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SOUTH AFRICAN NATIONAL STANDARD

Gas cylinders — Welded aluminium-alloy, carbon and stainless steel gas cylinders — Periodic inspection and testing

This national standard is the identical implementation of ISO 10460:2018, and is adopted with the permission of the International Organization for Standardization.

WARNING
This document references other documents normatively.

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Table of changes

Change No.	Date	Scope

National foreword

This South African standard was prepared by National Committee SABS/TC 058, *Vessels and systems under pressure,* in accordance with procedures of the South African Bureau of Standards, in compliance with annex 3 of the WTO/TBT agreement.

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Compliance with this document cannot confer immunity from legal obligations.

INTERNATIONAL STANDARD

ISO 10460

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Gas cylinders — Welded aluminium-alloy, carbon and stainless steel gas cylinders — Periodic inspection and testing

Bouteilles à gaz — Bouteilles à gaz soudées en alliage d'aluminium, carbone et acier inoxydable — 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 of 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: www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 10460:2005), which has been technically revised.

The main changes compared to the previous edition are as follows:

— inclusion of text to evaluate welded aluminium-alloy and welded stainless steel cylinders;

— removal of conformity assessment requirements;

— deletion of text on blocked valves as this edition now references a specific standard.

This corrected version of ISO 10460:2018 incorporates the following correction:

— In Table C.1, in the fourth column of the “Stamping” row, the “c” at the end of “Render unserviceablec” has been changed to superscript to lead to a footnote at the bottom of the table.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document contains requirements that reflect current practice and experience.

This document provides information and procedures for the periodic inspection and testing of welded cylinders and the condition of the test equipment. The principal aim of periodic inspection and testing is that at the satisfactory completion of the inspection the cylinders may be reintroduced into service for a further period of time.

This document has been written so that it is suitable to be referenced in the UN *Model Regulations*[1].

INTERNATIONAL STANDARD ISO 10460:2018(E)

Gas cylinders — Welded aluminium-alloy, carbon and stainless steel gas cylinders — Periodic inspection and testing

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

1 Scope

This document specifies the requirements for the periodic inspection and testing of welded aluminium-alloy, carbon and stainless steel gas cylinders of water capacity from 0,5 l to 150 l intended for compressed and liquefied gas service under pressure and to verify the integrity of such gas cylinders for further service.

It also applies, as far as is practical, to cylinders of less than 0,5 l water capacity and greater than 150 l up to 450 l.

This document does not apply to the periodic inspection and testing of acetylene cylinders or composite (fully wrapped or hoop-wrapped) cylinders.

It is primarily intended for use with cylinders containing industrial gases other than liquefied petroleum gas (LPG). This document may also be applicable to LPG. Requirements for LPG applications are also provided in ISO 10464.

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 10286, *Gas cylinders — Terminology*

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

ISO 13341, *Gas cylinders — Fitting of valves to gas cylinders*

ISO 13769, *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*

3 Terms and definitions

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

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

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

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

4 Intervals between periodic inspection and testing

A cylinder shall be due for periodic inspection and testing on its first receipt by a filler following the expiry of the established interval, e.g., in accordance with national or international regulations or, in the absence of such regulations, in accordance with the UN *Model Regulations* (packaging instruction P200)[1]. The inspection and test expiry date is based on the last test date stamped on the cylinder.

Annex A provides typical periodic inspection intervals. Annex B provides one example of an existing system to indicate the next periodic inspection date. Other systems are in use.

Provided there is no evidence that the cylinder has been subjected to abusive and/or abnormal conditions (e.g. being involved in an accident, being exposed to excessive heat or other severe conditions) that would render the cylinder unsafe, there is no requirement for the user to return the cylinder for inspection and test before the contents have been used even though the periodic inspection and testing interval has lapsed. However, it is recommended that the user be advised by the supplier to return the cylinder to the supplier once it is empty or if the cylinder is no longer needed by the user.

Shorter periodic inspection intervals than those shown in Annex A may be considered for applications where the cylinder could be exposed to severe conditions (e.g. marine service).

5 Periodic inspection and testing procedures

5.1 General

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

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

All cylinders shall undergo periodic inspection and testing. The procedures outlined in 5.2 and 5.3 shall be performed first and in the order presented. The tests and procedures outlined in 5.4, 5.5, 5.6, 5.7, 5.8 and 5.9 shall be performed after 5.2 and 5.3 and in any order. However, the order of the tests and procedures presented in this document is recommended.

Some procedures outlined in the following subclauses (e.g. 5.2, 5.3.2) are for preparations prior to but not part of periodic inspection.

Cylinders that fail a periodic inspection shall be rejected (the requirements set out in 5.10 and Annex C describe the actions to be taken if a cylinder is rejected).

If the condition of a cylinder that has passed the tests described in 5.2, 5.3, 5.4, 5.5, 5.6 and 5.8 remains in doubt, additional tests shall be performed to confirm its suitability for continued service or the cylinder shall be rendered unserviceable in accordance with 5.10.

Depending on the reason for rejection, some cylinders may be returned to service. The requirements for returning a rejected cylinder to service are provided in 5.7 and Annex C.

The mechanical properties of cylinders meeting the requirements of this document can be affected by heat. Therefore, the maximum temperature for any operation shall be limited to prevent any adverse effects on the performance of the cylinder when it is returned to service.

