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Prenosni plinski valji – Specifikacija za zasnovo in konstrukcijo ponovno polnljivih nevarjenih jeklenk za prenosne gasilne naprave in za dihalne aparate z vodno prostornino od 0,5 litra do 150 litrov

Transportable gas cylinders - Specification for the design and construction of refillable seamless steel cylinders for portable fire extinguishers and bottles for breathing apparatus of water capacities from 0,5 litre up to 15 litres

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Transportable gas cylinders - Specification for the design and construction of refillable seamless steel cylinders for portable fire extinguishers and bottles for breathing apparatus of water capacities from 0,5 litre up to 15 litres

Bouteilles à gaz transportables - Spécification pour la conception et la fabrication de bouteilles à gaz rechargeables et transportables en acier sans soudure d'extincteurs d'incedie portatif et bouteilles d'appareil respiratoir de capacité de l'eau comprise entre 0,5 l et 15 l inclus

Ortsbewegliche Gasflaschen - Gestaltung und Konstruktion von wiederbefüllbaren ortsbeweglichen nahtlosen Gasflaschen aus Stahl für Tragbare Feuerlösche und Atmungapparat mit einem Fassungsraum von 0,5 l bis einschließlich 15 l

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 23.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (prEN 15047:2004) has been prepared by Technical Committee CEN/TC 23 “Transportable gas cylinders”, the secretariat of which is held by BSI.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This European standard has been prepared to address the essential requirements of the Pressure Equipment Directive (PED) for portable, refillable seamless steel (with a high F-factor) fire extinguishers and breathing apparatus of water capacities from 0,5 litre up to and including 15 litres.

Annex A is normative. Annexes B, C and ZA are informative.

Introduction

The purpose of this standard is to provide a specification for the design, manufacture, inspection and approval of refillable seamless high F-factor steel for use in portable fire extinguishers and breathing apparatus

The specification given is based upon 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 draws upon established practice as outlined in the ADR (European Agreement Concerning the International Carriage of Dangerous Goods by Road) for determining the test pressure of gas cylinders (ADR, P200 4.1.4.1).

1 Scope

This standard specifies minimum requirements for the material, design, construction and workmanship, manufacturing processes and tests at manufacture of refillable seamless steel gas cylinders fitted with bursting disc devices for portable fire extinguishers and breathing apparatus of water capacities from 0,5 litre up to 15 litres. This standard is applicable to cylinders manufactured from steel with an R_m value of less than 1 100 MPa.

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 629-1, *Transportable gas cylinders — 25E taper thread for connection of valves to gas cylinders — Part 1: Specification*

EN 629-2, *Transportable gas cylinders — 25E taper thread for connection of valves to gas cylinders — Part 2: Gauge inspection*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Test method*

EN 10003-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

EN 10204:1991, *Metallic Products — Types of inspection documents*

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

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

EN ISO 13341, *Transportable gas cylinders — Fitting of valves to gas cylinders*

prEN ISO 13769: 2004, *Gas cylinders — Stamp marking*

prEN ISO 15245-1, *Transportable gas cylinders — Parallel threads for connection of valves to gas cylinders — Part 1: Specification*

prEN ISO 15245-2, *Transportable gas cylinders — Parallel threads for connection of valves to gas cylinders — Part 2: Gauge Inspection*

EURONORM 6-55, *Bend test for steel*

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 Re_L or, for steels that do not exhibit defined yield, the 0,2 % proof stress $Rp_{0,2}$

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 still air

3.1.3
quenching
hardening heat treatment in which a cylinder, which has been heated to a uniform temperature above the upper critical point (AC_3, as defined in EN 10052) of the steel, is cooled rapidly in a suitable medium

3.1.4
tempering
softening heat treatment which follows quenching (or in some cases normalizing), in which the cylinder is heated to a uniform temperature below the lower critical point (AC_1, as defined in EN 10052) of the steel

3.1.5
batch
a quantity of up to 200 cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design made from the same steel cast and subjected to the same heat treatment for the same duration of time

3.1.6
burst pressure
highest pressure reached in a cylinder during a burst test

3.1.7
working pressure
settled pressure at a uniform temperature of 15 °C and full gas content

