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Gas cylinders — Ball valves — Specification and testing

Bouteilles à gaz — Robinets à boisseau sphérique — Spécifications et essais

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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 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 2, *Cylinder fittings,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 23, *Transportable gas cylinders,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document covers the function of a ball valve as a closure (defined by the UN Model Regulations[29]). It is possible that additional features of ball valves (e.g. pressure regulators, residual pressure devices, non-return devices, pressure relief devices) are covered by other standards or regulations.

Ball valves conforming to this document can be expected to perform satisfactorily under normal service conditions.

This document pays particular attention to:

a) safety (mechanical strength, impact strength, endurance, leak tightness, resistance to acetylene decomposition);

b) suitability of materials;

c) testing;

d) marking.

This document has been written so that it is suitable to be referenced in the UN Model Regulations[29].

In this document 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 document are given as gauge pressure (pressure exceeding atmospheric pressure) unless noted otherwise.

Tests and examinations performed to demonstrate conformity to this document shall be conducted using instruments calibrated before being put into service and thereafter according to an established programme.

Any tolerances given in this document include measurement uncertainties.

Gas cylinders — Ball valves — Specification and testing

1 Scope

This document specifies design, type testing, marking, manufacturing tests and examinations requirements for ball valves used as:

a) closures of refillable transportable gas cylinders, pressure drums and tubes;

b) main valves for cylinder bundles;

c) valves for cargo transport units [e.g. trailers, battery vehicles, multi-element gas containers (MEGCs)];

which convey compressed gases, liquefied gases and dissolved gases.

NOTE 1 In this document, the term "valve" is used with the meaning of "ball valve".

This document does not apply to ball valves for:

— oxidizing gases as defined in ISO 10156;

— toxic gases (i.e. gases listed in ISO 10298 having an LC_{50} value ≤ 5 000 ppm[1)]);

— acetylene for single gas cylinders, pressure drums and tubes.

NOTE 2 The reason for the exclusion of oxidizing gases is that the use of ball valves as closures of high-pressure cylinders for oxidizing gases is known to lead to specific ignition hazards that cannot reasonably be mitigated through the ball valve design or type testing. Safety hazards concern both the ball valve itself and any downstream equipment.

NOTE 3 The reason for the exclusion of acetylene for single gas cylinders, pressure drums and tubes is that the risk of an acetylene decomposition cannot reasonably be mitigated through the ball valve design or type testing.

This document does not apply to ball valves for liquefied petroleum gas (LPG), cryogenic equipment, portable fire extinguishers and cylinders for breathing apparatus.

NOTE 4 Requirements for valves for cryogenic vessels are specified in ISO 21011.

NOTE 5 Certain specific requirements for quick-release valves for fixed fire-fighting systems in addition to those that are given in this document are specified in ISO 16003.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 10286, *Gas cylinders — Vocabulary*

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

1) ppm = parts per million.

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 14246, *Gas cylinders — Cylinder valves — Manufacturing tests and examinations*

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

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

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
ball valve
valve which uses the rotation of a ball with a through-passage to allow or shut-off flow through it

Note 1 to entry: Ball valves can have multiple ports.

3.2
main valve
valve which is fitted to the manifold of a bundle, battery vehicle, battery wagon or MEGC isolating it from the main connection(s)

[SOURCE: ISO 10286:—[2)], 3.1.5.4]

3.3
valve operating mechanism
<ball valves> mechanism which rotates the ball and which includes the external sealing systems and can include the internal sealing systems

3.4
valve operating device
component which actuates the *valve operating mechanism* (3.3)

EXAMPLE Handle/lever, handwheel/knob, key or actuator.

[SOURCE: ISO 10297:2014, 3.3, modified — The example has been changed.]

3.5
stop mechanism
system which limits the position of the *valve operating mechanism* (3.3)

EXAMPLE Stop pin and stop plate, mechanical stop in valve body and counterpart in handle/lever.

2) Under preparation. Stage at the time of publication: ISO/FDIS 10286:2021.