Before any work can be carried out, the relevant cylinder data (e.g. the requirements in ISO 13769), its contents and its ownership shall be identified and the owner shall authorize the retest. Cylinders with

incorrect or illegible markings, unknown gas contents or those that cannot be safely emptied of gas shall be set aside for special handling.

If the cylinder contents are identified as hydrogen or any other embrittling gas, only those cylinders manufactured or qualified for hydrogen service shall be used (see ISO 11114-1). It shall be confirmed that the cylinder is compatible for hydrogen service (e.g. cylinders marked in accordance with ISO 13769 are stamped H). Cylinders that have been used in hydrogen service but not stamped H shall be removed from this service and their suitability for continued use shall be evaluated in accordance with ISO 11621.

5.2 Depressurization and devalving procedures

5.2.1 Depressurization

Before performing any tests, cylinders shall be depressurized and emptied in a safe, controlled manner (e.g. using a safe and environmentally friendly venting system). Particular attention shall be given to cylinders containing flammable, oxidizing or toxic gases.

Cylinders that have contained a toxic or flammable gas shall be made safe (e.g. by purging with a suitable gas) before carrying out any further operations or inspections.

Refrigerant gases (e.g. chlorofluorocarbons) shall not be released to the atmosphere.

5.2.2 Devalving

WARNING — The uncontrolled removal of a valve from a cylinder can lead to serious injury, death or property damage.

A positive check shall be performed before removing any pressure-retaining accessories (e.g. the cylinder valve or a flange) to ensure that the cylinder does not contain any gas under pressure. A gas retention check shall be performed in accordance with ISO 25760.

Cylinders with inoperative or blocked valves shall be handled in accordance with ISO 25760.

After the requirements described in 5.2.1 and 5.2.2 have been met, the cylinder valve can be removed.

5.3 External visual inspection

5.3.1 General

An initial external visual inspection shall be performed on all cylinders before the removal of any paint or coatings to detect whether the cylinders have been subjected to abusive and/or abnormal conditions (e.g. being involved in an accident, being exposed to excessive heat or other severe conditions) that would render them unsafe. If a cylinder appears to be damaged, the damage shall be assessed in accordance with Annex C.

5.3.2 Preparation

Each cylinder shall be clean and have all loose coatings (e.g. corrosion products, tar, oil or other foreign matter) removed from its external surface (e.g. by brushing, shot-blasting [under closely controlled conditions], water jet abrasive cleaning or chemical cleaning). The presence of any corrosion products on external or internal surfaces of the cylinder should be noted prior to cleaning.

Externally mounted carrying handles or shrouds that interfere with a complete external visual inspection shall be removed before this inspection is carried out.

The method used to clean the cylinder shall be a validated, controlled process and care shall be taken at all times to avoid damage to the cylinder or the removal of excess amounts of cylinder wall. When

selecting the shot-blasting medium and the process parameters to be used, consider the following to ensure that as far as practicable only the surface coating or contamination is removed from the cylinder:

— medium hardness and shape;

— medium delivery pressure and volume flow rate;

— angle of impingement of the medium onto the surface of the cylinder;

— the temperature of the process itself, including monitoring the temperature of the cylinder surface to maintain it within acceptable limits when a heat source is used.

A cylinder coating (e.g. fused nylon, polyethylene) that is either damaged or prevents a complete external visual inspection shall be removed. If the coating is removed by the application of heat, in no case shall the temperature of the cylinder exceed:

a) 300 °C for carbon and stainless steel cylinders;

b) 80 °C for aluminium-alloy cylinders manufactured from non-heat-treated alloys (e.g. AA5283). For temperatures between 70 °C and 80 °C, the exposure time shall be limited to 30 min. If the heat exposure time exceeds 30 min at temperatures greater than or equal to 70 °C, or if at any time the temperature exceeds 80 °C, then agreement shall be obtained from the manufacturer regarding further use of the cylinder;

c) 175 °C for aluminium-alloy cylinders manufactured from AA 6XXX heat-treated alloys (e.g. AA 6061). Only testing facilities that can control heat input and record time and temperature may heat cylinders. The total cumulative time at temperatures between 110 °C and 175 °C shall be limited to the time recommended by the cylinder manufacturer.

5.3.3 Procedure

The external surface of each cylinder, including welds and areas adjacent to them, shall be inspected for:

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

b) heat damage, torch or electric-arc burns (as described in Table C.1);

c) corrosion (as defined in Table C.2);

d) other imperfections, e.g. illegible, incorrect or unauthorized stamp markings or unauthorized additions or modifications (as described in Table C.1);

e) the integrity of all permanent attachments (as described in C.2);

f) if relevant, base damage (as described in Table C.1).

When inspecting the cylinder for corrosion or other deposits (e.g. mud in the footring), special attention shall be given to areas where deposits/fluids could be trapped. These areas include but are not limited to the entire base area, the junction between the body and the footring and the junction between the cylinder body and shroud.

5.3.4 Inspection result

Cylinders that pass the external visual inspection shall undergo an internal visual inspection as described in 5.4.

If there is concern regarding the cylinder's wall thickness after the external visual inspection, the wall thickness may be measured provided the manufacturer's wall thickness requirements are known. When the manufacturer's wall thickness requirements are either not known or are not met, the cylinder shall be rendered unserviceable or set aside pending further investigation.

Rejection criteria are described in Annex C. Cylinders no longer suitable for service shall be rendered unserviceable in accordance with 5.10.

