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BSI Standards Publication

Gas cylinders — Cylinder valves — Specification and type testing (ISO 10297:2014)

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National foreword

This British Standard is the UK implementation of EN ISO 10297:2014. It supersedes BS EN ISO 10297:2006 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PVE/3, Gas containers, to Subcommittee PVE/3/1, Valve fittings for gas containers.

A list of organizations represented on this subcommittee 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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Foreword

This document (EN ISO 10297:2014) 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of an identical text or by endorsement, at the latest by January 2015, and conflicting national standards shall be withdrawn at the latest by January 2015.

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 10297:2006.

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Endorsement notice

The text of ISO 10297:2014 has been approved by CEN as EN ISO 10297:2014 without any modification.

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 58, *Gas cylinders*, Subcommittee SC 2, *Cylinder fittings*.

This third edition cancels and replaces the second edition (ISO 10297:2006), which has been technically revised.

The main technical modifications are:

a) Scope: inclusion of main valves and valves with integrated pressure regulator (VIPR), exclusion of quick-release valves, non-return valves and ball valves;

b) Terms, definitions and symbols: introduction of new definitions and adaptation of existing definitions;

c) Valve description: new clause with figures and general description;

d) Valve design requirements:

  1) General: inclusion of additional requirement of internal leak tightness at −40 °C during transport and storage;

  2) Materials: deletion of requirements already given in ISO 11114-1 and ISO 11114-2; deletion of ageing sensitivity test for non-metallic materials; addition of requirement on ductility of valve body material; addition of requirement on suitability of lubricants for valve test pressure;

  3) Dimensions: deletion of requirement on bore of the valve with regard to flow requirement and adaption of requirements for valves fitted with a valve protection cap according to ISO 11117;

  4) Valve connections: addition of requirements for separate valve filling connection;

  5) Resistance to mechanical impact: addition of requirement for impact testing valves protected by a valve guard but fixed only to the valve, modification of acceptance criteria;

6) Valve operating mechanism: inclusion of allowance to increase the endurance torque for some valve designs and to adjust compressed packed valves during endurance testing; replacement of acetylene flashback test by alternative tests without using acetylene and addition of acetylene decomposition test for main valves; modification of acceptance criteria;

7) Valve operating device: addition of requirement on the handwheel diameter required to achieve the minimum closing torque; modification of acceptance criteria for flame impingement test;

8) Resistance to ignition: addition of requirement of oxygen pressure surge testing for certain cylinder valves for gas mixtures containing oxygen and other oxidizing gases and of detailed information on acceptance criteria; addition of mandatory reference to oxygen pressure surge test for VIPR specified in ISO 22435 or ISO 10524-3 and for cylinder valves with residual pressure devices specified in ISO 15996;

e) Production requirements: deletion of all respective requirements but reference to ISO 14246 in scope;

f) Type testing:

1) General: addition of requirements for repeating tests depending on applied changes for a valve design;

2) Documentation: addition of detailed information on documentation required;

3) Test samples: addition of requirement to have pressure gauges/indicators fitted;

4) Test report: addition of detailed information required;

5) Test pressures: adaption of information on burst test pressure (former hydraulic test pressure);

6) Test gas: addition of requirement for using helium or hydrogen or an inert mixture of these gases for the leak tightness tests for cylinder valves for helium and hydrogen and their mixtures; extension of requirements on gas quality;

7) Test schedule: deletion of ageing as preconditioning and leak tightness test before ageing; addition of internal leak tightness test at −40 °C after endurance test; adaption of oxygen pressure surge test for cylinder valves with lubricants not rated for valve test pressure; listing of impact test;

8) Hydraulic burst pressure test: addition of testing the valve in closed position;

9) Excessive torque tests: addition of requirement to carry out the test with the valve operating device in place; differentiation between handwheel and key/toggle operated valves; extension of tests with requirement of two additional test samples;

10) Leak tightness tests: reference to informative Annex E for an example of a vacuum test; unification of the lower test pressure of 0,5 bar for all gases; implementation of internal leak tightness test at −40 °C; addition of information on required position of the valve operating mechanism for external leak tightness test; adaption of requirement for test order for all required test pressures; adaption of requirement for changing and maintaining the different test temperatures; adaption of requirement for minimum closing torque;

11) Endurance test: addition of requirement to carry out the test with the handwheel in place and of description of procedure for increasing the endurance torque for some valve designs;

12) Visual examination: addition of separate sub-clause for visual examination with detailed information on acceptance criteria;

13) Oxygen pressure surge test: information on test installation and test procedure transferred to normative Annex C; addition of detailed information on determination of pressure rise time; addition of divergent installation requirements for testing main valves; addition of detailed information on acceptance criteria;

14) Acetylene test: information transferred to normative Annex B;

15) Impact test: addition of information on the valving torque according to ISO 13341 to be used; addition of subsequent hydraulic burst pressure test and internal leak tightness test; modification of test procedure;

16) Marking: addition of requirement for marking cylinder valves oxygen pressure surge tested via different connections and of detailed information on marking of valve inlet, valve outlet and separate valve filling connections;

17) Example of test sequence: information transferred from informative Annex B to informative Annex D and adaptation according to new requirements for valve designs and changes and material specifications within a valve design;

18) Addition of informative Annex E, giving an example of a vacuum test;

19) Endurance test equipment and procedure: information transferred from normative Annex C to normative Annex F.

g) full editorial rework.

Introduction

This International Standard covers the function of a cylinder valve as a closure (defined by the UN Model Regulations). Additional features of cylinder valves (e.g. pressure regulators, residual pressure devices, non-return devices and pressure relief devices) might be covered by other standards and/or regulations.

Cylinder valves complying with this International Standard can be expected to perform satisfactorily under normal service conditions.

This International Standard pays particular attention to:

a) suitability of materials;

b) safety (mechanical strength, impact strength, endurance, leak tightness, resistance to ignition, resistance to acetylene flashback);

c) testing;

d) marking.

This standard has been written to be in conformity with the UN Model Regulations. When published it will be submitted to the UN Sub Committee of Experts on the Transport of Dangerous Goods with a request that it be included in the UN Model Regulations.

Where there is any conflict between this International Standard and any applicable regulation, the regulation always takes precedence.

Considering the changes described in the Foreword, when a cylinder valve has been approved according to the previous version of this International Standard the body responsible for approving the same cylinder valve to this new edition should consider which tests need to be performed.

In this International Standard the unit bar is used, due to its universal use in the field of technical gases. It should, however, be noted that bar is not an SI unit, and that the corresponding SI unit for pressure is Pa (1 bar = 10^5 Pa = 10^5 N/m^2).

Pressure values given in this International Standard are given as gauge pressure (pressure exceeding atmospheric pressure) unless noted otherwise.

Gas cylinders — Cylinder valves — Specification and type testing

1 Scope

This International Standard specifies design, type testing and marking requirements for:

a) cylinder valves intended to be fitted to refillable transportable gas cylinders;

b) main valves (excluding ball valves) for cylinder bundles;

c) cylinder valves or main valves with integrated pressure regulator (VIPR);

which convey compressed, liquefied or dissolved gases.

NOTE 1 Where there is no risk of ambiguity, cylinder valves, main valves and VIPR are addressed with the collective term “valves” within this International Standard.

This International Standard covers the function of a valve as a closure.

This International Standard does not apply to

— valves for cryogenic equipment, portable fire extinguishers and liquefied petroleum gas (LPG), and

— quick-release valves (e.g. for fire-extinguishing, explosion protection and rescue applications), non-return valves or ball valves.

NOTE 2 Requirements for valves for cryogenic vessels are specified in ISO 21011 and at a regional level e.g. in EN 1626. Requirements for LPG valves are specified in ISO 14245 or ISO 15995. Requirements for quick-release valves are specified e.g. in ISO 17871. Requirements for valves for portable fire extinguishers at a regional level are specified e.g. in EN 3 series. Requirements for non-return valves and ball valves might be specified in international/regional standards.

NOTE 3 Requirements for manufacturing tests and examinations of valves covered by this International Standard are given in ISO 14246.

NOTE 4 Additional requirements for VIPR are specified in ISO 22435 for industrial applications or ISO 10524-3 for medical applications. Additional requirements for residual pressure valves with or without a non-return function are specified in ISO 15996. Additional requirements for pressure-relief devices might be specified in international/regional regulations/standards.

NOTE 5 Additional specific requirements for valves for breathing apparatus at a regional level are specified e.g. in EN 144 series. Additional specific requirements for quick-release valves for fixed fire-fighting systems are specified in ISO 16003 and at a regional level e.g. in EN 12094–4.

2 Normative references

The following referenced 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 407, *Small medical gas cylinders — Pin-index yoke-type valve connections*

ISO 10286, *Gas cylinders — Terminology*

ISO 10524-3, *Pressure regulators for use with medical gases — Part 3: Pressure regulators integrated with cylinder valves*

ISO 11114-1, *Gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 1: Metallic materials*

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

ISO 11117:2008, *Gas cylinders — Valve protection caps and valve guards — Design, construction and tests*

ISO 13341, *Gas cylinders — Fitting of valves to gas cylinders*

ISO 15615:2013, *Gas welding equipment — Acetylene manifold systems for welding, cutting and allied processes — Safety requirements in high-pressure devices*

ISO 15996, *Gas cylinders — Residual pressure valves — General requirements and type testing*

ISO 22435, *Gas cylinders — Cylinder valves with integrated pressure regulators — Specification and type testing*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in ISO 10286, and the following apply.

3.1
valve operating mechanism
mechanism which closes and opens the valve orifice and which includes the internal and external sealing systems

Note 1 to entry: In ISO 22435 the valve operating mechanism is called shut-off mechanism.

Note 2 to entry: For some VIPR designs the pressure regulating valve can act as the shut-off mechanism.

EXAMPLE A threaded valve spindle which, when rotated, raises and lowers a seal/seat.

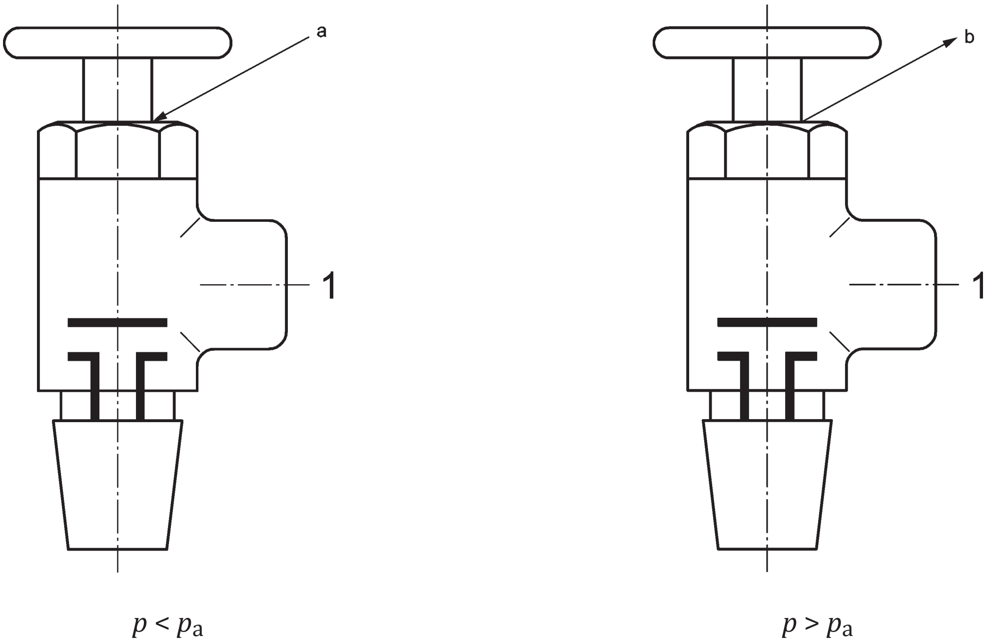
3.2
valve design
classification of valves with regard to the *valve operating mechanism* (3.1)

3.3
valve operating device
component which actuates the *valve operating mechanism* (3.1)

EXAMPLE Handwheel, key, knob, toggle, lever or actuator.

