



BSI Standards Publication

**Gas cylinders — High pressure cylinders  
for the on-board storage of natural gas  
as a fuel for automotive vehicles**

---

## National foreword

This British Standard is the UK implementation of EN ISO 11439:2013+A1:2021. It is identical to ISO 11439:2013, incorporating amendment 1:2021. It supersedes BS EN ISO 11439:2013, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee PVE/3/3, 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 committee manager.

The UK committee advises users that amendment 1:2021 to ISO 11439:2013 was initially prompted by multiple in-service failures of gas cylinders due to vehicle fires and external corrosion. An optional corrosion resistance test has now been introduced as Annex H, and it is the UK committee's view that once cylinder manufacturers have had an opportunity to evaluate the performance of their designs using this optional test, it may become a normative test in a future version of this standard.

Furthermore, users are advised that an improved fire test method based on the localized fire test in the United Nations Economic Commission for Europe (UNECE) Global Technical Regulations (GTRs) for hydrogen vehicles was also considered for incorporation into this amendment. However, the ISO working group decided to delay adopting this test since (at the time of publication of this standard) the UNECE's GTR fire test is undergoing an extensive revision, including round-robin testing by multiple test labs to ensure the proposed new format provides repeatable results.

### Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2022  
Published by BSI Standards Limited 2022

ISBN 978 0 539 04024 1

ICS 23.020.35; 43.060.40

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2013.

**Amendments/corrigenda issued since publication**

Date	Text affected
31 January 2022	Implementation of ISO amendment 1:2021 with CEN endorsement A1:2021

English Version

**Gas cylinders - High pressure cylinders for the on-board  
storage of natural gas as a fuel for automotive vehicles  
(ISO 11439:2013)**

Bouteilles à gaz - Bouteilles haute pression pour le  
stockage de gaz naturel utilisé comme carburant à  
bord des véhicules automobiles (ISO 11439:2013)

Gasflaschen - Hochdruck-Flaschen für die  
fahrzeuginterne Speicherung von Erdgas als  
Treibstoff für Kraftfahrzeuge (ISO 11439:2013)

This European Standard was approved by CEN on 18 April 2013.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC 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-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

## European foreword

This document (EN ISO 11439:2013) has been prepared by Technical Committee ISO/TC 58 "Gas cylinders" in collaboration with 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 December 2013, and conflicting national standards shall be withdrawn at the latest by December 2013.

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 ISO 11439:2000.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

### Endorsement notice

The text of ISO 11439:2013 has been approved by CEN as EN ISO 11439:2013 without any modification.

---

## European foreword to amendment A1

This document (EN ISO 11439:2013/A1:2021) has been prepared by Technical Committee ISO/TC 58 "Gas cylinders" in collaboration with 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 May 2022, and conflicting national standards shall be withdrawn at the latest by May 2022.

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

Any feedback and questions on this document should be directed to the users' national standards body/national committee. A complete listing of these bodies can be found on the CEN website.

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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

### Endorsement notice

The text of ISO 11439:2013/Amd 1:2021 has been approved by CEN as EN ISO 11439:2013/A1:2021 without any modification.

# Contents

	Page
<b>Foreword</b> .....	<b>vii</b>
<b>Introduction</b> .....	<b>viii</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>2</b>
<b>4 Service conditions</b> .....	<b>4</b>
4.1 General.....	4
4.1.1 Standard service conditions.....	4
4.1.2 Service life.....	4
4.2 Maximum pressures.....	4
4.3 Design number of filling cycles.....	4
4.4 Temperature range.....	4
4.4.1 Settled gas temperature.....	4
4.4.2 Cylinder temperatures.....	5
4.4.3 Transient temperatures.....	5
4.5 Gas composition.....	5
4.5.1 General.....	5
4.5.2 Dry gas.....	5
4.5.3 Wet gas.....	5
4.6 External surfaces.....	5
<b>5 Inspection and testing</b> .....	<b>6</b>
<b>6 Type approval procedure</b> .....	<b>6</b>
6.1 General.....	6
6.2 Type approval.....	6
6.3 Statement of service.....	7
6.4 Design data.....	7
6.4.1 Drawings.....	7
6.4.2 Stress analysis report.....	7
6.4.3 Material property data.....	7
6.4.4 Fire protection.....	8
6.5 Manufacturing data.....	8
6.6 Fracture performance and non-destructive examination (NDE) defect size.....	8
6.7 Specification sheet.....	8
6.8 Additional supporting data.....	8
6.9 Type approval certificate.....	8
<b>7 Requirements for type 1 metal cylinders</b> .....	<b>8</b>
7.1 General.....	8
7.2 Materials.....	9
7.2.1 General requirements.....	9
7.2.2 Controls on chemical composition.....	9
7.3 Design Requirements.....	9
7.3.1 Test pressure.....	9
7.3.2 Burst pressure.....	9
7.3.3 Stress analysis.....	9
7.3.4 Maximum defect size.....	9
7.3.5 Openings.....	10
7.3.6 Fire protection.....	10
7.3.7 Attachments.....	10
7.4 Construction and workmanship.....	10
7.4.1 End closure.....	10
7.4.2 Heat treatment.....	10
7.4.3 Neck threads.....	10

