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**Gas cylinders — Seamless  
aluminium-alloy gas cylinders —  
Periodic inspection and testing**

*Bouteilles à gaz — Bouteilles à gaz sans soudure en alliage  
d'aluminium — 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10461 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 4, *Operational requirements for gas cylinders*.

This second edition cancels and replaces the first edition (ISO 10461:1993), which has been technically revised.

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## Introduction

The principal aim of a periodic inspection and testing procedure is to be satisfied that at the completion of the inspection and test, the cylinders (single or those from bundles) can be reintroduced into service for a further period of time.

The inspection and test are to be carried out only by persons who are authorized under the relevant regulations and competent in the subject to assure all concerned that the cylinders are fit for continued safe use.

The results of inspection and testing for the cylinders that are specified in this International Standard determine whether a cylinder should be returned to service.

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# Gas cylinders — Seamless aluminium-alloy gas cylinders — Periodic inspection and testing

## 1 Scope

This International Standard deals with seamless aluminium-alloy transportable gas cylinders intended for compressed and liquefied gases under pressure, of water capacity from 0,5 l to 150 l; it also applies, as far as practical, to cylinders of less than 0,5 l water capacity.

This International Standard specifies the requirements for periodic inspection and testing to verify the integrity of such gas cylinders for further service.

This International Standard does not apply to periodic inspection and testing of acetylene cylinders or composite cylinders with aluminium-alloy liners.

## 2 Normative references

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

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

ISO 11114-2:2000, *Transportable 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, *Transportable gas cylinders — Fitting of valves to gas cylinders*

ISO 13769, *Gas cylinders — Stamp marking*

## 3 Intervals between periodic inspections and tests

A cylinder shall be due for a periodic inspection and test on its first receipt by a filler after the expiry of the interval in accordance with the requirements of the United Nations *Recommendations on the Transport of Dangerous Goods, Model Regulations* or as specified by national or international authorities (see examples in Annex A).

Provided the cylinder has been subjected to normal conditions of use and has not been subjected to abusive and abnormal conditions rendering the cylinder unsafe, there is no general requirement for the user to return a gas cylinder before the contents have been used even though the periodic inspection and test interval may have lapsed.

It is the responsibility of the owner or user to submit the cylinder for a periodic inspection and test within the interval specified by national or international authorities, or as specified in the relevant cylinder design standard if this is shorter.

## 4 List of procedures for periodic inspections and tests

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

- a) identification of cylinder and preparation for inspections and tests (Clause 5);
- b) depressurization and de-valving procedures (Clause 6);
- c) external visual inspection (Clause 7);
- d) check of internal condition (Clause 8);
- e) supplementary tests (Clause 9);
- f) inspection of cylinder neck (Clause 10);
- g) pressure test or ultrasonic examination (Clause 11);
- h) inspection of valve and other accessories (Clause 12);
- i) cylinder repairs (Clause 13);
- j) final operations (Clause 14);
- k) rejection and rendering cylinders unserviceable (Clause 15).

It is recommended that these procedures be performed in the sequence listed. In particular, the check of internal condition (Clause 8) should be carried out before the pressure test or, although not required, before the ultrasonic examination (Clause 11).

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Cylinders that fail an inspection or test shall be rejected (see Clause 15). Where a cylinder passes the above procedures, but when the condition of the cylinder remains in doubt, additional tests shall be performed to confirm its suitability for continued service (see Clause 9) or the cylinder shall be rendered unserviceable.

Depending on the reason for the rejection, some cylinders may be recovered (see Annex B).

The inspections and tests shall be carried out only by persons who are competent in the subject and authorized under the relevant regulations.

Mechanical properties of aluminium-alloy cylinders can be affected by heat exposure. Therefore, the maximum temperature for any operation shall be limited according to the manufacturer's recommendations (see 14.2.2).

## 5 Identification of cylinder and preparation for inspections and tests

Before any work is carried out, the relevant cylinder data (e.g. see ISO 13769) and its contents and ownership shall be identified (e.g. from the labelling and stamping). Cylinders with incorrect or illegible markings or unknown gas contents shall be set aside for special handling.