3.4
external leak tightness
leak tightness to atmosphere (leakage in and/or leakage out) when the valve is open

Note 1 to entry: See Figure 1.



Key

1 valve outlet connection (sealed)

a Leakage in (vacuum test)

b Leakage out

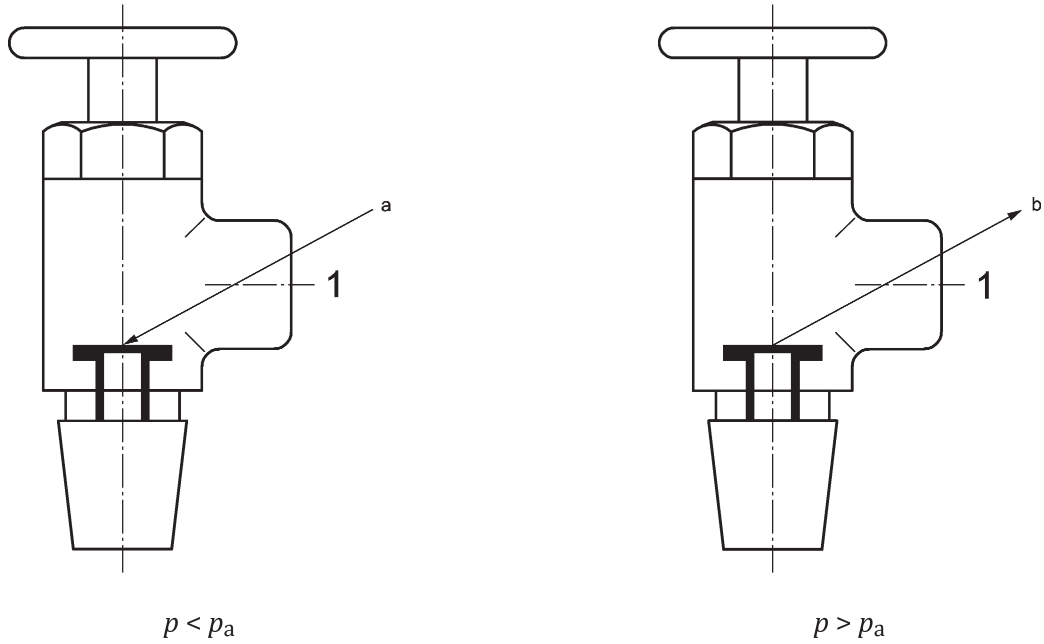
p internal pressure

p_a atmospheric pressure

Figure 1 — External leak tightness

3.5
internal leak tightness
leak tightness across the valve seat (leakage in and/or leakage out) when the valve is closed

Note 1 to entry: See Figure 2.



Key

1 valve outlet connection (open)

a Leakage in (vacuum test).

b Leakage out.

p internal pressure

p_a atmospheric pressure

Figure 2 — Internal leak tightness

3.6
valve working pressure
p_W
settled pressure of a compressed gas at a uniform reference temperature of 15 °C in a full gas cylinder or cylinder bundle for which the valve is intended

Note 1 to entry: This definition does not apply to liquefied gases (e.g. carbon dioxide), or dissolved gases (e.g. acetylene).

Note 2 to entry: The valve working pressure is expressed in bar.

3.7
valve burst test pressure
p_{vbt}
minimum pressure applied to a valve during hydraulic burst pressure test

Note 1 to entry: The valve burst test pressure is expressed in bar.

3.8
valve test pressure
p_{vt}
minimum pressure applied to a valve during testing

Note 1 to entry: The valve test pressure is expressed in bar.

3.9
handwheel diameter
D
nominal value of twice the largest radius from the centre of the handwheel

Note 1 to entry: The handwheel diameter is expressed in mm.

3.10
minimum torque
T_c
torque necessary to be applied to a *valve operating device* (3.3) of a newly manufactured valve to obtain *internal leak tightness* (3.5) at *valve test pressure* (3.8) and room temperature

Note 1 to entry: The minimum closing torque is expressed in Nm.

3.11
endurance torque
T_e
closing torque applied during the endurance test

Note 1 to entry: The endurance torque is expressed in Nm.

3.11.1
endurance torque at start
$T_{e,start}$
endurance torque (3.11) to be applied at the beginning of the endurance test

3.11.2
endurance torque at end
$T_{e,end}$
endurance torque (3.11) measured at the end of the endurance test to achieve *internal leak tightness* (3.5)

3.12
over torque
T_o
opening or closing torque (whichever is the lower value) applied to the *valve operating device* (3.3) to determine the level of torque which the *valve operating mechanism* (3.1) can tolerate and remain operable

Note 1 to entry: The over torque is expressed in Nm.

3.13
failure torque
T_f
opening or closing torque (whichever is the lower value) applied to the *valve operating device* (3.3) to obtain mechanical failure of the *valve operating mechanism* (3.1) and/or *valve operating device* (3.3)

Note 1 to entry: The failure torque is expressed in Nm.

3.14
total package mass
combined mass of a gas cylinder (including, for dissolved gases, any porous material and solvent), its valve(s), its permanent attachment(s) and its maximum allowed gas content

Note 1 to entry: Valve guards but not valve protection caps are examples of permanent attachments.

Note 2 to entry: The total package mass is expressed in kg.

3.15
main valve
valve which is fitted to a cylinder bundle’s manifold isolating it from the main connection(s)

3.16
valve inlet connection
connection on the valve which connects the valve to the cylinder(s)

3.17
valve outlet connection
connection on the valve used to discharge the cylinder(s)

Note 1 to entry: For most valves this connection is also used for filling the cylinder(s).

3.18
valve filling connection
connection on the valve used to fill the cylinder(s)

Note 1 to entry: For some valves (e.g. VIPRs) the valve filling connection is different from the valve outlet connection.

3.19
NTP
normal temperature and pressure

[SOURCE: 20,0 °C (293,15 K), 1,013 bar absolute (0,101 3 MPa absolute)]

4 Valve description

4.1 A valve typically comprises of:

a) valve body;

b) valve operating mechanism;

c) valve operating device;

d) means to ensure internal leak tightness;

e) means to ensure external leak tightness;

f) valve outlet connection(s);

g) valve inlet connection;

4.2 Valves can also include:

a) pressure-relief device;

NOTE The relevant transport regulation might require or forbid pressure relief devices for some gases, gas mixtures or gas groups.

b) dip tube;

c) outlet connection plug/cap;

d) excess flow device;

e) non-return valve on the valve filling connection;

f) residual pressure device with or without non-return function;

g) pressure regulating device;

h) separate valve filling connection;

i) flow restricting orifice;

j) filter(s).

4.3 Common valve designs are:

a) o-ring gland seal valves (see Figure 3);

b) diaphragm gland seal valves (see Figure 4);

c) compression packed gland seal valves (see Figure 5);

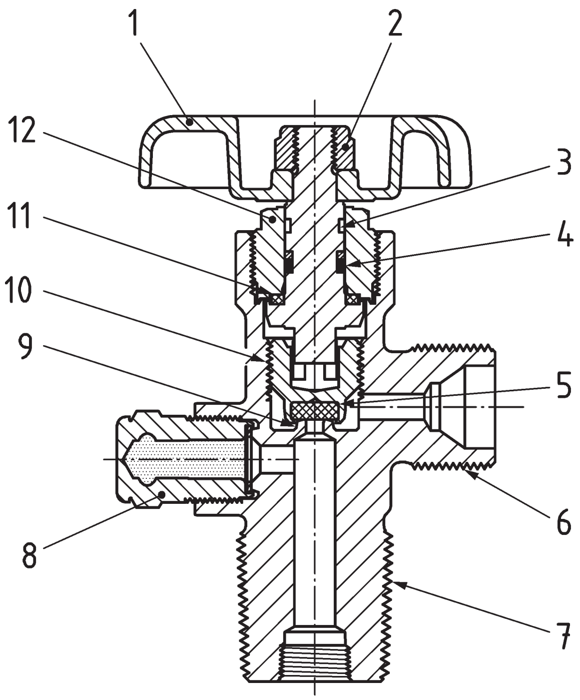
d) pressure seal valves (see Figure 6); and

e) reverse seated valves (see Figure 7).

The valve designs shown in Figures 3 to 7[1)] are given as typical examples, each with one sealing system and one valve operating device only.

1) Figure 3 to Figure 7 © Compressed Gas Association (CGA). These figures are reproduced from CGA V-9—2012, *Compressed Gas Association Standard for Compressed Gas Cylinder Valves*, with permission from the Compressed Gas Association. All rights reserved.

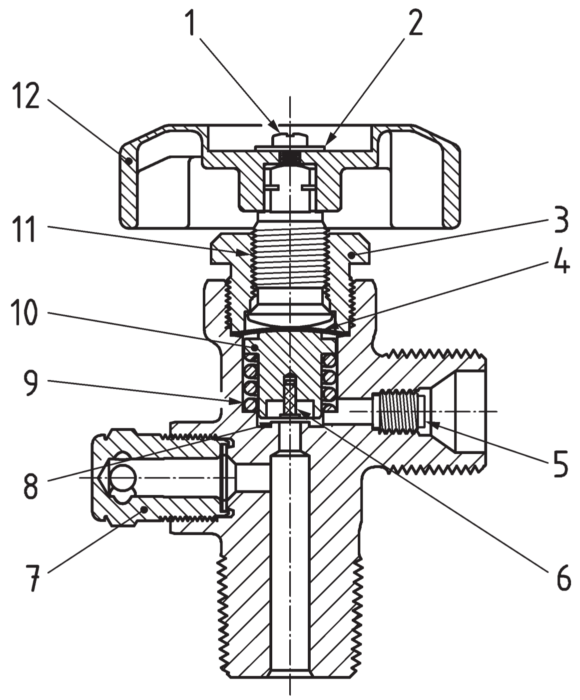
A pin-index (post-type medical) valve (see Figure 8[2)]) is shown for illustration to identify unique geometry in common medical gas cylinder applications.



