

**Gasflaskor – Återfyllningsbara svetsade gas-
flaskor av stål – Konstruktion och tillverkning –
Del 1: Kolstål**

**Transportable gas cylinders – Refillable welded
steel gas cylinders – Design and construction –
Part 1: Carbon steel**

Europastandarden EN 13322-1:2003 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 13322-1:2003.

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Telefon: 08 - 555 523 10. *Telefax:* 08 - 555 523 11
E-post: sis.sales@sis.se. *Internet:* www.sis.se

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Transportable gas cylinders - Refillable welded steel gas cylinders - Design and construction - Part 1: Carbon steel

Bouteilles à gaz transportables - Bouteilles à gaz rechargeables soudées en acier - Conception et construction - Partie 1: Acier au carbone

Ortsbewegliche Gasflaschen - Wiederbefüllbare geschweißte Flaschen aus Stahl - Gestaltung und Konstruktion - Teil 1: Flaschen aus Kohlenstoffstahl

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 13322-1:2003) 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of an identical text or by endorsement, at the latest by September 2003, and conflicting national standards shall be withdrawn at the latest by September 2003.

This European Standard has been submitted for reference into the RID and/or in the technical annexes of the ADR. Therefore in this context the standards listed in the normative references and covering basic requirements of the RID/ADR not addressed within the present standard are normative only when the standards themselves are referred to in the RID and/or in the technical annexes of the ADR.

For relationships with EC directives, RID and ADR see informative annex E, which is an integral part of this document.

This standard is one of a series of two standards concerning refillable welded steel gas cylinders of water capacities from 0,5 l up to and including 150 l for compressed, liquefied and dissolved gases:

Part 1: Carbon steel

Part 2: Stainless steel

Annexes A, B and C are normative. Annexes D and E are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

The purpose of this European Standard is to provide a specification for the design, manufacture, and testing of refillable, transportable, welded steel gas cylinders.

The specifications given are based on knowledge of, and experience with, materials, design requirements, manufacturing processes and control during manufacture, of cylinders in common use in the countries of the CEN members.

This standard is based on the traditional calculation method. It does not cover other methods such as finite element analysis (F.E.A) methods or experimental methods.

1 Scope

This European Standard specifies minimum requirements concerning material, design, construction and workmanship, manufacturing processes and testing of refillable transportable welded carbon steel gas cylinders of water capacities from 0,5 l up to and including 150 l for compressed, liquefied and dissolved gases.

For acetylene service, additional requirements for the cylinder and the basic requirements for the porous mass are given in EN 1800. For those cylinders made from high frequency induction (HFI) welded steel tubes, the requirements are given in annex A.

This standard is primarily for industrial gases other than LPG but may also be applied for LPG. However for dedicated LPG cylinders, see EN 1442, *Transportable refillable welded steel cylinders for liquefied petroleum gas (LPG) - Design and construction* prepared by CEN/TC 286 *Liquefied petroleum gas equipment and accessories*.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

EN 288-1, *Specification and qualification of welding procedures for metallic materials - Part 1: General rules for fusion welding*.

EN 288-3, *Specification and approval of welding procedures for metallic materials - Part 3: Welding procedure tests for the arc welding of steels*.

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

EN 962, *Transportable gas cylinders - Valve protection caps and valve guards for industrial and medical gas cylinders - Design, construction and tests*.

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

EN 1089-1, *Transportable gas cylinders - Gas cylinder identification (excluding LPG) - Part 1: Stampmarking*.

EN 1435, *Non-destructive examination of welds - Radiographic examination of welded joints*.

EN 1442, *Transportable refillable welded steel cylinders for liquefied petroleum gas (LPG) - Design and construction*.

EN 1964-1:1999, *Transportable gas cylinders - Specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0,5 litre up to and including 150 litres - Part 1: Cylinders made of seamless steel with an R_m value of less than 1100 MPa*.

EN 10002-1, *Metallic materials - Tensile testing - Part 1: Method of test at ambient temperature*.

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*.

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EN 10045-1, *Metallic materials - Charpy impact test - Part 1: Test method.*

EN 10083-1 + A1, *Quenched and tempered steels - Part 1: Technical delivery conditions for special steels (includes amendment A1:1996)*

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

EN 10208-2, *Steel pipes for pipelines for combustible fluids - Technical delivery conditions - Part 2: Pipes of requirement class B.*

EN 12517, *Non-destructive examination of welds - Radiographic examination of welded joints - Acceptance levels.*

EN 13445-2, *Unfired pressure vessels - Part 2: Materials.*

EN 25817, *Arc-welded joints in steel - Guidance on quality levels for imperfections (ISO 5817:1992).*

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

ISO 2504:1973, *Radiography of welds and viewing conditions for films - Utilization of recommended patterns of image quality indicators (I.Q.I.).*

3 Terms, definitions and symbols

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

3.1 Terms and definitions

3.1.1

yield stress

value corresponding to the lower yield stress, R_{eL} , or $0,92 \times$ the upper yield stress (R_{eH}) or for steels that do not exhibit a defined yield, the 0,2 % proof stress ($R_{p0,2}$)

[EN 10002-1]

3.1.2

normalizing

heat treatment in which a cylinder is heated to a uniform temperature above the upper critical point (AC_3 , as defined in EN 10052) of the steel and then cooled 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 lower critical point (AC_1 , as defined in EN 10052) of the steel and cooling in a still atmosphere

3.1.4

batch

quantity of 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 part on the same automatic welding machines and heat-treated under the same conditions of temperature and duration

NOTE 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.

