DRAFT INTERNATIONAL STANDARD ISO/DIS 9809-3.2

ISO/TC **58**/SC **3** Secretariat: **BSI**

Voting begins on: **2008-04-10** Voting terminates on: **2008-06-10**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing —

Part 3: Normalized steel cylinders

Bouteilles à gaz — Bouteilles à gaz rechargeables en acier sans soudure — Conception, construction et essais —

Partie 3: Bouteilles en acier normalisé

[Revision of first edition (ISO 9809-3:2000)]

ICS 23.020.30

ISO/CEN PARALLEL ENQUIRY

The CEN Secretary-General has advised the ISO Secretary-General that this ISO/DIS covers a subject of interest to European standardization. **In accordance with the ISO-lead mode of collaboration as defined in the Vienna Agreement, consultation on this ISO/DIS has the same effect for CEN members as would a CEN enquiry on a draft European Standard.** Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month FDIS vote in ISO and formal vote in CEN.

In accordance with the provisions of Council Resolution 15/1993 this document is circulated in the English language only.

Conformément aux dispositions de la Résolution du Conseil 15/1993, ce document est distribué en version anglaise seulement.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

Contents

Page

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 9809-3 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Cylinder design*.

This second edition cancels and replaces the first edition, ISO 9809-3:2000, which has been technically revised.

ISO 9809 consists of the following parts, under the general title *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*

— *Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1 100 MPa*

— *Part 3: Normalized steel cylinders*

— *Part 4: Stainless steel cylinders with an R_m value of less than 1 100 MPa*

This part of ISO 9809 has been prepared to address the general requirements in Section 6.2.1 of the UN model regulations for the transportation of dangerous goods ST/SG/AC.10/1/Rev.xx, as valid at the time of application. It is intended to be used under a variety of regulatory regimes but has been written so that it is suitable for use with the conformity assessment system in paragraph 6.2.2.5 of the above mentioned model regulations.

Introduction

The purpose of this part of ISO 9809 is to provide a specification for the design, manufacture, inspection and testing of a cylinder for worldwide usage. The objective is to balance design and economic efficiency against international acceptance and universal utility.

ISO 9809 aims to eliminate the concern about climate, duplicate inspections and restrictions currently existing because of lack of definitive International Standards. This standard should not be construed as reflecting on the suitability of the practice of any nation or region.

Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing —

Part 3:
Normalized steel cylinders

1 Scope

This part of ISO 9809 sets out minimum requirements for the material, design, construction and workmanship, manufacturing processes, examinations and tests at manufacture of refillable normalized or normalized and tempered seamless steel gas cylinders of water capacities from 0,5 l up to and including 150 l for compressed, liquefied and dissolved gases.

NOTE 1 If so desired, cylinders of water capacity less than 0,5 l may be manufactured and certified to this part of ISO 9809.

NOTE 2 For quenched and tempered cylinders with maximum tensile strength less than 1 100 MPa refer to ISO 9809-1. For quenched and tempered cylinders with maximum tensile strength ≥ 1 100 MPa refer to ISO 9809-2.

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 148-1, *Metallic materials — Charpy pendulum impact test – Part 1: Test method*

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

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

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

ISO 7438, *Metallic materials — Bend test*

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

ISO 9712:1999, *Non-destructive testing — Qualification and certification of 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 9809-2, *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 1 100 MPa*

ISO 10286, *Gas cylinders - Terminology*

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

ISO 13769, *Gas cylinders — Stamp marking*

3 Terms and definitions

For the purposes of this part of ISO 9809 the following terms and definitions apply.

3.1
yield strength
stress value corresponding to the lower yield strength R_{eL} or, for steels that do not exhibit a defined yield, the 0,2 % proof strength (non-proportional extension), $R_{p0,2}$ (see ISO 6892)

3.2
normalizing
heat treatment in which a cylinder is heated to a uniform temperature above the upper critical point (A_{c3}) of the steel and then cooled in still air

3.3
tempering
softening heat treatment which follows normalising, in which the cylinder is heated to a uniform temperature below the lower critical point (Ac1) of the steel

3.4
batch
quantity of up to 200 cylinders plus cylinders for destructive testing of the same nominal diameter, thickness, length and design made successively on the same equipment, from the same cast of steel and subjected to the same heat treatment for the same duration of time

3.5
test pressure
required pressure (p_h) applied during a pressure test

NOTE It is used for cylinder wall thickness calculation.

