BS EN 14638-3:2010

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

National foreword

This British Standard is the UK implementation of EN 14638-3:2010.

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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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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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of an identical text or by endorsement, at the latest by February 2011 and conflicting national standards shall be withdrawn at the latest by February 2011.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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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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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.

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*

EN 1803, *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*

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

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

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

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.

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).

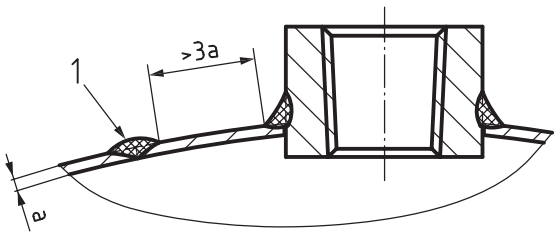
6 Construction and workmanship

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).

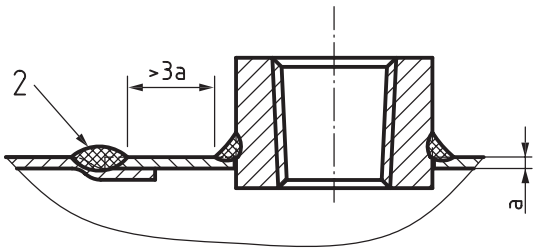
6.1.2 The manufacturer shall have the technical capability, have at his disposal all appropriate means, and qualified personnel to carry out the manufacture of cylinders.

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.



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).

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).

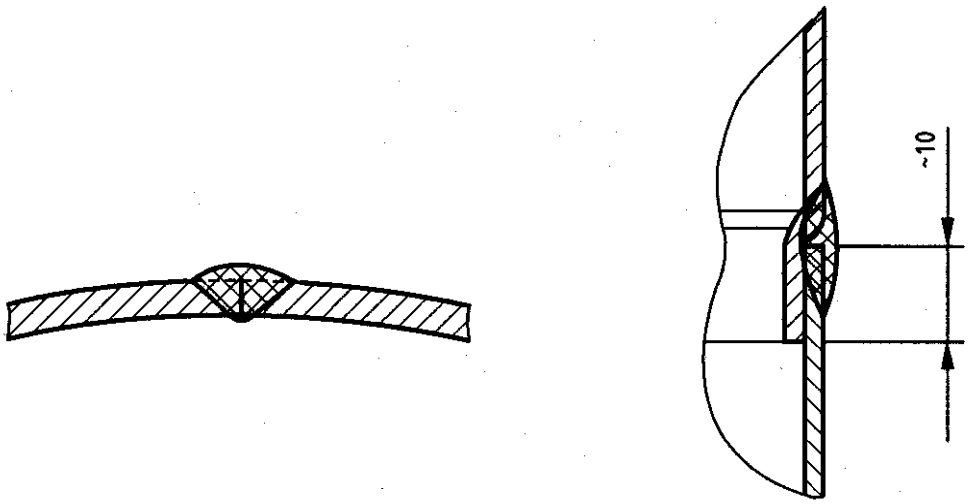
6.7.2 Welds

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).

Dimensions in millimetres



a) Butt welds **b) Joggle welds**

Figure 2 — Illustration of welding penetration

6.7.2.4 Radiographic examination, or radioscopic examination, or NDT examination carried out using another suitable method shall be as specified in Annex A.

6.8 Dimensional tolerances

6.8.1 General

The dimensional tolerances shall conform to the approved design drawing. In addition the following (6.8.2 to 6.8.4) shall apply for cylindrical shapes.

6.8.2 Out-of-roundness

The out-of-roundness of the cylindrical shell shall be limited so that the difference between the maximum and the minimum outside diameter in the same cross-section is not more than 2 % of the mean of these diameters.

6.8.3 Straightness

Unless otherwise agreed by the parties, the maximum deviation of the cylindrical part of the shell from a straight line shall not exceed 0,3 % of the cylindrical length. Unless otherwise specified on the manufacturing drawing, the maximum deviation of the cylindrical part of the shell from a straight line shall not exceed 0,3 % of the cylindrical length.

6.8.4 Verticality

When the cylinder is standing on its base, the cylindrical shell and top valve openings shall be vertical to within 1 % of the cylindrical length.

6.9 Stability

If the cylinder is designed to be free standing when resting on its base, the projected centre of gravity of the cylinder shall be such that it remains approximately within the outline of the base ring, in order to ensure adequate stability.

6.10 Tightness

Tests appropriate to the manufacturing process shall be carried out to ensure that there is no leakage from the cylinder in accordance with 8.2.2.

7 Type approval procedure

7.1 General requirements

7.1.1 General

A technical specification of the cylinder (or cylinder family), including design drawing, design calculation where appropriate, thicknesses and tolerances, specification for tests (including the leak test), material details and minimum guaranteed impact energy, welding and manufacturing process and heat treatment, shall be made available by the manufacturer.

NOTE Cylinders built according to this standard are subject to the conformity assessment system outlined in the Regulations [1 - 4], consisting of type approval, supervision of manufacture and initial inspection and test.

The bodies taking responsibility for these activities are the competent authority of the country of approval, who may delegate its functions in whole or in parts and inspection bodies approved by the competent authority.

7.1.2 New designs

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

— it is manufactured in a different factory;

— it is manufactured by a different welding or manufacturing process or a radical change in an existing process, e.g. change in heat treatment;

— it is manufactured from a steel of different specified composition range;

— there is a change in shape or curvature of the determined areas "i";

— the guaranteed minimum yield strength (R_{egi}) and/or minimum tensile strength (R_{mgi}), and/or minimum elongation after fracture (A_i) has been changed;

— the water capacity or gross weight have been increased;

— the guaranteed wall thickness have been decreased;

— the hydraulic test pressure has been changed (where the cylinder is to be used for a lower pressure duty from that approved at the design approval stage, it shall not be deemed a new design).

7.1.3 Cylindrical walled cylinders

For cylinders with cylindrical walls there is no need to repeat prototype testing for a family of cylinders, with the same diameter and shape, when the length of the cylindrical part of the cylinder has been reduced from the length of the prototype cylinder.

7.1.4 Valve protection

Changes in the method of valve protection are not considered to be a design change; only tests related to valve protection shall be repeated in accordance with EN ISO 11117.