3.6
external leak tightness
leak tightness to atmosphere (leakage in and/or leakage out) when the valve is open

[SOURCE: ISO 10297:2014, 3.4, modified — Note 1 to entry has been deleted.]

3.7
internal leak tightness
leak tightness across the seat (leakage in and/or leakage out) when the valve is closed

[SOURCE: ISO 10297:2014, 3.5, modified — Note 1 to entry has been deleted.]

3.8
valve working pressure
p_w
settled pressure of a compressed gas at a uniform reference temperature of 15 °C in a full pressure receptacle 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).

[SOURCE: ISO 10297:2014, 3.6, modified — "pressure receptacle" has replaced "gas cylinder or cylinder bundle" and Note 2 to entry has been deleted.]

3.9
valve burst test pressure
p_{vbt}
minimum pressure applied to a valve during hydraulic burst pressure test

[SOURCE: ISO 10297:2014, 3.7, modified — Note 1 to entry has been deleted.]

3.10
valve test pressure
p_{vt}
minimum pressure applied to a valve during testing

[SOURCE: ISO 10297:2014, 3.8, modified — Note 1 to entry has been deleted.]

3.11
lowest operating pressure
<ball valve> lowest settled pressure of the gas(es) for which the *ball valve* (3.1) is designed

3.12
endurance torque
T_e
torque used during the endurance test

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

[SOURCE: ISO 10297:2014, 3.11, modified — "torque used" has replaced "closing torque applied".]

3.13
over torque
T_o
torque applied to the *valve operating device* (3.4) in opening and closing direction which the *valve operating mechanism* (3.3) and/or *stop mechanism* (3.5) can tolerate and remain operable

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

[SOURCE: ISO 10297:2014, 3.12, modified — "torque" has replaced "opening or closing torque (whichever is the lower value)", "in opening and closing direction" has replaced "to determine the level of torque" and "and/or stop mechanism" has been added.]

3.14
failure torque
T_f
opening or closing torque (whichever is the lower value) applied to the *valve operating device* (3.4) at which mechanical failure occurs

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

[SOURCE: ISO 10297:2014, 3.13, modified — "at which mechanical failure occurs" has replaced "to obtain mechanical failure of the valve operating mechanism and/or valve operating device".]

3.15
valve inlet connection
connection on the valve which connects the valve to the pressure receptacle

[SOURCE: ISO 10297:2014, 3.16, modified — "pressure receptacle" has replaced "cylinder(s)".]

3.16
valve outlet connection
connection on the valve used to discharge the pressure receptacle

Note 1 to entry: For most valves, this connection is also used for filling.

[SOURCE: ISO 10297:2014, 3.17, modified — "pressure receptacle" has replaced "cylinder(s)".]

3.17
valve filling connection
connection on the valve used to fill the pressure receptacle

Note 1 to entry: The valve filling connection can be different from the *valve outlet connection* (3.16).

[SOURCE: ISO 10297:2014, 3.18, modified — "pressure receptacle" has replaced "cylinder(s)".]

4 Valve description

4.1 A ball valve (see Figure 1) typically comprises:

a) valve body;

b) valve operating mechanism;

c) valve operating device;

