BS EN 14638-3:2010

Incorporating corrigendum March 2012

BSI Standards Publication

Transportable gas cylinders — Refillable welded receptacles of a capacity not exceeding 150 litres

Part 3: Welded carbon steel cylinders made to a design justified by experimental methods

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National foreword

This British Standard is the UK implementation of EN 14638-3:2010, incorporating corrigendum March 2012.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by CEN corrigendum March 2012 is indicated in the text by ▌AC1⟩ ⟨AC1▐.

The UK participation in its preparation was entrusted to Technical Committee PVE/3/3, Gas containers - Transportable gas containers - Cylinder design, construction and testing at the time of manufacture.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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ISBN 978 0 580 78025 7

ICS 23.020.30

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 December 2010.

Amendments/corrigenda issued since publication

Date	Text affected
30 April 2012	Implementation of CEN corrigendum March 2012

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14638-3

August 2010

ICS 23.020.30

Incorporating corrigendum March 2012

English Version

Transportable gas cylinders - Refillable welded receptacles of a capacity not exceeding 150 litres - Part 3: Welded carbon steel cylinders made to a design justified by experimental methods

Bouteilles à gaz transportables - Récipients soudés rechargeables d'une capacité inférieure ou égale à 150 litres - Partie 3: Bouteilles en acier carbone soudées conçues par des méthodes expérimentales

Ortsbewegliche Gasflaschen - Wiederbefüllbare geschweißte Gefäße mit einem Fassungsraum von nicht mehr als 150 Liter - Teil 3: Flaschen aus geschweißtem Kohlenstoffstahl, ausgelegt nach experimentellen Verfahren

This European Standard was approved by CEN on 23 July 2010.

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Ref. No. EN 14638-3:2010: E

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Foreword

This document (EN 14638-3:2010) 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 February 2011 and conflicting national standards shall be withdrawn at the latest by February 2011.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports the objectives of the framework Directives on Transport of Dangerous Goods [1] and [2].

This European Standard has been submitted for reference into the RID [3] and/or in the technical annexes of the ADR [4].

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Introduction

The purpose of this European Standard is to provide a specification for the design, manufacture, inspection and approval of welded carbon steel gas cylinders for use in the countries of the CEN members.

The specifications given in the present standard establish the methodology to be adopted to demonstrate that a cylinder conforms to the functional requirements demanded, based on experience of materials, design prescriptions, manufacturing processes and controls manufacturing.

This European Standard specifies experimental methods and appropriate stress analysis calculations. It does not cover methods exclusively by means of traditional calculation.

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1 Scope

This European Standard specifies minimum requirements concerning material, design, construction and workmanship, procedures and tests at manufacture of refillable transportable welded cylinders made of carbon steel, justified by experimental methods, of water capacities from 0,5 l up to and including 150 l for compressed or liquefied gases and of a test pressure up to 90 bar.

NOTE This European Standard may also be used as a guideline for cylinders less than 0,5 l water capacity.

This European Standard is primarily intended for industrial gases other than LPG but may also be applied for LPG. However, for dedicated LPG cylinders see EN 14140 [5], prepared by CEN/TC 286.

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.

EN 287-1, *Approval testing of welders — Fusion welding — Part 1: Steels*

EN 462-1, *Non-destructive testing — Image quality of radiographs — Part 1: Image quality indicators (wire type) — Determination of image quality value*

EN 462-2, *Non-destructive testing — Image quality of radiographs — Part 2: Image quality indicators (step/hole type) — Determination of image quality value*

EN 473:2008, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

EN 910, *Destructive tests on welds in metallic materials — Bend tests*

EN 970, *Non-destructive examination of fusion welds — Visual examination*

EN 1418, *Welding personnel — Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*

EN 1435:1997, *Non destructive examination of welds — Radiographic examination of welded joints*

[AC1⟩EN 1803:2002 ⟨AC1], *Transportable gas cylinders — Periodic inspection and testing of welded carbon steel gas cylinders*

EN 10028-1, *Flat products made of steels for pressure purposes — Part 1: General requirements*

EN 10028-3, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10028-5, *Flat products made of steels for pressure purposes — Part 5: Weldable fine grain steels, thermomechanically rolled*

EN 10045-1, *Metallic materials — Charpy impact test — Part1: Test method*

EN 10052, *Vocabulary of heat treatment terms for ferrous products*

EN 10083-1, *Steels for quenching and tempering — Part1: General technical delivery conditions*

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EN 10084, *Case hardening steels — Technical delivery conditions*