3.6
burst pressure (p_b)
highest pressure reached in a cylinder during a burst test

3.7
design stress factor (variable) (*F*)
ratio of equivalent wall stress at test pressure (ph) to guaranteed minimum yield strength (R_{eg})

3.8
working pressure
settled pressure of a compressed gas at a uniform reference temperature of 15 deg. C in a full gas cylinder (see ISO 10286)

4 Symbols

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

a' Guaranteed minimum thickness, in millimetres, of the cylindrical shell

a_1 Guaranteed minimum thickness, in millimetres, of a concave base at the knuckle (see Figure 2)

a_2 Guaranteed minimum thickness, in millimetres, at the centre of a concave base (see Figure 2)

A Percentage elongation after fracture.

b Guaranteed minimum thickness, in millimetres, at the centre of a convex base (see Figure 1)

d_2 Maximum permissible deviation of burst profile, in millimetres (see Figure 5b), c) and d)

D Nominal design outside diameter of the cylinder, in millimetres, (see Figure 1)

D_F Diameter, in millimetres, of former (see Figure 8)

F Design stress factor (variable), see 7.2

h Outside depth (concave base end), in millimetres (see Figure 2)

H Outside height, in millimetres, of domed part (convex head or base end), (see Figure 1)

L_o Original gauge length, in millimetres, as defined in ISO 6892 (see Figure 7)

n Ratio of the diameter of the bend test former to actual thickness of test piece (t).

p_b Measured burst pressure, in bar[1)] above atmospheric pressure

p_h Hydraulic test pressure, in bar, above atmospheric pressure

p_y Observed pressure when cylinder starts yielding during hydraulic bursting test, in bar

r Inside knuckle radius, in millimetres (see Figures 1 and 2)

R_{eg} Minimum guaranteed value of the yield strength (see 7.1.1), in MPa, for the finished cylinder

R_{ea} Actual value of the yield strength, in MPa, as determined by the tensile test (see 10.2)

R_{mg} Minimum guaranteed value of the tensile strength, in MPa, for the finished cylinder

R_{ma} Actual value of the tensile strength, in MPa, as determined by the tensile test (see 10.2)

S_o Original cross-sectional area of tensile test piece, in square millimetres according to ISO 6892

t Actual thickness of the test specimen, in millimetres

u Ratio of distance between knife edges or platens in the flattening test to average cylinder wall thickness at the position of test

V Water capacity of cylinder, in litres

w Width, in millimetres, of the tensile test piece (see Figure 7)

5 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 used.

---

1) 1 bar = 10^5 Pa = 10^5 N/m^2.

To ensure that the cylinders conform to this part of ISO 9809, they shall be subject to inspection and testing in accordance with clauses 9, 10 and 11 by an authorized inspection body (hereafter referred to as "the inspector") recognized in the countries of use.

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

6 Materials

6.1 General requirements

6.1.1 Materials for the manufacture of normalized or normalized and tempered gas cylinders shall be those generically classified as carbon-steels or carbon-manganese steels. The maximum tensile strength for cylinders made from those steels shall not exceed 800 MPa.

Other steels specified in ISO 9809-1 or ISO 9809-2 for quenched and tempered cylinders may be used and subjected to normalizing and tempering as specified in 6.3 provided that they additionally pass the impact test requirements given in ISO 9809-1, and the maximum tensile strength R_{ma}, does not exceed 950 MPa.

The steel used shall fall within one of the following categories:

a) internationally recognized cylinder steels;

b) nationally recognized cylinder steels;

c) new cylinder steels resulting from technical progress.

6.1.2 The material used for the manufacture of gas cylinders shall be steel, other than rimming quality, with non-ageing properties, and shall be aluminium and/or silicon killed. If only aluminium is used for killing, the metallic aluminium content shall be at least 0,015 %.

Where examination of this non-ageing property is required by the customer, the criteria by which it is to be specified should be agreed with the customer and inserted in the order.

6.1.3 The cylinder manufacturer shall establish means to identify the cylinders with the cast of steel from which they are made.

6.1.4 Grades of steel used for cylinder manufacture shall be compatible with the intended gas service, e.g. corrosive gases, embrittling gases (see ISO 11114-1).