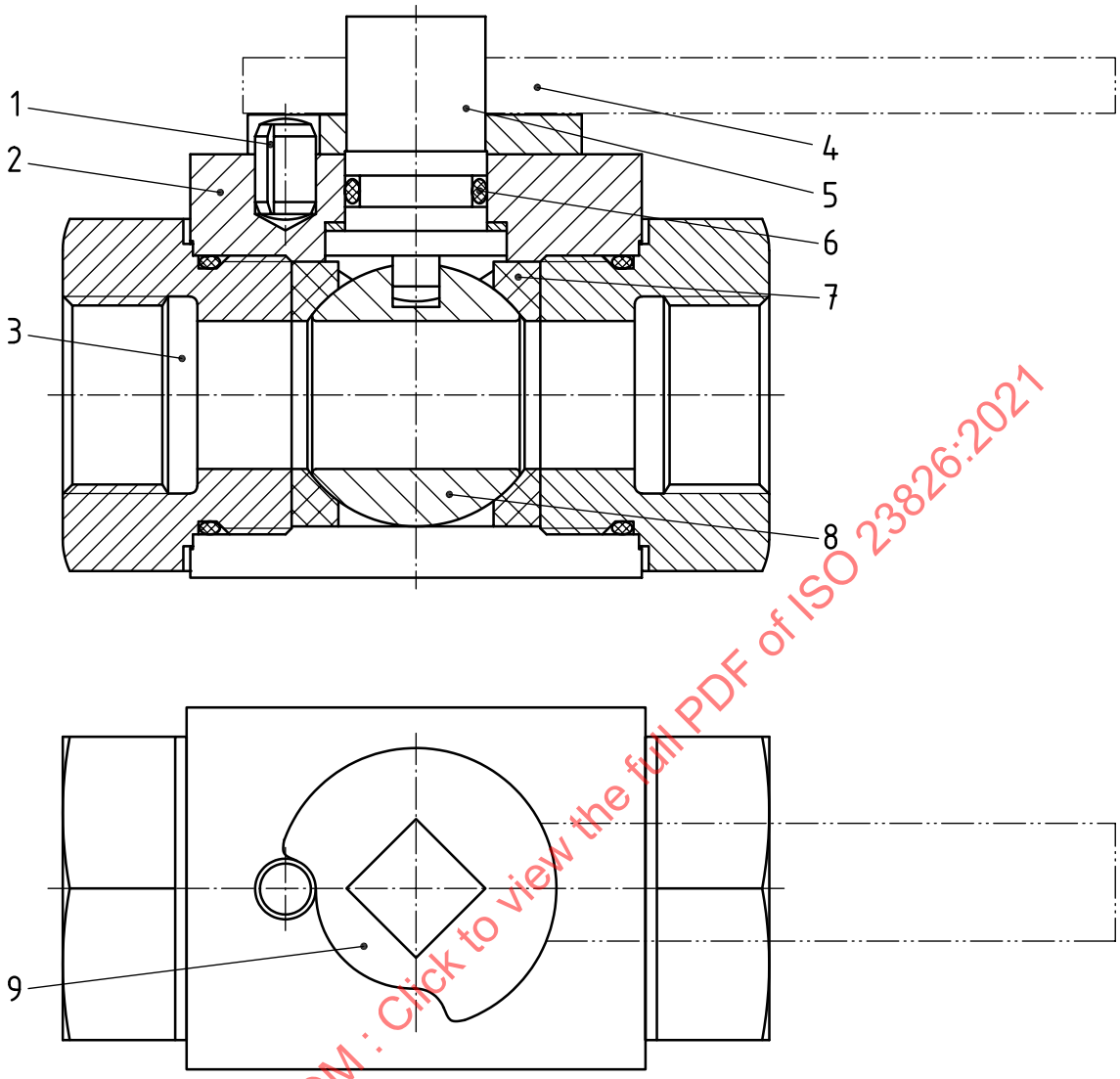
d) stop mechanism;

e) means to ensure internal leak tightness;

f) means to ensure external leak tightness;

g) valve outlet connection(s);

h) valve inlet connection.



Key

1	stop pin	6	stem sealing
2	valve body	7	seat
3	valve connection (inlet/outlet)	8	ball
4	handle/lever	9	stop plate
5	stem		

NOTE Stop plate and handle/lever can be combined in one component.

Figure 1 — Example of a ball valve design

4.2 Ball valves can also include:

a) pressure-relief device;

NOTE 1 The relevant transport regulation can require or forbid pressure relief devices for some gases, gas mixtures or gas groups. Additional requirements for pressure-relief devices can exist in international/regional regulations/standards.

b) dip tube;

c) 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;

NOTE 2 Requirements for residual pressure devices are given in ISO 15996.

g) pressure regulating device;

NOTE 3 Requirements for pressure regulating devices are given in ISO 22435 for industrial applications and in ISO 10524-3 for medical applications.

h) separate valve filling connection;

i) flow restricting orifice;

j) filter(s).