5.4 Internal visual inspection

5.4.1 General

Each cylinder shall be internally inspected using adequate illumination so as to be able to identify any imperfections that are present.

Precautions shall be taken to ensure that the method of illumination used presents no risk to the tester while the inspection is being carried out. For cylinders that have been used in flammable gas service, particular attention shall be paid to selecting the method of illumination used to minimize the risk of igniting any residual gas.

5.4.2 Preparation

Any cylinder internal liner or coating that prevents a complete internal visual inspection shall be removed.

5.4.3 Cleaning

Cylinders with foreign matter or more than light surface discolouration or staining shall be cleaned internally under closely controlled conditions (e.g. by dry medium blasting, water jet abrasive cleaning, flailing, steam jet, hot water jet, rumbling or chemical cleaning). The cleaning method chosen shall take into account the cylinder material and shall be a validated, controlled process. Care shall be taken at all times to avoid damaging the cylinder or removing excess amounts of cylinder wall.

The presence of any corrosion products on external or internal surfaces of the cylinder should be noted prior to cleaning.

If internal cleaning is required, the cylinder shall be visually re-inspected after the cleaning operation has been completed.

Caution shall be taken when applying dry medium blasting on certain welded cylinders (e.g. with joggle joint welds). Beads/pellets can get trapped in the seams during the blasting process, which is difficult to observe during visual inspection. These particles can be released from the seams during use of the cylinder and contaminate the gas.

5.4.4 Inspection result

Cylinders that pass the internal visual inspection shall be inspected and treated as described in 5.5, 5.6, 5.7, 5.8 and 5.9.

If there is concern regarding the cylinder's wall thickness after the internal visual inspection, the wall thickness may be measured provided the manufacturer's wall thickness requirements are known. When the manufacturer's wall thickness requirements are either not known or are not met, the cylinder shall be rendered unserviceable or set aside pending further investigation.

Rejection criteria are described in Annex C. Cylinders no longer suitable for service shall be rendered unserviceable in accordance with 5.10.

5.5 Cylinder neck inspection

5.5.1 Cylinder-to-valve threads

5.5.1.1 All cylinders

When the valve(s) is removed from the cylinder, the cylinder-to-valve threads shall be examined to ensure that they are

— clean,

— free of burrs,

— of full form,

— free of damage,

— free of cracks, and

— free of other defects.

The threads of cylinders in gas services other than toxic or corrosive service may be verified using appropriate gauges in cases of doubt. For cylinders in toxic or corrosive service, see 5.5.1.2 for additional requirements.

Cylinder neck threads that are dirty or exhibit burrs may be rectified. Cylinders with neck threads that are damaged, cracked or exhibit other defects shall be rectified only by an approved process or the cylinders shall be rendered unserviceable in accordance with 5.10.

5.5.1.2 Cylinders used in toxic or corrosive service

WARNING — Leakage of toxic or corrosive products has the potential to become a serious incident.

Annex D provides examples of gases that are known to be corrosive to welded steel cylinders.

In addition to the requirements shown in 5.5.1.1, the neck threads of cylinders used in toxic or corrosive service shall be examined using an appropriate thread gauge or gauges. For examples on the use of thread gauges, see ISO 11363-2.

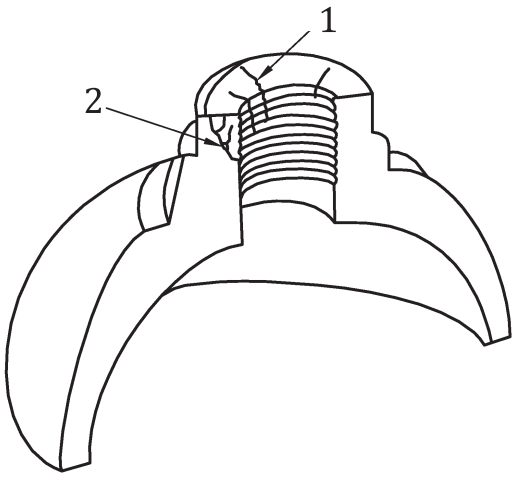
If a cylinder's neck threads are examined using a gauge and do not meet the gauging requirements of the valve intended to be used, the cylinder shall be rendered unserviceable in accordance with 5.10.

5.5.2 Other neck surfaces

Other surfaces of the cylinder neck shall be examined to ensure they are free of cracks or other imperfections. The requirements in Annex C shall be used to evaluate cylinder imperfections.

Any coating that prevents a complete visual inspection of the cylinder neck shall be removed.

Figure 1 provides an example of a cracked cylinder neck.



Key

1 neck crack

2 propagated crack in the neck

Figure 1 — Cracked cylinder neck

5.5.3 Neckring and/or collar attachment

When a neckring or collar is attached to the cylinder neck boss using a screw thread, an examination shall be carried out to ensure it is secure and to inspect it for thread damage.

A neckring attached to the cylinder shall not be changed using hot work (e.g. welding). The cylinder shall be rendered unserviceable in accordance with 5.10 if the neckring is damaged or if a complete visual examination cannot be carried out with it attached.

If it is necessary to change a neckring using cold work (e.g. a screw thread), a documented in-house procedure or an approved procedure shall be used. Care shall be taken when replacing the neckring, especially on aluminium-alloy cylinders, to avoid affecting the integrity of the cylinder neck.