Key

1	handwheel
2	handwheel retaining nut/stem nut
3	upper spindle/upper stem
4	o-ring
5	seat insert
6	valve outlet connection
7	valve inlet connection
8	pressure relief device
9	body seat
10	lower spindle/lower plug
11	washer
12	gland nut/bonnet

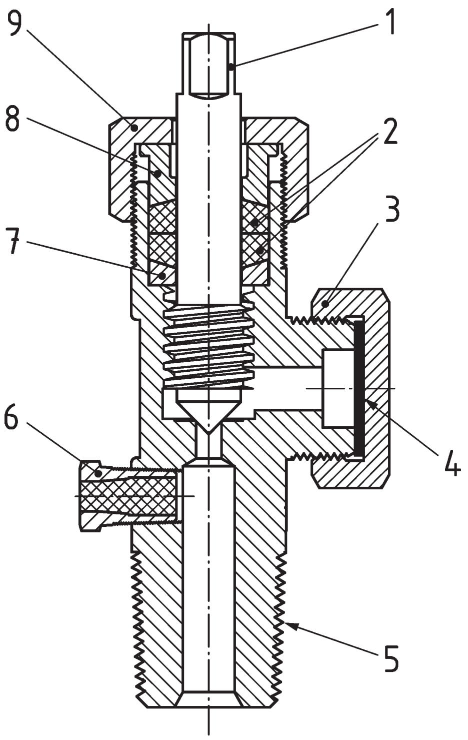
Figure 3 — O-ring gland seal valve (non-metallic seal, handwheel operated)[1)]



1	handwheel retaining screw
2	washer
3	gland nut/bonnet
4	diaphragms
5	flow restrictor (when specified)
6	seat insert
7	pressure relief device
8	body seat
9	seat opening spring
10	lower spindle/lower plug
11	upper spindle/upper stem
12	handwheel

Figure 4 — Diaphragm gland seal valve (non-metallic seal, handwheel operated)[1)]

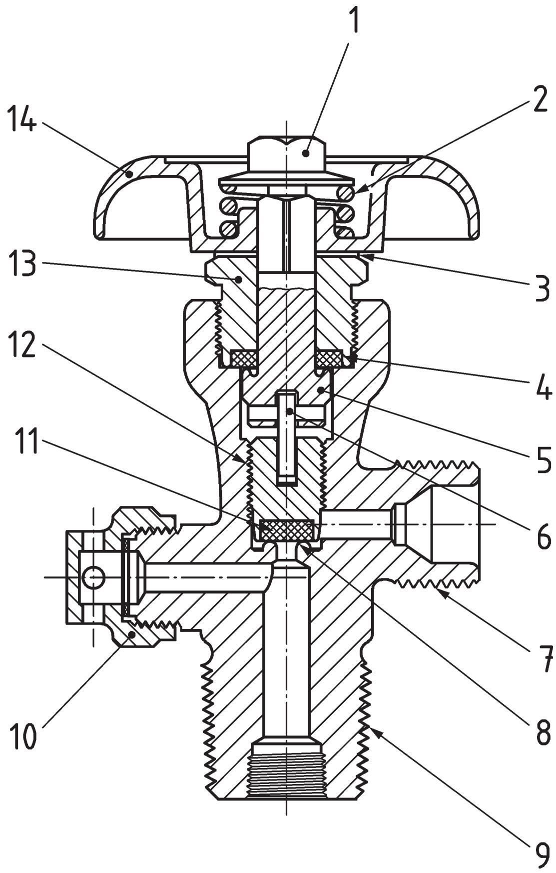
2) Figure 8 © Compressed Gas Association (CGA). This figure is reproduced from CGA V-9—2012, *Compressed Gas Association Standard for Compressed Gas Cylinder Valves*, with permission from the Compressed Gas Association. All rights reserved.



Key

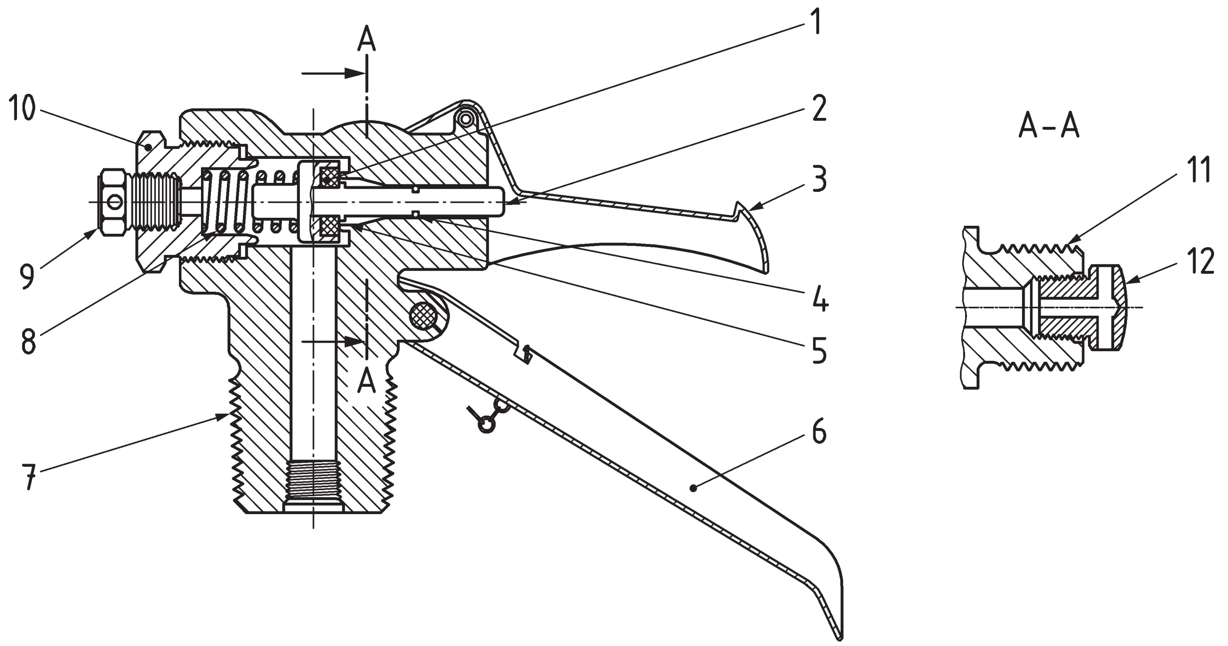
1	spindle/valve stem, one-piece
2	packings
3	cap nut/outlet seal cap
4	outlet seal gasket
5	valve inlet connection
6	pressure relief device
7	packing collar
8	packing gland
9	packing nut

Figure 5 — Compression packed gland seal valve (metal to metal seal, key operated)1)



1	handwheel retaining nut/stem nut
2	pressure seal loading spring
3	washer
4	packings
5	upper spindle / upper stem
6	tang
7	valve outlet connection
8	body seat
9	valve inlet connection
10	pressure relief device
11	seat insert
12	lower spindle/lower plug
13	gland nut/bonnet
14	handwheel

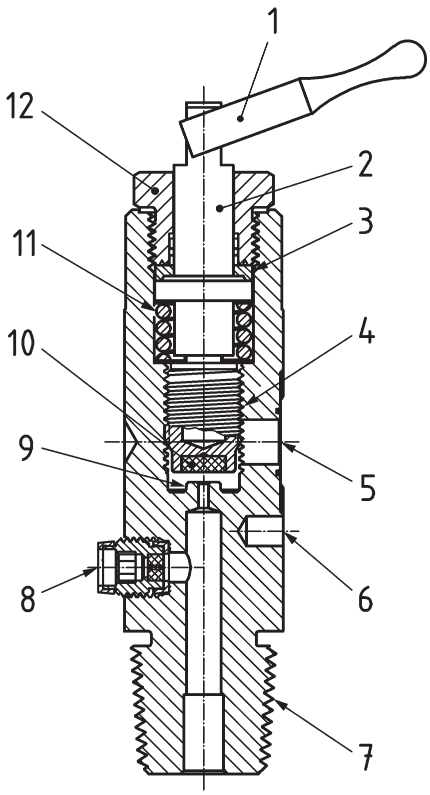
Figure 6 — Pressure seal valve (non-metallic seal, handwheel operated)1)



Key

1 seat insert
2 poppet
3 lever
4 o-ring
5 body seat
6 handle
7 valve inlet connection
8 seat closing spring
9 pressure relief device
10 gland nut/bonnet
11 valve outlet connection
12 diffuser

Figure 7 — Reverse seated valve (non-metallic seal, lever operated)[1)]



Key

1 toggle
2 upper spindle/upper stem
3 packings
4 lower spindle/lower plug
5 valve outlet connection
6 pin index holes
7 valve inlet connection
8 pressure relief device
9 body seat
10 seat insert
11 pressure seal loading spring
12 gland nut/bonnet

Figure 8 — Pin-index (post-type medical) valve (non-metallic seal, toggle operated)[2)]

5 Valve design requirements

5.1 General

Valves shall operate within specification and be leak tight over a range of service temperatures, from at least −20 °C to +65 °C in indoor and outdoor environments.

Closed valves shall be internally leak tight during transport and storage (see test 6 in Table 3) for temperatures down to −40 °C.

Where higher or lower service temperatures are required, any additional requirements and tests shall be agreed between the manufacturer and purchaser.

5.2 Materials

Metallic and non-metallic materials in contact with the gas shall be chemically and physically compatible with the gas, according to ISO 11114-1 and ISO 11114-2 under all intended operating conditions. For valves used for dissolved gases, the compatibility of the materials in contact with the solvent shall also be considered. For valves used with gas mixtures, the compatibility of the gas wetted materials with each component of the gas mixture shall be considered.

When using plated or coated components in gas wetted areas the material compatibility of both, the plating/coating material and the substrate material shall be taken into account. In addition consideration should be given to avoid flaking or particle generation, especially for oxygen, other oxidizing gases (as defined in ISO 10156) and gas mixtures containing oxygen or other oxidizing gases.

The material used for the valve body shall be either

a) a material not showing a ductile to brittle transition (e.g. copper alloys, austenitic stainless steels, aluminium alloys and nickel alloys), or

b) a ferritic material (e.g. carbon steel) having an impact value greater than 27 J at −40 °C when submitted to the Charpy pendulum impact test as specified in ISO 148-1.

Ignition resistance of non-metallic materials, lubricants and adhesives used in the gas wetted area of valves requiring oxygen pressure surge testing (see 5.9) should be considered (e.g. using an appropriate test procedure such as ISO 11114-3 for Auto Ignition Temperature (AIT) testing and ISO 21010:2004, Annex C for oxygen pressure surge testing of materials). Non-metallic materials used in oxygen wetted areas should have an AIT of at least 100 °C above its maximum service temperature tested at a pressure of at least 100 bar (see ISO 15001 or ASTM G63).

Lubricants used in the gas wetted area of valves for gases requiring oxygen pressure surge testing (see 5.9) shall either

1) be rated for

— at least p_{vt} in cases of single gases, or

— a pressure not less than the corresponding oxygen partial pressure in case of gas mixtures containing other oxidizing gases than air with a partial pressure greater than 30 bar, or

NOTE This rated pressure is the maximum pressure at which the lubricant passed the oxygen pressure surge test described in ISO 21010:2004, Annex C.

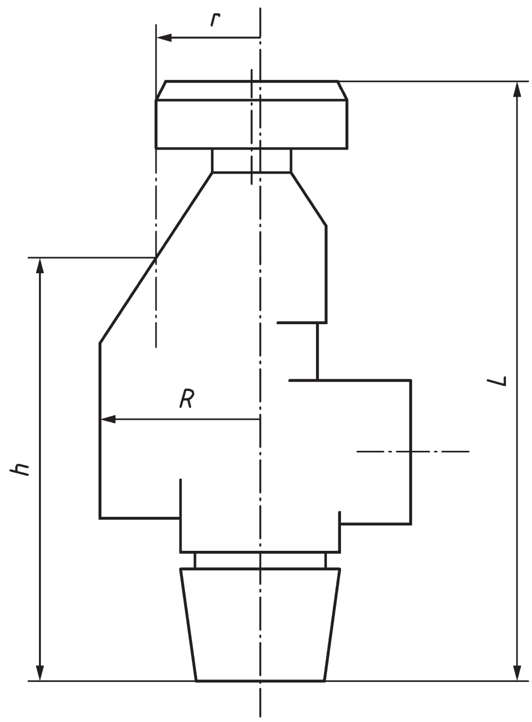
2) be permitted only if the corresponding valve passes the oxygen pressure surge test after being pre-conditioned via the endurance cycling procedure but without subsequent leak tightness tests and final visual examination being performed.

For medical and breathing applications ISO 15001 should be considered, especially when selecting materials to reduce the risk of toxic products of combustion/decomposition from non-metallic materials including lubricants.

5.3 Dimensions

For pin-index (post-type medical) valves in medical gas service (see Figure 8) the external dimensions shall be in accordance with the requirements of ISO 407.

If the valve is intended to be protected by a valve protection cap, the valve dimensions shall be such that the combination shall comply with the performance requirements of ISO 11117. For a valve to be used with a valve protection cap according to ISO 11117:2008, Figure 1, its external dimensions shall comply with the dimensions given in Figure 9.



Key

r ≤ 32,5 mm | *h* ≤ 90 mm

R ≤ 38 mm | *L* ≤ 125 mm

R shall be measured to the part of the valve furthest from the valve stem axis and includes any valve outlet plugs or caps if fitted

NOTE 1 *h* represents the length of the lower part of the valve when *R* is greater than *r*.

NOTE 2 *L* is the length of the valve in the closed position when not fitted to a cylinder.

