BS EN 16509:2014

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Transportable gas cylinders — Non-refillable, small transportable, steel cylinders of capacities up to and including 120 ml containing compressed or liquefied gases (compact cylinders) — Design, construction, filling and testing

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National foreword

This British Standard is the UK implementation of EN 16509:2014.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Transportable gas cylinders - Non-refillable, small transportable, steel cylinders of capacities up to and including 120 ml containing compressed or liquefied gases (compact cylinders) - Design, construction, filling and testing

Bouteilles à gaz transportables - Petites bouteilles transportables en acier, non rechargeables, de capacité inférieure ou égale à 120 ml et contenant des gaz comprimés ou liquéfiés (bouteilles compactes) - Conception, fabrication, remplissage et essais

Ortsbewegliche Gasflaschen - Nicht wiederbefüllbare kleine ortsbewegliche Flaschen aus Stahl mit einem Fassungsraum bis einschließlich 120 ml für verdichtete oder verflüssigte Gase (Kompaktflaschen) - Auslegung, Bau, Füllung und Prüfung

This European Standard was approved by CEN on 23 August 2014.

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Foreword

This document (EN 16509:2014) has been prepared by Technical Committee CEN/TC 23 “Transportable gas cylinders”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2015 and conflicting national standards shall be withdrawn at the latest by April 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This European Standard has been submitted for reference into the RID and the technical annexes of the ADR.

NOTE These regulations take precedence over any clause of this standard. It is emphasized that RID/ADR/ADN are being revised regularly at intervals of two years which may lead to temporary non-compliances with the clauses of this standard.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The purpose of this European Standard is to provide a specification for the design, construction, inspection, testing and filling of non-refillable small cylinders and their closures - containing compressed or liquefied gases (hereinafter referred to as compact cylinders). In this standard the term “compact cylinders” refers to completed and filled cylinders as well as to such cylinders in the course of design, manufacture, filling, testing and marking.

The compact cylinders dealt with in this standard have been used internationally for decades. However, with the withdrawal of some national rules/standards, which regulated a particular category of these cylinders and the ongoing harmonization process within Europe, there is a need to specify these cylinders in comprehensive terms to ensure safety during transport and in use.

The specifications given are based on knowledge of, and experience with, materials, design requirements, manufacture including filling and control during manufacture, of compact cylinders in common use in the countries of the CEN member countries.

1 Scope

This European Standard sets out the minimum requirements relating to the material, design, construction, filling, testing and inspection at time of manufacture of non-refillable, transportable small steel cylinders and their closures of water capacities up to and including 120 ml containing non-toxic, non-flammable compressed or liquefied gases (hereinafter referred to as “compact cylinders”).

NOTE 1 Such cylinders are referred as “small receptacle containing gas (gas cartridges)” in RID/ADR.

NOTE 2 For cylinders with capacities greater than 120 ml, see EN 12205 or ISO 11118.

2 Normative References

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

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*

3 Terms and definitions

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

3.1
compact cylinder
filled non-refillable cylinder and its closure

3.2
operating temperature

3.2.1
minimum operating temperature
minimum ambient temperature to which the cylinder contents may be exposed during operation in °C

3.2.2
maximum operating temperature
maximum permissible temperature to which the filled compact cylinder may be exposed during operation in °C

3.3
burst pressure
highest pressure reached in a compact cylinder during the burst test in bar

3.4
working pressure
settled pressure of a compressed gas at a uniform reference temperature of 15 °C in a full compact cylinder in bar

3.5
filling ratio
ratio of the mass of gas contained in the compact cylinder to the mass of the water at 15 °C that would completely fill the cylinder

3.6
water capacity
volume of water required to completely fill an empty compact cylinder at 15 °C in millilitres

3.7
design pressure
calculated pressure in the compact cylinder filled to the maximum filling ratio for liquefied gases or filled to the maximum working pressure for compressed gases, at test temperature in bar

3.8
test pressure
required pressure applied during the pressure test in bar

3.9
batch
quantity of completed and pressure tested cylinder shells/ compact cylinders made consecutively by the same manufacturer using the same manufacturing techniques, to the same design, size and material specifications using the same heat treatment conditions (when applicable)

3.10
outer packaging
packaging used to contain several compact cylinders for shipment and complying with the relevant regulation

4 Requirements

4.1 General

To ensure that the compact cylinders are in compliance with this European Standard they shall be inspected, tested and approved in accordance with Clause 6 by an authorized inspection body (hereafter referred to as “the inspector”) recognized in the countries of use.