7.2 Prototype tests

7.2.1 General

For the purpose of these tests, a minimum of 50 cylinders, which are guaranteed by the manufacturer to be representative of new design, shall be made available for prototype testing. However, if the total production is less than 50 cylinders, a sufficient number of cylinders shall be made to complete the prototype tests required, in addition to the production quantity. In this case the type approval validity is limited to the particular batch.

7.2.2 Verification and testing

a) In the course of the type approval process, It shall be verified that:

— the conditions specified in Clause 4 are fulfilled;

— the design conforms to Clause 5;

— the thickness of the walls in all determined areas "i" of two cylinders meet the requirements of the agreed technical specification with respect to the guaranteed minimum thickness (a_{bi}). The measurements shall be taken on at least three locations for each determined area "i".

— the requirements of Clause 6 and Annex A are met for all cylinders selected for the tests;

— the internal and external surfaces of the cylinders at various stages of production are free from any imperfection which may make them unsafe (see Annex B);

NOTE It can be necessary to section finished cylinders to undertake this inspection.

b) The following shall be performed on cylinders selected after the welds of the cylinders have been visually inspected.

— The tests specified in 7.2.3 (fatigue testing, two cylinders). The cylinders shall bear all representative markings.

— The tests specified in 7.2.5 (drop test, six cylinders). The cylinders shall bear all representative markings.

— The tests specified in 7.2.3, 7.2.4 and 7.2.5 (mechanical testing, two cylinders). The test pieces shall be identifiable with the batch.

— The tests specified in 8.2.1 (hydraulic burst test, two cylinders). The cylinders shall bear all representative markings.

These tests shall be performed on finished, unpainted cylinders, after all manufacturing processes have been completed.

7.2.3 Fatigue tests

The fatigue tests shall be carried out on two cylinders, bearing all representative stamp markings (see Clause 8). This test shall be carried out on two cylinders for each type approval, with a non-corrosive liquid, subjecting the cylinders to successive reversal at an upper hydraulic pressure equal to the test pressure, in which case the cylinder shall be subjected to 12 000 cycles without leakage or failure.

The value of the lower pressure shall not exceed 10 % of the upper cyclic pressure.

The frequency of reversals of pressure shall not exceed 5 cycles/min. The temperature measured on the outside surface of the cylinder shall not exceed 50 °C during the test.

After the test, one cylinder shall be sectioned to measure the profile and to ascertain that this profile is sufficiently close to that in the described design, to the satisfaction of the inspection body.

The second cylinder shall be subjected to a burst test in accordance with 8.2.1.

7.2.4 Impact test

7.2.4.1 General

7.2.4.1.1 The integrity of the cylinder shell, of the specified thickness(es), materials and mechanical properties, to withstand loadings other than internal pressure shall be demonstrated by a series of impact tests.

The specified impact energy and striking velocity shall be achieved by striking the test cylinder with a moving striker or by dropping the cylinder from an appropriate height. In all cases, the location of the impact shall be as specified in the test procedure and the direction of impact shall pass through the axis of the cylinder.

The strikers (flat surface and edge) shall be of metallic material having a hardness that is higher than that of the cylinder and sufficiently robust to prevent the impact energy being absorbed by deflection of the striker.

7.2.4.1.2 The cylinders tested shall have representative minimum thickness and shall be completely finished including the permanent protective devices.

7.2.4.1.3 The cylinders shall be filled with water so that the total mass corresponds to at least the tare of the cylinder, plus the mass of the maximum content specified by the manufacturer (gross weight of gas cylinders) or reach this weight through an effective system. In no case shall the total contents of the cylinders exceed 95 % of the water capacity. Cylinders used for permanent gases shall be filled with water to 40 % of the water capacity of the cylinder. In neither case shall the cylinder be pressurized for the drop test.

7.2.4.1.4 The choice of the impact areas of the cylinder shall correspond to the most critical zones, taking into account the shape of the cylinder, the protective elements and the foreseen handling systems. Consideration shall be given to areas of minimum thickness, welds, areas hardened due to deformation. The impact areas selected shall be agreed with the parties and recorded in the test report.

7.2.4.2 Flat surface impact test

The striker shall be a flat surface with a length equal to the overall cylinder length and width equal to the cylinder diameter.

The impact energy, F, shall be determined by

$F = 30\,M$

where

F is the energy, in Joules;

M is the maximum operating mass of the cylinder, in kg.

The striking velocity, v, shall be between 7 m/s and 8 m/s.

Two un-pressurised cylinders shall be impacted at five different positions in accordance with 7.2.4.1.4.

The tests shall be repeated with two further cylinders. These cylinders shall be pressurised with compressed air or any other inert gas to the maximum working pressure or 5 bar, whichever is the lower.

NOTE Appropriate measures should be taken (e.g. in a cage) to ensure safe operation and to contain any energy that may be released, which is considerably more than that in the hydraulic test.

If the cylinders withstand all of the impacts without leakage and with damage in excess of the criteria listed in EN 1803, then on completion of the impacts, both cylinders shall be subjected only to a burst test. The results shall be satisfactory when the burst pressure $p_{ba} > 1{,}3\,p_h$.

If the cylinders withstand all of the impacts with visible damage below the rejection criteria (see EN 1803), then on completion of the impacts, one cylinder subject to a fatigue test in accordance with 7.2.3 but with only 6 000 cycles and one cylinder shall be subjected to a burst test in accordance with 8.2.1.

7.2.4.3 Edge impact test

The impact energy, F, shall be determined by

$F = 12\,M$

where

F is the energy, in Joules;

M is the maximum operating mass of the cylinder, in kg.

The striking velocity, v, shall be between 4 m/s and 5 m/s.