NOTE 3 *r* relates to the axis of the valve inlet connection and not to the centreline of the valve operating device.

Figure 9 — Maximum dimensions for valves protected by a valve protection cap in accordance with ISO 11117:2008, Figure 1

5.4 Valve connections

Valve inlet and outlet connections shall conform to an International Standard, other regional or national standards or proprietary designs that have been qualified to an acceptable industry standard.

NOTE 1 International valve inlet connection standards are for example ISO 11363-1 and ISO 15245-1.

NOTE 2 International valve outlet connection standards are for example ISO 407, ISO 5145 and ISO 10692-1. A partial compilation of regional and national standards is given in ISO/TR 7470.

NOTE 3 Qualification procedures for proprietary valve inlet connection designs are for example given in ISO 10692-2.

NOTE 4 Qualification procedures for proprietary valve outlet connection designs are for example given in CGA V-1.

If the valve filling connection is separate to the valve outlet connection and not equipped with a non-return valve or isolating valve, it shall be provided with a pressure-tight device (e.g. a plug or cap which can be operated or removed only by the use of a special tool). Where applicable, such a pressure-tight device shall be designed to vent gas before becoming disengaged.

The valve filling connection non-return valve, if fitted, shall comply with the relevant requirements of ISO 22435 for industrial applications or ISO 10524-3 for medical applications.

NOTE 5 See ISO 5145 for examples of valve filling connections.

5.5 Mechanical strength

5.5.1 Resistance to hydraulic burst pressure

Valves shall withstand p_{vbt} (see 6.6.1) without permanent visible deformation or burst.

The hydraulic burst pressure test is given in 6.9.

5.5.2 Resistance to mechanical impact

Valves shall withstand a mechanical impact, if

a) used for cylinders with a water capacity greater than 5 l and not intended to be protected during transport by

   — a valve protection cap or a valve guard complying with ISO 11117, or

   — other means;

   NOTE Applicable transport regulations normally specify the variety of acceptable means.

b) used for cylinders of any water capacity where a valve guard is fixed only to the valve and not to the cylinder. The valve shall be tested without the valve guard fitted.

NOTE For valves used in cylinders with a water capacity less than 5 l, transport regulations might still require the valves to be inherently able to withstand damage without release of the contents or to be protected during transport.

Main valves during transport are adequately protected by the frame of the cylinder bundle, e.g. tested in accordance with ISO 10961; therefore no impact test is required.

Distortion due to impact is permissible. After being impacted, the closed valve shall withstand a hydraulic pressure test in the closed position only and an internal tightness test, each at p_{vt}. Leakage of gas through the threaded joint between the valve and the cylinder/test fixture is acceptable except if it results from cracks in the valve inlet connection. This shall be checked by applying p_{vt} through the valve inlet gas passage. In addition the test sample shall remain capable of being opened for emergency venting purposes by hand or by using a simple tool (e.g. a valve key) or actuating connector provided the opening torque, if relevant, does not exceed Tf, see Table 1.

The impact test is given in Annex A.

5.6 Valve operating mechanism

5.6.1 The valve operating mechanism shall meet the requirements of 5.6.2 to 5.6.6.

5.6.2 It shall be possible to open and close the valve at pressures up to p_{vt} (see 6.6.2) without using any additional equipment not recommended by the manufacturer. This shall be verified during endurance test, see 6.13.

It should be designed in such a way that the setting of the operating position of the valve cannot be inadvertently altered, i.e. if the valve is closed it should remain closed during normal service or normal transport.

5.6.3 The valve operating mechanism shall function satisfactorily after 2 000 opening and closing cycles with T_e according to Table 1 at p_{vt} according to 6.6.2 without replacement of the sealing system. For some valve designs T_e is allowed to be increased during the given cycles. For compression packed valves, if needed, adjustment of the packing nut according to the manufacturer's specification is permitted.

The number of cycles may be increased for certain designs necessary for special applications. This number of cycles shall be defined by the manufacturer on the basis of a specification from the customer or industry regarding the likely service conditions.

The endurance test is given in 6.13.

After the endurance test and the subsequent leak tightness tests have been performed a visual examination shall be carried out to ensure that no components are displaced (no longer in the place where it was installed), non-functional (e.g. broken) or missing.

The visual examination is given in 6.14.

5.6.4 The valve operating mechanism shall withstand T_o and T_f each according to Table 1.

At T_o the valve shall be able to work without noticeable difficulties. It shall not show any damage or failure of any component of the valve operating mechanism and/or valve operating device. This shall be checked by visual examination after dismantling the valve.

At T_f, the valve operating mechanism may be severely damaged and not operable. Mechanical failure shall occur prior to the valve operating mechanism unscrewing itself from the valve body and shall be in a manner that will not result in ejection of valve components. This shall be checked by visual examination.

The excessive torque tests are given in 6.11.

The tests are not applicable if an excessive torque cannot be applied, e.g. for lever operated valves or for valves with pneumatic actuator. For VIPR designs where the pressure regulating valve is acting as the main-shut off mechanism, test requirement and test procedure have to be decided on a case by case basis and agreed between the manufacturer and the test laboratory.

Table 1 — Torques to be used for the endurance test and excessive torque tests

Valve design as given in 4.3	**Valve seal/ seat**	**Valve operating device**	**Endurance torque** T_e (with a relative tolerance of $^{+10}_{0}$ %)	**Over torque** T_o	**Failure torque** T_f
O-ring gland seal valve and pressure seal valve and reverse seated valve	Non-metallic	Handwheel diameter D = 65 mm	7 Nm	20 Nm	25 Nm
		other handwheel diameters	D × 7/65	D × 20/65	1,25 × T_o
		Key/toggle[a]	T_o / 3	T_f / 1,25	T_f

NOTE 1 Standard industry practice is to apply a 7 Nm closing torque on commonly used 65 mm handwheel diameter valves during operation.

NOTE 2 There is a general consensus that a nominal maximum torque of 16 Nm can be achieved by hand with a 65 mm handwheel diameter.

[a] The determination of T_f and T_o is given in 6.11.3.

Table 1 *(continued)*

Valve design as given in 4.3	Valve seal/ seat	Valve operating device	Endurance torque T_e (with a relative tolerance of $^{+10}_{0}$ %)	Over torque T_o	Failure torque T_f
Diaphragm gland seal valve and compression packed gland seal valve	Non-metallic	Handwheel diameter D = 65 mm	$T_{e,start}$ = 7 Nm $T_{e,end}$ ≤ 10,5 Nm	20 Nm	25 Nm
		other handwheel diameters	$T_{e,start} = D \times 7/65$ $T_{e,end} \leq 1{,}5 \times T_{e,start} \leq 16$ Nm	$D \times 20/65$	$1{,}25 \times T_o$
		Key/toggle[a]	$T_{e,start} = T_o/3$ $T_{e,end} \leq 1{,}5 \times T_{e,start}$	$T_f/1{,}25$	T_f
O-ring gland seal valve and diaphragm gland seal valve and compression packed gland seal valve	Metal to metal	Handwheel diameter D = 65 mm	$T_{e,start}$ is to be specified by the manufacturer, but not less than $1{,}5 \times T_c$ and not less than 7 Nm $T_{e,end} \leq 1{,}5 \times T_{e,start} \leq 16$ Nm	20 Nm	25 Nm
		other handwheel diameters	$T_{e,start}$ is to be specified by the manufacturer, but not less than $1{,}5 \times T_c$ and not less than $D \times 7/65$ $T_{e,end} \leq 1{,}5 \times T_{e,start} \leq D \times 16/65$	$D \times 20/65$	$1{,}25 \times T_o$
		Key/toggle[a]	$T_{e,start} = T_c$ $T_{e,end} \leq T_o$	T_f/ 1,25	T_f

NOTE 1 Standard industry practice is to apply a 7 Nm closing torque on commonly used 65 mm handwheel diameter valves during operation.

NOTE 2 There is a general consensus that a nominal maximum torque of 16 Nm can be achieved by hand with a 65 mm handwheel diameter.

[a] The determination of T_f and T_o is given in 6.11.3.

If a valve design is not covered by Table 1, the valve manufacturer shall specify the torque values to be used for the tests and include them in the operating instructions.

5.6.5 For acetylene valves for gas cylinders, the valve operating mechanism shall be designed to permit the closure of the valve after exposure to an acetylene flashback.

The tests for acetylene valve are given in Annex B.

Acetylene main valves shall additionally be tested as a stop valve in accordance with ISO 15615:2013, Table A.1, for decomposition and internal gas tightness after decomposition if they are not intended to be protected by a flame arrestor, a flow cut-off device or both between the cylinders and the main valve.

VIPRs used in acetylene service shall additionally meet the requirements of the acetylene decomposition test described in ISO 22435.

5.6.6 Valves for gases requiring oxygen pressure surge testing should have a slow opening characteristic curve to avoid rapid pressure surge. For manually operated valves this can be achieved by a design which requires more than one turn to reach full flow capacity. It can also be achieved using flow limiting devices.

5.7 Valve operating device

If the valve operating device closes the valve by rotation this shall be in a clockwise direction except for certain VIPR designs where a combination (isolation and flow control) valve design is used. In these cases the VIPR may close in an anti-clockwise direction but must be clearly marked as such.

If a handwheel is used, D shall be chosen such that T_c can be achieved. This shall be verified using Formula (1).

$$D = \frac{T_c \times 65}{7} \qquad (1)$$

For manually operated valves the valve operating device shall be designed to permit the closure of the valve after exposure to a flame. Although the valve operating device may be damaged during the test, a manually operated valve shall still be possible to be closed by hand or using a simple tool after cooling. For other than manually operated valves it shall be verified that either the valve operating mechanism is still functioning (open/close) or that the valve is in the closed position.

The flame impingement test is given in 6.10.

5.8 Leakage

Unless otherwise stated (see Annex B for acetylene valves), the internal leakage shall not exceed 6 cm^3/h corrected to NTP over the range of pressures and temperatures specified in Table 3 and 4, with the valve operating mechanism in the 'fully closed' position.

NOTE The leakage of 6 cm^3/h is approximately 4 bubbles of 3,5 mm diameter per minute.

The torque required to close the valve and to meet the leakage requirements shall not be greater than $T_{e,end}$.

The total external leakage (typically comprising that from the valve external sealing system plus e.g. pressure relief device, residual pressure device, pressure indicating devices and pressure regulating or reduction system) shall not exceed 6 cm^3/h for a cylinder valve or main valve, or 12 cm^3/h for a VIPR, corrected to NTP over the range of pressures and temperatures specified in Table 3 and 4, with the operating mechanism in different positions between and including the 'fully open' and the 'fully closed' position, (see 6.12.3), if applicable.

NOTE For pure or toxic gases, lower permitted leakage rates may be agreed upon between manufacturer and customer. For electronic applications, the permitted leakage rates are typically 1×10^{-7} He atm cm^3/s.

The leak tightness tests are given in 6.12.

5.9 Resistance to ignition

To verify the resistance to ignition, an oxygen pressure surge test shall be carried out on valves used for:

a) oxygen at any pressure;

b) other oxidizing gases (as defined in ISO 10156) having a minimum valve test pressure of 30 bar;

NOTE 1 The threshold value of 30 bar was chosen to exclude specific oxidizing gases (e.g. chlorine) not requiring oxygen pressure surge testing based on minimum cylinder test pressures given in Packing Instruction P 200 of the UN Model Regulations.

c) gas mixtures, other than natural air or pre-mixed synthetic air, containing oxygen at any oxygen partial pressure or other oxidizing gases with a partial pressure greater than 30 bar.

The oxygen pressure surge test is not required if only metallic materials and lubricants rated for a pressure not less than p_{vt} are used in the oxygen wetted area of the valve.

If the valve is leaking (audible sound) during oxygen surge testing the test sample shall be considered to have failed the test.