## 6 Depressurization and de-valving procedures

### 6.1 General

Cylinders to be internally inspected or tested by a pressure test are required to be depressurized and de-valved. Cylinders not internally visually inspected and tested by ultrasonic examination do not require complete depressurization and de-valving unless the ultrasonic examination indicates there is an unacceptable flaw present and the inspector wishes to further investigate (see 11.4.6).



## 6.2 Cylinders requiring depressurization

Cylinders shall be depressurized in a safe, controlled manner before proceeding. Particular attention shall be given to cylinders containing flammable, oxidizing, corrosive or toxic gases to eliminate risks at the internal inspection stage.

Before removing any pressure-retaining accessory (valve, flange, etc.), a positive check shall be performed to ensure that the cylinder does not contain any gas under pressure. This can be performed as described in Annex C using a device such as shown in Figure C.1.

Cylinders with inoperative or blocked valves shall be treated as outlined in Annex C.

Similarly in the case of cylinders disassembled from bundles not equipped with cylinder valves, the connecting tee junctions shall also be checked to determine whether the gas is able to pass freely from the cylinders using for example the device shown in Figure C.1.

Provided the requirements previously stated have been complied with, the cylinder shall be depressurized safely and the valve shall be removed.

## 6.3 Cylinders not requiring de-valving

Cylinders shall be depressurized below 5 bar to perform ultrasonic examination.

For cylinders being inspected by the ultrasonic method, refer to Clause 8.

## 7 External visual inspection

### 7.1 Preparation for external visual inspection

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. The cylinder shall be cleaned and have all loose coatings, corrosion products, tar, oil or other foreign matter removed from its external surface by a suitable method, e.g. brushing, water jet abrasive cleaning, chemical cleaning or other suitable methods (see Annex D or consult the cylinder manufacturer). Alkaline solutions and paint strippers that are harmful to aluminium and its alloys shall not be used. 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 or removing excess amounts of cylinder wall (see Annex B).

If fused nylon, polyethylene or a similar coating has been applied and the coating is seen to be damaged or it prevents a proper inspection, then the coating shall be stripped. If the coating has been removed by the application of heat at a temperature exceeding the limits specified in 14.2.2 or shows signs of heat damage, the manufacturer shall be consulted before the cylinder is returned into service and the necessary tests and inspections carried out.

### 7.2 Inspection procedure

The external surface of each cylinder shall then be inspected for

- a) dents, cuts, gouges, bulges, cracks, laminations or excessive base wear;
- b) heat damage, torch or electric-arc burns (as specified in Table B.1);
- c) corrosion (as specified in Table B.2);
- d) other defects such as illegible, incorrect or unauthorized stamp markings, or unauthorized additions or modifications; and
- e) integrity of all permanent attachments (see B.2).

When inspecting for corrosion [see c)], special attention shall be given to areas where water could be trapped. These include the entire base area, the junction between the body and the foot ring and the junction between the body and the shroud.

For rejection criteria, see Annex B. Cylinders no longer suitable for future service shall be rendered unserviceable (see Clause 15).

## 8 Check of internal condition

Cylinders shall be inspected internally to complete periodic inspection and testing requirements.

When the valve is removed, an internal visual inspection shall be performed.

For cylinders being examined by the ultrasonic method in lieu of the pressure test and when reference notches as specified in 11.4.4.2.2 are used for calibration, the valve need not be removed. However, for aluminium-alloy cylinders susceptible to sustained-load cracking, such as those manufactured from IAA 6351A or IAA 6082A alloy, the shoulder and neck area shall be internally visually inspected; alternative non-destructive examination methods, such as eddy current or ultrasonic examination, may be used if approved by the competent authority.