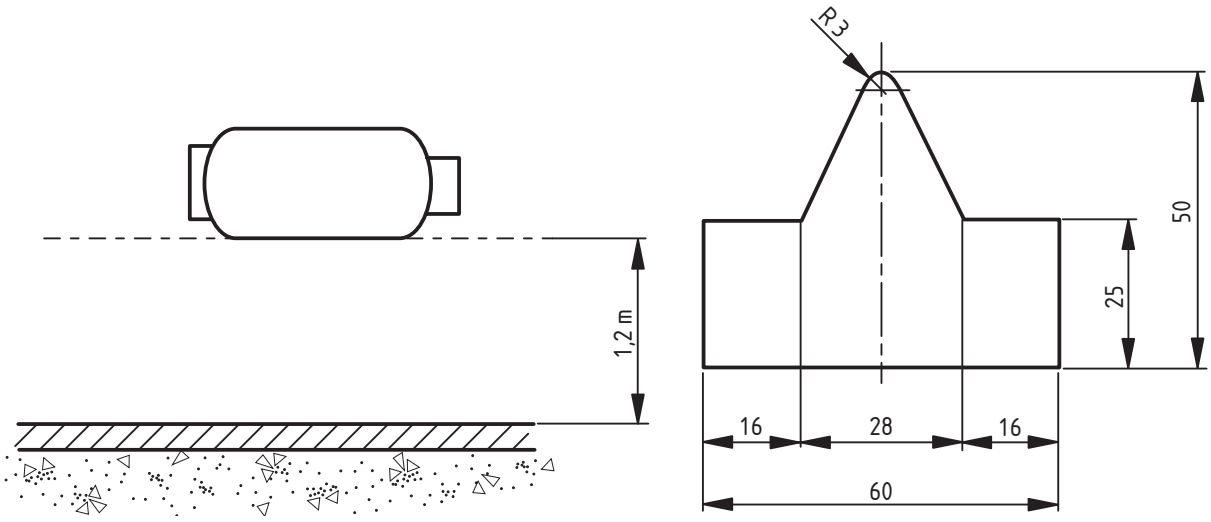
Two un-pressurised cylinders shall each be impacted with the edge parallel to the cylinder axis (see Figure 3). The cylinders shall then be impacted with the edge perpendicular to the cylinder axis. The tests shall be repeated with two further cylinders. These cylinders shall be pressurised with compressed air, or any other inert gas, to the maximum working pressure or 5 bar, whichever is the lower.

NOTE Appropriate measures should be taken (e.g. in a cage) to ensure safe operation and to contain any energy that may be released, which is considerably more than that in the hydraulic test.

If the cylinders withstand all of the impacts without leakage and with damage in excess of the criteria listed in EN 1803, then on completion of the impacts, both cylinders shall be subjected only to a burst test. The results shall be satisfactory when the burst pressure $p_{ba} > 1{,}3\,p_h$.

If the cylinders withstand all of the impacts with visible damage below the rejection criteria (see EN 1803), then on completion of the impacts, one cylinder shall be subject to a fatigue test in accordance with 7.2.3 but with only 6 000 cycles and one cylinder shall be subjected to a burst test in accordance with 8.2.1.

Dimensions in millimetres



a) Cylinder drop **b) Striker details**

Figure 3 — Impact tests

7.2.5 Type approval certificate

If the results are satisfactory, a type examination report shall be issued by the inspection body as a basis for the type approval certificate issued by the competent authority, a typical example of which is given in Annex E.

8 Production tests

8.1 Batch tests

8.1.1 General

All production tests shall be carried out on finished cylinders.

For the purpose of acceptance testing, the manufacturer shall provide:

— the type approval certificate (7.2.5);

— the certificates stating the cast analyses of the steel supplied for the construction of the cylinder;

— a list of cylinders, stating serial numbers and stamp markings as required;

— information that the threads are in accordance with 6.7.

The manufacturer shall carry out the following tests on the cylinders selected:

— mechanical testing specified in 8.1.3; 8.1.4; 8.1.5;

— hydraulic burst tests specified in 8.1.7;

— non-destructive examination, if applicable, as referred to in Annex A;

— pressure test specified in 8.2.1;

— leak test specified in 8.2.2.

8.1.2 Batch sampling

8.1.2.1 For the purpose of carrying out the tests, a random sample of cylinders as indicated in Tables 1 to 3, shall be taken from each batch.

8.1.2.2 For acceptance purposes, the batch shall be divided into inspection lots not exceeding 1 000 cylinders.

8.1.2.3 For selection of sample cylinders for either burst or mechanical tests, each lot shall be sub-divided into batches of 250 cylinders during the first 3 000 cylinders and batches of 500 or 1 000 cylinders, depending on burst pressure, thereafter.

8.1.2.4 The reduced rate of sampling (see Tables 2 and 3) after the first 3 000 cylinders shall be subject to the manufacturer demonstrating that the batch production test results and manufacturing processes are consistently reliable without any major interruption of manufacture (see 8.1.2.7). This shall be considered as demonstrated if the corresponding tests on the first 3 000 cylinders are acceptable without having to repeat any test, except when the repetition is due to failure in the test performance (see 4.4.2).

8.1.2.5 In the case of unsatisfactory results in any of the tests, batch controls shall be carried out as it is done at the beginning of a fabrication, although the test repetitions are correct and the batch is accepted.

8.1.2.6 For a batch of less than 3 000 cylinders and for the first 3 000 cylinders of a batch greater than 3 000 cylinders, see Table 1:

Table 1 — Cylinders per batch size

Batch size			**Cylinders taken as samples**	**Cylinder subjected to the**	
Lots of 1 000 cylinders				**mechanical tests**	**burst tests**
1st sub-lots	1 to	250	2	1 and	1
2nd sub-lots	251 to	500	1		1
3rd sub-lots	501 to	750	2	1 and	1
4th sub-lots	751 to	1 000	1		1

For the next two lots of the 1 000 cylinders, repeat this sequence of tests.

8.1.2.7 For the next cylinders of a batch greater than 3 000 cylinders:

a) for burst pressure less than 1,2 p_b, see Table 2.

Table 2 — Cylinders per batch size

Batch size			**Cylinders taken as samples**	**Cylinder subjected to the**	
Lots of 1 000 cylinders				**mechanical tests**	**burst tests**
1st sub-lots	3 001 to	3 500	2	1 and	1
2nd sub-lots	3 501 to	4 000	1	1	
after 4 000			Repeat the above sequence		

b) For burst pressures greater than 1,2 p_b i.e. greater than 1,2 × 2,25 p_h, see Table 3.

Table 3 — Cylinders per batch size

Batch size			**Cylinders taken as samples**	**Cylinder subjected to the**	
Lots of 1 000 cylinders				**mechanical tests**	**burst tests**
sub-lots	3 001 to	4 000	2	1 and	1
after 4 000			Repeat the above sequence		

At the beginning and the end of each shift, or alignment of the welding machine, an additional bursting test or NDT examination shall be carried out. In the case of continuous production, this may be limited to one test per shift.

8.1.3 Tensile test

8.1.3.1 The tensile test on final material shall be carried out on a test sample from a finished cylinder in accordance with EN ISO 6892-1.