The cylinder shall be rendered unserviceable in accordance with 5.10 if the neckring is damaged and cannot be replaced using an approved procedure.

5.6 Pressure test

5.6.1 General

WARNING — Appropriate measures shall be taken to ensure safe operation and to contain any energy that could be released during a pressure test. It should be noted that pneumatic pressure tests require more precautions than hydraulic pressure tests since, regardless of the size of the container, any error in carrying out this test is highly likely to lead to a rupture under gas pressure. Therefore, these tests shall be carried out only after ensuring that the safety measures satisfy the safety requirements.

WARNING — Attention shall be paid to the use of air as medium for the pneumatic pressure test. The partial oxygen pressure at test pressure shall be considered, in particular when cylinders for flammable gas service or with a coating (e.g. corrosion inhibitor which might contain hydrocarbons) are tested.

Each cylinder shall be subjected to either a hydraulic or a pneumatic pressure test.

A suitable fluid such as water shall be used as the test medium. The test pressure to be used shall be established from the stamp mark on the cylinder.

The pressure in the cylinder shall be increased gradually until the test pressure is reached. The test pressure shall be held for at least 30 s with the cylinder isolated from the pressure source, during which time there shall be no decrease in the recorded pressure or any evidence of leakage. Adequate safety precautions shall be taken during the test.

For aluminium-alloy cylinders, the temperature used during the drying process shall meet the requirements of 5.3.2 b) or 5.3.2 c), as applicable. The time that a cylinder is exposed to the drying process shall be kept to a minimum. Cylinders shall not be left in the oven at the drying temperature for an extended period.

For carbon and stainless steel cylinders, the temperature used during the drying process shall not exceed 300 °C. The time that a cylinder is exposed to the drying process shall be kept to a minimum. Cylinders shall not be left in the oven at drying temperature overnight.

5.6.2 Test equipment

5.6.2.1 All rigid pipe work, flexible tubing, valves, fittings and components forming the test equipment pressure system shall be able to withstand a pressure at least 1,5 times the maximum test pressure of any cylinder that could be tested.

5.6.2.2 Pressure gauges shall at a minimum meet the requirements of Class 1. Each pressure gauge shall be checked for accuracy against a calibrated master gauge at established intervals and in any case not less than once a month. The master gauge shall be calibrated in accordance with national requirements. The pressure gauge shall be chosen so that the test pressure is between approximately one-third and two-thirds of its full-scale deflection.

5.6.2.3 When a liquid medium is used for the pressure test, the design and installation of the test equipment, connection of the cylinder to the test equipment and the operating procedures used shall avoid trapping air in the system.

5.6.2.4 All joints within the system shall be pressure tight.

5.6.2.5 A suitable system control device shall be fitted to the test equipment to ensure that a cylinder is not subjected to a pressure in excess of its test pressure by more than the tolerances specified in 5.6.3.3.

5.6.3 Test criteria

5.6.3.1 More than one cylinder may be tested at a time provided that they all have the same test pressure. If one cylinder leaks while several cylinders are being tested simultaneously on the same manifold, all cylinders being tested shall be individually retested.

5.6.3.2 Before applying the test pressure using the proof pressure test method, the external surface of the cylinder shall be dry if a liquid medium is used for the pressurization.

5.6.3.3 The applied pressure shall not be below the test pressure and shall not exceed the test pressure by 10 % or 10 bar, whichever is lower. If the test pressure exceeds this limit, the cylinder shall be rendered unserviceable in accordance with 5.10.

5.6.3.4 On attaining the test pressure, the cylinder(s) shall be isolated from the pump and the pressure held for a minimum period of 30 s.

5.6.3.5 If there is a leakage in the pressure system, it shall be corrected and the cylinder(s) retested.

5.6.4 Acceptance criteria

During the 30 s hold period, the pressure shown on the test gauge shall remain constant and there shall be no visible leakage on the entire surface of the cylinder.

There shall be no visible permanent deformation of the cylinder.

Any cylinder failing to comply with the requirements of 5.6 shall be rendered unserviceable in accordance with 5.10.

5.7 Cylinder repair

5.7.1 General

All corrosion products shall be removed from the cylinder prior to repair.

5.7.2 Major repairs

Major repairs such as removing dents, boss realignment, or replacement of footrings and shrouds shall not be performed unless specific, written procedures are provided by the cylinder manufacturer. The repair of pressure-retaining welds is not permitted.

After all major repairs, the cylinder shall undergo a complete periodic inspection and testing procedure.

5.7.3 Minor repairs

Minor repairs (e.g. reforming damaged shrouds, carrying handles) not involving welding or heating on pressure-retaining parts may be carried out.

5.8 Inspection of valve and other accessories

Valves or any other accessories to be reintroduced into service shall be inspected and maintained to ensure that they perform satisfactorily and meet the gas tightness requirements of their manufacturing standards (e.g. ISO 10297).

For requirements on the inspection and maintenance of cylinder valves and their connections, see ISO 22434.

5.9 Final operations

5.9.1 Drying, cleaning, painting and coating

Minor repairs (e.g. reforming damaged shrouds, carrying handles) not involving welding or heating on pressure-retaining parts may be carried out.

5.9.1.1 Drying and cleaning

Immediately after hydraulic pressure testing, the interior of each cylinder shall be thoroughly dried by a suitable method in accordance with 5.6.1 so there is no trace of free water remaining in the cylinder.