The design, materials and construction of compact cylinders shall be capable of withstanding the physical and chemical properties of the gas contents in accordance with EN ISO 11114-1 and EN ISO 11114-2 at the conditions specified by the manufacturer, whilst also fulfilling the requirements set down in this clause.

Compact cylinders shall be manufactured from the materials and in accordance with the processes specified in 4.3 and satisfy the tests as in Clause 5. Additionally the type approval requirements of Clause 6, the tests of Clause 7 and Clause 8 and the marking requirements of Clause 9 shall be met.

4.2 Design

4.2.1 General

The design of compact cylinders shall be based on experimental results and shall ensure that the compact cylinders meet all performance tests set out in this standard.

The compact cylinder shall be essentially cylindrical with an opening and a convex base or a second opening along the central cylinder axis.

The compact cylinder may be designed with or without an external threaded neck.

The compact cylinders shall be fitted with closures that satisfy the requirements of 4.3.2. The closure shall be gastight (see 5.8), and, once opened, render the compact cylinders non refillable.

4.2.2 Design drawing and specification

Fully dimensioned drawings and complete specifications of the compact cylinder shall be provided which include as a minimum the following information:

a) material specifications (shell and closure);

b) test temperature (°C) see 5.4;

c) minimum guaranteed burst pressure (bar);

d) design pressure (bar);

e) minimum thickness of the cylindrical shell (mm);

f) minimum guaranteed water capacity (ml);

g) nominal compact cylinder outside diameter (mm);

h) dimensions of neck and if any, the thread specification (mm);

i) nominal overall length of the compact cylinder (mm);

j) minimum and maximum operating temperature (°C) see 4.4;

k) method of construction;

l) design standard (i.e. EN 16509);

m) date and/or revision number of drawing;

n) manufacturers identity;

o) gas and gas specification;

p) nominal mass and mass tolerance of the gas filling (g);

q) maximum filling ratio for liquefied gases, (kg/l), or the working pressure for compressed gases (bar);

r) surface protection ; if any (e.g. zinc coated);

s) maximum opening force of the closure (N) see 5.9 (if applicable);

t) dimensions of closure and method of attachment.

4.3 Materials and construction

4.3.1 General

The materials used for compact cylinders and closures shall be suitable for the temperatures, pressures and the chemical and mechanical stresses anticipated within the prescribed operational limits, including prolonged operating periods. (e.g. ageing; pressure cycling resulting from temperature changes). All materials shall be

suitable for use at the minimum operating temperature in the country of use or at –20 °C, whichever is the lower.

4.3.2 Cylinder shells

Compact cylinder shells shall be manufactured from low-alloy, fully-killed carbon steel with non-aging properties and a maximum carbon content of 0,55 %. Stainless steels of suitable quality are also permitted to be used in accordance with EN 10088-1. The chemical and physical specifications of the material shall correspond to the technical requirements of the compact cylinders and be unambiguously specified and documented between the supplier of the material and the manufacturer of the compact cylinders.

Compact cylinder shells shall be of seamless construction and manufactured using one of the following processes:

a) deep drawing from plate:

for this process, steel plate in accordance with EN 10130 or EN 10139 or other equivalent steel plate suitable for deep drawing may be used;

b) forming from seamless tubes:

for this process, tubes in accordance with EN 10305-1 or other equivalent steel tubes suitable for the process may be used. Metal shall not be added in the process of closing the base end.

4.3.3 Closures

The closure shall be permanently attached to the compact cylinder shell by welding or crimping. If the closure is welded, its material shall be of weldable quality and compatible with the cylinder shell material.

The closure shall be so designed and constructed that it can be used only once for the containment of the contents. Once it is opened for the release of the gas it shall not be re-closable.