For cylinders that are internally visually inspected, adequate illumination shall be used to identify any defects similar to those listed in 7.2 a) and 7.2 c). Precautions shall be taken to ensure that the method of illumination presents minimum safety risk to the inspector while performing this operation. Any internal liner or coating that may obstruct optimum internal visual inspection shall be removed. Any cylinder showing presence of foreign matter or signs of more than light surface corrosion shall be cleaned internally by water jet abrasive cleaning, flailing, steam jet, hot water jet, chemical cleaning, blasting with glass beads or other suitable method (see Annex D or consult the cylinder manufacturer). Blasting with material other than aluminium or glass beads shall be avoided; hard media could embed itself in the aluminium and result in contamination of the contents. Alkaline solutions and paint strippers that are harmful to aluminium and its alloys shall not be used. 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 or removing excess amounts of cylinder wall in accordance with Annex B. If cleaning is required, the cylinder shall be re-inspected after the cleaning operation.

For cylinders of non-corrosive gases and < 0,5 l water capacity with an internal neck diameter < 9 mm, the following alternative methods may be substituted for the internal visual inspection.

- Looking for free moisture at the time of degassing the cylinder whilst in an inverted position and prior to valve removal. If any moisture is present, the cylinder shall be rendered unserviceable.
- Looking for contamination, e.g. in the water used after the hydraulic test. If contamination is observed in the hydraulic test fluid, the cylinder shall be rendered unserviceable.

## 9 Supplementary tests

Where there is doubt concerning the type and/or severity of a defect found on visual inspection, additional tests or methods of examination shall be applied, e.g. ultrasonic techniques, check weighing or other non-destructive tests.

When a hardness test is performed (e.g. see ISO 6506) or an alternative method is used (e.g. conductivity), it shall meet at least the minimum required design hardness value. An alternative method may only be used if it was employed at the time of cylinder manufacture, approved for use by the authorized body, and results and approval recorded accordingly. When this value is not known, the cylinder shall be hardness tested both before and after the stoving operation, and there shall be no appreciable decrease in the hardness value. All hardness tests shall be performed on the parallel section of the cylinder, taking adequate care to ensure deep impressions are not formed and deflection of the sidewall does not occur.

## 10 Inspection of cylinder neck

### 10.1 Cylinder to valve threads

When the valve is removed, the cylinder to valve threads shall be examined to identify the type of thread (e.g. see ISO 11191 for 25E) and to ensure that they are

- clean and of full form,
- free of damage,
- free of burrs,
- free of cracks – examine thoroughly for evidence of cracks (see Annex B),
- free of other imperfections, e.g. corrosion.

Cracks manifest themselves as lines that run vertically down the thread and across the thread faces (see Figure B.6). They should not be confused with tap marks (thread machining stop marks) (see Figure B.7). Special attention shall be paid to the area at the bottom of the threads for the detection of shoulder cracks or other defects (see Figure B.8).

### 10.2 Other neck surfaces

Other surfaces of the neck shall also be examined to ensure they are free of cracks or other defects (see Annex B).

### 10.3 Damaged internal neck threads

Where necessary and where the manufacturer or the competent design authority confirms that the design of the neck permits, threads may be re-tapped only by competent persons to provide the appropriate number of effective threads. After re-tapping, the threads shall be checked with the appropriate thread gauge, e.g. ISO 11191 for 25E threads.

### 10.4 Neck ring and collar attachment

When a neck ring/collar is attached, an examination shall be carried out to ensure that it is secure and to inspect for external thread damage. A neck ring shall only be changed using an approved procedure. If it is found that any significant damage to cylinder material has occurred by replacement of the neck ring/collar, the cylinder shall be rendered unserviceable. If the neck ring has been reattached by welding or brazing, the cylinder shall be rendered unserviceable.

## 11 Pressure test or ultrasonic examination

### 11.1 General

Each cylinder shall be submitted to either a pressure test or an ultrasonic examination.

**WARNING — Appropriate measures shall be taken to ensure safe operation and to contain any energy released. 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.**

Each cylinder subjected to a hydraulic pressure test shall use a suitable liquid, normally water, as the test medium. The hydraulic pressure test may be a proof pressure test or a volumetric expansion test as appropriate to the design specification of the cylinder. The hydraulic proof pressure test may be replaced by a pneumatic

proof pressure test. Having decided to use one particular type of test, its result shall be final. The test pressure shall be in accordance with the stamp markings of the cylinder.

