

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 12245:2009

<https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009>

EUROPEAN STANDARD

EN 12245

NORME EUROPÉENNE

EUROPÄISCHE NORM

January 2009

ICS 23.020.30

Supersedes EN 12245:2002

English Version

Transportable gas cylinders - Fully wrapped composite cylinders

Bouteilles à gaz transportables - Bouteilles entièrement
bobinées en matériaux compositesOrtsbewegliche Gasflaschen - Vollumwickelte Flaschen
aus Verbundwerkstoffen

This European Standard was approved by CEN on 29 November 2008.

CEN members are bound to comply with the CEN/GENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, 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.

INTERNATIONAL STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 12245:2009

<https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009>



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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

	Page
Foreword.....	3
1 Scope.....	5
2 Normative references	5
3 Terms, definitions and symbols	7
3.1 Terms and definitions.....	7
3.2 Symbols	9
4 Design and manufacture	9
4.1 General.....	9
4.2 Liner.....	10
4.3 Composite overwrap.....	11
4.4 Finished cylinder.....	12
5 Cylinder and material tests	13
5.1 General.....	13
5.2 Requirements and test methods.....	14
5.3 Failure to meet test requirements	31
6 Conformity evaluation	31
7 Marking	32
8 Operating instructions (cylinders with non-metallic liners).....	33
Annex A (normative) Prototype, design variant and production testing	34
A.1 General.....	34
A.2 Prototype testing.....	34
A.3 Design variant testing.....	37
A.4 Production testing	42
Annex B (informative) Examples of prototype approval and production testing certificates	45
B.1 Type approval certificate – composite cylinders with metallic liners	45
B.2 Type approval certificate – composite cylinders with non-metallic liners	46
B.3 Type approval certificate – composite cylinders without liners	47
B.4 Design variant approval certificate – composite cylinders with metallic liners.....	48
B.5 Production test certificate.....	49
Bibliography	51

Foreword

This document (EN 12245:2009) 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 July 2009, and conflicting national standards shall be withdrawn at the latest by July 2009.

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

This document supersedes EN 12245:2002.

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 EC Directive(s).

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, 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 the United Kingdom.

[SIST EN 12245:2009](https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009)

<https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009>

EN 12245:2009 (E)**Introduction**

The purpose of this European Standard is to provide a specification for the design, manufacture, inspection and testing of refillable, transportable fully wrapped composite 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.

**iTeh STANDARD PREVIEW
(standards.iteh.ai)**

SIST EN 12245:2009

<https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009>

1 Scope

This European Standard specifies minimum requirements for the materials, design, construction, prototype testing and routine manufacturing inspections of composite gas cylinders for compressed, liquefied and dissolved gases.

NOTE 1 For the purposes of this European Standard, the word "cylinder" includes tubes (seamless transportable pressure receptacles of a water capacity exceeding 150 litres and of not more than 3 000 litres).

This European Standard is applicable to cylinders that comprise a liner of metallic material (welded or seamless) or non-metallic material (or a mixture thereof), reinforced by a wound composite consisting of fibres of glass, carbon or aramid (or a mixture thereof) embedded in a matrix.

This European Standard is also applicable to composite cylinders without liners.

This European Standard is not applicable to gas cylinders which are partially covered with fibres and commonly called "hoop wrapped" cylinders. For hoop wrapped composite cylinders, see EN 12257.

NOTE 2 This European Standard does not address the design, fitting and performance of removable protective sleeves. Where these are fitted, they should be considered separately.

This European Standard is primarily for industrial gases other than LPG but may also be applied to LPG.

NOTE 3 For dedicated LPG cylinders, see EN 14427.