4.4 Minimum and maximum operating temperatures

The minimum and maximum operating temperature shall be specified by the manufacturer. The maximum operating temperature shall not exceed the minimum temperature reached during the pressure test as set out in 5.4.

4.5 Gas

The gas filled into compact cylinders shall be compressed or liquefied, with non-toxic, non-flammable properties.

The specification of the gas shall be set by the manufacturer of the cylinder and shall be unambiguously specified and documented and shall be agreed with the supplier of the gas.

The type and quantity of gas to be put in the compact cylinder shall be unambiguously specified and documented in the design drawing/ specification set out in 4.2.2.

For compact cylinders filled with liquefied gases, the filling ratios and corresponding test pressures stipulated in applicable regulations shall be complied with.

NOTE Test pressures and filling ratios for compressed and liquefied gases are specified in RID/ADR Packing Instruction P200.

Compressed gases shall be charged into compact cylinders so that at a temperature of 15 °C the pressure does not exceed the working pressure specified in the design drawing/specification set out in 4.2.2. The working pressure shall not exceed two thirds of the test pressure.

The gas quantity shall be verified in accordance with 5.6.

5 Tests

5.1 General

The test procedures and test requirements for compact cylinders are described in Clause 5, Clause 6, Clause 7 and Clause 8.

All test samples used in the tests described shall be selected at random for every compact cylinder type from routine production. The test samples shall be with or without closures as specified for the relevant test.

The test results and the test methods applied shall be recorded.

5.2 Hydraulic tests

5.2.1 Pressure test

This test is to confirm that the cylinder shell does not leak or permanently deform when subjected to a pressure of 1,5 times the internal pressure at 65 °C.

The hydraulic pressure shall be applied at 20 °C ± 5 °C to a sample of cylinder shells of each design until the prescribed test pressure is reached (with a minimum of 10 bar). This pressure shall be held for at least 1 min. After this time no leakage or visible permanent deformation shall have occurred.

5.2.2 Burst test

This test is to determine the burst pressure of the compact cylinder shell, without closure.

The pressure shall be hydraulically increased on a continuous basis at a rate between 20 bar/s and 30 bar/s during the elastic deformation. Then, the pump discharge rate shall be maintained at a level as constant as possible until the compact cylinder bursts. A record shall be made of the pressure/time characteristic of the pressurization.

The initiation of the fracture shall in each case take place only in the cylindrical area. The cylinder shall remain in one piece. The fracture surface shall have a ductile appearance.

The hydraulic burst pressure shall be at least twice the design test pressure of that compact cylinder as specified in the documentation and as listed in 4.2.1

5.3 Ductility tests

5.3.1 General

Either of the tests specified in 5.3.2 or 5.3.3 shall be used to confirm the ductility of the compact cylinder shell.

5.3.2 Gas burst test

A compact cylinder that has been filled in accordance with 4.5 and checked in accordance with 5.5 is placed in a suitable oven and heated until bursting. If the closure also serves as a pressure relief device, this function shall be rendered inoperable, e.g. by blanking over the neck opening area.

WARNING — It should be noted that this gas burst test is more dangerous than the hydraulic burst test. Therefore, these tests should only be carried out after assuring safety of personnel and properties.

The initiation of the fracture shall in each case take place only in the cylindrical area. The compact cylinder shall remain in one piece. The fracture surface shall have a ductile appearance.

5.3.3 Flattening test

Cylinders shells without surface treatment (e.g. plating or painting) shall be flattened between wedge shaped knife edges with a 60° included angle, the edges being rounded to a nominal radius of 13 mm. The length of the wedges shall be not less than the width of the flattened cylinder. The longitudinal axis of the cylinder shall be at an angle of approximately 90° to the knife edges.

The test cylinder shall be flattened until the distance between the knife edges is 6 times the wall thickness of the cylinder.

No cracks shall be visible when viewed by the naked eye.

5.4 Proof pressure test

This test is not required to be performed if the hot water bath test described in 5.7.2. is performed on each compact cylinder.

