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Gas cylinders — Seamless steel and seamless aluminium-alloy gas cylinders and tubes — Periodic inspection and testing

Bouteilles à gaz — Bouteilles et tubes à gaz en acier et en alliages d'aluminium, sans soudure — Contrôles et essais périodiques

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 58, *Gas cylinders*, Subcommittee SC 4, *Operational requirements for gas cylinders*.

This first edition cancels and replaces ISO 6406:2005 and ISO 10461:2005, which have been technically revised. It also incorporates the Amendment ISO 10461:2005/Amd 1:2006.

The main changes are:

— a section has been added for symbols used in the document;

— a detailed account of steps to be taken if the actual cylinder wall thickness is less than the minimum design wall thickness has been added;

— a clearer way to ultrasonically test cylinders with a built-in footring, especially for seamless steel cylinders with a convex base, has been added;

— improved guidelines have been added for dealing with the effects of heating of seamless aluminium-alloy cylinders.

Introduction

This document provides information and procedures for the periodic inspection and testing of seamless steel and seamless aluminium-alloy cylinders and the condition of the test equipment. The principal aim of periodic inspection and testing is that at the completion of the test the cylinders have been requalified and are suitable to be reintroduced into service for a further period of time.

This document requires that well-trained and competent personnel undertake the work as described in this document, who consult the cylinder's manufacturer if there are doubts about aspects of the document, so that the cylinder manufacturer's current recommendations are taken into account.

This document has been written so that it is suitable to be referenced in the UN *Model Regulations*[23].

Gas cylinders — Seamless steel and seamless aluminium-alloy gas cylinders and tubes — Periodic inspection and testing

CAUTION — Some of the tests specified in this document involve the use of processes that could lead to a hazardous situation.

1 Scope

This document specifies the requirements for periodic inspection and testing to verify the integrity of cylinders and tubes to be re-introduced into service for a further period of time.

This document is applicable to seamless steel and seamless aluminium-alloy transportable gas cylinders (single or those that comprise a bundle) intended for compressed and liquefied gases under pressure, of water capacity from 0,5 l up to 150 l and to seamless steel and seamless aluminium-alloy transportable gas tubes (single or those that comprise a bundle) intended for compressed and liquefied gases under pressure, of water capacity greater than 150 l. It also applies, as far as practical, to cylinders of less than 0,5 l water capacity.

This document does not apply to the periodic inspection and maintenance of acetylene cylinders or to the periodic inspection and testing of composite cylinders.

NOTE Unless noted by exception, the use of the word "cylinder" in this document refers to both cylinders and tubes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 9809-1, *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 10286, *Gas cylinders — Terminology*

ISO 11621, *Gas cylinders — Procedures for change of gas service*

ISO 13769[1)], *Gas cylinders — Stamp marking*

ISO 22434, *Transportable gas cylinders — Inspection and maintenance of cylinder valves*

ISO 25760, *Gas cylinders — Operational procedures for the safe removal of valves from gas cylinders*

1) To be published. Stage at the time of publication: ISO/FDIS 13769:2018.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10286 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
liquefied gas
gas, which, when packaged under pressure, is partially liquid at temperatures above −50 °C

Note 1 to entry: A distinction is made between

a) high pressure liquefied gas: a gas with a critical temperature between −50 °C and 65 °C, and

b) low pressure liquefied gas: a gas with a critical temperature above 65 °C.

3.2
rejected cylinder
cylinder not fit for service

3.3
competent authority
any national body or authority designated or otherwise recognized as such, having jurisdiction for the transport of dangerous goods and the approval of gas cylinders

Note 1 to entry: Adapted from UN *Model Regulations*[23].

3.4
minimum design wall thickness
thickness of the cylinder wall calculated from the design standard, taking into account the material properties and dimensions at time of manufacture

3.5
stove
treat by heating in a stove or an oven in order to apply a desired surface coating

4 Abbreviated terms and symbols

FBH	flat bottom hole
PE	permanent expansion
SBT	sidewall-to-base transition region
UT	ultrasonic testing
C	compressibility (expressed in m^2/N or Pa^{-1})
D	depth of notch in ultrasonic test sample (expressed in mm)
K	factor for individual temperature (listed in Table C.1)
L	length of notch in ultrasonic test sample (expressed in mm)
P	pressure (expressed in bar)
V	cylinder water capacity (expressed in l)

W width of notch in ultrasonic test sample (expressed in mm)

X flaw length (expressed in mm)

Y flaw depth ratio

t_{mc} minimum measured wall thickness of the calibration specimen (expressed in mm)

t_m minimum design wall thickness (expressed in mm)

5 Intervals between periodic inspections and tests

A cylinder shall be due for periodic inspection and testing on its first receipt by a filler following the expiry of the established interval or, in the absence of regulations, in accordance with the UN *Model Regulations*[23]. Annex A lists the intervals for period inspection and testing as outlined in the 19th revised edition of the UN *Model Regulations*. The expiry date is based on the last test date shown on the cylinder. Other means of indicating the expiry date may be used.