EN 10120, *Steel sheet and strip for welded gas cylinders*

EN 10268, *Cold rolled steel flat products with high yield strength for cold forming — Technical delivery conditions*

EN 14784-1, *Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates — Part 1: Classification of systems*

EN 14784-2, *Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates — Part 2: General principles for testing of metallic materials using X-rays and gamma rays*

EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2003, corrected version:2005, including Technical Corrigendum 1:2006)*

EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1:2009)*

EN ISO 10692-2, *Gas cylinders — Gas cylinder valve connections for use in the microelectronics industry — Part 2: Specification and type testing for valve to cylinder connections (ISO 10692-2:2001)*

EN ISO 11114-1, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 1: Metallic materials (ISO 11114-1:1997)*

EN ISO 11117:2008, *Gas cylinders — Valve protection caps and valve guards — Design, construction and tests (ISO 11117:2008)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

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

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
yield strength
stress value corresponding to the lower yield strength, R_{eL}, or 0,92 × the upper yield strength, R_{eH}, or for steels that do not exhibit a lower (R_{eL}) and an upper (R_{eH}) yield strength (sometimes named “lower and upper yield point” at tensile testing, the 0,2 % proof strength $R_{p0,2}$

3.1.2
normalizing
heat treatment in which the steel is heated to a uniform temperature above the upper critical point (Ac3) of the steel and then cooled in still air or in a controlled atmosphere

3.1.3
stress relieving
heat treatment given to the finished cylinder, the object of which is to reduce the residual stresses without altering the metallurgical structure of the steel, by heating to a uniform temperature below the critical point (Ac1, as defined in EN 10052) of the steel and cooling in a still atmosphere

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3.1.4
parent material
material corresponding to the cylinder after finishing its manufacturing process and ready for service/operation

NOTE The material characteristics may be variable at any point of the cylinder.

3.1.5
batch
finished cylinders made consecutively during the same or consecutive days to the same design, size and material specifications and from the same material supplier for each pressure containing parts on the same automatic welding machines and, if applicable, heat-treated under the same conditions of temperature and duration

NOTE 1 In this context consecutively need not imply continuous production.

NOTE 2 This definition allows different suppliers to be used for the different pressure containing parts within a batch, e.g. one supplier for heads, another for bases.

3.1.6
cylinder
transportable pressure receptacle of a water capacity not exceeding 150 l

3.1.7
finished cylinder
cylinder which is fully assembled and appropriately stamp marked, but without any external coatings

3.1.8
cold forming
final deformation treatment at ambient temperature given to the prefabricated cylinder, known as the preform, which results in a permanent increase in the material strength and a permanent decrease in elongation

3.1.9
valve boss or pad
connection between valve and cylinder

3.2 Symbols

a Minimum thickness, in millimetres, for calculation of weld clearance (see Figure 1)

a_{si} Calculated minimum thickness, in millimetres, at a determined area "i" of the cylinder

a_{bi} Minimum thickness, in millimetres, at a determined area "i" of the cylinder (including any corrosion allowance) guaranteed by the manufacturer

A_i Percentage elongation after fracture, at a determined area "i" of the cylinder

i Area of the cylinder used for the calculation under consideration

L Original gauge length, in millimetres, in accordance with EN 10002-1

n Ratio of diameter of bend test former to the thickness of the test piece

p_h Test pressure, in bar, above atmospheric pressure

p_b Minimum burst pressure, in bar

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p_{ba} Actual burst pressure, in bar

R_{eH} Upper yield strength, in MPa

R_{eL} Lower yield strength, in MPa

$R_{p0,2}$ 0,2 % proof strength, in MPa

$R_{pi0,2}$ Minimum value of 0,2 % proof strength in MPa, guaranteed by the cylinder manufacturer for the finished cylinder, at a determined area "i" of the cylinder

R_{mgi} Minimum guaranteed value of tensile strength, in MPa, for the finished cylinder, at a determined area "i" of the cylinder

R_{mai} Actual value of tensile strength, in MPa, at a determined area "i" of the cylinder

R_{egi} Minimum guaranteed value of the yield strength (see 3.1.1), in MPa, for the finished cylinder, at a determined area "i" of the cylinder

R_{eai} Actual value of yield strength, in MPa, at a determined area "i" of the cylinder

s Nominal butt weld thickness

4 Materials and heat treatment

4.1 General

4.1.1 The cylinder materials subject to pressure shall conform to EN 10028-1 and EN 10028-3, or EN 10028-1 and EN 10028-5, or EN 10120 or EN 10268 or other carbon steel standards, provided that they satisfy the requirements of this European Standard.