The valve and its non-metallic components after being oxygen pressure surge tested shall undergo a visual examination and not show any traces of ignition (e.g. surface deterioration including change in surface texture and/or colour, material loss) and no components shall be displaced (no longer in place where it was installed) due to testing, non-functional (e.g. broken) or missing. It might be necessary to compare the tested sample with a non-oxygen tested sample from the other type tests.

The oxygen pressure surge test for valves without residual pressure device and for valves without integrated pressure regulator is given in Annex C.

The oxygen pressure surge test for VIPR shall be carried out according to ISO 22435 for industrial applications or ISO 10524-3 for medical applications.

The oxygen pressure surge test for valves with residual pressure devices shall be carried out according to ISO 15996.

NOTE 2 For common VIPR designs where a RPV is not installed in the valve filling connection the oxygen test of the RPV is already included in the oxygen test according to the applicable VIPR standard given above.

6 Type testing

6.1 General

6.1.1 To comply with this International Standard, valves shall be type tested.

A type test is valid for a given valve design (see 4.3).

6.1.2 Some changes within the valve design which could adversely affect valve performance require tests to be repeated using the number of test samples quoted in Table 3 including:

a) increase of valve test pressure (repetition of all tests except flame impingement test and excessive torque tests);

b) change in gas service (addition of oxygen pressure surge or acetylene tests, if intended for such service); In addition, the compatibility between each new gas or gas mixture and the used materials shall be verified;

c) changes of the valve body material (repetition of any tests to be decided case by case depending on changes of chemical composition and mechanical properties);

d) change of the handwheel material (repetition of endurance test with one test sample only without subsequent leak tightness tests but with visual examination of the handwheel and handwheel to spindle interface, excessive torque tests and flame impingement test);

e) decrease of the handwheel diameter [only possible if Formula (1) is satisfied and if the maximum closing torque needed to achieve leak tightness during earlier type testing can be achieved with the torque corresponding to the new reduced handwheel diameter which shall be calculated according to Table 1, repetition of excessive torque tests];

f) increase of the handwheel diameter (repetition of endurance test, subsequent internal leak tightness tests, visual examination and excessive torque tests);

g) changes of the basic design dimensions of the valve components [e.g. inner spindle diameter, spindle thread pitch, seat diameter, dimension of o-ring(s), diaphragm thickness] (repetition of tests to be decided case by case depending on the change);

h) changes of metallic material of the valve operating mechanism components (e.g. gland nut, spindle, diaphragm, springs) (repetition of tests to be decided case by case depending on the change);

i) changes of the valve filling connection gas passage geometry, e.g. diameter and flow impingement angles (repetition of oxygen pressure surge test, if intended for oxygen service, for the critical connection(s) only, to be decided case by case depending on the change);

j) changes of the thread and/or any dimension of the valve inlet connection (only repetition of impact test, if applicable and hydraulic test, to be decided case by case depending on the change and in addition oxygen pressure surge test for main valves for oxygen cylinder bundles); and

k) integration or removal of optional components like residual pressure device and non-return valve or functions like pressure reduction function (repetition of any tests to be decided case by case depending on the change). Integration or removal of a pressure relief device will not require any tests to be repeated.

6.1.3 Material variants within a valve design, e.g. for reasons of compatibility between gas and non-metallic material require repetition of only the relevant parts of the type test, using a reduced number of test samples for the leak tightness and endurance test.

The test samples for leak tightness tests and endurance test shall be:

a) if no material variants are specified, five test samples (nos. 7 to 11) of the basic valve design shall be tested (see Table 3);

b) if one material variant (a) is specified, three test samples (nos. 7, 8 and 9) of the basic specification and two test samples (nos. 10a and 11a) of the material variant shall be tested.

c) if two or more material variants (a, b, etc.) are specified, two test samples (nos. 7 and 8) of the basic specification and two test samples of each material variant (nos. 9a and 10a, 9b and 10b, etc.) shall be tested.

Examples of components which might constitute material variants include:

— o-ring/back-up ring;

— diaphragm;

— packing;

— seat insert;

— lubricant;

— spring;

— adhesives;

— thrust washer;

— gasket.

6.2 Documentation

The manufacturer shall make available, to the test laboratory:

a) a set of drawings consisting of the assembly drawing, parts list, material specifications including material standard for metallic materials and certificates (for the materials used for test samples), and drawings of sufficient details to comply with test sample verification (any change and/or material variant within the given valve design shall be clearly identified) including information about lubricants and adhesives, their approximate amounts and where they are applied;

b) information on markings;

c) a description of the valve and method of operation as well as minimum closing torque (T_c), specified torque value to be applied for the endurance test ($T_{e,start}$) and the intentional failure torque value (T_f) for the excessive torque tests, if applicable;

d) information on the intended use of the valve (gases and gas mixtures, valve working or test pressure, service temperatures if outside of the normal temperature range (see 5.1), use with or without valve protection, etc.);

   1) If the valve will be used without valve protection the maximum total package mass shall be defined.

   2) It shall be clearly indicated which gases and gas mixtures can be used with each valve material variant.

e) certificates of material compatibility, if not covered by ISO 11114-1 or ISO 11114-2.

6.3 Test samples

For valves designed to incorporate pressure relief devices their ports shall be plugged or sealed. Valves designed to incorporate pressure gauges or pressure indicators, shall have these devices fitted during type testing where their performance can influence the outcome of the test with the exception of the hydraulic burst pressure test.

The number of test samples for testing a valve design is given in Table 3. Additional test samples can be required for changes or for material variants within the valve design in accordance with the requirements of 6.1.

The test samples after being tested shall be rendered unserviceable or shall be clearly marked as test samples to avoid entering into service.

6.4 Test report

A written report shall be issued summarizing the tests carried out and the results obtained, and shall include or reference the documentation listed in 6.2 and, if applicable:

a) T_c as determined;

b) $T_{e,start}$ and $T_{e,end}$;

c) number of endurance cycles and service conditions, if greater than required;

d) pressure rise time determined during the oxygen pressure surge test and information on the cycles needed for its calibration; and

e) information on the applied (screwing) torque during impact test and number of protruding threads, if any;

f) vacuum conditions, as applied;

g) all relevant data for valve designs not covered by Table 1.

This report shall be signed by the responsible person(s) of the test laboratory.

6.5 Test temperatures

The test temperatures are given in Table 3.

6.6 Test pressures

6.6.1 Valve burst test pressure

For compressed gases, p_{vbt} is given by Formula (2)

$$p_{vbt} = 1,5 \times 1,5 \times p_w = 2,25 \times p_w \qquad (2)$$

For liquefied gases and acetylene, p_{vbt} is given by Formula (3):

$$p_{vbt} = 1,5 \times p_{vt} \qquad (3)$$

6.6.2 Valve test pressure

For compressed gases, p_{vt} is given by Formula (4):

$$p_{vt} = 1,2 \times p_w \qquad (4)$$

For liquefied gases, e.g. carbon dioxide, and acetylene, p_{vt} shall be at least equal to the minimum test pressure quoted in the relevant transport regulation for that gas or gas group. Where the transport regulation does not specify a minimum test pressure, the test pressure marked on the cylinder for which the valve is intended shall be used.

NOTE Regulations might require the valve test pressure to correspond with the valve outlet connection pressure rating.

6.7 Test gases

6.7.1 Gas quality

Gas quality shall correspond to Table 2.

Table 2 — Gas quality

Parameter	Oxygen	All other gases (including air)
Dew point ≤ −40 °C at atmospheric pressure [a]	Yes	Yes
Oil content ≤ 0,1 mg/m^3 [a]	Yes	Yes
Minimum purity ≥ 99,5 % by volume	Yes	No
Hydrocarbon content ≤ 0,01 % by volume	Yes	No
Maximum particle size ≤ 40 µm	Yes	Yes

[a] These values are identical to Class 2 requirements in ISO 8573-1:2010.

NOTE Standard industrial gases normally meet the above requirements.

6.7.2 Leak tightness tests

In general the leak tightness tests should be carried out with air or nitrogen. Helium, hydrogen or inert mixtures of these gases may be used alternatively if agreed between the manufacturer and the test laboratory.

For valves for helium, hydrogen or their mixtures, the test gas shall be helium, hydrogen or an inert mixture of these gases.

WARNING — Caution should be taken during handling and testing with hydrogen due to flammability risks. Proper training, procedures and precautions shall be in place prior to testing.

6.7.3 Endurance test

In general the endurance test should be carried out with air or nitrogen. Other gases may be used alternatively if agreed between the manufacturer and the test laboratory.

6.7.4 Oxygen pressure surge test

The oxygen pressure surge test shall be carried out with oxygen.

6.8 Test schedule

The tests shall be carried out in accordance with the schedule given in Table 3.

NOTE See Annex D for an example test schedule for a valve design with material variants.

Table 3 — Test schedule for type testing (valve design without material variants)

Test	Test and relevant subclause	Condition of test sample	Test temperature °C	Test pressure bar	Test sample number	Number of tests per sample	Total number of tests
1	Hydraulic burst pressure, 6.9	As received	Room temperature [a]	p_{vbt}	1	2	2
2	Flame impingement, 6.10	As received	Room temperature [a]	—	2	1	1
3	Excessive torque, 6.11	As received	Room temperature [a]	—	3 to 6	1	4
4	Internal/external leak tightness, 6.12	As received	Room temperature [a]	See Table 4	7 to 11 [b]	6 or 8 [e]	30 or 40 [b,e]
5	Endurance, 6.13	From test 4	Room temperature [a]	p_{vt}	7 to 11 [b,c]	1	5 [b,c]
6	Internal leak tightness, 6.12.2.3	From test 5	-40_{-5}^{0}	p_{vt}	7 to 11 [b]	3 or 4 [e]	15 or 20 [b,e]
7	Internal/external leak tightness, 6.12	From test 6	-20_{-5}^{0}	See Table 4	7 to 11 [b]	6 or 8 [e]	30 or 40 [b,e]
8	Internal/external leak tightness, 6.12	From test 7	$65_{-2,5}^{+2,5}$	See Table 4	7 to 11 [b]	6 or 8 [e]	30 or 40 [b,e]
9	Internal/external leak tightness, 6.12	From test 8	Room temperature [a]	See Table 4	7 to 11 [b]	6 or 8 [b,e]	30 or 40 [b,e]
10	Visual examination, 6.14	From test 9	Room temperature [a]	—	7 to 11 [b]	1	5 [b]
11 (if required, see 5.5.2)	Impact, Annex A	As received	Room temperature [a]	p_{vt}	12	1	1
12 (if required, see 5.6.5)	Acetylene hydraulic burst pressure, Annex B.1	As received	Room temperature [a]	909	13m to 15m	1	3

a Typically between 15 °C and 30 °C.

b For additional material variants, test sample numbers and number of tests will change (see 6.1 and Annex D).

c For valves required being pre-conditioned before oxygen pressure surge testing (see 5.2); three test samples in addition shall be tested.

d For metal-to-metal sealing valve designs and VIPR without separated valve operating mechanism this test need not be carried out, see Annex B.2.

e The number of tests per sample shall be 8 if vacuum testing is required. The total number of tests results to 30 without vacuum testing and to 40 if vacuum testing is required.

Table 3 *(continued)*

Test	Test and relevant subclause	Condition of test sample	Test temperature °C	Test pressure bar	Test sample number	Number of tests per sample	Total number of tests
13 (if required, see 5.6.5)	Acetylene seat leak tightness, Annex B.2 [d]	As received (without soft seal)	Room temperature [a]	p_{vt}	16m to 18m	1	3
14 (if required, see 5.9)	Oxygen pressure surge, Annex C	As received (for valves with lubricants rated for valve test pressure, see 5.2) or pre-conditioned via endurance cycling procedure (test 5) (for valves with lubricants not rated for valve test pressure, see 5.2)	See Annex C	p_{vt}	13n to 15n	1	3

a Typically between 15 °C and 30 °C.

b For additional material variants, test sample numbers and number of tests will change (see 6.1 and Annex D).

c For valves required being pre-conditioned before oxygen pressure surge testing (see 5.2); three test samples in addition shall be tested.

d For metal-to-metal sealing valve designs and VIPR without separated valve operating mechanism this test need not be carried out, see Annex B.2.

e The number of tests per sample shall be 8 if vacuum testing is required. The total number of tests results to 30 without vacuum testing and to 40 if vacuum testing is required.