3.1.8
test pressure
required pressure applied during a pressure test

3.1.9
design stress factor (F) (variable)
the ratio of equivalent wall stress at test pressure (p_h) to guaranteed minimum yield stress (R_e)

3.1.10
mass
the weight of a cylinder, expressed in kilograms, comprising the combined weight of cylinder and permanently attached parts (eg foot ring, neck ring, etc) but without valve

3.2 Symbols

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

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

A Percentage elongation, determined by the tensile test **7.2.2.2**

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

d Diameter of former, in millimetres figure 4

D Nominal outside diameter of the cylinder, in millimetres see figure 1

F Design stress factor (variable) see **3.1.9**

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

n The ratio of the diameter of the bend test former to actual thickness of test piece (t)

P_b Measured burst pressure, in bar[1] above atmospheric pressure

P_{lc} Lower cyclic pressure, in bar[1] above atmospheric pressure

P_h Hydraulic test pressure, in bar[1] above atmospheric pressure

P_S Maximum allowable pressure in bar for which the cylinder is designed, as specified in **5.2**.

r Inside knuckle radius, in millimetres (see figure 1)

r_i Inside crown radius, in millimetres (see figure 1)

R_e Minimum guaranteed value of yield stress (see **3.1.1**) in megapascals, for the finished cylinder

R_{ea} Actual value of yield stress, in megapascals, determined by the tensile test **8.1.2.1**

R_g Minimum guaranteed value of tensile strength, in megapascals, for the finished cylinder

R_m Actual value of tensile strength, in megapascals, determined by the tensile test **8.1.2.1**

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

T_s Maximum allowable temperature °C

t Actual thickness of test specimen, in millimetres

4 Material requirements

4.1 General provisions

4.1.1 Steels for the manufacture of gas cylinders shall meet the requirements of this standard.

4.1.2 The steel used for the fabrication of gas cylinders shall have acceptable non-ageing properties and shall not be rimming quality. In cases where examination of this non-ageing property is required, the criteria by which it is to be specified shall be agreed between the parties.

4.1.3 The cylinder manufacturer shall identify the cylinders with the cast of steel from which they are made.

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

4.2 Controls on chemical composition

4.2.1 The chemical composition of all steels shall be specified and recorded, including:

– maximum sulfur and phosphorus content;

– carbon, manganese and silicon content;

– nickel, chromium, molybdenum and all other alloying elements intentionally added.

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[1] 1bar = 10^5 Pa = 0.1MPa

The content of carbon, manganese, silicon and where appropriate, nickel, chromium and molybdenum shall be given, with tolerances, such that the differences between the maximum and minimum values of the cast do not exceed the values shown in table 1.

Table 1 — Chemical composition tolerances

Element	Nominal content in %	Maximum permissible range in %
Carbon	< 0,30 % ≥ 0,30 %	0,06 % 0,07 %
Manganese	All values	0,30 %
Silicon	All values	0,30 %
Chromium	< 1,50 % ≥ 1,50 %	0,30 % 0,50 %
Nickel	All values	0,40 %
Molybdenum	All values	0,15 %
NOTE The maximum permissible range for each element is not required to be centred on its nominal content. As an example, for a steel with nominal carbon content of 0,10 %, the following three maximum permissible ranges are equally acceptable:		
+0,00 %, -0,06 %	+0,00 %, -0,06 %	
	+0,06 %, -0,00 %	
+0,03 %, -0,03 %	+0,03 %, -0,03 %	

The combined content of the following elements: V, Nb, Ti, B, Zr, shall not exceed 0,15 %.

4.2.2 Sulfur and phosphorus in the cast analysis of material used for the manufacture of gas cylinders shall not exceed the values shown in table 2.

Table 2 — Sulfur and phosphorus limits

	R_m in MPa	
	$R_m < 950$	$950 \leq R_m < 1\,100$
Sulfur	0,020 %	0,010 %
Phosphorus	0,020 %	0,020 %
Sulfur + phosphorus	0,030 %	0,025 %

4.2.3 The cylinder manufacturer shall obtain and provide certificates of cast analyses of the steels supplied for the manufacture of gas cylinders. Should check analyses be required, they shall be carried out either on specimens taken during manufacture from material in the form as supplied by the steel maker to the cylinder manufacturer, or from finished cylinders avoiding decarbonised zones from the cylinder surface. In any check analysis, the maximum permissible deviation from the limits specified for cast analyses shall conform to the values specified in EN 10028-1.