5.9.1.2 Painting and coating

If a cylinder is to be painted or coated after testing, the cylinder owner shall determine the paint or coating to be used (e.g. based on the cylinder contents). All markings stamped on the cylinder shall remain legible after the application of the paint/coating.

In no case during painting or coating shall the temperature of the cylinder exceed those identified in 5.6.1, as exceeding these temperatures can change the mechanical properties of the cylinder material.

5.9.2 Cylinder revalving

Before revalving the cylinder, its thread type shall be identified and the interior of the cylinder shall be inspected to ensure that it is dry and free from contaminants. The cylinder owner shall determine the valve to be used for revalving (e.g. based on the cylinder contents). Only a new valve or a valve that has been inspected and meets the requirements of ISO 22434 shall be fitted to the cylinder in accordance with ISO 13341. Cylinder valves shall meet the requirements of ISO 11114-1 or ISO 11114-2 and meet the appropriate valve outlet standard for the gas service (e.g. ISO 5145).

The torque applied to the valve when it is being re-installed shall take into consideration the size and form of the thread, the valve material and the type of sealing material and shall be in accordance with the manufacturer's recommendations. When the use of a lubricant or sealant is permitted during valve re-installation, only those materials approved for the gas service shall be used.

5.9.3 Cylinder tare check

Cylinders intended for liquefied gas service shall have their tare measured.

The tare shall include the mass of the cylinder, its valve(s) and all permanently attached fittings. Particular attention shall be paid to the tare when replacing any valves, dip tubes, guards/shrouds and footrings. The measured tare shall be marked on the cylinder in a permanent or durable and legible fashion in accordance with ISO 13769.

Cylinder tare shall be measured using a calibrated scale with its calibration traceable to national or international standards. The scale's performance shall be checked on a daily basis. The capacity of the scale shall be suitable for the weight of the cylinder being weighed.

If the measured tare of the cylinder differs from the tare stamped on it by more than the values shown in Table 1 and the difference is not due to damage, the previous tare shall be obliterated by stamping a diagonal line through it. The new tare shall be stamped as close as possible to the previous tare.

Table 1 — Maximum differences between scale weight reading to marked tare

Cylinder water capacity, V l	Maximum permissible deviation in tare g
$0{,}5 \leq V < 5{,}0$	±50
$5{,}0 \leq V \leq 20$	±200
$V > 20$	±400

5.9.4 Cylinder marking after periodic inspection and testing

5.9.4.1 General

After satisfactory completion of the periodic inspection and testing, each cylinder shall be permanently marked in accordance with a relevant standard (e.g. to meet the requirements of ISO 13769) with, at least

— the identification of the inspection body or test station, and

— the present test date.

5.9.4.2 Retester identification and periodic inspection and testing date

The retester identification identifies the inspection body or test station that performed the periodic inspection.

The retest date is the date of the current periodic inspection that the cylinder has undergone and shall be indicated by the year and month (YYYY/MM or YY/MM).

5.9.4.3 Stamp marks

Any stamp marks applied to a cylinder after completion of its periodic inspection shall be in accordance with a relevant standard (e.g. ISO 13769).

5.9.5 Reference to next periodic inspection and testing date

If required, the next periodic inspection and testing date shall be shown by an appropriate means (e.g. a disc fitted between the valve and the cylinder) that indicates the year (YYYY) of the next periodic inspection.

Annex B provides one example of an existing system for indicating retest dates. Other systems with different shapes and colours are used as well.

5.9.6 Reports

The following information for each cylinder that has undergone period inspection and testing shall be recorded by the retester and shall be made available for review:

a) the owner's name;

b) the serial number(s);

c) the cylinder manufacturer's identification (if available);

d) the cylinder mass (empty weight) or tare, where applicable;

e) the type of test performed;

f) the test pressure;

g) the test results. In case of failure, the reason(s) should be recorded;

h) the retest date (year/month/day);

i) the identification of the retest body or test station;

j) the identification of the individual performing the periodic inspection;

k) the details of any repairs made to the cylinder as described in Annex C.

Additional available information about the cylinder may be included in the report. Examples of such information include

— the manufacturing design specification or cylinder design standard,

— the cylinder’s water capacity, and

— the manufacturing test date.

5.10 Rejection and rendering cylinders unserviceable

The decision to reject a cylinder may be taken at any stage during the periodic inspection and testing procedure. If it is impossible to recover a rejected cylinder, the owner shall be notified. It is the responsibility of the testing station to render the cylinder unserviceable so that no part of the cylinder, especially the shoulder, can be placed into service. In some cases, it might be necessary to transport cylinders that have been rejected to another location for them to be rendered unserviceable.

In case of any disagreement regarding a cylinder's rejection, it is important that the legal implications of the contemplated action are fully understood.

Ensure that the cylinder is empty in accordance with 5.2.1 prior to it being rendered unserviceable.

A cylinder may be rendered unserviceable by any of the following methods:

— crushing using mechanical means;

— burning or punching an irregular hole in the top dome equivalent in area to approximately 10 % of the area of the top dome or, in the case of a thin-walled cylinder, by piercing it in at least three places;

— irregular mechanical or flame cutting of the neck;

— irregular mechanical or flame cutting of the cylinder into two or more pieces, one of which should be the shoulder;

— bursting using a safe method.