Not all of these components have test requirements detailed in this document.

4.3 There are typically two ball valve types:

a) floating ball type (see Figure 2);

b) trunnion type (see Figure 3).

The valve designs shown in Figures 2 and 3 are given as typical examples only.

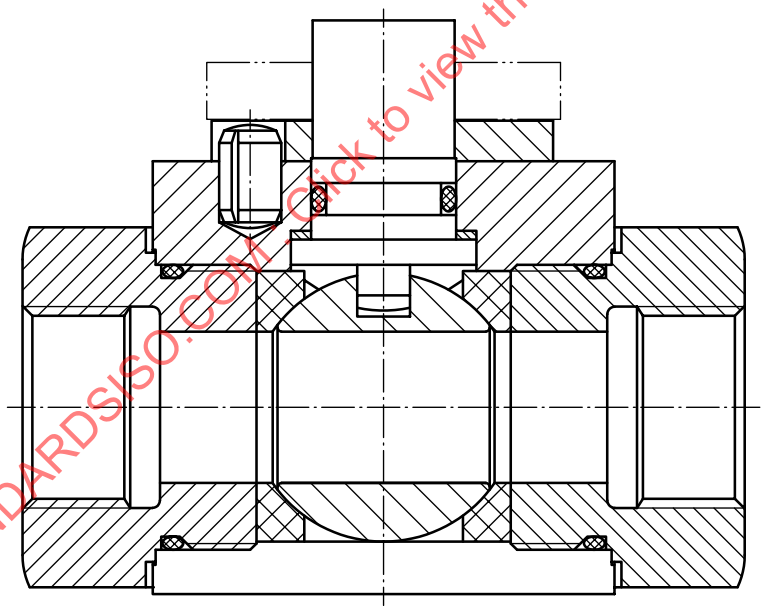


Figure 2 — Floating ball type design

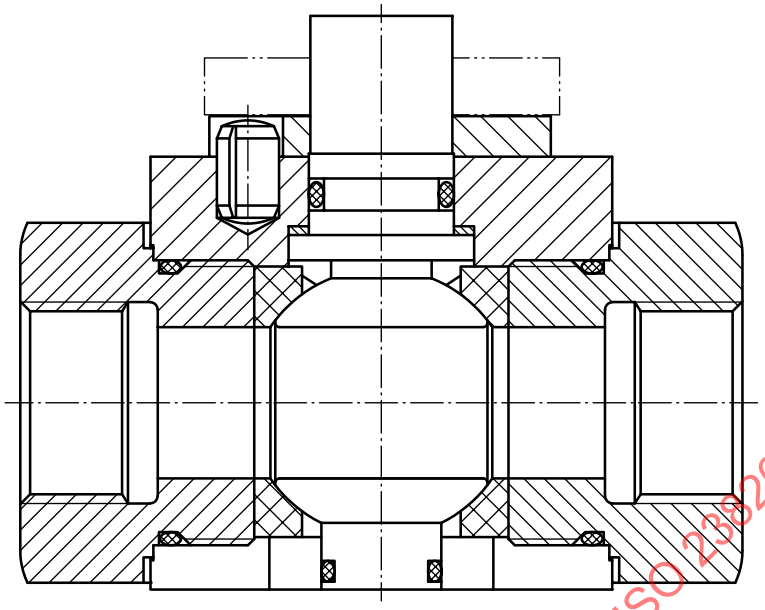


Figure 3 — Trunnion type design

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.

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

Additional testing at higher or lower service temperatures is contingent on specific agreements between the manufacturer and the purchaser.

Ball valves used in liquefied gas service shall incorporate a cavity relief system (e.g. a vent through the ball) to prevent trapping of the gas within the ball cavity in the closed condition.

For ball valves with multiple ports, the requirements according to 5.3 and 5.7 (internal leakage only) shall be fulfilled for each port.