2 Normative references

[SIST EN 12245:2009](#)

[standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009](#)

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 720-2, *Transportable gas cylinders — Gases and gas mixtures — Part 2: Determination of flammability and oxidizing potential of gases and gas mixtures*

EN 1964-1, *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 1964-2, *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 2: Cylinders made of seamless steel with an R_m value of 1100 MPa and above*

EN 1964-3, *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 3: Cylinders made of seamless stainless steel with an R_m value of less than 1100 MPa*

EN 1975, *Transportable gas cylinders — Specification for the design and construction of refillable transportable seamless aluminium and aluminium alloy gas cylinders of capacity from 0,5 litre up to 150 litres*

EN 12862, *Transportable gas cylinders — Specification for the design and construction of refillable transportable welded aluminium alloy gas cylinders*

EN 12245:2009 (E)

EN 13322-1, *Transportable gas cylinders — Refillable welded steel gas cylinders — Design and construction - Part 1: Carbon steel*

EN 13322-2, *Transportable gas cylinders — Refillable welded steel gas cylinders — Design and construction - Part 2: Stainless steel*

EN 14638-1, *Transportable gas cylinders - Refillable welded receptacles of a capacity not exceeding 150 litres - Part 1: Welded austenitic stainless steel cylinders made to a design justified by experimental methods*

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 11114-2, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 2: Non-metallic materials (ISO 11114-2:2000)*

EN ISO 11114-3, *Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 3: Autogenous ignition test in oxygen atmosphere (ISO 11114-3:1997)*

EN ISO 11114-4, *Transportable gas cylinders – Compatibility of cylinder and valve materials with gas contents – Part 4: Test methods for selecting metallic materials resistant to hydrogen embrittlement (ISO 11114-4:2005)*

EN ISO 11120, *Gas cylinders — Refillable seamless steel tubes for compressed gas transport, of water capacity between 150 l and 3000 l — Design, construction and testing (ISO 11120:1999)*

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

EN ISO 13769, *Gas Cylinders – Stamp marking (ISO 13769:2002)*

ISO 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method*

ISO 75-3, *Plastics — Determination of temperature of deflection under load — Part 3: High-strength thermosetting laminates and long-fibre-reinforced plastics*

ISO 175, *Plastics — Methods of test for the determination of the effects of liquid chemicals*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

ISO 1183 (all parts), *Plastics — Methods of determining the density and relative density of non-cellular plastics*

ISO 1628-3, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 3: Polyethylenes and polypropylenes*

ISO 2884-1, *Paints and varnishes — Determination of viscosity using rotary viscometers — Part 1: Cone-and-plate viscometer operated at a high rate of shear*

ISO 3146, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods*

ISO 3341, *Textile glass -- Yarns -- Determination of breaking force and breaking elongation*

ISO 8521, *Plastics piping systems -- Glass-reinforced thermosetting plastics (GRP) pipes -- Determination of the apparent initial circumferential tensile strength*

ISO 10156, *Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets*

ISO 10618, *Carbon fibre -- Determination of tensile properties of resin-impregnated yarn*

ISO 14130, *Fibre-reinforced plastic composites -- Determination of apparent interlaminar shear strength by short-beam method*

ISO 15512, *Plastics - Determination of water content*

ASTM D 2196-86, *Test methods for rheological properties of non-newtonian materials by rotational (Brookfield) viscometer*

ASTM D 2290-92, *Test method for apparent tensile strength of ring or tubular plastics and reinforced plastics by split disk method*

ASTM D 2291-83, *Fabrication of ring test specimens for glass-resin composites*

ASTM D 2343-03, *Test Method for Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics*

ASTM D 2344-84, *Test method for apparent interlaminar shear strength of parallel fiber composites by short beam method*

ASTM D 3418-99, *Standard test method for transition temperature of polymers by differential scanning calorimetry* <https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009>

ASTM D 4018-93, *Test methods for tensile properties of continuous filament carbon and graphite fibre tows*

STANDARD PREVIEW
(standards.iteh.ai)

3 Terms, definitions and symbols

For the purposes of this European Standard, the following terms, definitions and symbols apply.