NOTE These materials correspond to the materials received by the manufacturer, before having been submitted to any manufacturing process.

4.1.2 Materials supplied for boss shall conform to EN 10083-1 or EN 10084.

4.1.3 The welding consumables shall be such that they are capable of giving consistent welds. The material characteristics on the welds shall be considered by design.

4.1.4 Grades of steel used for the cylinder manufacture shall be compatible with the intended gas service, e.g. corrosive gases, embrittling gases according to EN ISO 11114-1.

4.1.5 The manufacturer shall be able to guarantee cylinder steel casting traceability for each pressure retaining part.

4.1.6 All parts welded or in contact with the cylinder shall be made of compatible material with the cylinder without harming its characteristics or favouring corrosion processes.

4.1.7 The cylinder manufacturer shall obtain and provide certificates of the ladle analysis of the steel supplied for the construction of the pressure retaining parts of the cylinder and of welding consumables.

4.2 Heat treatment

When the manufacturer considers that heat treatment is necessary, it should be in accordance with EN 10052. When no heat treatment is performed, because there is a risk of strain ageing, especially for

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cylinders which experience deep drawing, the manufacturer shall demonstrate that there is no risk of deterioration in the properties of the cylinder over its expected lifetime, e.g. by performing cycling tests at temperatures up to 100 °C and verifying that the mechanical properties are at least above the minimum specified (see 8.1.3.2), tensile testing after holding samples at up to 100 °C for 60 h, etc.

4.3 Test requirements

The material of the finished cylinders shall conform to Clause 7.

4.4 Failure to meet test requirements

4.4.1 In the event of failure to meet test requirements, retesting shall be carried out as given in 4.4.2 and 4.4.3.

4.4.2 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 the retest is satisfactory, the first test shall be ignored.

4.4.3 If the test has been carried out in a satisfactory manner, the cause of test failure shall be identified, as follows:

— if the failure is considered to be due to inappropriate heat treatment (if applied), the manufacturer may subject all the cylinders of the batch to a further heat treatment;

— if the failure is not due to inappropriate heat treatment (if applied), all the identified faulty cylinders shall be rejected or repaired by an approved method. The remaining cylinders are then considered as a new batch.

In both cases the new batch shall be tested. All the relevant prototype or batch tests needed to prove the acceptability of the new batch, shall be performed again and shall satisfy the requirements for batch or prototype testing.

If one or more tests prove even partially unsatisfactory, all the cylinders of the batch shall be rejected.

5 Design

5.1 General

For any new design, the concepts outlined in 5.2 and 5.3 shall be followed. It is recommended that an approximate calculation for the initial design is made. This initial calculated design may then be optimized if results from the experimental method exceed the minimum requirements.

5.2 Calculation

Where a calculation is to be used as the basis for the design, the following conditions shall be considered:

— the calculation of the wall thickness of the pressure containing parts "i" shall be related to the guaranteed yield strength of the material, of the finished product in each area "i" to be considered;

— for calculation purposes, the value of the guaranteed yield strength R_{eai}, is limited to a maximum of 0,85 R_{mgi};

— the internal pressure upon which the calculation of gas cylinders is based, shall be the test pressure p_h.

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At the test pressure, the stress in the metal at the most severely stressed point of the cylinder shall not exceed 77 % of the guaranteed yield strength (R_{egi}). This can be verified by, for example, studying the stress analysis.

5.3 Experimental method

An experimental method shall be used as the basis for the design. The following conditions shall be met:

— the actual wall thickness, mechanical properties and the geometry of the cylinders submitted to the prototype tests shall be recorded. The actual thickness of the prototype cylinder shall be not more than the minimum guaranteed thickness plus 5 %.

— the manufacturer shall take into account the requirements of 7.1.2 and ensure that the properties recorded represent the minimum values that would be used for production.

5.4 Openings

Each opening in the cylinder shall be reinforced, either by a valve boss or pad, of weldable and compatible steel, securely attached by welding and so designed as to be of adequate strength and to result in no harmful stress concentrations. This shall be confirmed by prototype testing.

Openings shall be clear of longitudinal and circumferential joints by a distance not less than 3*a* (see Figure 1).

6 Construction and workmanship

6.1 Manufacturing methods

6.1.1 The essential characteristics of the manufacturing processes applied and the corresponding parameters shall be defined in the technical specification of the cylinder (see 7.1.1).

6.1.2 The manufacturer shall have the technical capability, have at his disposal all appropriate means, and qualified personnel to carry out the manufacture of cylinders.