For ball valves where anti-static and fire safe behaviour is of importance, examples of respective requirements are given in ISO 10497 and in EN 12266-2:2012, Annex B.

5.2 Materials

Metallic and non-metallic materials in contact with the gas shall be chemically and physically compatible with the gas, in accordance with ISO 11114-1 and ISO 11114-2 under all intended operating conditions.

The compatibility of the lubricant(s) and glue(s), if used in gas wetted areas, shall also be considered.

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 separation of the surface coating or particle generation.

The material used for the valve body shall be either:

a) a material not showing a ductile to brittle transition (examples of such materials are 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.

5.3 Valve connections

Valve inlet and outlet connections shall conform to:

— an International Standard; or

— regional or national standards; or

— proprietary designs that have been qualified to an acceptable industry standard.

NOTE 1 Valve inlet connection standards are, for example, ISO 11363-1, ISO 15245-1, ISO 228-1, ISO 6162-1, ISO 6162-2, ISO 11926-1 and ANSI/ASME B1.20.1.

NOTE 2 Valve outlet connection standards are, for example, ISO 5145, ISO 10692-1, ISO 228–1, ISO 6162-1, ISO 6162-2, ISO 11926-1 and ANSI/ASME B1.20.1. 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 closure device (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 proprietary tool provided by the manufacturer). Where applicable, such a pressure-tight device shall be designed to vent gas before becoming disengaged.

The valve filling connection closure device, if fitted, shall conform to the relevant endurance and subsequent leakage requirements of ISO 22435 for industrial applications or ISO 10524-3 for medical applications.

5.4 Mechanical strength

5.4.1 Resistance to hydraulic burst pressure

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

The hydraulic burst pressure test is given in 6.9.

5.4.2 Resistance to mechanical impact

This document does not include a test to validate that the valve is inherently able to withstand damage from impact without release of the contents.

NOTE Applicable transport regulations normally specify a variety of acceptable means to maintain the integrity of the pressure receptacle. For example, main valves used in cylinder bundles in accordance with ISO 10961 are protected by the frame.

5.5 Valve operating mechanism

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

5.5.2 The valve operating mechanism shall function satisfactorily without replacement of the sealing system after 2 000 opening and closing cycles at p_{vt} (see 6.6.2) using the endurance torque T_e to be specified by the manufacturer.

During movement from one end position to the other, the torque shall not exceed T_e.

For compression packed sealing design valves, if needed, adjustment of the packing nut according to the manufacturer's specification is permitted.

The number of cycles may be increased. 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 places where they were installed), non-functional (e.g. broken) or missing.

The visual examination is given in 6.14.

5.5.3 Manually operated valves shall withstand the over torque T_o according to Formula (1):

$$T_o = 2 \times T_e \quad (1)$$

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

Above T_o, any failure shall not result in ejection of internal valve components. After failure it shall still be possible to open and close the valve using the handle/lever or a simple tool. This shall be checked by visual examination or by hydraulically pressurizing the valve with p_{vt} if necessary.

The excessive torque tests are given in 6.11.

5.5.4 For ball valves used in acetylene service (if not excluded by the scope of this document), the valve operating mechanism shall be designed to permit the closure of the valve after exposure to an acetylene decomposition. Such valves shall therefore be tested for decomposition through the outlet as

a remotely actuated shut-off valve in accordance with ISO 15615:2013, Table A.1, at 25 bar only. Internal gas tightness shall be tested after decomposition, also following ISO 15615:2013, Table A.1.

Valves with integrated pressure regulators (VIPRs) based on a ball valve design, used in acetylene service, shall additionally meet the requirements of the acetylene decomposition test described in ISO 22435. For such VIPRs, the hydraulic burst pressure test given in 6.9 is not required.

NOTE It is assumed that mechanical strength is already validated by the acetylene decomposition test.

5.6 Valve operating device

5.6.1 For manually operated valves, the open and closed positions of the valve shall be indicated on the valve operating device or the valve body.