Annex A
(informative)

Intervals between periodic inspections and tests

Table A.1 shows the intervals between periodic inspections and tests as outlined in the UN *Model Regulations*[1].

Table A.1 — Intervals between periodic inspections and testing for typical gas types

Gas type	Examples	UN recommended interval years
Liquefied gases (non-corrosive, non-toxic)	Refrigerants	10
	LPG	5, 10 or 15
Liquefied gases (corrosive and/or toxic)	Anhydrous ammonia, hydrogen bromide, hydrogen chloride, sulphur dioxide, chlorine, hydrogen sulphide	5
NOTE Certain requirements can necessitate a shorter time interval (e.g. the dew point of the gas, polymerization reactions and decomposition reactions, cylinder design specifications, change of gas service).		

Annex B
(informative)

Gas cylinder periodic inspection date rings

Table B.1 specifies a typical system of colour and shape of rings to identify the date of the next period inspection. Other systems (also with different colours) are used as well.

Table B.1 — System using ring colour and shape to identify periodic inspection dates

Year	Colour	Shape
2013[a]	Red	Circle
2014	Blue	Circle
2015	Yellow	Circle
2016	Green	Circle
2017	Black	Circle
2018	Grey	Circle
2019	Red	Hexagon
2020	Blue	Hexagon
2021	Yellow	Hexagon
2022	Green	Hexagon
2023	Black	Hexagon
2024	Grey	Hexagon
2025	Red	Square
2026	Blue	Square
2027	Yellow	Square
2028	Green	Square
2029	Black	Square
2030	Grey	Square
2031[a]	Red	Circle
2032	Blue	Circle
2033	Yellow	Circle
2034	Green	Circle
2035	Black	Circle
2036	Grey	Circle

[a] The sequence of colour and shape of the test date rings is to be repeated on an 18-year cycle. Hence, 2031 is a repeat of 2013.

Annex C
(normative)

Description and evaluation of imperfections and conditions for rejection at visual inspection

C.1 General

Cylinder imperfections can be physical, material or due to corrosion and can arise as a result of environmental or service conditions to which the cylinder has been subjected during its life.

Annex C provides a convenient summary of most of the conditions identified in this document. It describes the features for which the cylinder shall be inspected as well as the criteria applied to the features.

Annex C shall be applied to all cylinders; however, those cylinders that contain gases with special characteristics (e.g. toxicity, corrosivity) may require additional controls.

Defining rejection limits for all sizes and types of cylinder and their service conditions is very difficult; rejection criteria are usually established following considerable field experience.

Imperfections in the form of a sharp notch may be removed by grinding, machining or other approved method. After such a repair, the wall thickness shall be checked (e.g. ultrasonically) and shall not be less than the minimum design wall thickness.

C.2 Physical or material imperfections

Evaluation of physical or material imperfections shall be in accordance with Table C.1.

Permanent attachments (e.g. footrings or shrouds) shall be visually inspected and shall be suitable for their intended purposes.

C.3 Corrosion

C.3.1 General

Cylinders can be subjected to environmental conditions that could cause external corrosion.

Internal corrosion can also occur due to service conditions.

Extensive experience and judgment are required in evaluating whether cylinders that have corroded internally or externally are safe and suitable for return to service. The presence of any corrosion products on external or internal surfaces of the cylinder should be noted prior to cleaning. It is important that the metal is cleaned of all surface corrosion products prior to inspection of the cylinder. See 5.3.2 for information on cleaning.

C.3.2 Types of corrosion

Types of corrosion shall be classified as shown in Table C.2.

Table C.1 — Rejection limits relating to physical and material imperfections in the cylinder

Type of flaw	Definition	Rejection limits in accordance with 5.10[a]	Repair or render unserviceable
Bulge	Visible swelling of the cylinder	All cylinders with such a defect	Render unserviceable
Dent	A depression in the cylinder that has neither penetrated nor removed metal and is greater in depth than 1 % of the outside diameter of the cylinder	When the depth of the dent exceeds 3 % of the outside diameter of the cylinder OR when the diameter of the dent is less than 15 times its depth	Render unserviceable Render unserviceable
Cut or gouge	A sharp impression where metal has been removed or redistributed (see Figure C.1)	When the depth of the cut or gouge exceeds 10 % of the wall thickness OR when the wall thickness is less than the minimum guaranteed wall thickness	Repair possible[b] Render unserviceable
Crack	A split in the metal (see Figure C.2)	All cylinders with such a defect	Render unserviceable
Fire damage	Excessive general or localized heating of cylinder usually indicated by a) partial melting of cylinder; b) distortion of cylinder; c) charring or burning of paint; d) fire damage to valve, melting of plastic guard or date ring	All cylinders in categories a) and b) All cylinders in categories c) and d) may be acceptable after inspection and testing	Render unserviceable Repair possible only for welded carbon and stainless steel cylinders
Stamping	Marking by means of a metal punch	All cylinders with illegible, modified or incorrect markings	Render unserviceable[c]
Arc or torch burns	Partial melting of the cylinder, the addition of weld metal or the removal of metal by scarfing or cratering	All cylinders with such defects	Render unserviceable
Other marks	Marks introduced other than by the cylinder manufacturing process and approved repair	All cylinders with such imperfections	Continued use possible after additional identification and verification
Base damage	Deformed or incorrectly attached footring, damaged base or excessive base wear	Instability which could present a risk during service (especially if fitted with footring)	Repair if possible or render unserviceable
Weld	Any defect of a pressure weld including those listed in Table C.1	Any defect of a pressure weld that results in a leak	Render unserviceable

[a] When applying the rejection criteria, the conditions of use of the cylinders, the severity of the imperfection and safety factors in the design shall be taken into consideration.

