (using the adaptor, if any) leak tightness shall be tested at 0,5 bar and at p_{vt}. The leak rate shall not exceed the requirements of A.2.2.2.4.

a) The value for p_{vt} shall be

   1) for compressed gases, p_{vt} = 1,2 x p_w;

   2) for liquefied gases, p_{vt} is at least equal to the minimum test pressure of the cylinder quoted in the relevant transportation regulation for that gas or gas group taking account of the actual filling ratio to be used.

b) The valve shall be tested in the flow direction, in the two following conditions:

   1) the valve closed, and

   2) the valve open (by an appropriate device, if any) the outlet being plugged.

A.3.2.4 Testing for non-refillability

One sample shall be tested to ensure the valve will resist a positive pressure in the reverse flow direction. The test media shall be air for valves used for compressed gases and water may be used for liquefied gases.

a) For non-return valve types, either

   1) attach a suitable container of the same water capacity as the cylinder intended to be used to the valve outlet. The valve stem shall be at atmospheric pressure for these tests. Pressurize the container to a positive pressure of 10 % of p_{vt}, but not less than two bar. Ensure that the valve is open. After 1 h, check the pressure in the container. The fall in pressure of the container shall not exceed 5 % of the original pressure, or

   2) attach the valve stem to a suitable container of the same water capacity as the cylinder intended to be used. Apply a continuous positive pressure of 10 % of p_{vt}, but not less than two bar to the valve outlet. Ensure that the valve is open. After 1 h, check the pressure in the container. The pressure shall not exceed 5 % of the applied pressure.

b) For valves of the single use operating mechanism type.

   1) By visual examination, it shall be established that it is not possible to reassemble the mechanism for the purpose of refilling.

A.3.2.5 Oxygen pressure surge valve test

Three samples shall be tested at p_{vt} in accordance with ISO 10297.

The value for p_{vt} shall be

a) for compressed gases, $p_{vt} = 1{,}2 \times p_w$, and

b) for liquefied gases, p_{vt} is at least equal to the minimum test pressure of the cylinder quoted in the relevant transportation regulation for that gas or gas group taking account of the actual filling ratio to be used.

A.3.2.6 Valve to cylinder interface test

One sample valve and cylinder shall be subjected to a hydraulic overpressure to prove each design of valve to cylinder interface. The interface shall not fail at less than1,6 times the highest test pressure of any cylinder to be used for that design of interface.

A.4 Prototype tests of pierceable metal sealing membranes

A.4.1 General

The test specified in this section shall be carried out on completed non-refillable cylinder. The manufacturer shall make available to the inspector the following:

a) a set of drawings consisting of the general arrangement, parts list, and material specifications;

b) which gases and gas mixtures can be used with each pierceable metal sealing membrane;

c) certificates of material.

A.4.2 Schedule of tests

A minimum of 50 cylinder valves guaranteed by the manufacturer to be representative of the new design shall be made available for prototype testing. As a minimum

a) two samples for the burst pressure test and interface test (see A.4.3);

b) five samples for the leak tightness test (see A.4.4);

c) one sample for any additional test which may be required.

A.4.3 Membrane/cylinder interface test

After filling and sealing the cylinder, the gas shall be released by drilling a suitable hole in the cylinder base (furthest from the membrane). The cylinder shall be hydraulically pressurized through this hole.

The membrane shall pass when it does not become detached from the cylinder and

a) where the membrane acts as a pressure relief device, it releases the contents at a pressure in excess of the test pressure without the cylinder rupturing, or

b) where the membrane acts simply as sealing device, the cylinder ruptures at a pressure exceeding 1,6 times the test pressure.

A.4.4 Leak tightness test

The sample shall consist of five filled and sealed cylinders. The leak tightness test shall be carried out by heating the sample to a temperature sufficient to achieve a pressure of at least p_{vt} in the cylinder. The leak rate shall not exceed the requirements of A.2.3.5.

Annex B
(informative)

Type approval certificate

This annex provides an example of a suitable form of a type approval certificate. Other formats are also acceptable.

TYPE APPROVAL CERTIFICATE

Issued by: ____

(Inspector)

Applicable regulation or ISO-Standard: ISO 11118

Date: _________________________

Approval number: _____________________

Type of cylinder shell: _____________________________________

Drawing number(s) _____________________________________

____

P_h	_______________	bar	D_{min}	_______________	mm
D_{max}	_______________	mm	a	_______________	mm
L_{min}	_______________	mm	L_{max}	_______________	mm
V_{min}	_______________	L	V_{max}	_______________	L

Material specifications: R_{eg} ____________ **MPa** R_{mg}____________ **MPa**

Heat treatment (if any): ____________________________

Manufacturer or agent: ____

(Manufacturer or agent name)

____

(Address)

All the information can be obtained from:

____

(Name of approval body)

____

(Address of approval body)

<u>Type of non-refillable sealing device</u>

Drawing number ___________________________________

Manufacturer ___________________________________

<u>Type of non-refillable cylinder</u>

Drawing number ___________________________________

Manufacturer ___________________________________

I hereby certify that the non-refillable cylinders represented by this certificate comply with the design requirements of ISO 11118.

Signature of inspector: ____________________________________

Date: ________________________________

Annex C
(informative)

Certificate of compliance

This annex provides an example of a suitable form of a certificate of compliance. Other formats are also acceptable.