Once a cylinder has failed one of the above-mentioned tests, none of the other test methods shall be applied to approve the cylinder.

## 11.2 Proof pressure test

### 11.2.1 Preamble

The following proposes a typical method for carrying out the test. Any cylinder failing to comply with the requirements of a proof pressure test shall be rendered unserviceable.

This test requires that the pressure in the cylinder be increased gradually until the test pressure is reached. The cylinder 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 evidence of any leakage. Adequate safety precautions shall be taken during the test.

### 11.2.2 Test equipment

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

**11.2.2.2** Pressure gauges shall be to Industrial Class 1 ( $\pm 1$  % deviation from the end value) with a scale appropriate to the test pressure (e.g. EN 837-1 or EN 837-3). They shall be checked for accuracy against a calibrated master gauge at regular 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 the value capable of being measured on the pressure gauge.

**11.2.2.3** The design and installation of the equipment, the connection of the cylinders and the operating procedures shall be such as to avoid trapping air in the system when a liquid medium is used.

**11.2.2.4** All joints within the system shall be leak tight.

**11.2.2.5** A suitable system control device shall be fitted to the test equipment to ensure that no cylinder is subjected to a pressure in excess of its test pressure by more than the tolerances specified in 11.2.3.3.

### 11.2.3 Test criteria

**11.2.3.1** More than one cylinder may be tested at a time provided that they all have the same test pressure. If individual test points are not used, then in case of leakage all cylinders being tested shall be individually retested.

**11.2.3.2** Before applying pressure, the external surface of the cylinder shall be dry.

**11.2.3.3** The pressure applied shall not be below the test pressure and shall not exceed the test pressure by 3 % or 10 bar, whichever is lower.

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

**11.2.3.5** If there is a leakage in the pressure system, it shall be corrected and the cylinders retested.

#### 11.2.4 Acceptance criteria

During the 30 s hold period the pressure as registered on the pressure gauge shall remain constant.

There shall be absence of visible leakage on the entire surface of the cylinder. This check can be made during the 30 s hold. There shall be no visible permanent deformation.

#### 11.3 Hydraulic volumetric expansion test

Annex E proposes typical methods for carrying out the test and gives details for determining the volumetric expansion of seamless aluminium-alloy gas cylinders by the preferred water jacket method or the non-water jacket method. The test methods, equipment and procedure chosen shall be approved by the authorized body. The water jacket volumetric expansion test shall be carried out on equipment with a levelling burette, with a fixed burette or with a weigh bowl. Care should be taken that the entire external surface of the cylinder is wet without any bubbles.

The permanent volumetric expansion of the cylinder expressed as a percentage of the total expansion at test pressure shall not exceed the percentage given in the design specification after the cylinder has been held at test pressure for a minimum period of 30 s. If this figure for permanent expansion is exceeded, the cylinder shall be rendered unserviceable.

#### 11.4 Ultrasonic examination

##### 11.4.1 Background

The ultrasonic examination on gas cylinders as described below is based on the ultrasonic examination of pipes according to ISO 9305, ISO 9764 and ISO 10543. The special geometrical features of gas cylinders and the boundary conditions for periodic inspections have been taken into account.

##### 11.4.2 Scope

The ultrasonic examination (UE) of seamless aluminium-alloy gas cylinders (water capacity  $\geq 2$  l) within the framework of periodic inspections may be carried out in lieu of the tests specified in 11.2 and 11.3.

##### 11.4.3 Requirements

###### 11.4.3.1 General

The cylindrical part of the cylinder, the transition to the shoulder, the transition at the base and critical zones of the base shall be examined ultrasonically with the help of an automated examination device (e.g. Figure 1). For aluminium-alloy cylinders susceptible to sustained-load cracking, such as those manufactured from IAA 6351 or IAA 6082 alloy, the transition area from the shoulder to the neck shall be examined. When such an examination device is not able to do this outside the cylindrical part, a supplementary manual examination shall be performed.

Cylinders that are suspected of fire or heat damage shall not be examined ultrasonically.