[b] Repair is possible provided that after repair by a suitable metal removal technique, the remaining wall thickness is at least equal to the minimum guaranteed wall thickness.

[c] If it can be clearly established that the cylinder fully complies with the appropriate specifications, altered operational and modified markings may be acceptable and inadequate markings may be corrected, provided there is no possibility of confusion.

Table C.2 — Disposition of cylinders with corrosion

Type of corrosion	Definition	Rejection limits in accordance with 5.10[a]	Return to service or render unserviceable
General corrosion	Loss of wall thickness over an area of more than 20 % of the cylinder surface (see Figure C.3)	If the depth of penetration exceeds 10 % of the thickness of an uncorroded section of the cylinder wall OR if the measured wall thickness is less than minimum guaranteed wall thickness	Render unserviceable Render unserviceable
Local corrosion	Loss of wall thickness over an area of less than 20 % of either the interior or exterior total surface area of the cylinder, except for chain pitting or line corrosion; isolated pits; or crevice corrosion (stainless steel)	If the depth of penetration exceeds 20 % of the thickness of an uncorroded section of the cylinder wall OR if the measured wall thickness is less than minimum guaranteed wall thickness	Render unserviceable Render unserviceable
Chain pitting or line corrosion	Corrosion forming a narrow longitudinal or circumferential line or strip, or isolated craters or pits which are almost connected (see Figure C.4)	If a total length of corrosion in any direction does not exceed the diameter of the cylinder and the depth does not exceed 10 % of the thickness of an uncorroded section of the cylinder wall OR If a total length of corrosion in any direction exceeds the diameter of the cylinder and the depth exceeds 10 % thickness of an uncorroded section of the cylinder wall OR if the measured wall thickness is less than minimum guaranteed wall thickness	Return to service Render unserviceable Render unserviceable
Isolated pits	Corrosion forming isolated craters, without significant alignment (see Figure C.5)	If the diameter of a pit is less than 5 mm and the depth is less than 20 % thickness of an uncorroded section of the cylinder wall If the diameter of a pit is greater than 5 mm	Return to service Render unserviceable
Crevice corrosion (stainless steel)	Corrosion that occurs in, or immediately around, an intersection of two surfaces (e.g. shroud and cylinder body)	If, after thorough cleaning, corrosion cracks are present	Render unserviceable

[a] If the bottom of the imperfection cannot be seen and if its extent cannot be determined using appropriate equipment, the cylinder shall be rendered unserviceable in accordance with 5.10.