3.1 Terms and definitions

3.1.1

ambient temperature

temperature of surroundings varying between 10 °C and 35 °C (for test purposes only)

3.1.2

autofrettage

pressure application procedure which strains the metal liner past its yield point sufficiently to cause permanent plastic deformation, and results in the liner having compressive stresses and the fibres having tensile stresses when at zero internal gauge pressure

3.1.3

batch (of fibres, pre-impregnated fibres or components of the matrix system)

homogeneous quantity of material, identified and certified as such by the supplier

EN 12245:2009 (E)**3.1.4****batch (of metallic liners)**

quantity of liners of the same nominal diameter, thickness, length and design, made successively from the same material cast and subjected to the same heat treatment for the same length of time

3.1.5**batch (of non-metallic liners)**

quantity of liners of the same nominal diameter, thickness, length and design, made successively from the same batch of materials and subjected to the same manufacturing process

3.1.6**batch (of finished cylinders with liners)**

quantity of up to 200 finished cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design which may contain different batches of liners (providing the batches are nominally the same and have had the same treatments), fibres and matrix materials

3.1.7**batch (of finished cylinders with no liners)**

production quantity of up to 200 finished cylinders, plus cylinders for destructive testing, of the same nominal diameter, thickness, length and design

3.1.8**burst pressure**

highest pressure reached in a cylinder or liner during the relevant burst test

3.1.9**composite overwrap**

fibres and matrix taken together as a combined unit

3.1.10**elastomer**

material which at ambient temperature can be stretched repeatedly to at least twice its original length and will return with force to approximately its original length immediately upon release of the stress

3.1.11**exterior coating**

layer of clear or pigmented material applied to the cylinder as protection or for cosmetic purposes

3.1.12**fibre or strand**

load-carrying part of the composite overwrap e.g. glass, aramid or carbon

3.1.13**fully wrapped cylinder**

cylinder reinforced by wrapping to take both circumferential and longitudinal stress

3.1.14**liner**

metallic or non-metallic vessel that contains the gas but may also contribute to the mechanical behaviour of the cylinder

3.1.15**non-load sharing liner**

liner that contributes less than 5 % of the load bearing of the overall cylinder design at test pressure, and is intended only to prevent diffusion of the contained gas

3.1.16**non-metallic liner**

liner made from thermoplastic, thermosetting or elastomer material

3.1.17**cylinder without liner**

cylinder having no liner and consisting wholly of the composite winding

3.1.18**matrix**

material which is used to bind and hold the fibres in place

3.1.19**rejected cylinder**

cylinder which in its present condition has not passed the test requirements

3.1.20**thermoplastic**

plastics capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature

3.1.21**thermoset**

plastics which, when cured by the application of heat or chemical means, change into a substantially infusible and insoluble product

ITeH STANDARD PREVIEW
(standards.iteh.ai)

3.2 Symbols

p_b	actual burst pressure of composite cylinder, in bar ¹⁾ above atmospheric pressure
p_{bL}	burst pressure of liner, in bar ¹⁾ above atmospheric pressure
p_{bmin}	minimum burst pressure of composite cylinder obtained during design variant approval testing, in bar ¹⁾ above atmospheric pressure
p_h	hydraulic test pressure of composite cylinder, in bar ¹⁾ above atmospheric pressure
p_{max}	maximum developed pressure at 65 °C, in bar ¹⁾ above atmospheric pressure

4 Design and manufacture**4.1 General**

A fully wrapped composite gas cylinder may be manufactured with a metallic or non-metallic liner or without a liner. Cylinders without a liner may be manufactured from two parts joined together with adhesive. An optional exterior coating may be used to provide external protection and when this is an integral part of the design shall be permanent.

The cylinder may also include additional parts (e.g. rings and bases).

Cylinders shall be designed with one or two openings along the central axis only.

1) 1 bar = 10⁵ Pa = 0,1 MPa.