6.9 Hydraulic burst pressure test

For VIPR this test does not cover the low pressure chamber.

NOTE 1 The pressure test for the low pressure chamber of VIPR is given in ISO 22435 or ISO 10524-3, respectively.

The burst pressure test shall be carried out consecutively on the same test sample in the following order:

a) the valve seat in closed position (valve outlet connection(s) opened); and

NOTE 2 This requirement is to meet transport regulation.

b) the valve seat in open position (valve outlet connection(s) closed and for VIPR the pressure regulator valve closed or held in the closed position), except for valves for acetylene, see Annex B. Valves equipped with actuators shall be opened according to the manufacturer's specification.

Water or another suitable liquid shall be used as test medium.

The hydraulic pressure shall be applied via the valve inlet connection and be raised continuously and gradually until at least p_{vbt} is reached. The pressure shall be maintained for at least 2 min with the hydraulic pump turned off.

For the test in the closed position it is permissible for the valve to leak through the seat at a pressure above p_{vt} but below p_{vbt} provided no parts are ejected.

6.10 Flame impingement test

The valve operating device of the test sample in the open position shall be exposed for 1 min $^{+5}_{0}$ s to a LPG blowpipe flame of approximately 150 mm length, such that the flame reaches a typical temperature of between 800 °C and 1 000 °C. The valve operating device shall be completely enveloped by the flame.

6.11 Excessive torque tests

6.11.1 General

If the valve is designed for an intentional failure mode at T_f, e.g. handwheel or spindle failure to occur at a value less than the valve given in Table 1, the manufacturer shall specify the intentional failure torque value and the test samples shall be tested at this stated value.

6.11.2 Handwheel operated valves

For handwheel operated valves a closing torque on one test sample shall gradually be increased to T_o according to Table 1. At T_o the valve shall be able to work without noticeable difficulties.

To determine T_f, a closing torque on a different test sample than used for the determination of T_o shall gradually be increased slowly until failure of any part of the valve operating mechanism or valve operating device occurs.

This test shall then be repeated on two other test samples under the same conditions, but applying an opening torque instead of a closing torque.

The value of T_f determined from applying a closing and an opening torque shall be not less than the value given in Table 1 or in case of an intentional failure mode, the value specified by the manufacturer.

6.11.3 Key/toggle operated valves

For key/toggle operated valves T_f first shall be determined using two test samples.

To determine T_f a closing torque on one test sample and an opening torque on a second test sample shall gradually be increased slowly until failure of any part of the valve operating mechanism or operating device occurs.

Then T_o shall be calculated on the basis of the lowest of these two failure torque values using the formula given in Table 1. This value of T_o shall be applied on two other test samples then used for the determination of T_f.

6.12 Leak tightness tests

6.12.1 General

Each internal and external leak tightness test temperature sequence (see Table 3) shall comprise the test pressures as given in Table 4 in increasing order for room and high temperature tests and decreasing order for −20 °C test.

NOTE This order was chosen to reflect normal cylinder operations.

Table 4 — Test pressures for leak tightness tests

Vacuum if required (e.g. by the manufacturer). An example of a vacuum test is given in Annex E.
0,5 bar
10 bar
p_{vt} (see 6.6.2)

Prior to the test the valves shall achieve the relevant test temperature as given in Table 3 and shall be maintained at that temperature throughout the complete test procedure.

After the valves are tested at low temperatures allow the test samples to naturally come to room temperature before applying high temperature to avoid temperature shocks between tests.

6.12.2 Internal leak tightness test

6.12.2.1 General

T_c shall be specified by the manufacturer and shall be verified by the test laboratory during the first leak tightness test (Test 4 according to Table 3).

The internal leak tightness shall be determined for each of the submitted test samples in accordance with 6.12.2.2 and 6.12.2.3.

6.12.2.2 Test at room and high temperature

The test shall be carried out in the following order:

a) Seal valve outlet connection(s).

b) Open the valve.

c) The pressure shall be applied to the valve inlet and be raised until the test pressure is reached.

d) Close the valve to the closing torque. For the leak tightness test carried out before the endurance test the closing torque is T_c. For the leak tightness test carried out after the endurance test the closing torque required to achieve tightness shall not be greater than $T_{e,end}$.

e) Open the valve outlet connection.

f) Wait at least 1 min before measuring the seat leakage rate.

NOTE Some valve designs require extended time before measuring the leak due to trapped air in the non-gas wetted area.

This test sequence shall be repeated for each test pressure given in Table 4. Before applying the next test pressure it is allowed to vent the valve.

6.12.2.3 Test at low temperatures

The test shall be carried out in the following order:

a) Seal valve outlet connection(s).

b) Open the valve.

c) The pressure shall be applied to the valve inlet and be raised until the test pressure is reached.

d) Close the valve to the closing torque. The closing torque required to achieve tightness shall not be greater than $T_{e,end}$. For the leak tightness test at −40 °C the valve shall be closed at room temperature before being cooled down [see f)].

e) Open the valve outlet connection.

f) For the leak tightness test at −40 °C the valve then shall be cooled down avoiding temperature shocks. It shall be ensured that after cooling the valve down it is at test pressure before measuring the leakage rate.

g) Wait at least 1 min before measuring the seat leakage rate.

NOTE Some valve designs require extended time before measuring the leak due to trapped air in the non-gas wetted area.

This test sequence shall be repeated for each test pressure given in Table 4 except for the test at −40 °C where only p_{vt} is required. Before applying the next test pressure it is allowed to vent the valve. To carry out the tests at −20 °C it is only necessary to raise the temperature without passing through room temperature.

6.12.3 External leak tightness test

The external leak tightness shall be determined for each of the submitted test samples in the following order:

a) Blank all existing openings of the valve except the one used to apply the test pressure.

b) Fully open the valve.

c) The pressure shall be applied to the selected opening and be raised until the test pressure is reached.

Measure the total leakage rate. In addition, except for diaphragm valve, the leakage rate shall be determined with the valve operating mechanism in two intermediate positions (e.g. approximately 2/3 and 1/3 of the ‘fully open’ position).

Wait at least 1 min before measuring the seat leakage rate.

This test sequence shall be repeated for each test pressure given in Table 4. Before applying the next test pressure it is allowed to vent the valve.

NOTE Some valve designs require extended time before measuring the leak due to trapped air in the non-gas wetted area.

6.13 Endurance test

An endurance test of 2 000 cycles (opening and closing) shall be carried out using T_e as given in Table 1 at p_{vt}. The valve inlet shall remain pressurized to p_{vt} throughout the entire test. The valve outlet shall be connected to a venting device that remains closed during the closing and opening portions of the cycle. After each closure, by opening the venting device, the pressure downstream of the valve seat shall be released to atmosphere to reach atmospheric pressure. For VIPR the pressure regulator shall be in the setting which allows maximum gas flow through the regulator seat when the VIPR will be vented.

For handwheel operated valves the valve shall be operated by the handwheel. Some valve designs require special operation of the handwheel to engage with the valve operating mechanism, e.g. valves with handwheels that incorporate a push to turn locking mechanism. With such valves it is permissible to override this mechanism or to carry out the endurance test manually.

For valves equipped with actuators, the test shall be conducted using the manufacturer’s recommended parameters, e.g. actuation pressure, voltage supplies.

For valves actuated with a lever the test shall be carried out by operating the lever through its full travel from closed to open. For some VIPR designs test requirement and test procedure have to be decided on a case by case basis and agreed between the manufacturer and the test laboratory.

T_e and the leakage (by pressure drop) shall be established immediately before commencing every cycle. If the pressure drop due to the valve leaking externally is greater than 10 bar, the valve has failed the test.

For some valve designs as given in Table 1 it is permitted to increase T_e during the test when the internal tightness is no longer achieved. For those designs, if the pressure measured at the high pressure transducer (key no. 4 of Figure F.1) after having vented the outlet is more than 5 bar, T_e shall be increased by nominal 10 % of the allowed torque range (range between T_e and $T_{e,end}$) or 0,5 Nm (whichever is the higher value) but in any case shall not be higher than $T_{e,end}$.

After each closure, by opening the venting device, the pressure downstream of the valve seat shall be released to atmosphere to reach atmospheric pressure.

The test equipment shall meet the requirements given in Annex F except if the test is carried out manually.

There shall be a pause of at least 6 s at each open and fully closed position.

For all subsequent tests, $T_{e,end}$ shall not be exceeded.

The test shall be performed at no more than three cycles per minute and no less than one cycle per 3 minutes. The manufacturer may specify a cycle rate within this allowed range.

6.14 Visual examination

When the endurance test and the subsequent leak tightness tests have been completed, components such as diaphragms, handwheel and handwheel to spindle interface, bellows and o-rings shall be subjected to a visual examination.

In case of a change of the handwheel material only the handwheel and handwheel to spindle interface shall be examined.

During the visual examination verification that the valve and its components correspond to the submitted set of drawings shall be carried out and recorded.

7 Marking

Valves complying with this International Standard shall be durably and legibly marked in service with:

a) coded identification of this International Standard:

   1) all valves shall be marked with “ISO V” except for the following;

   2) valves oxygen pressure surge tested for use as a main valve (see C.1) shall be marked with “ISO VB”;

b) manufacturer’s identification;

c) year and month (or week) of manufacture, i.e. YY/MM (or YY-WW) or YYYY/MM (or YYYY-WW);

d) identification of the valve inlet connection if it is not already required by the relevant inlet connection standard. This identification shall be given by a unique alphanumeric code such as that given in ISO/TR 11364;

e) identification of the valve outlet connection if it is not already required by the relevant outlet connection standard. This identification shall be given by a unique alphanumeric code identified by the manufacturer.

f) identification of the valve filling connection if separate to the valve outlet connection and if it is not already required by the relevant filling connection standard. This identification shall be given by a unique alphanumeric code identified by the manufacturer.

g) For valves meeting the requirement of 5.5.2, the maximum permitted total package mass for which the valve has been tested shall be marked (e.g. 70 kg).

h) If the valve operating device closes the valve operating mechanism by rotation in an anti-clockwise direction the closing direction shall be clearly marked.

Additional marking can be required for valves used in medical, breathing applications or upon request.

NOTE The relevant transport regulation might require additional marking.

Annex A
(normative)

Impact test

The test sample shall be tested in the closed condition (closed to $T_{e,start}$ in accordance with Table 1). The test sample shall be fitted into a steel gas cylinder neck equipped with the corresponding screw thread, or a similar test fixture made of steel (see Figure A.1). The valving procedure shall meet ISO 13341, other industry standards or be carried out according to manufacturers published installation procedures.

For taper threads the test sample shall be fitted using the minimum of all given torque values for the tested valve inlet connection or the minimum torque value specified by the valve manufacturer. For parallel threads the test sample shall be fitted using the maximum of all given torque values for the tested valve inlet connection or the maximum torque value specified by the valve manufacturer.

The test sample shall be struck by a plummet weight, tipped with a 13 mm diameter hardened steel ball. At impact the plummet weight and hardened steel ball assembly shall have a minimum velocity of 3 m/s and an impact energy (in Joules) numerically equal to at least 3,6 times the total package mass in kilograms, with a relative tolerance of ± 2,5 %, or (40 ± 1) J, whichever is the greater.

EXAMPLE A total package mass of 100 kg requires an impact test with 360 J.

The impact shall be at 90° to the longitudinal axis of the test sample and co-incident with a plane passing through the same axis.