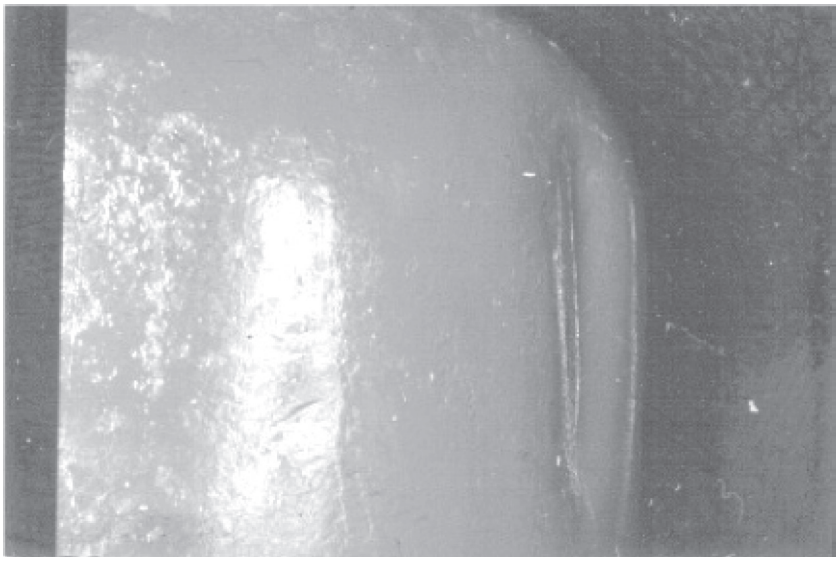


Figure C.1 — Cut or gouge

Figure C.2 — Crack

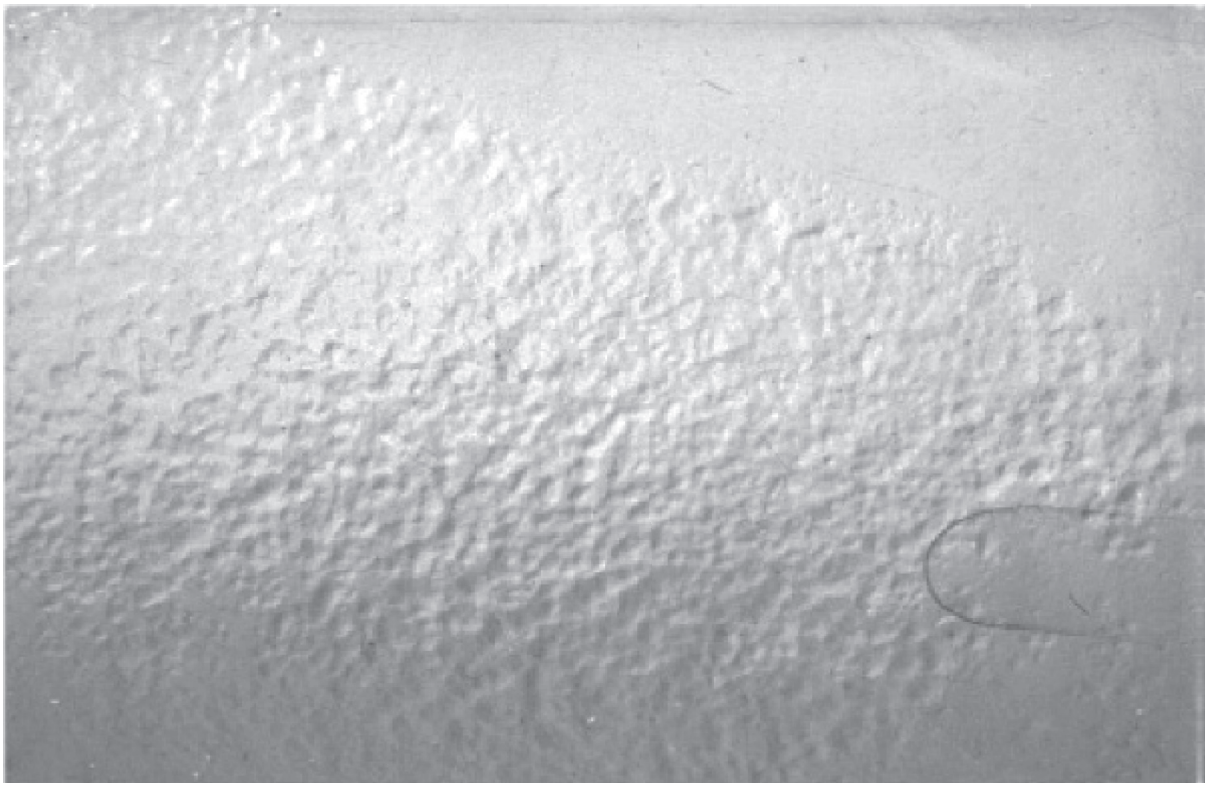


Figure C.3 — General corrosion

Figure C.4 — Line corrosion

Figure C.5 — Isolated pits

Annex D
(informative)

Gases corrosive to carbon steel cylinders

Some gases known to be corrosive to carbon steel cylinders are shown in Table D.1.

Table D.1 — Gases corrosive to carbon steel cylinders

Gas name	Chemical formula	UN class or division	Subsidiary risk
Boron trichloride	BCl_3	2.3	8
Boron trifluoride	BF_3	2.3	8
Chlorine	Cl_2	2.3	8
Dichlorosilane	SiH_2Cl_2	2.3	2.1, 8
Fluorine	F_2	2.3	5.1, 8
Hydrogen bromide	HBr	2.3	8
Hydrogen chloride	HCl	2.3	8
Hydrogen cyanide	HCN	6.1	3
Hydrogen fluoride	HF	8	6.1
Hydrogen iodide	HI	2.3	8
Methyl bromide	CH_3Br (R40B1)	2.3	
Nitric oxide	NO	2.3	5.1, 8
Nitrogen dioxide	N_2O_4	2.3	5.1, 8
Phosgene	$COCl_2$	2.3	8
Silicon tetrachloride	$SiCl_4$	8	
Silicon tetrafluoride	SiF_4	2.3	8
Sulphur tetrafluoride	SF_4	2.3	8
Trichlorosilane	$SiHCl_3$	4.3	3, 8
Tungsten hexafluoride	WF_6	2.3	8
Vinyl bromide	C_2H_3Br (R1140B1)	2.1	
Vinyl chloride	C_2H_3CI (R1140)	2.1	
Vinyl fluoride	C_2H_3F (R1141)	2.1	
NOTE 1 These gases in a pure form are recognized to be potentially corrosive to low-alloy steels (see ISO 11114-1). NOTE 2 Mixtures containing these gases might not be corrosive.			

Bibliography

[1] UN Model Regulations, *Recommendations on the Transport of Dangerous Goods — Model Regulations*

[2] ISO 32, *Gas cylinders for medical use — Marking for identification of content*

[3] ISO 3807, *Gas cylinders — Acetylene cylinders — Basic requirements and type testing*

[4] ISO 5145, *Gas cylinders — Cylinder valve outlets for gases and gas mixtures — Selection and dimensioning*

[5] ISO 7225, *Gas cylinders — Precautionary labels*

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

[7] ISO 10464, *Gas cylinders — Refillable welded steel cylinders for liquefied petroleum gas (LPG) — Periodic inspection and testing*

[8] ISO 11363-2, *Gas cylinders — 17E and 25E taper threads for connection of valves to gas cylinders — Part 2: Inspection gauges*

[9] ISO 13338, *Gas cylinders — Gases and gas mixtures — Determination of tissue corrosiveness for the selection of cylinder valve outlets*

[10] ISO 14246, *Gas cylinders — Cylinder valves — Manufacturing tests and examinations*

[11] EN 837-1, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

[12] EN 837-3, *Pressure gauges — Part 3: Diaphragm and capsule pressure gauges — Dimensions, metrology, requirements and testing*