The tensile test transverse to the weld shall be carried out on a test sample having a reduced section 25 mm wide over a length of 15 mm beyond the edge of the weld. Outside this central part, the width of the test sample shall increase gradually.

The two faces of the test sample formed by the inside and the outside of the cylinder shall not be machined.

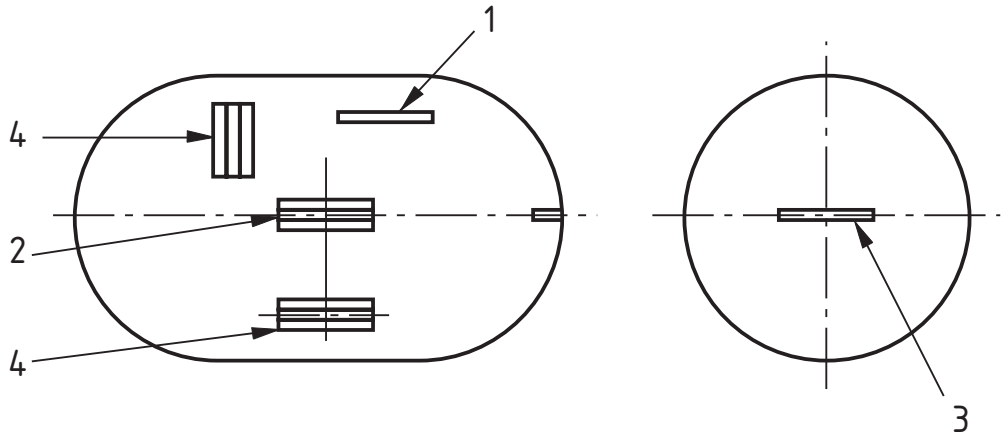
8.1.3.2 The values obtained for the yield strength, tensile strength, shall be not less than 95 % of those actually recorded by the cylinder manufacturer at the prototype test for each determined area "i" in accordance with 5.2, and in no case be less than those given in EN 10028-1 and EN 10028-3, or EN 10028-1 and EN 10028-5, or EN 10120 or EN 10268 or other carbon steel standards, provided that they meet the requirements of this part of EN 14638.

Lower values for mechanical properties shall result in a new prototype test from cylinders so affected.

The minimum percentage elongation values shall be those guaranteed by the cylinder manufacturer for each determined area "i" given in the technical specification for the cylinder (see 7.1.1) and shall not be less than 14 %. However, a lower value than 14 % may also be applied, provided that appropriate measures (e.g. no fragmentation during burst testing, possible use of a safety relief device) are taken to compensate for these lower values and the specific requirements are verifiable in accordance with Annex D.

8.1.3.3 For tensile test samples taken from parent material, one tensile test sample shall be taken for each determined area "*i*" with different characteristics given in the technical specification for the cylinder (see 7.1.1).

8.1.3.4 For tensile test samples taken from welds, one tensile test sample shall be taken from each pressure bearing weld, except from the bung area. The tensile strength value obtained shall be at least equal to the minimum value given in the technical specification for the cylinder (see 7.1.1).



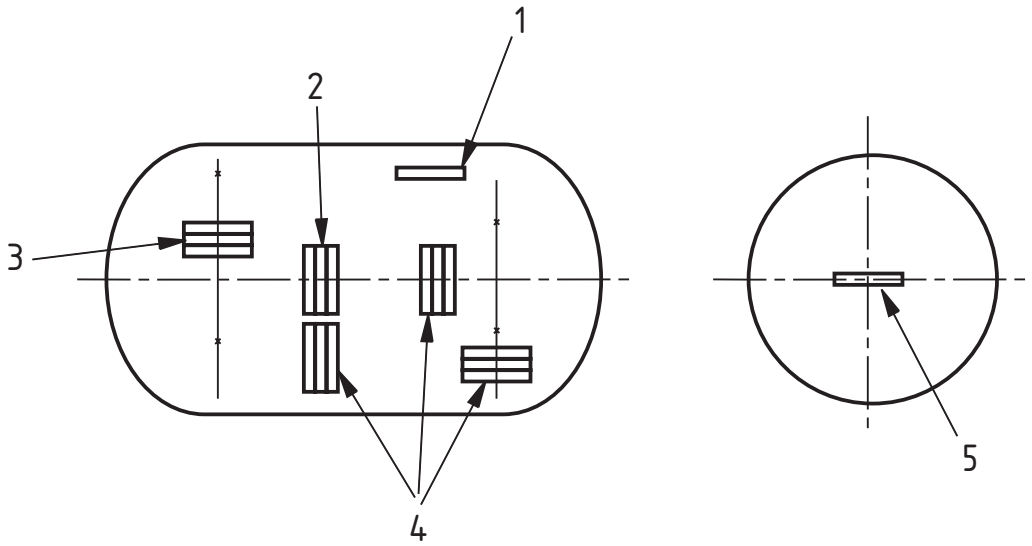
a) Test pieces in two-part cylinders

Key

1 one tensile test piece

2 and 4 one tensile test piece, root bend test piece, face bend test piece

3 one tensile test piece. Required only if insufficient cylindrical length available



b) Test pieces in three-part cylinders

Key

1 one tensile test piece

2 one tensile test piece, one root bend test piece, one face bend test piece

3 one tensile test piece, one root bend test piece, one face bend test piece. Required only if welded by a different process from the longitudinal weld (see 3.1.5)

4 impact test piece

5 one tensile test piece

Figure 4 — Test pieces for cylindrical cylinders with an end concave to pressure

NOTE For cylinders of a different shape, the principles of Figures 3 and 4 should be followed to determine the test piece position.

8.1.4 Charpy impact test

8.1.4.1 The Charpy impact test shall be carried out in accordance with EN 10045-1. This test is not required for thicknesses less than 5 mm, except for steels having less than 14 % elongation after fracture on the finished cylinder (see Annex D).

8.1.4.2 The test temperature shall be - 40 °C.

8.1.4.3 The following Charpy impact test samples shall be taken:

— three Charpy impact test samples from the final metal from areas of maximum tensile strength, as stated in the technical specification for the cylinder (see 7.1.1);

— three Charpy impact test samples from each pressure bearing weld type, except from the bung.