The point of impact shall be two-thirds of the distance, L, from the plane where the valve inlet connection thread meets the cylinder (cylinder top) to the furthest point of the valve body, measured along the longitudinal (valve inlet connection) axis of the valve (see Figure A.1).

The point of impact at that location shall be chosen such that the weakest position of the valve body will be tested but shall not be obstructed by features such as outlet connecting threads, pressure-relief devices, handwheel, etc.

If the calculated point of impact for the test cannot be used (e.g. due to installed features/components or configuration of the valve body, e.g. “Y”-shaped cylinder valves), a different point of impact shall be chosen and a corrected impact energy value calculated and used.

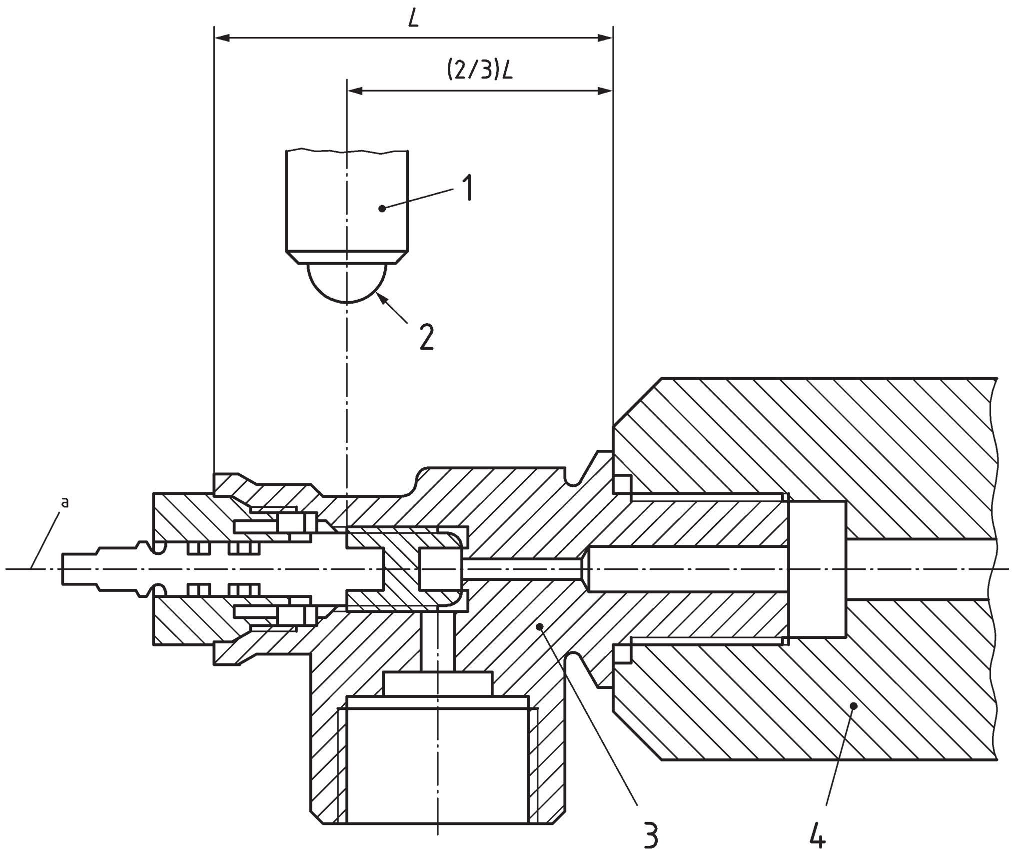
The test sample shall be struck once only.

After impact testing, the test sample may, if necessary, be removed from the cylinder or test fixture.

The valve shall be hydraulically pressure tested according to 6.9, but with p_{vt} and in the closed position only.

It shall be closed with T_0 in accordance with Table 1.

After the hydraulic pressure test an internal leak tightness test at room temperature with the test sample remaining in the closed position shall be carried out using p_{vt} only.



Key

1 plummet weight

2 hardened steel ball, diameter 13 mm

3 test sample

4 test fixture or cylinder

a Longitudinal axis.

Figure A.1 — Impact test fixture

Annex B
(normative)

Tests for acetylene valves

B.1 Hydraulic burst pressure test

The test shall be carried out on three test samples according to 6.9 but in the open position only using a minimum test pressure of 909 bar.

NOTE The test pressure is calculated as 26 bar absolute pressure × 35 (this represents a pressure multiplier that derives from an acetylene detonation plus reflection, see EIGA IGC 123/13), minus 1 bar (in order to consider gauge pressure as opposed to absolute pressure).

B.2 Seat leak tightness test

This particular test is specific for soft seal valve designs and need not be carried out for metal-to-metal sealing valve designs.

This test is not applicable to VIPR without separated valve operating mechanism.

The test shall be carried out on three test samples. The test samples shall be specially prepared by the manufacturer.

The soft seat assembly (lower spindle with soft seat) shall be as manufactured and then the soft seat shall be removed without damaging the seat holder e.g. subjecting the seat to a flame until completely consumed. The remaining seat holder is then assembled into a complete valve without any additional cleaning.

With the valve closed to a torque of maximum 12 Nm the internal tightness shall be determined according to 6.12.2 with p_{vt} only; the leakage of the test sample shall not exceed 50 cm^3/h.

Annex C
(normative)

Oxygen pressure surge test

C.1 General

All valves shall be tested via the valve filling connection.

If a valve is used in an application where it can be subjected to an oxygen pressure surge via additional connections the oxygen pressure surge test shall be carried out via all those connections.

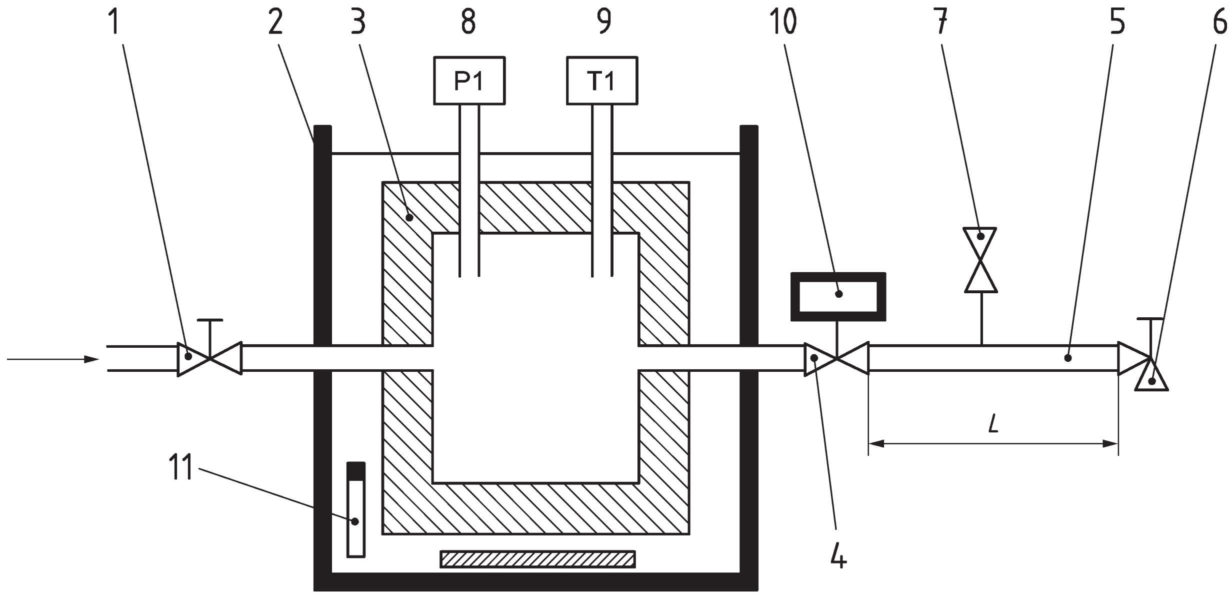
All main valves shall be tested via the valve filling connection and valve inlet connection.

In case lubricants used are not rated for the valve test pressure; the test samples shall be pre-conditioned via the endurance cycling procedure according to 6.13 (without subsequent leak tightness tests and visual examination) before being oxygen pressure surge tested, see 5.2.

C.2 Test installation requirements

Before testing the first test sample, the ignition test installation shall be checked for the required pressure rise (for example of test installation see Figure C.1, for pressure cycle specification and determination of pressure rise time see Figure C.2).

For this purpose a blank plug shall be used. The pressure gauge used for calibration purposes shall be placed on the connecting tube upstream of the blank plug.



Key

1 inlet valve

2 pre-heating device (e.g. water bath with electric heating)

3 oxygen high-pressure vessel

4 quick opening valve

5 connecting tube

6 test sample

7 depressurization valve

8 pressure gauge

9 temperature gauge

10 actuator

11 thermostat

L length of the connecting tube: *L* = 0,75 m (with a diameter of 14 mm) for main valves or *L* = 1 m (with a diameter of 5 mm) for cylinder valves

Figure C.1 — Example of an oxygen pressure surge test installation

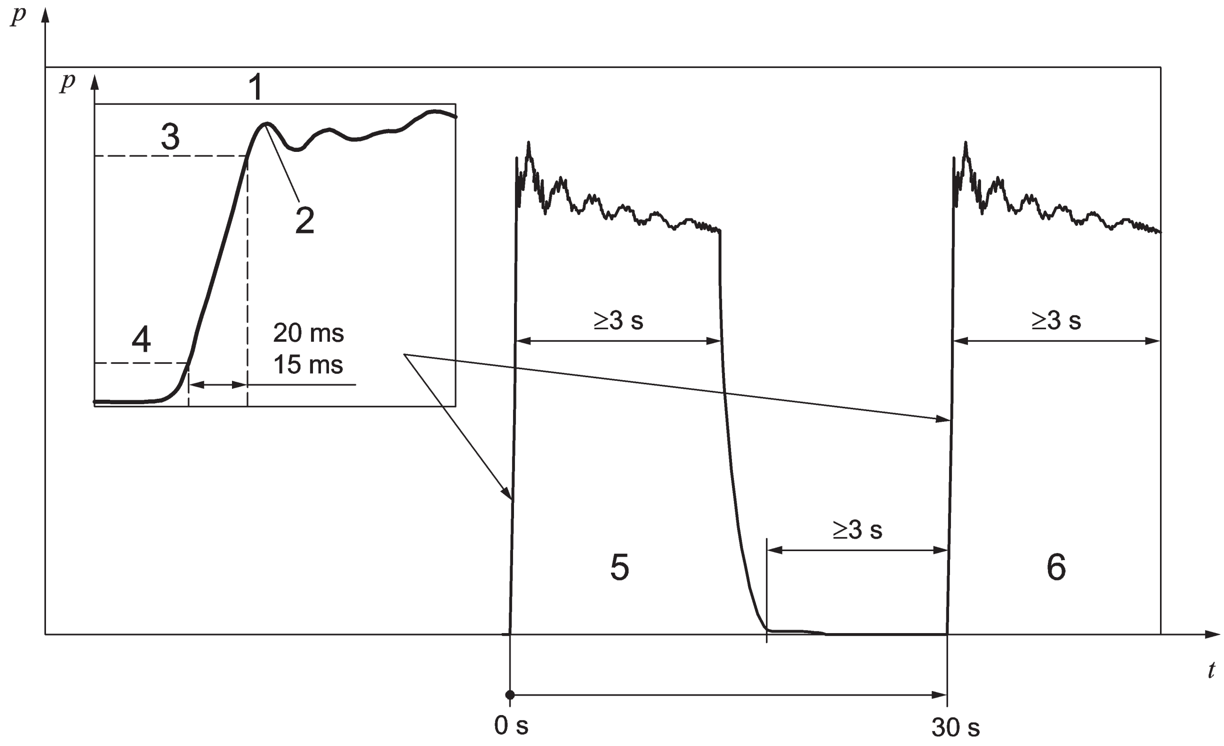
The pressure at the dead end of the tube (measured by a suitable pressure indicating device and recorded) shall be achieved within 20^{0}_{-5} ms. The pressure rise time shall be calculated from the time difference between where the pressure goes from 10 % of the first pressure peak to 90 % of the first pressure peak, see Figure C.2, or as an alternative where the pressure goes from 10 % of p_{vt} to 90 % of p_{vt} when the 14 mm diameter tube is used.