CERTIFICATE OF COMPLIANCE

Issued by: ____

(Inspector)

Applicable regulation or ISO-Standard: ISO 11118

Date: _________________________

Approval number: ______________________

Type of cylinder shell: _____________________________________

Drawing number(s) _____________________________________

____

Drawing number	Manufacturer	Batch number	Burst pressure (bar)	Fracture location	Ductile fracture (Y or N)

Batch number	C	Mn	P	S	Al	Si

NOTE The chemical analyses symbols will need to be modified depending on the material being used (e.g. carbon steel, aluminium, stainless steel, etc.).

All the information can be obtained from:

____

(Name of approval body)

____

(Address of approval body)

Type of non-refillable sealing device

Drawing number _________________________________

Manufacturer _________________________________

Type of non-refillable cylinder

Drawing number _________________________________

Manufacturer _________________________________

I hereby certify that the non-refillable cylinders represented by this certificate comply with the design requirements of ISO 11118.

Signature of inspector: ___________________________________

Date: __________________________

Annex D
(informative)

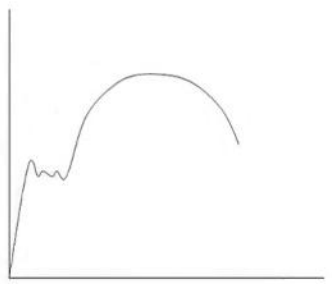
Yield point elongation (YPE)

The information in this annex is to assist the user of this International Standard in understanding yield point elongation (YPE).

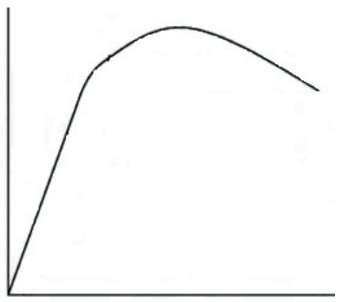
Yield point elongation is defined as the extension associated with discontinuous yield which occurs at approximately constant load following the onset of plastic flow. It is associated with the propagation of Luder lines or stretcher strain visible on the material surface. Yield point elongation (YPE) in cold rolled steel is usually associated with NOT using enough extension (typically less than 1,0 %) in the temper-mill following the anneal operation. Continuous annealed steel can be more susceptible to YPE versus batch annealed materials. To eliminate YPE, cold rolled steel should be temper-rolled (typically GREATER than 1,5 %) after annealing. Temper-rolling is typically the last step in the manufacturing process to produce cold rolled steel.

In materials that exhibit a yield point, the yield point elongation (YPE) is the difference between the elongation of the specimen at the start and at the finish of discontinuous yielding (the area in which an increase in strain occurs without an increase in stress).

Yield point elongation (YPE) can be determined by review of the stress-strain curve in the material. Below are examples of stress-strain curves with and without yield point elongation (YPE).



Stress-strain curve with YPE



Normal stress-strain curve

Figure D.1 — Stress Curves

Yield point elongation (YPE) can impact the strength of a non-annealed completed cylinder and cause the unexpected rupture of the cylinder at a pressure less than the minimum setting of the pressure relief device. In order to detect yield point elongation (YPE), it is necessary to artificially age the non-annealed cylinder prior to conducting the burst test as defined in 9.2.4.4.

After artificially aging and burst testing a non-annealed cylinder, yield point elongation (YPE) can be visually present in a highly stressed area. The following photographs are of material demonstrating yield point elongation (YPE).

Figure D.2 — Typical YPE strain lines in carbon steel

Figure D.3 — Example of YPE strain lines and YPE fracture

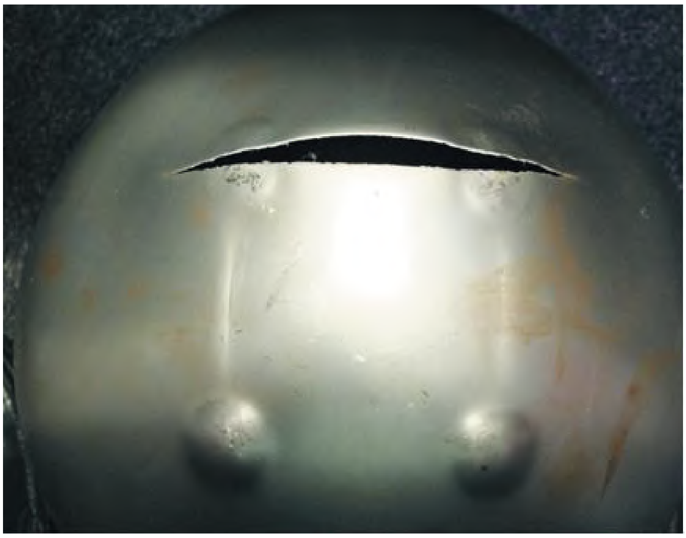


Figure D.4 — Example of YPE strain lines and YPE fracture

Bibliography

[1] ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

[2] ISO 6506-2, *Metallic materials — Brinell hardness test — Part 2: Verification and calibration of testing machines*

[3] ISO 6506-3, *Metallic materials — Brinell hardness test — Part 3: Calibration of reference blocks*

[4] ISO 11114-3, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 3: Autogenous ignition test for non-metallic materials in oxygen atmosphere*

[5] ISO 13585, *Brazing — Qualification test of brazers and brazing operators*

[6] ISO 17639, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*

[7] EN 13134, *Brazing — Procedure approval*

[8] Aluminium Association Incorporated — Registration Record of International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys

[9] United Nations — Recommendations on the transport of Dangerous Goods: Model Regulations, UN,

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