4.3 Heat treatment

4.3.1 The cylinder manufacturer shall provide a certificate stating the heat treatment process applied to the finished cylinders.

4.3.2 Quenching in media other than mineral oil is permissible provided that the method produces cylinders free of cracks. If the rate of cooling in the medium is greater than 80 % of that in water at 20 °C without additives, every production cylinder shall be subjected to a non-destructive test to prove freedom from cracks.

4.3.3 The tempering process for quenched and tempered cylinders and for normalized and tempered cylinders shall achieve the required mechanical properties. The actual temperature to which a type of steel is subjected for a given tensile strength shall not deviate by more than 30 °C from the temperature specified by the cylinder manufacturer.

5 Design requirements

5.1 General provisions

5.1.1 The calculation of the wall thickness of the pressure containing parts shall be related to the yield stress (R_e) of the material.

5.1.2 For calculation purposes the value of the yield stress (R_e) is limited to a maximum of 0,90 R_g.

5.1.3 The internal pressure upon which the calculation of wall thickness is based shall be the hydraulic test pressure (P_h).

5.2 Calculation of cylindrical wall thickness

The guaranteed minimum thickness of the cylindrical shell (a') shall not be less than the thickness calculated using the equation:

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

where the value of F shall not exceed 0,875.

R_e / R_g shall be limited to 0,90.

The calculated minimum thickness shall also satisfy the equation:

$$a \geq \frac{D}{100} + 1 \text{ mm}$$

With an absolute minimum of a = 1,5 mm.

Cylinders for CO_2 fire extinguishers applications shall be designed for hydraulic test pressures related to selected filling ratios. The test pressure shall not be less than the developed pressure at 65°C (see Table 3). For breathing apparatus applications the test pressure shall not be less than 1,5 x working pressure (see **3.1.7**).

Table 3 — Test pressure versus filling ratio for CO_2

Filling (kg/l)	P_S (bar)	Minimum test pressure P_h (bar)
0,667	136,8	200
0,675	138,4	200
0,750	173,5	250

When choosing the minimum guaranteed value of the thickness of the cylindrical shell (a'), the manufacturer shall take into account all requirements for type and production testing, particularly the burst test requirements of **8.2**.

For examples of wall thickness calculations see annex B.

5.3 Calculation of convex ends (heads and base ends)

5.3.1 The shapes shown in figure 1 are typical for convex heads and base ends. Shapes A and B are base ends formed from tubing, shapes D and E are base ends formed during the piercing of a billet, and shapes C and F are heads.