6.2 Controls on chemical composition

6.2.1 The chemical composition of all steels shall be defined at least by :

— the carbon, manganese and silicon contents in all cases;

— the chromium, nickel and molybdenum contents or other alloying elements intentionally added to the steel;

— the maximum sulfur and phosphorus contents in all cases.

The carbon, manganese and silicon contents shall be given, with tolerances, such that the differences between the maximum and minimum values of the cast do not exceed the values shown in Table 1.

Table 1 — Chemical composition tolerances

Element	Maximum content (*m/m*)	Permissible range (*m/m*) %
Carbon	< 0,30 % ≥ 0,30 %	0,06 0,07
Manganese	All values	0,30
Silicon	All values	0,30

The actual content of any element deliberately added shall be reported and their maximum content shall be representative of good steel making practice.

6.2.2 Except for steels conforming to ISO 9809-1 or ISO 9809-2, the following limits on carbon, manganese, sulfur, phosphorus and other alloying elements, shall not be exceeded in the cast analysis of material used.

Carbon	0,45 %
Manganese	1,70 %
Chromium	0,20 %
Molybdenum	0,20 %
Nickel	0,20 %
Copper	0,20 %
Combined value of micro alloying elements : i.e. V, Nb, Ti, B, Zr, Sn	0,15 %
Sulfur	0,015 %
Phosphorus	0,020 %
Sulfur + Phosphorus	0,030 %

6.2.3 The cylinder manufacturer shall obtain and make available certificates of cast (heat) analyses of the steels supplied for the construction of gas cylinders.

Should check analyses be required, they shall be carried out either on specimens taken during manufacture from the material in the form as supplied by the steel maker to the cylinder manufacturer, or from finished cylinders. In any check analysis, the maximum permissible deviation from the limits specified for the cast analyses shall conform to the values specified in ISO 9329-1.

6.3 Heat treatment

The heat treatment process applied to the finished cylinder shall be either normalizing or normalizing and tempering. The cylinder manufacturer shall certify the heat treatment process applied.

The heat treatment process shall achieve the required mechanical properties.

The actual temperature to which a type of steel is subjected for a given tensile strength shall not deviate by more than 30 °C from the temperature specified by the cylinder manufacturer.

6.4 Test requirements

The material of the finished cylinders shall meet the requirements of clauses 9, 10 and 11.

6.5 Failure to meet test requirements

In the event of failure to meet the test requirements, retesting or re-heat treatment and retesting shall be carried out as follows:

a) If there is evidence of a fault in carrying out a test, or an error of measurement, a further test shall be performed. If the result of this test is satisfactory, the first test shall be ignored.

b) If the test has been carried out in a satisfactory manner, the cause of test failure shall be identified.

1) If the failure is considered to be due to the heat treatment applied, the manufacturer may subject all the cylinders representing the nature of the failure to a further heat treatment e.g. if the failure is in a test representing the prototype or batch cylinders, test failure shall require re-heat treatment of all the represented cylinders prior to re-testing.

This heat treatment shall consist of re-normalizing or re-normalizing and tempering or re-tempering.

Whenever cylinders are re-heat treated, the minimum guaranteed wall thickness shall be maintained,

Only the relevant prototype or batch tests needed to prove the acceptability of the batch shall be performed again. If one or more of these retests prove even partially unsatisfactory, all cylinders of the batch shall be rejected.

2) If the failure is due to a cause other than the heat treatment applied, all cylinders with imperfections shall be either rejected or repaired such that the repaired cylinders pass the test(s) required for the repair. They shall then be re-instated as part of the original batch.

7 Design

7.1 General requirements

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

7.1.2 Cylinders may be designed with one or two openings along the central cylinder axis only.

7.1.3 For calculation purposes, the value of R_{eg} shall not exceed 0,75 R_{mg}.

7.1.4 The internal pressure upon which the calculation of wall thickness is based shall be the hydraulic test pressure p_h.

7.2 Calculation of cylindrical shell thickness

The guaranteed minimum thickness of the cylindrical shell (a') shall not be less than that calculated using the following equations (1) and (2). Additionally condition (3) shall be satisfied:

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

where $F \leq 0,85$

The wall thickness shall also satisfy the formula