5.6.2 For manually operated valves, the connection between the valve operating device and the valve operating mechanism 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 after the connection between the valve operating device and the valve operating mechanism being exposed to a flame, 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.

5.7 Leakage

Unless otherwise specified, the internal leakage shall not exceed:

— 6 cm^3/h for a valve having an internal nominal diameter of 13 mm or less;

— 12 cm^3/h for a valve having an internal nominal diameter of more than 13 mm.

over the range of pressures and temperatures specified in Tables 3 and 4, with the valve operating mechanism in the closed position.

NOTE 1 The leakage of 6 cm^3/h is approximately four bubbles of 3,5 mm diameter per minute.

The total external leakage (typically comprising that from the valve external sealing system plus, for example, pressure relief device, residual pressure device, pressure indicating devices and pressure regulating or reduction system) shall not exceed 6 cm^3/h over the range of pressures and temperatures specified in Tables 3 and 4, with the valve in the open position.

For high purity gases, lower permitted leakage rates may be agreed upon between the manufacturer and the customer.

NOTE 2 For electronic applications, the permitted leakage rates are typically 1×10^{-7} He mbar·l/s.

The leak tightness tests are given in 6.12.

5.8 Securing arrangements

In order to prevent uncontrolled release of cylinder contents, every ball valve shall offer a means to prevent inadvertent opening.

This means shall be either:

— a removable valve operating device; or

— a securing means (e.g. pin or mechanical interlock).

No such means shall interfere with the normal closing operation of the valve.

5.9 Manufacturing tests and examinations

Manufacturing tests and examinations shall be carried out in accordance with ISO 14246 with the following exceptions:

a) the leak rate for the internal leak tightness test is given in 5.7;

b) for the leak tightness test, no specific torque is required to close the valve.

6 Type testing

6.1 General

6.1.1 To conform to this document, valves shall be type tested according to Table 3. A type test is valid for a given valve design.

6.1.2 Some changes to the valve design which can adversely affect valve performance require tests to be repeated using the number of test samples quoted in Table 3 (unless otherwise specified) according to Table 1.

Table 1 — Tests required after changes to the valve design

	Hydraulic burst pressure	Flame impingement	Excessive torque	Internal/external leak tightness before endurance	Endurance	Internal/external leak tightness after endurance	Visual examination	Acetylene decomposition test	Endurance of the valve filling connection closure device
Increase of valve test pressure p_{vt}	x			x	x	x	x		x
Increase of endurance torque			x	x	x	x	x		
Change in gas service[a]								x[b]	
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.								
Change of the material of the stop mechanism		x	x		x[c]				
Change of the type of the valve operating device		x	x		x[c]				
Change of the material of the valve operating device		x	x		x[c]		x		
Change of a dimension of the valve operating device	Repetition of tests to be decided case by case depending on the change. Change of the length of the handle/lever will not require any tests to be repeated.								
Changes of the nominal passage diameter	x		x	x	x	x	x	x	
Changes of metallic material of the valve operating mechanism components (e.g. stem, ball)	x	x	x	x	x	x	x	x	
Changes of the thread and/or any dimensions of the valve connection	x[d]								
Integration or removal of optional components such as residual pressure device and non-return valve or functions such as pressure reduction function	Repetition of any tests to be decided case by case depending on the change. Removal of a pressure relief device will not require any tests to be repeated. Integration of a pressure relief device will require repetition of hydraulic burst pressure test only.								

[a] The compatibility between each new gas or gas mixture and the used materials shall be verified.

[b] If intended for acetylene service.

[c] With one test sample only, without subsequent leak tightness tests and visual examination.

[d] To be decided case by case depending on the change. For proprietary connections, see NOTE 3 and NOTE 4 of 5.3.

In case that more than one of the changes listed above is applied during the same design change, tests may be combined.

6.1.3 Material variants within a valve design other than those specified in Table 1, e.g. for reasons of compatibility between gas and 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 the 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 can constitute material variants include:

— o-ring/back-up ring;

— packing;

— seat;

— lubricant;

— spring;

— adhesives.