5.3.2 The thickness (b) at the centre of the convex end shall be not less than that required by the following criteria:

Where the inside knuckle radius (r) is not less than 0,075 D, then

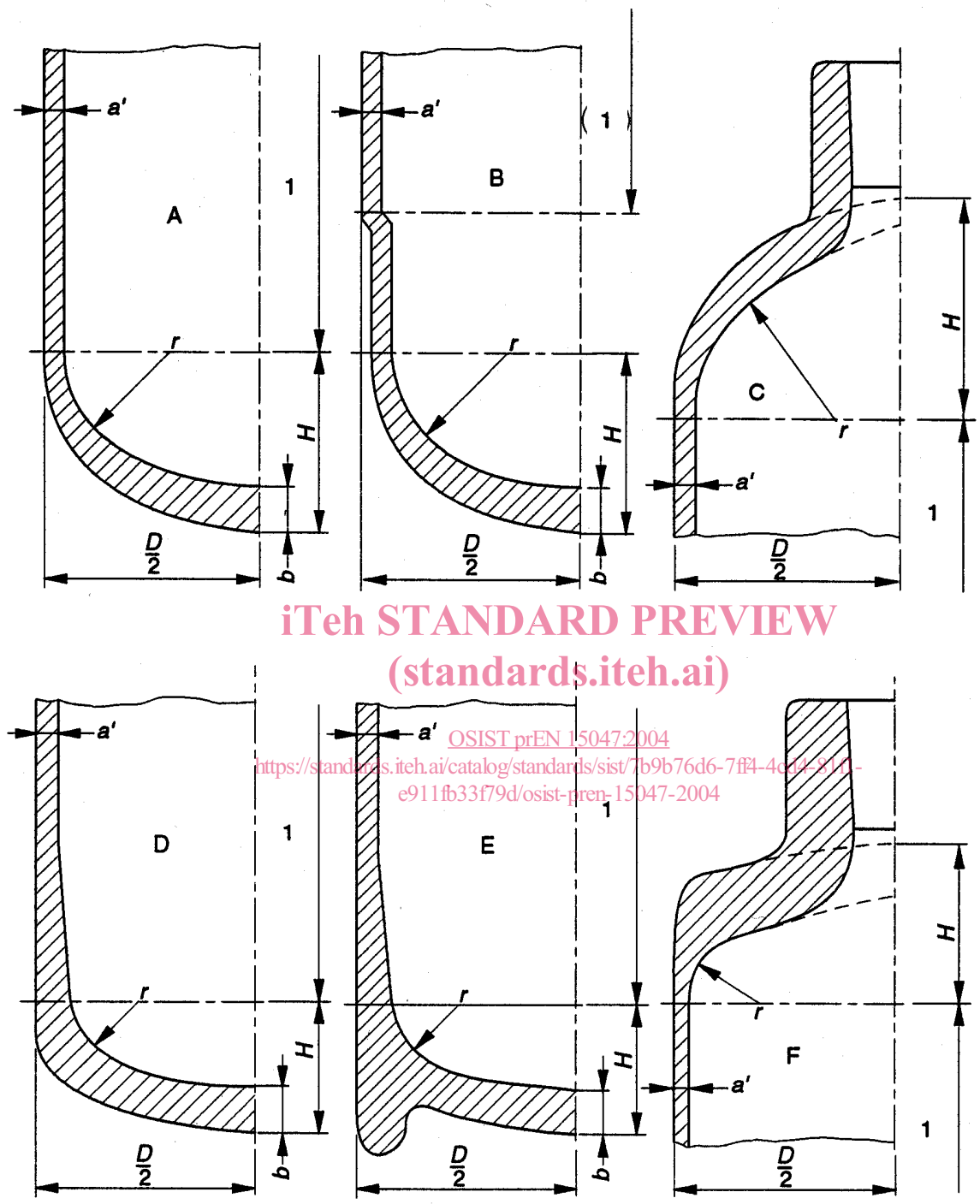
$b \geq 1{,}5a$ for $0{,}40 > H/D \geq 0{,}20$

$b \geq a$ for $H/D \geq 0{,}40$

In order to obtain a satisfactory stress distribution in the region where the end joins the cylindrical part, any thickening of the end that may be required, shall be gradual from the point of juncture. For the application of this rule, the point of juncture between the cylindrical part and the end is defined by the horizontal line indicating dimension H in figure 1.

Shape B shall not be excluded from this requirement.

The cylinder manufacturer shall prove by the pressure cycling test as required in **8.3** that the design is satisfactory.



Key

1 Cylindrical part

Figure 1 — Typical convex ends

5.4 Calculation of concave base ends

When concave base ends are used, the dimensions defined in figure 2 shall be not less than the following calculated values:

