INTERNATIONAL STANDARD

ISO 11118

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

Bouteilles à gaz — Bouteilles à gaz métalliques non rechargeables — Spécifications et méthodes d'essai

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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 3.

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.

International Standard ISO 11118 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Gas cylinder design*.

Annex A forms a normative part of this International Standard.

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Introduction

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 usage. 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 existent because of lack of definitive International Standards. This International Standard should not be considered as reflecting on the suitability of the practice of any nation or region.

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

1 Scope

This International Standard specifies minimum requirements for the material, design, construction and workmanship, manufacturing processes and tests at manufacture of non-refillable metallic gas cylinders of welded, brazed or seamless construction for compressed, liquefied and dissolved gases exposed to extreme worldwide ambient temperatures.

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

This International Standard is applicable to cylinders where:

a) the maximum permissible operating pressure does not exceed 250 bar (i.e. $p_{ms} \leqslant 250$ bar);

b) the product of the maximum permissible operating pressure and the water capacity does not exceed 1 000 bar.litres (i.e. $p_{ms} \cdot V \leqslant 1\,000$ bar.l);

c) where the maximum permissible operating pressure exceeds 35 bar, the water capacity does not exceed 5 l (i.e. for $p_{ms} > 35$ bar, then $V \leqslant 5$ l).

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This International Standard is not applicable to cylinders exceeding these pressure and volume limits, for which reference may be made to refillable cylinder standards.

This International Standard is also not applicable to cartridges/aerosol dispensers[1)] and spherical containers.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*.

ISO 3574:1986, *Cold reduced carbon steel sheet of commercial and drawing qualities*.

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1) Cartridges are non-refillable containers which do not contain an integral dispensing device, have a maximum water capacity of 1 l and have a limited maximum permissible operating pressure (as defined by the country of use). Aerosol dispensers are non-refillable thin-walled containers which do contain an integral dispensing device, have a maximum water capacity of 1 l and have a limited maximum permissible operating pressure (as defined by the country of use).

ISO 3807[2)], *Dissolved acetylene cylinders — Basic requirements*.

ISO 4705:1983, *Refillable seamless steel gas cylinders*.

ISO 4706, *Refillable welded steel gas cylinders*.

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*.

ISO 7866:1999, *Gas cylinders — Refillable seamless aluminium alloy gas cylinders — Design, construction and testing*.

ISO 9328-5, *Steel plates and strips for pressure purposes — Technical delivery conditions — Part 5: Austenitic steels*.

ISO 9809-1:1999, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1100 MPa*.

ISO 9809-2:1999, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1100 MPa*.

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

3 Terms and definitions

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

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3.1
batch
quantity of completed and pressure-tested cylinders of the same design, prototype design, water capacity, material, heat treatment (if any) and manufacturing process made successively during one production shift of up to 12 h

3.2
cylindrical shell
portion of the cylinder, excluding the heads (ends), which is parallel to the centreline axis of the cylinder

3.3
heads (ends)
portions of the cylinder which are not parallel to the centreline axis of the cylinder

3.4
material certificate
document, issued by the material manufacturer, which states 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
maximum permissible operating pressure
highest pressure permitted to be developed during service

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2) To be replaced by ISO 3807-1 and ISO 3807-2.

3.7
test pressure
required pressure applied during the pressure test (see annex A)

3.8
working pressure
settled pressure of permanent gas at a uniform temperature of 15 °C (288 K) (see annex A)

3.9
maximum operating temperature
maximum ambient temperature to which the cylinder contents can be exposed in the country of use (see annex A)

3.10
minimum operating temperature
minimum ambient temperature to which the cylinder contents can be exposed in the country of use (see annex A)

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_h	Hydraulic test pressure, in bar[3] above atmospheric pressure
p_{ms}	Maximum permissible operating pressure, in bar[3] above atmospheric pressure
p_w	Working pressure, in bar[3] above atmospheric pressure
R_e	Minimum guaranteed value of yield stress, in megapascals, for the finished cylinder
R_g	Minimum guaranteed value of the tensile strength, in megapascals, for the finished cylinder
V	Water capacity of the cylinder, in litres

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5 Materials

5.1 General

5.1.1 Non-refillable gas cylinders shall be made of carbon or low alloy steels, austenitic stainless steel, aluminium or aluminium alloys.

The materials used are specified by type (see 5.2) and chemical composition (see 5.3).

Materials shall not contain seams, cracks, laminations or other injurious defects.

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/supplier of the material. The certificate shall be issued by the manufacturer of the material and shall confirm compliance with the material specification.

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3) 1 bar = 10^5 Pa = 0,1 MPa.

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

5.1.5 All materials used in the construction of the pressure-containing parts of the cylinder shall be identified by the cast number/code.

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

5.1.7 The material used for cylinder manufacture shall be compatible with the intended gas service (e.g. corrosive gases, embrittling gases), as specified in ISO 11114-1.

5.1.8 Cylinders for service with dissolved acetylene shall incorporate an appropriate porous mass. The completed cylinder containing the porous mass shall meet the requirements of ISO 3807.

5.2 Type

5.2.1 Carbon and low-alloy steels

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

5.2.1.2 Carbon steel for cold deep drawn welded or brazed cylinders shall be in accordance with Table 1 of ISO 3574:1986, having non-ageing properties, drawing quality, processed free of stretcher strains and shall have an aluminium content in excess of 0,01 %.