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) for actuator operated valves, the manufacturer's specification of the actuator;

c) information on markings;

d) a description of the valve and method of operation as well as T_e;

e) 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) and lowest operating pressure] – it shall be clearly indicated which gases and gas mixtures can be used with each valve material variant;

f) 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 referencing this document including its year of publication 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) number of endurance cycles and service conditions, if greater than required in this document;

b) vacuum conditions, as applied.

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) based on the valve working pressure p_w:

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

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

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

For acetylene, p_{vbt} is 909 bar.

6.6.2 Valve test pressure

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

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

For liquefied gases, e.g. carbon dioxide, and acetylene, p_{vt} shall be at least equal to the minimum test pressure of the pressure receptacle or cargo transport unit for that gas or gas group. Minimum values can be found in the relevant transport regulation. Where a minimum test pressure is not specified, the test pressure marked on the pressure receptacle or cargo transport unit for which the valve is intended shall be used or the manufacturer shall specify p_{vt}.

NOTE Transport regulations can 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 meet the requirements specified in Table 2.

Table 2 — Gas quality

Parameter	Requirement
Dew point	≤ −40 °C at atmospheric pressure[a]
Oil content	≤ 0,1 mg/m^3[a]
Maximum particle size	≤ 40 µm
[a] These values are identical to Class 2 requirements in ISO 8573-1:2010.	
NOTE 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 for the tightness tests after the endurance test shall be a choice of helium, hydrogen or an inert mixture of these gases.

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

6.7.3 Endurance tests

In general, the endurance tests should be carried out with air or nitrogen. Alternatively, other gases may be used if agreed between the manufacturer and the test laboratory.

6.8 Test schedule

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

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

Test no	Applicability	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	Not for VIPR for acetylene service	Hydraulic burst pressure, 6.9	As received	Room temperature[a]	p_{vbt}	1 (3 for valves for acetylene service[d])	1	1 (3 for valves for acetylene service)
2	All valves	Flame impingement, 6.10	As received	Room temperature[a]	—	2	1	1
3	See 5.5.4	Excessive torque, 6.11	As received	Room temperature[a]	—	3 to 6	1	4
4	All valves	Internal/external leak tightness, 6.12	As received	Room temperature[a]	See Table 4	7 to 11[b]	6 or 8[c]	30 or 40[b,c]
5	All valves	Endurance, 6.13	From test 4	Room temperature[a]	p_{vt}	7 to 11[b]	1	5[b]
[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).								
[c] The number of tests per sample shall be 2 or 8 if vacuum testing is required. The total number of tests results to 10 or 40 if vacuum testing is required.								
[d] The three samples in case of acetylene service are identified as 1a, 1b and 1c.								

Table 3 *(continued)*

Test no	Applicability	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
6	All valves	Internal leak tightness, 6.12.2.3	From test 5	-40^{0}_{-5}	p_{vt}	7 to 11[b]	1 or 2[c]	5 or 10[b,c]
7	All valves	Internal/external leak tightness, 6.12	From test 6	-20^{0}_{-5}	See Table 4	7 to 11[b]	6 or 8[c]	30 or 40[b,c]
8	All valves	Internal/external leak tightness, 6.12	From test 7	$65^{+2,5}_{-2,5}$	See Table 4	7 to 11[b]	6 or 8[c]	30 or 40[b,c]
9	All valves	Internal/external leak tightness, 6.12	From test 8	Room temperature[a]	See Table 4	7 to 11[b]	6 or 8[b,c]	30 or 40[b,c]
10	All valves	Visual examination, 6.14	From test 9	Room temperature[a]	—	7 to 11[b]	1	5[b]
11	See 5.5.4	Acetylene decomposition test, ISO 15615:2013	As received	Ambient temperature	25 bar	12 to 17	1	6
12	See 5.5.4	Acetylene decomposition test for VIPRs, ISO 22435	As received	Ambient temperature	25 bar	18 to 20	1	6
13	See 5.3	Endurance of the valve filling connection closure device, ISO 22435 or ISO 10524-3	As received	Room temperature[a]	p_{vt}	21 to 23	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).