8.1.4.4 For the parent material, the transverse impact test pieces shall be taken from the wall of the cylinder. The notch shall be perpendicular to the face of the wall. The test pieces shall be machined on four faces only, with the inner and outer face of the cylinder wall un-machined.

8.1.4.5 If the radius is equal to or less than 70 mm, a longitudinal impact test may be performed instead of the transverse test. Such cylinders may not have a diameter but a local radius (internal or external is possible).

8.1.4.6 For the welds, impact test pieces transverse to the weld shall be taken. The notch shall be in the centre of the weld and shall be perpendicular to the face of the cylinder. The test pieces shall be machined all over (on six faces). If the wall thickness does not permit a final test piece width of 10 mm, the width shall be as near as practicable to the nominal thickness of the cylinder wall.

8.1.4.7 The average of three test pieces shall meet the values given in Table 4; no test piece shall show less than 70 % of average.

Table 4 — Minimum values for impact test pieces

Material	Parent	Weld
Impact energy, (J/cm^2) for d > 140 mm. Transverse test	35	35
Impact energy (J/cm^2) for $d \leq 140$ mm. Longitudinal test	50	50

8.1.5 Bend test

8.1.5.1 The bend test shall be carried out in accordance with EN 910. Test pieces shall be taken in accordance with Figure 4 with dimensions as shown in Figure 5. The test pieces shall be taken from the final metal from areas of maximum tensile strength as stated in the technical specification for the cylinder (see 7.1.1).

8.1.5.2 The face and the reverse side of the parent metal shall not be machined but shall represent the surface of the cylinder as manufactured (see Figure 5).

The following bend tests shall be carried out:

— one root and one face bend test from any longitudinal weld;

— one root and one face bend test from each circumferential weld, if made by a different welding process.

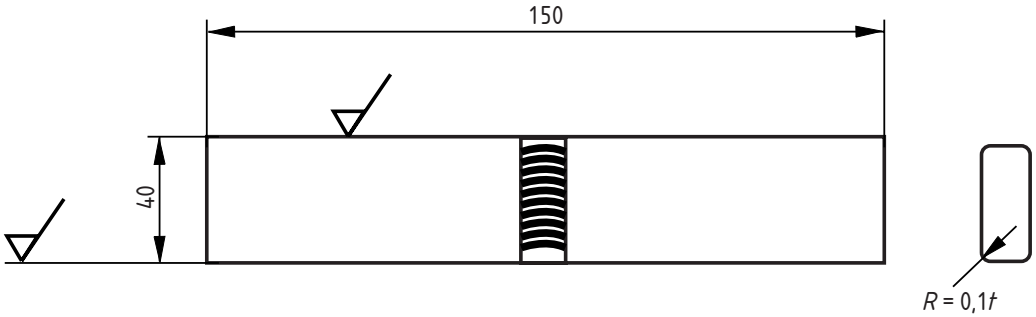
8.1.5.4 The test piece shall not crack when bent inwards around a former until the inside edges are no further apart than the diameter of the former (see Figure 5).

8.1.5.5 The ratio, *n*, between the diameter (D_f) of the former and the thickness (*t)* of the test piece shall be as shown in Table 5.

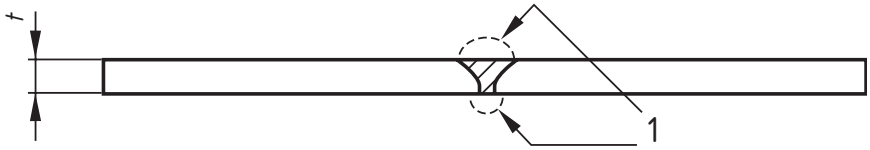
Table 5 — Bend test requirements

Actual tensile strength R_m MPa	**Value of *n***
$R_m \leq 440$	2
$440 < R_m \leq 520$	3
$520 < R_m \leq 600$	4
$600 < R_m \leq 700$	5
$700 < R_m$	6

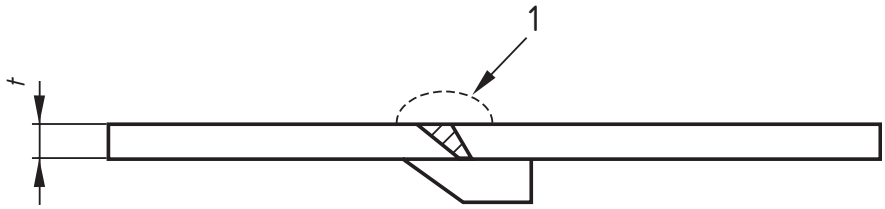
Dimensions in millimetres



(i) Test piece preparation details



(ii) Butt weld test piece

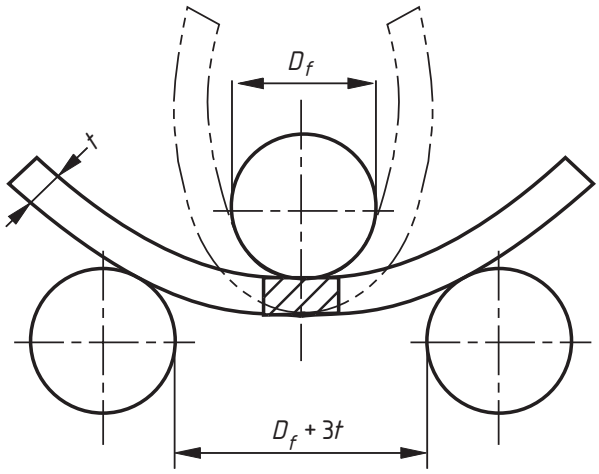


(iii) Joggle joint weld test piece

Key

1 weld dressed flush

a) — Transverse guided bend test



b) — Illustration of bend test

Figure 5 — Bend tests

8.1.6 Macroscopic examination of weld cross-sections

The cross-section of each pressure bearing weld not mechanically tested (one cylinder per batch) shall be macroscopically tested and shall show a sound weld. All imperfections contravening the requirements given in EN ISO 5817, level C, are inadmissible.

8.1.7 Burst test

8.1.7.1 Cylinders subjected to this test shall bear markings in accordance with the complete stamp markings required for the finished cylinder. The hydraulic burst test shall be carried out with equipment that enables the pressure to be increased at a controlled rate until the cylinder bursts and the change in pressure with time to be recorded.