EN 12245:2009 (E)**4.2 Liner****4.2.1 Metallic liners**

Metallic liners shall be manufactured in accordance with the relevant sections of:

- a) seamless steel liners: EN 1964-1 or EN 1964-2, as appropriate;
- b) seamless stainless steel liners: EN 1964-3;
- c) seamless aluminium alloy liners: EN 1975;
- d) welded steel liners: EN 13322-1 or prEN 14638-3, as appropriate;
- e) welded stainless steel liners: EN 13322-2 or EN 14638-1, as appropriate;
- f) welded aluminium liners: EN 12862;
- g) steel tubes (i.e. > 150 l): EN ISO 11120.

The relevant sections are those covering materials, thermal treatments, neck design, construction and workmanship and mechanical tests.

NOTE This excludes the design requirements, since these are specified by the manufacturer for the design of the composite cylinder. For liners with water capacity above 150 l manufactured of stainless steel, aluminium or welded steel, the relevant sections of the appropriate standard also apply.

The liner material shall be compatible with the gases intended to be used as determined by EN ISO 11114-1 and EN ISO 11114-4.

4.2.2 Non-metallic liners

[SIST EN 12245:2009](https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936e-1d4288e2906b/sist-en-12245-2009)

[https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-](https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936e-1d4288e2906b/sist-en-12245-2009)

A cylinder with a non-metallic liner shall be designed as if the liner will be non-load sharing. The liner material shall be compatible with the gases intended to be used as determined by EN ISO 11114-2.

Where a metal end boss is used in a non-metallic liner, it shall be considered part of the liner material and shall fulfil the material requirements specified in the relevant standard, as listed in 4.2.1.

The drawing of the liner shall include the specification of the material and material properties of the boss. Important material properties shall be specified in the design and are those such as:

- a) minimum yield stress;
- b) minimum tensile strength;
- c) minimum elongation of the boss material;
- d) compatibility with the contained gas as determined by EN ISO 11114-1.

The metal end boss bearing the cylinder thread shall be designed to withstand the torque applied in fitting the valve to the cylinder and the tests specified in Test 16 (see 5.2.16) and Test 17 (see 5.2.17).

4.2.3 Design drawing

A fully dimensioned drawing of the liner shall be supplied which includes the specification of the material and material properties. Material and liner properties to be specified on the drawing are:

- a) for metallic liners:

- 1) minimum yield stress;
 - 2) minimum tensile strength;
 - 3) minimum elongation;
 - 4) minimum burst pressure;
 - 5) compatibility with the contained gas as determined by EN ISO 11114-1.
- b) for non-metallic liners:
- 1) density;
 - 2) melting point, as determined by:
 - i. ISO 3146 for thermoplastics; or
 - ii. ISO 75-1 and ISO 75-3 for thermoset materials;
 - 3) auto-ignition temperature in oxygen as determined by EN ISO 11114-3 (for cylinders intended for air and oxidising gases (see ISO 10156 for definition of oxidising gases));
 - 4) glass transition temperature as determined by differential scanning calorimetry;
 - 5) composition;
 - 6) compatibility with the contained gas as determined by EN ISO 11114-2;
 - 7) end boss design in accordance with 4.2.2.

<https://standards.iteh.ai/catalog/standards/sist/42692712-0286-4851-936a-b4c288e2906b/sist-en-12245-2009>

4.2.4 Design of ends

The external diameter and thickness of the formed neck end of the liner shall be designed to withstand the torque applied in fitting the valve to the cylinder and the tests specified in Test 16 (see 5.2.16) and Test 17 (see 5.2.17).

4.2.5 Neck ring

When a neck ring is provided, it shall be of a material compatible with that of the cylinder, and shall be securely attached by a method appropriate to the liner (or cylinder for cylinders without liner) or boss material.

4.3 Composite overwrap

4.3.1 Materials

Material requirements for the fibre and matrix or the pre-impregnated material shall be as specified by the manufacturer.