Provided the cylinder has not been subjected to abusive and abnormal conditions such as being involved in an accident, heat exposure or other severe conditions that would render it unsafe, there is no requirement for the user to return a cylinder before the contents have been used even though the periodic inspection and testing interval has lapsed. However, cylinders, particularly those containing corrosive gases, should be retested within a period not exceeding twice the time interval.

Seamless steel or seamless aluminium-alloy cylinders used for self-contained breathing apparatus or self-contained underwater breathing apparatus that are not covered by transport regulations may be submitted for inspection within the interval shown in Table A.1.

6 List of procedures for periodic inspections and tests

Assessment of conformity to this document shall be carried out in accordance with the applicable regulations of the countries of use.

Tests and examinations performed to demonstrate compliance shall be conducted using instruments calibrated before being put into service and thereafter according to an established programme.

Each cylinder shall be submitted to periodic inspections and tests. The following procedures, when applicable, form the requirements for such inspections and tests and are explained more fully in subsequent clauses:

a) identification of cylinder and preparation for inspection and tests (see Clause 7);

b) depressurization and de-valving procedures (see Clause 8);

c) external visual inspection (see Clause 9);

d) inspection of cylinder neck (see Clause 10);

e) check of internal condition (see Clause 11);

f) supplementary tests (see Clause 12);

g) cylinder repairs (see Clause 13);

h) pressure test or UT (see Clause 14);

i) inspection of valve and other accessories (see Clause 15);

j) replacement of cylinder parts (see Clause 16);

k) final operations (see Clause 17);

l) rejection and rendering cylinder unserviceable (see Clause 18).

These procedures should be performed in the sequence listed in order to improve the safety of the operation and to detect potential harmful damage. In particular, the external visual inspection (see Clause 9) shall be carried out before the internal visual inspection (when required) (see Clause 11), the pressure test, or UT (see Clause 14).

When a cylinder passes the above listed procedures but the condition of the cylinder remains in doubt, additional, supplementary tests shall be performed to confirm its suitability for continued service (see Clause 12) or the cylinder shall be rendered unserviceable in accordance with Clause 18.

Depending on the reason for rejection, some cylinders may be recovered in accordance with Annex B.

Mechanical properties of seamless steel and seamless aluminium-alloy cylinders can be affected by heat exposure. Therefore, the maximum temperature for any operation shall be limited in accordance with the manufacturer's recommendation (for seamless aluminium-alloy cylinders, see 17.1.2.3).

Cylinders that fail an inspection or test and cannot be recovered shall be rendered unserviceable in accordance with Clause 18.

The eyesight acuity of operators is critical and should be checked by an optician on a yearly basis.

7 Identification of cylinder and preparation for inspection and tests

The labelling and permanent markings on the cylinder shall be checked and the information recorded before carrying out any further work. When a toxic, flammable or pyrophoric gas is involved, the owner or the individual presenting the cylinder for retest shall inform the testing facility accordingly. Cylinders with incorrect or illegible markings or unknown gas contents shall be set aside for special handling.

Cylinders intended for a change of gas service shall be evaluated in accordance with ISO 11621.

For seamless steel cylinders, the following applies in addition:

If the contents are identified as hydrogen or other embrittling gas, only those cylinders manufactured or qualified as hydrogen cylinders shall be used for that service. Check that the cylinder is compatible for hydrogen service, i.e. with respect to the maximum tensile strength and internal surface condition. Seamless steel cylinders marked in accordance with ISO 13769 are stamped "H". Seamless steel cylinders that have not been checked or are not stamped "H" shall not be reintroduced into hydrogen service. Their suitability for their new, intended service shall be evaluated in accordance with ISO 11621.