Each compact cylinder filled with liquefied gas shall be heated up to and held for at least 1 min at a test temperature of $65\,^{+8}_{0}$ °C.

EXAMPLE 1 In the case of a compact cylinder filled with CO_2 or N_2O with a filling ratio of 0,75 kg/l, the developed pressure specific to this cylinder is 250 bar at 65 °C.

Each compact cylinder filled with compressed gas shall be heated up and held for at least 1 min to a test temperature such that the developed pressure is equal to or greater than 1,5 times the working pressure.

EXAMPLE 2 In the case of a compact cylinder filled with Argon at a working pressure of 200 bar, the developed pressure at 110 °C will be 300 bar.

In each test no permanent deformation of the cylinder shell shall be visible after completion of the test. For leakage requirements, see 5.7.

5.5 Water capacity check

The water capacity of a compact cylinder shall be determined by completely filling the cylinder shell prior to attachment of the closure with water at a temperature of $15\,^{+5}_{0}$ °C.

The water capacity is then determined by differential weighing of the empty compact cylinder and the water filled compact cylinder. This shall be greater than/equal to the minimum water capacity stated in the design drawing/specification pursuant to 4.2.1.

The check of the water capacity can also be made by monitoring and checking relevant dimensions during production.

5.6 Gas quantity check

The mass of gas in the compact cylinder shall be determined by differential weighing before and after filling.

The scales shall be accurate to 0,1 g or better for mass determination.

The mass of gas shall be as specified in the documentation.

5.7 Leakage test

5.7.1 General

Each compact cylinder shall be tested for tightness. The compact cylinders shall be complete in all respects but need not already be surface treated and marked.

The manufacturer shall use the hot water bath test (see 5.7.2) or an alternative test method (see 5.7.3) consistent with the processes employed to demonstrate tightness and robustness of every compact cylinder.

5.7.2 Hot water bath test

Each compact-cylinder filled with liquefied gases shall be immersed in a water-bath at 65^{+8}_{0} °C for at least 20 min.

Each compact-cylinder filled with permanent gases shall be immersed in a water-bath at 95 °C for at least 20 min.

Leaking compact cylinders shall be identified by the appearance of any bubble formed during this 20 min period.

Each compact cylinder found to be leaking or with a permanent deformation shall be rejected.

5.7.3 Leakage testing by alternative methods

An appropriate alternative method to the hot water bath test to demonstrate tightness and robustness shall be established.

NOTE RID/ADR 2013 requires the approval of the Competent Authority when alternative methods to the hot water bath to demonstrate tightness and robustness are used.

An example of a suitable method for establishing the leakage rate for a compact cylinder is by differential weighing of each compact cylinder before and after a 14 days storage period at room temperature. The weighing equipment shall be accurate to 0,1 mg for determining the mass.

The leakage rate for a compact cylinder at a reference temperature of 20 °C ± 5 °C shall not exceed $1{,}0 \times 10^{-4}$ mbar.l.s^{-1}.

Certain applications (e.g. customer requirements) or specifications may require lower leakage rates which shall be agreed between the parties concerned.

All compact cylinders with a leakage rate exceeding the minimum specified rate shall be rejected.

An example of a suitable method for determining the robustness including the rejection criteria is proof pressure testing according to 5.4.

5.8 Check of gross mass

Compact cylinders shall be checked prior to packing/dispatch for compliance with their specified minimum requisite gross mass.

5.9 Check of force to open the closure

Where the release of the gas is effected by the application of a force along the longitudinal axis of the compact cylinder this force shall be at least 40 N. The maximum allowable force to open the closure shall be stated in the design drawing/ specification pursuant to 4.2.2 depending on the function of the closures.

A method for determining the opening force is described in EN ISO 12402-7:2006, 4.12.2.2.4.

Where it is not practical to open the closures by the method described in EN ISO 12402-7:2006 another suitable method shall be used. This method shall be prescribed in the design and closures tested for compliance with specified criteria.

6 Type approval procedure

6.1 General requirements

The design drawing and specification details (to 4.2.2) of each new design of compact cylinder shall be submitted by the manufacturer to the inspector. The results of the tests to be performed shall be summarized in a report and recorded.