NOTE The Regulations [1 - 4] require that quality assurance system applied by the manufacturer shall conform to the requirements of the competent authority and that the manufacturing process is subject to a survey by the relevant body.

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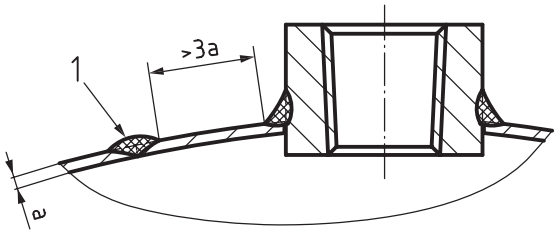
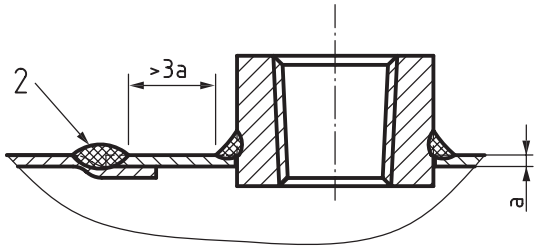


Key
1 longitudinal joint

a)



Key
2 circumferential joint

b)

Figure 1 — Weld clearance

6.2 Welding procedures

Each manufacturer, before proceeding with the production of a given design of cylinder, shall qualify the welding procedures and welders according to EN ISO 15614-1 and EN 287-1 or EN 1418. Records of such qualification shall be kept on file by the manufacturer.

6.3 Pressure-retaining welded joints

Except for the boss weldments, all welded joints shall be either of a butt or a joggle configuration (see Figure 2). For cylindrical shapes, longitudinal joints shall be butt welded.

6.4 Non-pressure-containing attachments

6.4.1 Non-pressure-containing parts such as footrings, handles and neckrings which are not submitted to pressure shall be made in accordance with 4.1.6.

6.4.2 Each attachment shall be designed to permit inspection of the welds, which shall be clear of longitudinal and circumferential joints, and so designed as to avoid trapping water.

6.4.3 A footring or other suitable supports shall be fitted when applicable to the cylinder to provide stability, and attached so as to permit inspection of the welds. The footring, if attached, shall have drainage and the space enclosed by the footring shall be ventilated.

6.4.4 In the case of cylinders subjected to a cold-forming, the non-pressure retaining attachments shall be welded to the cylinder preform before cold forming or cryoforming.

6.5 Valve protection

6.5.1 Valves of cylinders of more than 5 l water capacity shall be effectively protected from damage that could cause release of gas, either by the design of the cylinder (for example protective shroud) or by a valve protection device (see EN ISO 11117).

6.5.2 When a protective shroud is used, it shall fulfil the requirements of the drop test (see EN ISO 11117).

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6.5.3 The requirements of 6.5.1 and 6.5.2 may be waived when the cylinders are used and conveyed in bundles or cradles, or when some other effective valve protection is provided, for example a self-protected valve or when the cylinder is inside a protective box.

6.6 Cylinder openings

6.6.1 Standard openings

Cylinder openings shall conform to a recognized standard agreed between the parties to permit the use of a corresponding valve thus minimizing neck stresses following the valve torquing operation. Internal neck threads shall be checked using gauges corresponding to the agreed neck thread, or by an alternative method agreed between the parties.

NOTE For example, where the neck thread is specified to be in accordance with EN ISO 11363-1, the corresponding gauges are specified in EN ISO 11363-2.

Particular care shall be taken to ensure that neck threads are accurately cut, are of full form and free from any sharp profiles, e.g. burrs.

6.6.2 Special openings

If a special valve/cylinder connection is used (e.g. flanges), it shall be checked that it conforms to the testing requirements of EN ISO 10692-2.

6.7 Visual examination

6.7.1 Unacceptable imperfections

Before assembly, the pressure containing parts of the cylinder shall be examined for uniform quality and freedom from unacceptable imperfections (see Annex B).

6.7.2 Welds

6.7.2.1 Before the cylinders are closed, wherever possible, the welds shall be visually examined from both sides as described in 6.7.2.2 and 6.7.2.3. Permanent backing strips shall not be used with longitudinal welds.

6.7.2.2 All welds shall have a smooth finish without concavity and shall merge into the parent material without under-cutting or abrupt irregularity.

6.7.2.3 Butt welds shall have full penetration. For joggle welds, the penetration shall be full on the straight edge and shall be sufficient on the swaged edge (see Figure 2).

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