8.1.7.2 For cylinders with a test pressure (p_h) ≤ 60 bar, the burst pressure (p_b) shall be at least 9/4 times the test pressure, and for cylinders with a test pressure > 60 bar, the burst pressure shall be equal to at least twice the test pressure.

The burst test shall not cause any fragmentation of the cylinder.

The main fracture shall not show any brittleness, i.e. the edges of the fracture shall not be radial but shall be at an angle to a diametral plane and display a reduction of area throughout their thickness.

Under no circumstances shall the fracture initiate from a weldment.

8.2 Tests/examinations on every cylinder

8.2.1 Pressure test

All cylinders in each batch shall be subjected to a pressure test. When carrying out a pressure test, a suitable fluid, normally water, shall be used as the test medium.

NOTE A pneumatic pressure test can be substituted, provided that approval from the Competent Body has been obtained. Appropriate measures will need to be taken to ensure safe operation and to contain any energy which may be released, which will be considerably more than that in the hydraulic test.

The pressure in the cylinder shall be increased at a controlled rate until the pressure (p_h) is reached. The cylinder shall remain under pressure p_h for at least 30 s to establish that the pressure does not fall and that there are no leaks, permanent deformations or cracks.

8.2.2 Leak test

All cylinders in each batch shall be subjected to a leak test. The leak test shall be defined by the manufacturer according to the technical specification for the cylinder (see 7.1). There shall not be any leak.

8.2.3 Non-destructive examination (NDE)

Annex A specifies the requirements for the non-destructive examination of welds.

8.3 Certification

Each batch of cylinders shall be covered by a certificate of conformity, a typical example of which is given in Annex C.

9 Marking

Each cylinder shall be permanently and legibly stamp marked on a nameplate or other appropriate permanently attached non-pressure part.

Where cylinders are directly marked on the pressure bearing parts, it shall be demonstrated by the burst and pressure cycling tests that the failure does not initiate at the markings. Such pressure bearing parts shall be in areas where the vessel is least stressed, e.g. dome ends.

Stamp marking shall be in accordance with the requirements of the current version of RID/ADR/ADN and with this European Standard. The requirements of RID/ADR/ADN shall override conflicting requirements of this standard.

Annex A
(normative)

Non-destructive examination (NDE) of welds

A.1 General

Radiography of welds shall be carried out in accordance with EN 1435:1997, class B, and in accordance with EN 14784-1 and EN 14784-2, where applicable. Radiography personnel shall be qualified to EN 473:2008, level 1, and shall be supervised by personnel qualified to EN 473:2008, level 2. The extent of radiography shall be as shown in Figure A.1. The radiographic examination may be replaced by radioscopy provided that it is carried out according to a process that provides the equivalent quality of examination, imperfection detection and the same level of records, as the radiographic examination.

A.2 Radiographic requirements

A.2.1 The radiographic examination shall be carried out on cylinders manufactured according following Table A.1 or Table A.2:

Table A.1 — Longitudinal welds

	Actual burst pressure p_{ba}			
	$p_{ba} \leq 1{,}2\ p_b$		**$p_{ba} > 1{,}2\ p_b$**	
	Butt weld	**Joggle weld**	**Butt weld**	**Joggle weld**
Radiographic control frequency	1 %	2 %	One at beginning and one at end/shift and machine	One at beginning and one at end/ shift and machine
% Length	100 %	100 %	50 %	50 % min
Intersection of joint	All	All	50 % min	All
Overlapping zone of welds	All	All	Yes	Yes

Table A.2 — Circumferential welds

	Actual burst pressure p_{ba}			
	$p_{ba} \leq 1{,}2\ p_b$		**$p_{ba} > 1{,}2\ p_b$**	
	Butt weld	**Joggle weld**	**Butt weld**	**Joggle weld**
Radiographic control frequency	1 %	1 %	One at beginning and one at end/shift and machine	One at beginning and one at end/ shift and machine
% Length	25 %	25 %	10 %	10 % min
Intersection of joint	50 % min	All	50 % min	All
Overlapping zone of welds	Yes	Yes	Yes	Yes

A.2.2 Welded joints shall be radiographed for a distance of 50 mm (25 mm on each side) beyond the intersection of the joint (see Figure A.1).

A.2.3 Assessment of the weld radiographs shall be based on the original films in accordance with EN 1435, with radiography whose quality is in accordance with EN 462-1 or EN 462-2.

A.2.4 The following imperfections as defined in EN ISO 5817 level C shall not be permitted:

— cracks, inadequate welds or lack of penetration or lack of fusion of the weld;

— any elongated inclusion or any group of rounded inclusions in a row where the length represented over a weld length of $12 \times s$ is greater than 6 mm;
— any gas pore measuring more than s/3 mm;
— any gas pore measuring more than s/4 mm, which is 25 mm or less from any other gas pore;
— gas pores over any 100 mm length, where the total area, in mm^2, of all the figures is greater than $2s$.

A.2.5 If any of the radiographs show an unacceptable imperfection, the whole of the relevant shift's production shall be radiographed 100 % on all similar welds.

Until the cause of the imperfection has been established and rectified, the subsequent production of cylinders shall be radiographed on all similar welds.

Where more than one welding machine is used for production, the above procedure shall apply to each such machine.