8 Depressurization and de-valving procedures

8.1 General

Cylinders that require an internal visual inspection shall be depressurized and emptied in a safe, controlled manner and de-valved prior to inspection in accordance with ISO 25760.

Particular attention shall be given to cylinders containing flammable, oxidizing, corrosive or toxic gases to eliminate risks at the internal inspection stage. See Annex C for a list of gases that are corrosive to cylinder material.

Cylinders (other than those with a footring) to be ultrasonically inspected may be examined without being depressurized or having the valve removed.

WARNING — The uncontrolled opening and/or removal of valves from cylinders can lead to injury, death and/or property damage.

When ultrasonically testing cylinders that are under pressure, care shall be taken to ensure the safety of personnel and property (e.g. by placing a valve protection device over the valve or by depressurizing the cylinder to 5 bar or less).

8.2 Cylinders requiring de-valving

All cylinders received for testing for which an internal visual inspection is required shall be safely de-valved in accordance with ISO 25760.

Cylinders with a footring shall be de-valved for internal inspection and may be subsequently evaluated by UT.

8.3 Cylinders not requiring de-valving

Cylinders without a footring that are to be evaluated by UT do not require the valves to be removed unless otherwise specified in this document.

8.4 Cylinders requiring shot blasting

Cylinders that require shot blasting shall be depressurized before processing.

9 External visual inspection

9.1 Preparation

If a cylinder's external condition prevents or hinders a proper visual inspection of the surface, then the cylinder shall be prepared before the inspection. If any welded or brazed attachment (e.g. neckring) is seen, the cylinder shall be rendered unserviceable in accordance with Clause 18.

The cylinder shall be cleaned and have all loose coatings, labels, corrosion products, tar, oil or other foreign matter removed from its external surface. The cylinder shall not at this stage be brushed or blasted until after the external visual inspection has been completed in order to not remove signs of previous damage. Seamless aluminium-alloy cylinders should be prepared for visual examination (see Annex F). They shall not be shot blasted using steel media; however, blasting may be conducted with other appropriate media (e.g. walnut shells, dry ice pellets, etc.).

The method used to clean the cylinder shall be a validated, controlled process. Care shall be taken at all times to avoid damaging the cylinder taking into account the information provided in Annex B.

If fused nylon, polyethylene or a similar coating has been applied and it is damaged or prevents proper inspection, then this coating shall be removed. If the coating has been removed by the application of heat, then care shall be taken that the applied temperature has not altered the mechanical properties of the cylinder material. The temperatures at which damage occurs are as follows:

a) For seamless steel cylinders: in no case shall the temperature of the cylinder have exceeded 300 °C.

b) For seamless aluminium-alloy cylinders: in no case shall the temperature of the cylinder have exceeded the limits specified in 17.1.2.3.

For both seamless steel and seamless aluminium-alloy cylinders, contact the manufacturer if there is doubt about heat exposure. If the manufacturer cannot be consulted, the cylinder shall be rendered unserviceable in accordance with Clause 18.

9.2 Inspection procedure

The external surface of each cylinder shall be inspected for the following in accordance with Table B.1, Table B.2 or Table B.3 as applicable:

a) dents, cuts, gouges, bulges, cracks, laminations or excessive base wear;

b) heat damage, torch damage or electric arc burns;

c) corrosion;

d) other defects such as illegible, incorrect or unauthorized stamp markings, or unauthorized additions or modifications;

e) integrity of all permanent attachments;

f) vertical stability.

Corrosion is likely to occur in the footring area, especially the transition area cylindrical part/footring, and the gap-area convex base/footring. When inspecting cylinders with footrings, extra attention shall be given to these areas.

At this stage, the cylinder shall be visually inspected for signs of corrosion (see Table B.2 for rejection criteria). Attention shall be given to areas where water can be trapped. These areas include the entire base area and the neckring. If corrosion is detected, then the corrosion products and paint shall be removed (e.g. shot blasted), particularly where the corrosion appears on the cylinder shell. If the extent of the corrosion cannot be determined, including doubt about the remaining wall thickness, then the cylinder shall be rejected.

Rejection criteria shall be in accordance with Annex B. Cylinders no longer suitable for future service shall be rendered unserviceable in accordance with Clause 18.

10 Inspection of cylinder neck

10.1 Cylinder-to-valve threads

After the valve is removed, the cylinder-to-valve threads shall be examined to identify the type of thread (e.g. see ISO 11363-2) and to ensure that they are:

— clean and of full form, and

— free of damage (e.g. burrs, cracks, cross-threading, corrosion, etc.).