7.4.4	Exterior environmental protection.....	10
7.4.5	Traceability.....	11
7.5	Prototype testing procedure.....	11
7.5.1	General requirements.....	11
7.5.2	Prototype tests.....	11
7.5.3	Change of design.....	12
7.6	Batch tests.....	13
7.6.1	General requirements.....	13
7.6.2	Required tests.....	13
7.7	Tests on every cylinder.....	14
7.8	Batch acceptance certificate.....	15
7.9	Failure to meet test requirements.....	15
<b>8</b>	<b>Requirements for type 2 hoop-wrapped cylinders.....</b>	<b>15</b>
8.1	General.....	15
8.2	Materials.....	16
8.2.1	General requirements.....	16
8.2.2	Controls on chemical composition.....	16
8.2.3	Composite materials.....	16
8.3	Design requirements.....	17
8.3.1	Test pressure.....	17
8.3.2	Burst pressures and fibre stress ratios.....	17
8.3.3	Stress analysis.....	18
8.3.4	Maximum defect size.....	18
8.3.5	Openings.....	18
8.3.6	Fire protection.....	18
8.4	Construction and workmanship.....	18
8.4.1	General.....	18
8.4.2	Liner.....	18
8.4.3	Neck threads.....	18
8.4.4	Overwrap.....	19
8.4.5	Exterior environmental protection.....	19
8.4.6	Traceability.....	20
8.5	Prototype testing procedure.....	20
8.5.1	General requirements.....	20
8.5.2	Prototype tests.....	20
8.5.3	Change of design.....	22
8.6	Batch tests on liners and cylinders.....	22
8.6.1	General requirements.....	22
8.6.2	Required tests.....	22
8.7	Tests on every liner and cylinder.....	25
8.8	Batch acceptance certificate.....	26
8.9	Failure to meet test requirements.....	26
8.9.1	Liners.....	26
8.9.2	Cylinders.....	26
<b>9</b>	<b>Requirements for type 3 fully-wrapped cylinders.....</b>	<b>26</b>
9.1	General.....	26
9.2	Materials.....	27
9.2.1	General requirements.....	27
9.2.2	Controls on chemical composition.....	27
9.2.3	Composite materials.....	27
9.3	Design requirements.....	28
9.3.1	Test pressure.....	28
9.3.2	Burst pressures and fibre stress ratios.....	28
9.3.3	Stress analysis.....	29
9.3.4	Maximum defect size.....	29
9.3.5	Openings.....	29
9.3.6	Fire protection.....	29