Dimensions in millimetres

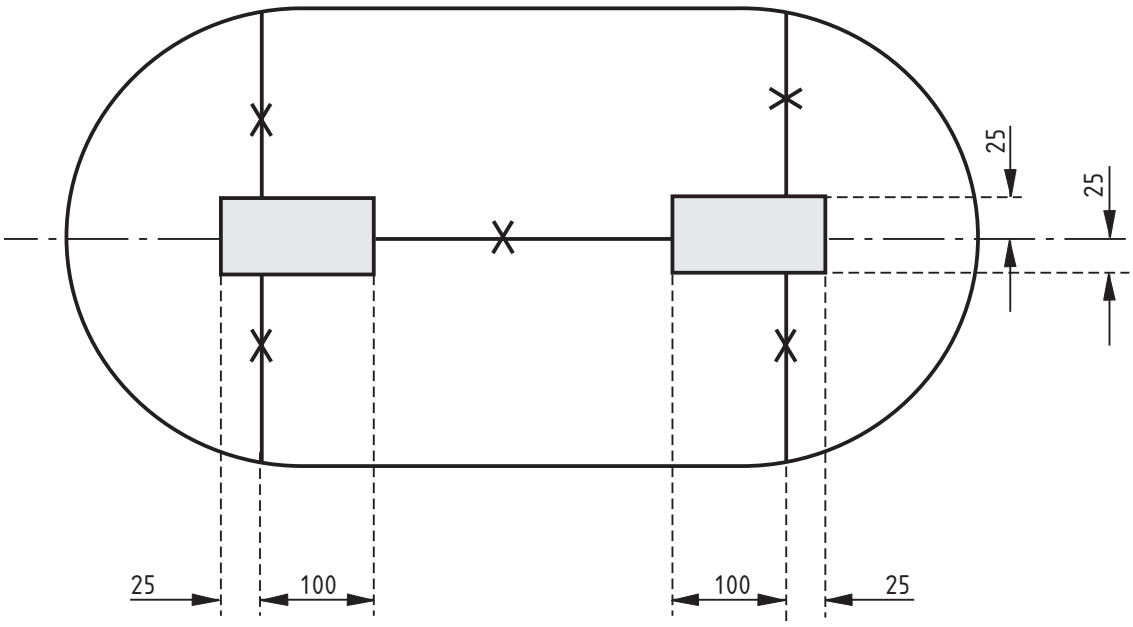


Figure A.1 — Extent of spot-radiography at weld intersections

Annex B
(normative)

Description, evaluation of manufacturing imperfections and conditions for rejection of welded carbon steel gas cylinders at time of final visual inspection by the manufacturer

B.1 Introduction

Several types of imperfections can occur during the manufacturing of a welded carbon steel gas cylinder. Such imperfections can be mechanical or material. They can be due to the basic material used, the manufacturing process, heat treatments, marking operations and other occurrences during manufacture.

The aim of this annex is to identify the manufacturing imperfections most commonly met and to provide rejection criteria to the inspectors who perform the visual inspection. Nevertheless extensive field experience and good judgement are necessary by the inspector to detect and to be able to evaluate and judge a imperfection at the time of the visual inspection (see EN ISO 5817).

B.2 General

B.2.1 Visual examination shall be carried out in accordance with EN 970. It is essential to perform the visual internal and external inspection in good conditions. Appropriate sources of illumination with sufficient intensity shall be used, e.g. at least 50 lux.

The surface of the metal and, in particular, of the inner wall shall be clean, dry and free from oxidation products, corrosion and scale as these could obscure more serious imperfections. Where necessary, the surface shall be cleaned under closely controlled conditions by suitable methods before further inspection.

When this visual inspection is carried out after the circumferential welding, the internal neck area shall be examined by means of an introscope, dental mirror or other suitable appliance.

B.2.2 Imperfections may be repaired in accordance with Table B.1. Great care shall be taken to avoid introducing new imperfections. After such repair the cylinders shall be re-examined, and, if necessary, the wall thickness shall be re-checked.

B.3 Manufacturing imperfections

The most commonly found manufacturing imperfections and their definitions are listed in Table B.1. Rejection limits for repair or rejection are included in this table. These rejection limits have been established following considerable field experience. They apply to all sizes and types of cylinder and service conditions. Nevertheless some customer specifications, some types of cylinder or some special service conditions may require more stringent criteria. Rejection limits for repair or reject of weld imperfections shall be in accordance with EN ISO 5817, level C.

B.4 Rejected cylinders

All rejected cylinders shall be rendered unserviceable.

Table B.1 — Manufacturing imperfections in welded carbon steel gas cylinders

Imperfection	Description	Conditions	Repair/scrap
Bulge	Swelling of the cylinder	All cylinders with such a imperfection	Scrap
Dent	A depression in the cylinder that has neither penetrated nor removed metal (see Figure B.1) and is greater in depth than 1 % of the outside diameter	When the depth of the dent exceeds 3 % of the external diameter of the cylinder or	Scrap
		When the diameter of the dent is less than 15 times its depth	Scrap
Cut or gouge	A sharp impression where metal has been removed or redistributed and whose depth exceeds 5 % of the cylinder wall thickness	When the depth of the cut or gouge exceeds 10 % of the wall thickness or when the length exceeds 25 % of the outside diameter of the cylinder	Repair possible
Lamination	Layering of the material within the cylinder wall sometimes appears as a discontinuity or crack (see Figure B.2)	Inside imperfection: all cylinders with such imperfection	Repair, if possible
		Outside imperfection: all cylinders with such imperfection	Repair possible
Crack	A split or rift in the metal	All cylinders with such imperfections	Scrap
Internal neck threads damaged	Neck threads damaged, with dents, cuts, burrs	When the design permits it, threads may be re-tapped and re-checked by the appropriate thread gauge and carefully visually re-examined. The appropriate number of effective threads shall be guaranteed.	Repair
		If not repairable	Scrap
Neck ring not secure	Neck ring turn and pull under application of low torque* * See EN ISO 13341	All cylinders presenting such a imperfection	Repair possible, in accordance with approved method only
Non conformity with design drawing			Repair or scrap
Stamping	Marking	All cylinders with illegible, modified or incorrect markings	Repair or scrap

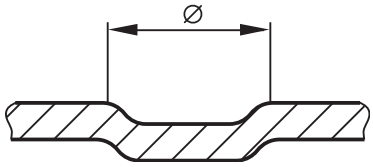


Figure B.1 — Dent

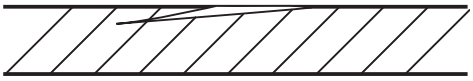


Figure B.2 — Lamination

Annex C
(informative)

Certificate of conformity

Application of CEN Standard EN 14638-3.....

Competent body (Name and address)..... .....

.....

Date .....

Type approval No .....

Description of vessels (Identification of inspected cylinders)
.....

.....

CEN production testing No .....

Manufacturing batch No ..... to .....

Manufacturer .....
(Name and address)
.....

.....

Country ..... Mark .....

Owner .....
(Name and address)
.....

.....

Customer .....
(Name and address)

Production tests

1 - Measurements of sample cylinders

Test No	Batch consisting of No. ..... to No.	Water capacity (litres)	Mass empty (kg)	Minimum measured thickness (mm)	
				of the shell	of the base

3 - Mechanical tests carried out on sample cylinders

Test No	Heat treatment No	Test-piece in accordance with EN 10002-1	Yield strength R_{ea} (MPa)	Tensile strength R_{ma} (MPa)	Elongation A (%)	Bend test 180° without cracking	Burst pressure (bar)	Descrip -tion of the fracture

Minimum
values specifies

Annex D
(normative)

Specific requirements for cylinders manufactured with steel that has an elongation less than 14 %

D.1 General

This annex applies to steel, which has an elongation after fracture (*A*), on the finished cylinder, less than 14 %, and for which it is necessary to demonstrate that there is no embrittlement, also under extreme use conditions.