Cylinders in toxic or corrosive gas service shall have their threads gauged for wear and ovality using a plug gauge (see Figures 1, 2 and 3). The threads of cylinders in other gas services may be verified using appropriate gauges in cases of doubt.

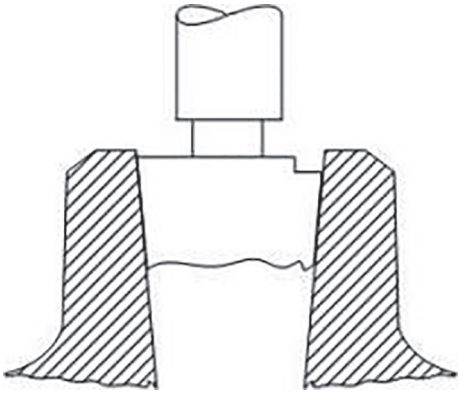
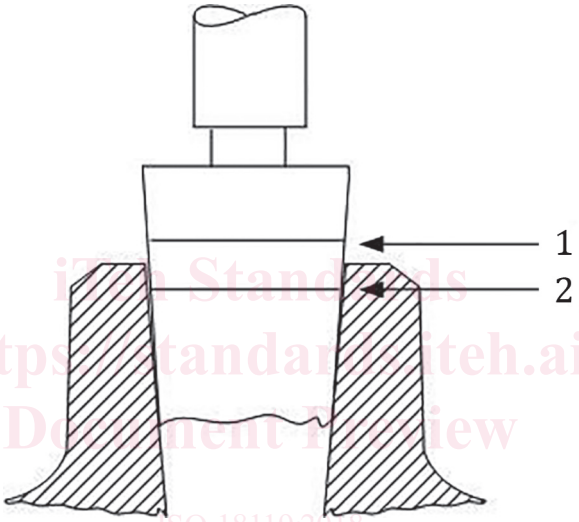


Figure 1 — Example of a calibrated upper thread plug gauge (thread failed)

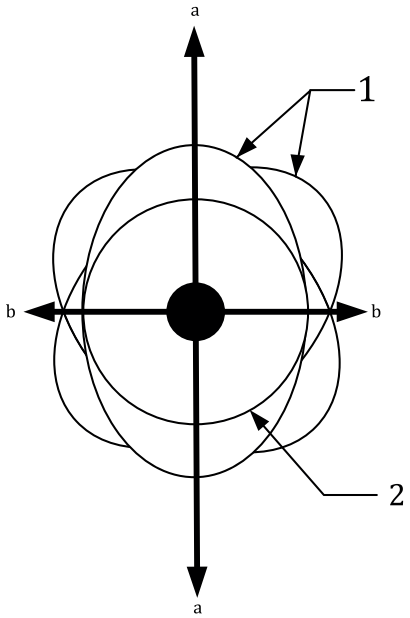


Key

1 maximum

2 minimum

Figure 2 — Example of a "Go/no-go" plug gauge (thread passed)

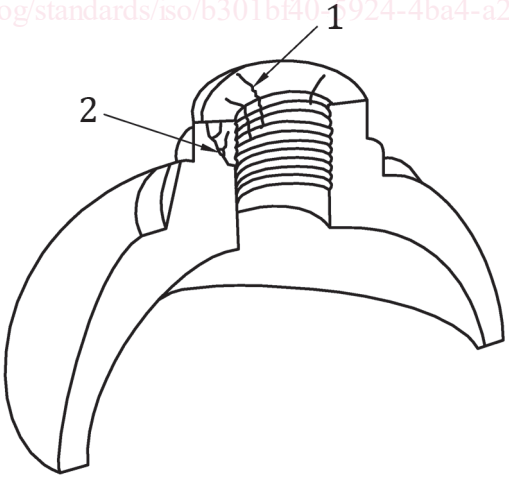


Key

1 oval thread in cylinder neck
2 plain taper plug gauge
a Large movement.
b Small movement.

Figure 3 — Ovality check

Neck cracks manifest themselves as lines that run down the thread across the thread faces (see Figure 4). Special attention should be paid to look for the presence of cracks in the area at the bottom of the last thread. They should not be confused with tap marks (tap stop marks). See Figure 5.



Key

1 neck crack
2 propagated crack in the neck

Figure 4 — Neck cracks