3.1.5

design stress factor (F)

ratio of equivalent wall stress at test pressure (p_n) to guaranteed minimum yield stress (R_e)

3.2 Symbols

- a* Calculated minimum thickness, in millimetres, of the cylindrical shell
- a'* Guaranteed minimum thickness, in millimetres, of the cylindrical shell (including any corrosion allowance see 7.1)
- a*₁ Calculated value of *a* used in the calculation of *b* (see 5.3.2)
- A* Percentage elongation after fracture
- b* Calculated minimum thickness, in millimetres, of the cylinder end (see Figure 1)
- b'* Guaranteed minimum thickness, in millimetres, of the cylinder end (see 7.1)
- C* Shape factor of dished ends
- D* Outside diameter, in millimetres, of the cylinder (see Figure 1)
- D*_f Diameter of former in millimetres (see Figure 11)
- F* Design stress factor (see 3.1.5)
- h* Height, in millimetres, of the cylindrical part of the end (see Figure 1)
- H* Outside height, in millimetres, of the domed part of the end (see Figure 1)
- J* Stress reduction factor (see annex B)
- L* Length, in millimetres, of the cylinder
- n* Ratio of diameter of bend test former (*D*_f) to the thickness of the test piece (*t*)
- p*_b Measured burst pressure, in bar¹, above atmospheric pressure, in the burst test
- p*_h Hydraulic test pressure, in bar¹, above atmospheric pressure
- r* Inside radius of knuckle end, in millimetres (see Figure 1)
- R* Inside radius of the dished end, in millimetres (see Figure 1)
- R*_e Yield stress, in megapascals, as defined in 3.1.1 and used for design calculation
- R*_{ea} Value of the actual yield stress in megapascals determined by the tensile test
- R*_{eH} Minimum value of the upper yield stress, in megapascals, guaranteed by the cylinder manufacturer for the finished cylinder, in accordance with EN 10002-1
- R*_{eL} Minimum value of the lower yield stress, in megapascals, guaranteed by the cylinder manufacturer for the finished cylinder, in accordance with EN 10002-1
- R*_g Minimum value of tensile strength, in megapascals, guaranteed by the cylinder manufacturer for the finished cylinder
- R*_m Actual value of tensile strength, in megapascals, determined by the tensile test (see 8.4)

1 1 bar = 10⁵ Pa = 0,1 MPa

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S_0 Original cross-sectional area of tensile test piece, in square millimetres, according to EN 10002-1

t Actual thickness of the test specimen, in millimetres (see Figure 7)

4 Materials and heat treatment

4.1 General

4.1.1 Materials supplied for shells and end pressing shall conform to EN 10120, or EN 10028-1 and EN 10028-3, or EN 10028-1 and EN 10028-5.

4.1.2 Materials supplied for bungs shall conform to EN 10083-1 + A1.

4.1.3 Grades of steel used for the manufacture shall be compatible with the intended gas service (e.g. corrosive gases, embrittling gases) in accordance with EN ISO 11114-1.

4.1.4 All parts welded to the cylinder shall be made of compatible material with respect to the weldability.

4.1.5 The welding consumables shall be such that they are capable of giving consistent welds with minimum tensile strength at least equal to that specified for the parent material in the finished cylinder.

4.1.6 The 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.

4.1.7 The manufacturer shall be able to guarantee cylinder steel casting traceability for each cylinder.

4.1.8 Cylinders for acetylene service shall be manufactured with materials compatible with the manufacturing process of the porous mass, or an internal coating shall be applied.

4.2 Heat treatment

Cylinders shall be delivered in either the normalised or the stress-relieved condition. The cylinder manufacturer shall certify that the cylinders have been heat-treated after completion of all welding and shall certify the process of heat treatment applied. Localised heat treatment of cylinders is not permitted, nor in the case of repaired cylinders.

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

5 Design

5.1 General requirements

5.1.1 The calculation of the wall thickness of the pressure parts shall be related to the yield stress of the parent material.

5.1.2 For calculation purposes, the value of the yield stress R_e is limited to a maximum of 0,85 R_g .

5.1.3 The internal pressure upon which the calculation of gas cylinders is based shall be the test pressure p_t .

5.1.4 A fully dimensioned drawing including the specification of the material shall be produced.

5.1.5 Cylinders for acetylene service shall be designed to allow for a test pressure of at least 60 bar.

5.1.6 Cylinders for acetylene service shall be designed and manufactured to ensure that conditions are safe for the eventual filling of the porous mass, e.g. preventing sharp edges and voids.

5.2 Calculation of cylindrical wall thickness

The wall thickness of the cylindrical shell shall be not less than that calculated using the formula

$$a = \frac{D}{2} \cdot \left(1 - \sqrt{\frac{10 \cdot F \cdot J \cdot R_e - \sqrt{3} \cdot p_h}{10 \cdot F \cdot J \cdot R_e}} \right)$$

where the value of F is the lesser of $\frac{0,65}{(R_e/R_g)}$ or 0,77.

R_e/R_g shall not exceed 0,85.

The value of J shall be selected in accordance with annex B.

The minimum wall thickness shall also satisfy the requirements of 5.4.

5.3 Design of convex ends (see Figure 1)

5.3.1 The shape of ends of gas cylinders shall be such that the following conditions are fulfilled:

- for torispherical ends (see Figure 1a):
 - $R \leq D$;
 - $r \geq 0,1 D$;
 - $h \geq 4b$.
- for ellipsoidal ends (see Figure 1b):
 - $H \geq 0,192 D$;
 - $h \geq 4b$.

5.3.2 The wall thickness of the ends of gas cylinders shall be not less than that calculated using the formula:

$$b = a_1 \times C$$

where

a_1 is the value of a calculated in accordance with 5.2 using $J = 1,0$;

C is a shape factor, whose value shall be obtained from the graphs given in Figures 2 and 3.