This demonstration implies three types of prototype tests and one production test, which are carried out under temperature conditions for the steel ≤ –40 °C.

The prototype tests (D.2, D.3 and D.4), which shall validate a type of steel for a type of cylinders, shall be carried out in addition to the prototype tests required in 7.2.

The production test (D.4) shall validate a production of cylinders and shall be realized in addition to the production tests required in 8.1. This production test shall be carried out on each steel production cast used.

The aim of the first prototype test (D.2) is to simulate, by a burst test, a high strain rate condition at extreme low temperature.

The aim of the second prototype test (D.3) is to simulate, by an impact test, a rapid rate of loading at extreme temperature.

The requirements for these tests are identical to the requirements of the tests carried out of steels with an elongation (*A*) of 14 %.

The aim of the additional prototype and production test (D.4) is to verify that the properties obtained here are comparable with the results of the prototype tests.

D.2 Burst test

A prototype burst test shall be carried out on one cylinder in accordance with 8.2.1, under the following conditions:

— The cylinder shall be filled with a suitable liquid that withstands a temperature lower than or equal to – 40 °C.

— The cylinder shall be at – 40 °C when performing the test, e.g. by immersion in a methanol bath cooled by liquid nitrogen (the receptacle used shall be insulated).

The results after bursting shall conform to 8.2.1, in particular concerning the type of fracture.

D.3 Impact tests

The prototype impact tests as described in 7.2.4 shall be carried out in the following conditions:

— The cylinder shall be filled with a suitable liquid that withstands a temperature lower than or equal to – 40 °C.

— The cylinder shall be at – 40 °C when performing the test, e.g. by immersion in a methanol bath cooled by liquid nitrogen (the receptacle used shall be insulated).

The test procedure and the requirements shall be conform to 7.2.4.3, except that only one cylinder at its maximum stressed point shall be tested. This point of maximum stress shall be determined during the impact test programme at room temperature.

D.4 Charpy impact test

The geometry of the test piece shall be as shown in Figure D1. The test pieces shall be cut out from the top or bottom of the cylinder and flattened prior to performing the test.

The Charpy impact test shall be carried out on 3 test pieces at – 40 °C in accordance with ISO 148-1.

The average value of the three test pieces shall be not less than 90 % of the average value found during prototype testing. If this value is not met, further tests as described in D.2 and D.3 shall be performed to verify the suitability of the steel. These new results may be appended on prototype certificate.

Linear dimensions in millimetres

General tolerances ± 0,2 mm

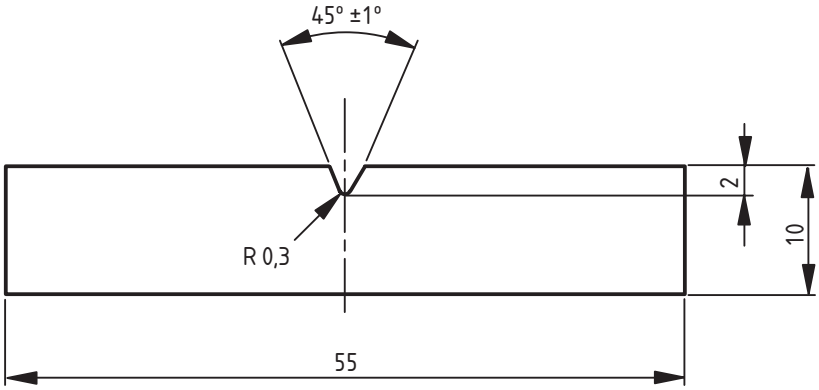


Figure D.1 — Test piece

Annex E
(informative)

Type approval certificate

Type of approval / according to regulation : .....

Certificate number : .....

Manufacturer .....
(Name and address)
.....

Applied standard : EN 14638-3, issue .....and ADR, Version..... :
.....……

Identification of tested cylinders .....

.....

Drawing N°. : .....……

Filling weight (kg) : .....……

Volume (l) : .....……..

Material : : .....……..

Test Pressure (bar) : .....…….

Service equipment : ……..

Reference of the Type examination report : ……

Any requirements resulting from the examination :
……

Note : The test report shall include the list of standards used for the and manufacture, the list of material used, the approved welding qualification, the description of the design heat treatment and the procedures, descriptions and records of all relevant tests required in this standard for the type approval.

Location, Date

Established by :
Name and address of the competent body

Mark of the competent body

Name and signature

Bibliography

[1] EUROPEAN COMMUNITIES, 94/55/EC, Council Directive of 21 November 1994 on the approximation of the laws of the Member States with regard to the transport of dangerous goods by road. Luxembourg: Office for Official Publications of the European Communities, 1994, as amended

[2] EUROPEAN COMMUNITIES, 96/49/EC, Council Directive 96/49/EC of 23 July 1996 on the approximation of the laws of the Member States with regard to the transport of dangerous goods by rail, Official Journal L 235, 17/09/1996, p. 25, as amended

[3] UNITED NATIONS, European agreement concerning the international carriage of dangerous goods by road, ECE/TRANS/140, Geneva: Economic Commission for Europe Inland Transport Committee, 2003[1)]

[4] INTERGOVERNMENTAL ORGANISATION FOR INTERNATIONAL CARRIAGE BY RAIL (OTIF), Regulations concerning the International Carriage of Dangerous Goods by Rail, 2001[2)]

[5] EN 14140, *LPG equipment and accessories — Transportable refillable welded steel cylinders for LPG — Alternative design and construction*

[6] EN ISO 11363-1, *Gas cylinders — 17E and 25E taper threads for connection of valves to gas cylinders — Part 1: Specifications (ISO 11363-1:2010)*

[7] EN ISO 11363-2, *Gas cylinders — 17E and 25E taper threads for connection of valves to gas cylinders — Part 2: Inspection gauges (ISO 11363-2:2010)*

[8] EN ISO 13341, *Transportable gas cylinders — Fitting of valves to gas cylinders (ISO 13341:1997)*

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1) Commonly known as ADR.

2) Commonly known as RID.

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