The type approval tests detailed in 6.2 shall be carried out on each new design under the supervision of the inspector.

A compact cylinder shall be considered to be of a new design compared with an existing approved design, when at least one of the following applies:

a) it is manufactured in a different manufacturing facility;

b) it is manufactured by a different process, e.g. deep drawing to spinning process;

c) the cylinder is manufactured from a steel of different specification;

d) it is given a different heat treatment, if applicable;

e) the overall length has increased or decreased by more than 25 %;

f) the ends (base or neck) have changed in shape or thickness;

g) the nominal outside diameter of the cylinder has been increased or decreased by more than 1 % of the original design diameter or 2 mm, whichever is the greater;

h) the guaranteed minimum wall thickness has changed;

i) the design pressure has increased;

j) the minimum guaranteed burst pressure has changed;

k) changes of the closure in material and/or design.

6.2 Prototype tests

A minimum of 100 compact cylinders which are guaranteed by the manufacturer to be representative of the new design shall be made available for prototype testing.

Compact cylinders representative of the prototype design shall be tested as described in Clause 5 and dimensional checks shall be carried out.

Each test described in Clause 5 shall be carried out on a minimum of five representative prototype cylinders.

Additional dimensional checks shall be carried out on five representative prototype cylinders and closures.

If the results of these tests and the dimensional checks are satisfactory, the inspector shall issue a new design type approval certificate.

7 Batch tests

Tests according to 5.2, 5.3 and 5.5 shall be performed on at least:

— 5 samples every working day where daily production ≤ 250 000 units, or

— 2 samples per 100 000 where daily production > 250 000 units.

The sampling rate for the test specified in 5.6 shall be at least 1 unit per 10 000 compact cylinders that have been filled in accordance with 4.5.

At least five cylinders from each working day's production shall be tested in accordance with 5.8. This test batch can be made up of samples taken from more than one but not more than twenty days' production.

The opening force as specified in 5.9 shall be checked on 1 per 200 000 compact cylinders equipped with the same closure batch, or 20 compact cylinders equipped with the same closure, batch, whichever is greater.

8 Tests/examinations on every compact cylinder

Tests according to 5.4, 5.7 and 5.8 shall be performed on each compact cylinder.

9 Marking of compact cylinders

9.1 General

Compact cylinders shall be visibly, legibly and durably marked. The following markings are the minimum requirements, which shall be placed, as required, directly on the compact cylinders and/or on the packaging as specified in 9.2.

NOTE The European Directive on Transportable Pressure Equipment 2010/35/EU includes additional marking requirements (Π-marking).

9.2 Required markings

9.2.1 On cylinder and outer packaging

— Name or mark of the manufacturer/party placing the compact cylinders on the market;

— country of origin;

— gas identification by name and/or chemical formula;

— nominal gas weight or working pressure as appropriate;

— inspector’s mark (if applicable).

For cylinders less than 10 ml, the only mandatory markings placed on the cylinders are gas identification and manufacturer mark.

9.2.2 On outer packaging only

— Risk identification – by symbol/text as appropriate (e.g. “pressurized container”), example of hazard labels can be seen in EN ISO 7225;

— number of this standard, i.e. EN 16509.

9.2.3 On cylinder only

Production date and/or batch number.

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[4] EN 10305-1, *Steel tubes for precision applications — Technical delivery conditions — Part 1: Seamless cold drawn tubes*

[5] EN 12205, *Transportable gas cylinders — Non-refillable metallic gas cylinders*

[6] EN ISO 7225, *Gas cylinders — Precautionary labels (ISO 7225)*

[7] EN ISO 12402-7:2006, *Personal flotation devices — Part 7: Materials and components — Safety requirements and test methods (ISO 12402-7:2006)*

[8] ISO 11118, *Gas cylinders — Non-refillable metallic gas cylinders — Specification and test methods*

[9] ADR, *European Agreement concerning the International Carriage of Dangerous Goods by Road*

[10] RID, *Regulation concerning the International Carriage of Dangerous Goods by Rail*

[11] TPED 2010/35/EU*, Transportable Pressure Equipment Directive*

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