$$a_1 = 2a \; ; \; a_2 = 2a \; ; \; h = 0{,}12D \; ; \; r = 0{,}075D$$

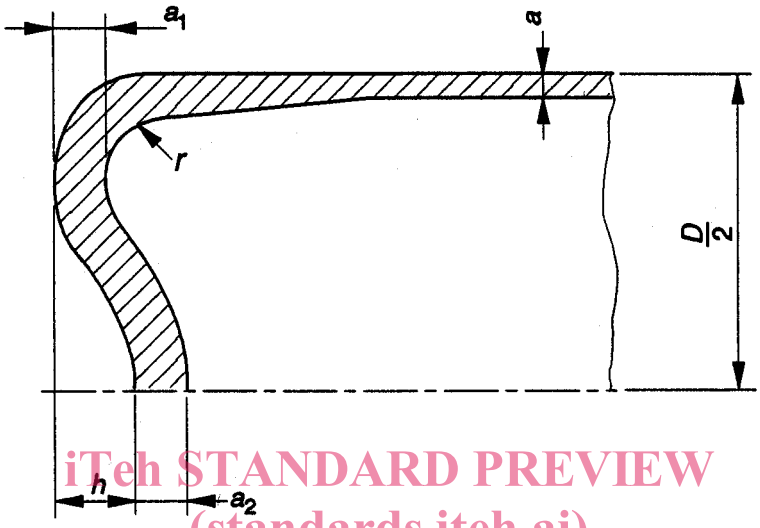


Figure 2 — Concave base ends

In order to obtain a satisfactory stress distribution, the thickness of the cylinder shall increase progressively in the transition area region between the cylindrical part and the base, and the wall shall be free from defects.

The cylinder manufacturer shall prove by the pressure cycling test for a new design as required in **7.1** that the design is satisfactory.

5.5 Neck design

5.5.1 The external diameter and thickness of the formed neck end of the cylinder shall be designed for the torque applied in fitting the valve to the cylinder. The torque may vary according to the diameter of thread, the form, and the sealant used in the fitting of the valve. The torques specified in EN ISO 13341 shall not be exceeded, since this could result in permanent damage to the cylinder. Where the cylinder manufacturer specifies a lower torque this also shall not be exceeded. The manufacturer shall notify any such requirements to the purchaser of aluminium or aluminium alloy cylinders for portable CO_2 fire extinguishers.

5.5.2 The thickness of the wall in the cylinder neck shall be sufficient to prevent permanent expansion of the neck during initial and subsequent fitting of the valve into the cylinder. Where the cylinder is specifically designed to be fitted with neck reinforcement, such as a neck ring or shrunk-on collar this may be taken into account (see EN ISO 13341).

5.5.3 Cylinders for portable CO_2 fire extinguishers may be designed with one or two opening(s) along the central cylinder axis only.

5.6 Foot-rings

When a foot-ring is provided, it shall be sufficiently strong to support the cylinder in a vertical orientation and made of material compatible with that of the cylinder. The shape should be cylindrical and shall give the cylinder sufficient stability. The foot-ring shall be secured to the cylinder by a method other than welding, brazing or soldering. Any

gaps which may form water traps shall be sealed to prevent ingress of water, by a method other than welding, brazing or soldering.

5.7 Neck-rings

When a neck-ring is provided, it shall be made of a material that is compatible with that of the cylinder, and shall be securely attached by a method other than welding, brazing or soldering.

The manufacturer shall ensure that the axial load required to remove the neck-ring is greater than 10 times the weight of the empty cylinder and not less than 1 000 N, also that the minimum torque required to turn the neck-ring is greater than 100 N·m.

5.8 Design drawing

A fully dimensioned drawing shall be prepared which includes the specification of the material, and details of the permanent fittings.

6 Construction and workmanship requirements

6.1 General

The cylinder shall be produced by:

— forging or drop forging from a solid ingot or billet; or

— manufacturing from seamless tube; or

— pressing from a flat plate.

Metal shall not be added in the process of closure of the end. Manufacturing defects shall not be corrected by plugging of bases. Welding of seamless steel cylinders shall not be permitted under any circumstances.

Once the manufacturing route has been established and new design approval obtained, no other significant changes to the process shall be permitted unless the product is submitted for re-approval.

6.2 Wall thickness

Each cylinder shall be examined for thickness and for external and internal surface defects. The wall thickness at any point shall not be less than the minimum design thickness.

6.3 Surface defects

The internal and external surfaces of the finished cylinder shall be free from defects that would adversely affect the safe working of the cylinder. See annex A. Such defects shall be removed by local dressing. The wall thickness of any dressed area shall not be less than the minimum thickness specified.

6.4 Ultrasonic examination

6.4.1 General

Except as identified in **6.4.6**, all cylinders shall be ultrasonically examined for defects. These tests are based on techniques used by cylinder manufacturers. Other techniques of ultrasonic examination may be used, provided these have been demonstrated to be suitable for the manufacturing method.