The first pressure peak shall not exceed 110 % of p_{vt}.

The actual pressure-time curve may exhibit a different wave form for each test laboratory. Stabilization time at p_{vt} is not fixed but shall be greater than or equal to 3 s. Before the next pressure surge, the system (test sample and connecting tube) shall be depressurized down to atmospheric pressure. Stabilization time at atmospheric pressure is not fixed but shall be greater than or equal to 3 s.

The total time of the pressure cycle shall be 30 s, as illustrated in Figure C.2. Total time is the time between the beginnings of two consecutive pressure surges.

For calibration purposes, heated oxygen at (60 ± 3) °C shall be used.



Key

t time, in s

p pressure, in bar

1 pressure rise time measurement for each test cycle

2 first pressure peak measured at start of each cycle

3 90 % of 1st pressure peak

4 10 % of 1st pressure peak

5 test cycle 1

6 test cycle 2

Figure C.2 — Determination of pressure rise time and pressure cycle specification

C.3 Test procedure

Each test shall be carried out as follows:

a) Supply oxygen at a temperature of (60 ± 3) °C, directly into the connection of the valve to be tested which shall be mounted in vertical position (if possible), by means of an oxygen compatible metallic tube having an internal diameter of 5 mm (or 14 mm for main valves) and a length of 1 m (or 0,75 m for main valves). The specified dimensions of the tube are essential in order to ensure that a well-defined energy input into the valve to be tested is achieved.

b) Perform two test sequences in accordance with Table C.1. The test sample shall be cooled down to at least room temperature at the start of each sequence.

Table C.1 — Test sequence for oxygen pressure surge

Test sequence	Valve operating mechanism	Connection to the cylinder
1	Closed	Open
2	Open	Sealed with a screwed metallic plug

c) The oxygen is heated to (60 ± 3) °C in the oxygen pre-heating device. A quick opening valve (see Figure C.1) controls the admittance of oxygen to the test sample. The test consists in subjecting the test sample to 20 pressure cycles from atmospheric to p_{vt} (see Figure C.2).

Before testing the next sample the filling adaptor shall be allowed to cool. It shall be visually examined for damage or worn seal and corrective action taken if necessary.

Annex D
(informative)

Example of test schedule

Table D.1 gives an example test schedule for one valve design with two additional different o-ring material specifications (material variants) and two additional different valve outlet connections.

The o-ring specifications are:

a) O_2 service — fluorocarbon (FPM);

b) C_2H_2 service — ethylene propylene diene monomer (EPDM);

c) N_2 service — nitrile butadiene rubber (NBR).

Table D.1 — Test schedule for type testing (basic valve design plus one design change [valve outlet connection] and one material variant within this valve design)

Basic design O_2 service with given valve outlet connection		Material variant C_2H_2 service with different o-ring material and different valve outlet connection		Material variant N_2 service with different o-ring material and different valve outlet connection	
Test according to Table 3	Test sample number	Test according to Table 3	Test sample number	Test according to Table 3	Test sample number
1	1	1	—	1	—
2	2	2	—	2	—
3	3 to 6	3	—	3	—
4	7 and 8	4	7a and 8a	4	7b and 8b
5	7 and 8	5	7a and 8a	5	7b and 8b
6	7 and 8	6	7a and 8a	6	7b and 8b
7	7 and 8	7	7a and 8a	7	7b and 8b
8	7 and 8	8	7a and 8a	8	7b and 8b
9	7 and 8	9	7a and 8a	9	7b and 8b
10	7 and 8	10	7a and 8a	10	7b and 8b
11	12	11	—	11	—
12	—	12	13m to 15m	12	—
13	—	13	13m to 15m	13	—
14	—	14	13m to 15m	14	—
15	13n to 15n	15	—	15	—

Annex E
(informative)

Example of a vacuum test

The test shall be carried out in the following order:

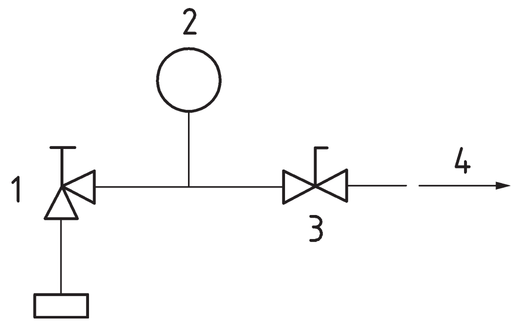
a) Block the valve inlet with a pressure-tight cap or plug.

b) Connect a vacuum pump via an appropriate pipe with a suitable vacuum gauge or transducer and display and an isolation valve to the valve outlet using the correct fitting for the valve outlet, see Figure E.1. It is recommended to make a blank test replacing the valve to be tested by a simple fitting connected on one end to the blank and the other end to the appropriate pipe in order to verify that there is no leak through the testing installation.

c) Set the valve in the half open position.

d) Apply vacuum to the valve and when the pressure within the valve measured by the vacuum gauge has reduced to the level specified by the manufacturer close the isolation valve to the vacuum pump.

e) Measure the leakage rate.



Key

1 test sample

2 vacuum gauge

3 isolation valve

4 to vacuum pump

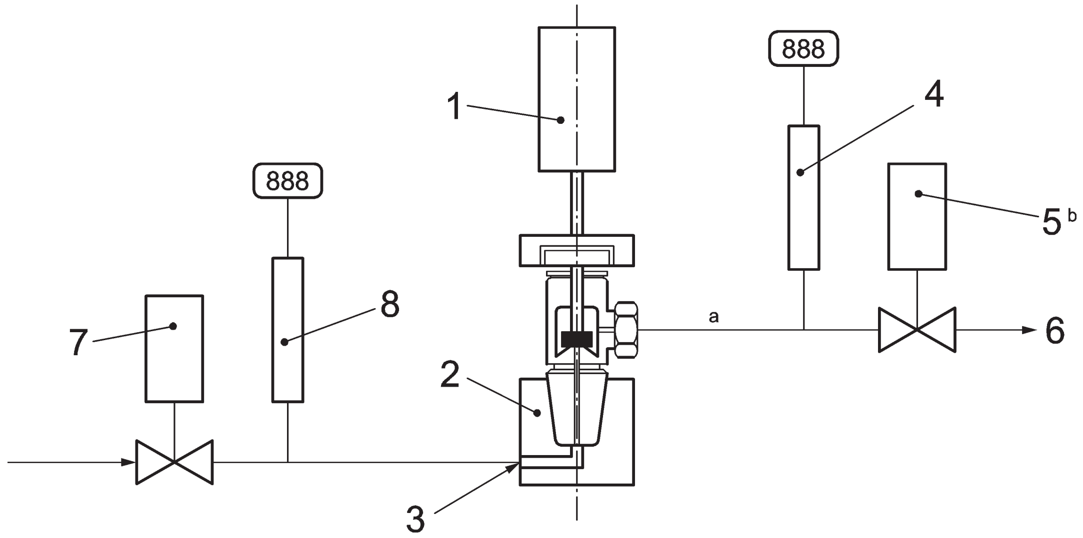
Figure E.1 — Test installation for the vacuum test

Annex F
(normative)

Endurance test machine

F.1 Typical arrangement

Figure F.1 shows a typical arrangement of a computer controlled test machine.



Key

1 DC motor with torque transmitter
2 test sample with adapter
3 input test medium
4 high pressure transducer with display
5 venting valve
6 outlet
7 valve
8 inlet high pressure transducer with display for monitoring of p_{vt}
a In closed position: From p_{vt} to atmospheric pressure. In open position: p_{vt}.
b In closed position: Sequence closed/open/closed. In open position: closed.

Figure F.1 — Typical arrangement of a computer controlled test machine

F.2 Requirements

F.2.1 Speed and application of torque

The test machine shall be able to open and close the test sample at a speed of between 10 r/min and 30 r/min.

At the end of the closing part of the test cycle, drift in torque due to dynamic effects shall be no more than 10 % of the set value.

F.2.2 Alignment

The test sample and the test machine spindles shall be aligned in such a way that no significant side or axial load is put on the valve during the test.

F.2.3 Verification

Verification of the test machine with regard to all test parameters to be controlled and measured such as torque and pressure shall be carried out before commencing and after completion of each endurance test.

F.2.4 Stroke of the endurance test

The test sample shall be cycled through its full stroke except that the valve spindle rotation shall be stopped 45° to 90° before the fully open position. This will ensure that the test machine does not apply torque in the fully open position.

F.2.5 Record

The test cycle shall be recorded automatically (e.g. as an illustration, see Figure F.2).

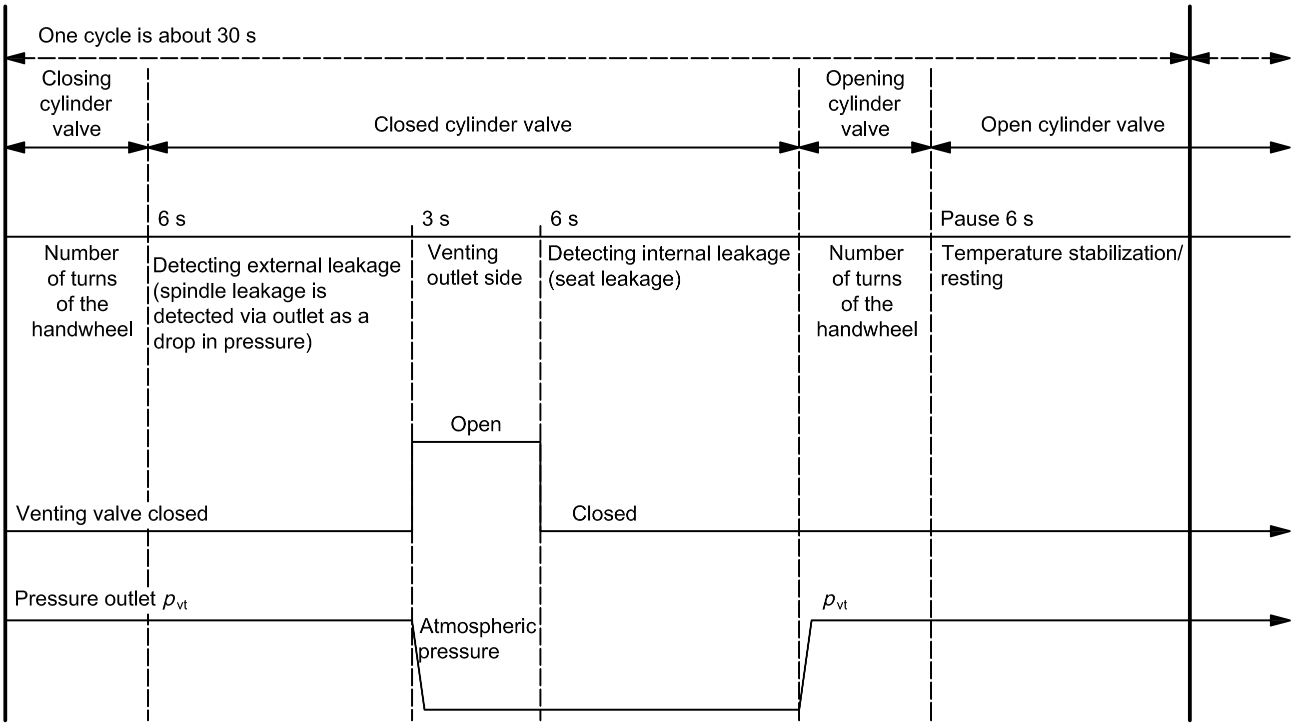


Figure F.2 — Diagram showing a typical cycle for the endurance test

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