9.4	Construction and workmanship .....	29
9.4.1	General .....	29
9.4.2	Liner .....	30
9.4.3	Neck threads .....	30
9.4.4	Overwrap .....	30
9.4.5	Exterior environmental protection .....	31
9.4.6	Traceability .....	31
9.5	Prototype testing procedure .....	31
9.5.1	General requirements .....	31
9.5.2	Prototype tests .....	31
9.5.3	Change of design .....	33
9.6	Batch tests on liners and cylinders .....	35
9.6.1	General requirements .....	35
9.6.2	Liner tests .....	35
9.6.3	Cylinder tests .....	35
9.6.4	Cylinder failures .....	36
9.7	Tests on every liner and cylinder .....	36
9.7.1	General .....	36
9.7.2	Liner tests .....	36
9.7.3	Cylinder tests .....	36
9.8	Batch acceptance certificate .....	37
9.9	Failure to meet test requirements .....	37
9.9.1	Liners .....	37
9.9.2	Cylinders .....	37
<b>10</b>	<b>Requirements for type 4 fully-wrapped composite cylinders .....</b>	<b>38</b>
10.1	General .....	38
10.2	Materials .....	38
10.2.1	General requirements .....	38
10.2.2	Resins .....	38
10.2.3	Fibres .....	38
10.2.4	Plastic liners .....	38
10.2.5	Metal bosses .....	38
10.3	Design requirements .....	38
10.3.1	Test pressure .....	38
10.3.2	Burst pressures and fibre stress ratios .....	39
10.3.3	Stress analysis .....	39
10.3.4	Openings .....	39
10.3.5	Fire protection .....	39
10.4	Construction and workmanship .....	40
10.4.1	General .....	40
10.4.2	Neck threads .....	40
10.4.3	Curing of thermosetting resins .....	40
10.4.4	Exterior environmental protection .....	40
10.4.5	Traceability .....	40
10.5	Prototype testing procedure .....	40
10.5.1	General .....	40
10.5.2	Prototype tests .....	41
10.5.3	Change of design .....	42
10.6	Batch tests .....	46
10.6.1	General requirements .....	46
10.6.2	Required tests .....	46
10.7	Tests on every cylinder .....	47
10.8	Batch acceptance certificate .....	47
10.9	Failure to meet test requirements .....	48
<b>11</b>	<b>Marking .....</b>	<b>48</b>
<b>12</b>	<b>Preparation for dispatch .....</b>	<b>49</b>



<b>Annex A</b> (normative) <b>Test methods and criteria</b> .....	<b>50</b>
<b>Annex B</b> (normative) <b>Ultrasonic examination</b> .....	<b>59</b>
<b>Annex C</b> (informative) <b>Non-destructive examination (NDE) defect size by flawed cylinder cycling</b> .....	<b>63</b>
<b>Annex D</b> (informative) <b>Report forms</b> .....	<b>64</b>
<b>Annex E</b> (informative) <b>Standard working pressures</b> .....	<b>67</b>
<b>Annex F</b> (informative) <b>Verification of stress ratios using strain gauges</b> .....	<b>68</b>
<b>Annex G</b> (informative) <b>Manufacturer's instructions for handling, use and inspection of cylinders</b> .....	<b>69</b>
<b>Annex H</b> (informative) <b>Corrosion resistance</b> .....	<b>71</b>
<b>Bibliography</b> .....	<b>75</b>

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 11439 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Cylinder design*.

This second edition cancels and replaces the first edition (ISO 11439:2000), which has been technically revised. In addition to editorial improvements, the principal technical difference between the first and second editions is the clarification and alteration of the “Change of Design” requirements for the various cylinder types.

## **Introduction**

Cylinders for the on-board storage of fuel for natural gas vehicle service are required to be light-weight, at the same time maintaining or improving on the level of safety currently existing for other pressure vessels.

Owners or users of cylinders designed to this International Standard should note that the cylinders are designed to operate safely if used in accordance with specified service conditions for a specified finite service life only. The expiry date is marked on each cylinder and it is the responsibility of owners and users to ensure that cylinders are not used after that date, and that they are inspected in accordance with the manufacturer's instructions.

Users of this International Standard are encouraged to consider the environmental impacts associated with performing certain tests.

# Gas cylinders — High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles

## 1 Scope

This International Standard specifies minimum requirements for light-weight refillable gas cylinders intended only for the on-board storage of high pressure compressed natural gas as a fuel for automotive vehicles to which the cylinders are to be fixed. The service conditions do not cover external loadings that can arise from vehicle collisions, etc.

This International Standard covers cylinders of any seamless steel, seamless aluminium alloy or non-metallic material construction, using any design or method of manufacture suitable for the specified service conditions. This International Standard does not cover cylinders of stainless steel. Although this standard uses 200 bar as a reference working pressure, other working pressures can be used.

Cylinders covered by this International Standard are designated Type 1, Type 2, Type 3 and Type 4.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

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

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

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

ISO 7866, *Gas cylinders — Refillable seamless aluminium alloy gas cylinders — Design, construction and testing*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 9809-1, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 1: Quenched and tempered steel cylinders with tensile strength less than 1 100 MPa*

ISO 9809-2, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 2: Quenched and tempered steel cylinders with tensile strength greater than or equal to 1 100 MPa*

ISO 9809-3, *Gas cylinders — Refillable seamless steel gas cylinders — Design, construction and testing — Part 3: Normalized steel cylinders*

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

ISO 15403-1, *Natural gas — Natural gas for use as a compressed fuel for vehicles — Part 1: Designation of the quality*