4.3.2 Winding

Appropriate procedures shall be defined for the winding and curing process to ensure good repeatability and traceability.

Parameters to be specified and monitored are:

EN 12245:2009 (E)

- a) composite overwrap component percentages;
- b) batch numbers of the material used as defined in 3.1.3;
- c) number of strands used;
- d) winding tension per strand (if applicable);
- e) winding speed(s);
- f) winding angle and/or pitch for each layer;
- g) resin bath temperature range (if applicable);
- h) temperature of the strand before consolidation (if applicable);
- i) number and order of layers;
- j) procedure used to obtain correct impregnation (e.g. wet winding or pre-impregnation);
- k) polymerisation cycle (if applicable);
- l) polymerisation process (e.g. thermal cycling, ultrasonic, ultraviolet or radiation).

For thermal polymerisation, the temperature and the length of the polymerisation cycle of the resin system shall be such that they do not adversely affect the mechanical characteristics of the liner. In addition, tolerances for holding time and temperature at each stage shall be defined.

4.3.3 Cylinders without liners comprising two or more parts

[SIST EN 12245:2009](https://standards.iteh.ai/standards/italian-standards/sist-en-12245-2009)

For cylinders without liners which comprise of two parts joined with adhesive, additional procedures and parameters shall be defined, monitored and recorded and are:

- a) adhesive system component percentages and batch numbers;
- b) polymerisation cycle;
- c) polymerisation process used (e.g. thermal cycling, ultrasonic, ultraviolet or radiation).

4.4 Finished cylinder**4.4.1 Design drawings**

A fully dimensioned drawing of all parts that constitute the finished cylinder shall be supplied. The design drawing shall include tolerances on all dimensions, including out-of-roundness and straightness.

The drawing shall include the specification of the material(s), the material properties and the reinforcement pattern. The specifications and the reinforcement patterns may be given in a technical specification enclosed with the drawing.

The details of an exterior coating, if it is an integral part of the design, shall be defined.

The test pressure, autofrettage pressure (if applicable) and minimum burst pressure for the design shall be specified.

Any special characteristics or special limitations (e.g. design life, underwater suitability, vacuum suitability and/or maximum fitting torque restrictions) shall be stated.

4.4.2 Cylinders without liner

The requirements for the composite materials and their properties to be specified are:

- a) tensile strength;
- b) tensile modulus;
- c) elongation;
- d) heat distortion temperature;
- e) viscosity.

The composite materials shall be compatible with the contained gas as determined by EN ISO 11114-2. The auto-ignition temperature in oxygen gas shall be determined in accordance with EN ISO 11114-3 for cylinders intended for air, oxygen and oxidising gases.

Where a metal end boss is used in a cylinder without liner, the drawing of the cylinder shall include the specification of the material and material properties of the boss in accordance with 4.2.2.2.

4.4.3 Autofrettage

Internal pressurisation to autofrettage pressure of cylinders with metallic liners can be part of the manufacturing process; if so this operation shall be executed after polymerisation of the composite for thermosetting resins or after the consolidation process for thermoplastics.

During the autofrettage operation, the parameters to be recorded are:

- a) autofrettage pressure;
- b) length of application of the autofrettage pressure;
- c) expansion at autofrettage pressure;
- d) permanent expansion after autofrettage.

If autofrettage is used, a check shall be made on all cylinders that the procedure has been effectively performed.

4.4.4 Manufacturing requirements for the finished cylinder

The internal and external surfaces of the finished cylinder shall be free of defects which can adversely affect the safe working of the cylinder. In addition, there shall be no visible foreign matter present inside the cylinder (e.g. resin, swarf or other debris).

5 Cylinder and material tests

5.1 General

This clause describes tests to be conducted on fully wrapped composite cylinders, cylinder liners and the materials used in manufacture of cylinders for prototype testing of new cylinder designs, design