The chemical composition shall meet the requirements of 5.3.1.1.

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

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5.2.1.4 Carbon steel for cylinders 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 comply with either ISO 4705, ISO 4706, ISO 9809-1 or ISO 9809-2.

5.2.2 Aluminium and aluminium alloys

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

5.2.2.2 Aluminium and aluminium alloys shall have a chemical composition which meets the requirements of 5.3.2.

5.2.2.3 Aluminium and aluminium alloys for seamless cylinders shall meet the requirements of ISO 7866.

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 shall be in accordance with ISO 9328-5.

5.2.3.4 The chemical composition shall meet the requirements of 5.3.3.

NOTE 1 There is a risk of sensitization to intergranular corrosion resulting from hot working/welding of certain stainless steels. In such cases consideration should be given to carrying out an integranular corrosion tests, for example as specified in ISO 3651-2.

NOTE 2 Some grades of stainless steels may 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 in accordance with Table 1 of ISO 3574:1986, having non-ageing properties, drawing quality for cold deep drawn welded or brazed cylinders shall have the following chemical composition limits, in (*m*/*m*):

Carbon	⩽ 0,12
Manganese	⩽ 0,5
Phosphorus	⩽ 0,025
Sulphur	⩽ 0,025

5.3.1.2 Carbon steel for welded cylinders other than cold deep drawn shall have the following chemical composition limits, in (*m*/*m*):

Carbon	⩽ 0,25
Manganese	⩽ 0,5
Phosphorus	⩽ 0,025
Sulphur	⩽ 0,025

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5.3.1.3 Carbon steel for cylinders made of seamless steel tubing with integrally formed ends, hot drawn and finished shall have the following chemical composition limits, in (*m*/*m*):

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Carbon	⩽ 0,55
Manganese	⩽ 1,2
Phosphorus	⩽ 0,025
Sulphur	⩽ 0,025

5.3.1.4 Low alloy steels shall comply with 5.2.1.5.

5.3.2 Aluminium and aluminium alloys

Aluminium and aluminium alloys may be used to produce gas cylinders provided that they meet all requirements of this International Standard and have maximum lead and bismuth contents not exceeding 0,003 %.

NOTE A list of registered alloys is maintained by the Aluminum Association Inc.[4)] entitled *Registration Record of International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys*.

5.3.3 Austenitic stainless steels

Austenitic stainless steel shall meet the requirements of ISO 9328-5.

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4) Aluminum Association Inc., 900, 19th Street N.W., Washington DC, 20006-2168, U.S.A.

6 Inspection and testing

Evaluation of conformity is required to be performed in accordance with the relevant regulations of the country(ies) where the cylinders are to be used.

In order to ensure that the cylinders are in compliance with this International Standard they shall be subject to inspection and testing in accordance with clauses 9, 10 and 11 by an authorized inspection authority (hereafter referred to as 'the inspector') recognized in the countries of use. The inspector shall be competent for inspection of cylinders.

7 Design

7.1 General

7.1.1 The calculation of the cylindrical wall thickness of the pressure-containing parts shall be related to the yield stress (R_e).

7.1.2 The relationship between the working pressure, maximum permissible operating pressure and the test pressure shall be in accordance with annex A.

7.1.3 The design of the heads shall be such that the pressure-containing parts when subjected to the test pressure (p_h) shall not show any permanent visible deformation.

7.2 Calculation of dimensions of pressure-containing parts

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

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2221f6d2585c/iso-11118-1999

a) The minimum thickness of the cylindrical shell shall be not less than that necessary for the minimum burst pressure to be greater than two times the hydraulic 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 be not less than that calculated by the Lamé-von Mises formula, as follows:

$$a = \frac{D}{2}\left[1 - \sqrt{\frac{10FR_e - \sqrt{3}p_h}{10FR_e}}\right]$$

where $F = 1$.

c) The minimum thickness of the cylindrical shell shall be not less than that calculated using one of the following formulae:

for steel: $a = \frac{D}{650} + 0,5$;

for aluminium and aluminium alloys: $a = \frac{D}{300} + 0,5$.

7.3 Design drawing

A fully dimensioned drawing of the cylinder shall be supplied which includes as a minimum:

a) material specifications including R_e and R_g in megapascals;

b) test pressure in bar;

c) minimum burst pressure in bar;

d) minimum thickness of the cylindrical shell in millimetres;

e) minimum water capacity in litres;

f) nominal cylinder outside diameter in millimetres;

g) dimensions of heads in millimetres;

h) overall length of the cylinder in millimetres;

i) heat treatment (if any);

j) method of construction;

k) welding/brazing procedure designation;

l) valve connection specification;

m) cylinder design identification and approval number;

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

o) date and revision identity of drawing;

p) manufacturer's identity;

q) content and position of markings.

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8 Construction and workmanship

8.1 Construction

8.1.1 General

8.1.1.1 Types of construction

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

8.1.1.2 Seamless construction

Seamless cylinders shall be produced by:

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

b) manufacturing from seamless tube or

c) pressing from a flat plate.

Welding and brazing shall be carried out for no other purpose than the provision of attachments and openings (see 8.1.2) and shall comply with the requirements of 9.2.6. Furthermore:

— welding shall be carried out only on cylinders made of weldable materials;

— brazing shall be carried out only on cylinders made of materials not degraded by this procedure.