[c] The number of tests per sample shall be 2 or 8 if vacuum testing is required. The total number of tests results to 10 or 40 if vacuum testing is required.

[d] The three samples in case of acetylene service are identified as 1a, 1b and 1c.

6.9 Hydraulic burst pressure test

The burst pressure test shall be carried out with the valve in the open position (valve outlet/filling connection(s) plugged and for VIPR the pressure regulator valve closed or held in the closed position). 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 by hydraulic pump (if necessary) for at least 2 min.

6.10 Flame impingement test

The connection between the valve operating device and the valve operating mechanism 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 area of the connection shall be completely enveloped by the flame.

6.11 Excessive torque test

For manually operated valves, a closing torque on one test sample shall gradually be increased to T_o.

In case of a handle/lever, the force corresponding to T_o shall be applied as near to the end of the handle/lever as practically possible.

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

In case of a handle/lever, the force corresponding to T_f shall be applied as near to the end of the handle/lever as practically possible.

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.

6.12 Leak tightness test

6.12.1 General

Each internal and external leak tightness test temperature sequence (see Table 3) shall comprise the 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 — Pressures for leak tightness tests

Condition	Pressure to be applied bar
If required by the manufacturer (based on application). An example of a vacuum test is given in ISO 10297:2014, Annex E.	Vacuum
If required by the manufacturer (based on application)	(0,5 ± 0,1) bar
Mandatory	Lowest operating pressure ± 0,3 bar
Mandatory	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

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 appropriate pressure as specified in Table 4 is reached.

d) Close the valve to the closing position. For manually operated valves, the torque required to close the valve shall not exceed T_e.

e) Open the valve outlet connection.

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

g) For bi-directional valves, repeat a) to f) in the other direction.

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

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 appropriate pressure as specified in Table 4 is reached.

d) Close the valve to the closing position. For manually operated valves, the torque required to close the valve shall not exceed T_e. 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.

h) For bi-directional valves, repeat a) to g) in the other direction.

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

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) Open the valve to the opening position.

c) The pressure shall be applied to the selected opening and be raised until the appropriate pressure as specified in Table 4 is reached.

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

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 gas in the non-gas wetted area.

6.13 Endurance test

An endurance test of 2 000 cycles (opening and closing) shall be carried out 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.

A manually operated valve shall be tested with either the valve operating device or an adaptor of the same material and dimensions to replicate the stop mechanism used in service.

NOTE The test does not qualify the valve operating device, but the stop mechanism. The valve operating device qualification is part of the excessive torque test.

Some manually operated valve designs require a special operation (e.g. deactivating a securing arrangement) of the valve operating device to engage with the valve operating mechanism. With such valves it is permissible to override this mechanism or to carry out the endurance test manually.

The test shall be carried out by operating the valve through its full movement from closed to open within a maximum of 3 s. For an actuator operated valve, the test shall be carried out using the manufacturer's recommended parameters, e.g. actuation pressure and voltage supplies. For manually operated valves, a torque of not more than the endurance torque T_e shall be applied during opening and closing including impact with the stop pin. During every cycle it has to be verified that T_e ($\frac{+0}{-5}$ %) is reached at each end position.

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

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 A except if the test is carried out manually.

There shall be a pause between 3 s to 12 s at each open and fully closed position. The manufacturer shall specify a pause within this allowed range. Under exceptional circumstances due to temperature rise, this pause may be extended by agreement between the manufacturer and test laboratory.

6.14 Visual examination

When the endurance test and the subsequent leak tightness tests have been completed, components such as ball, seat, stem, stem sealing, stop mechanism and valve operating device (or adapter) shall be subjected to a visual examination.

If necessary, possible rejection of valve components shall be checked by hydraulically pressurizing the valve with p_{vt}.

In case of a change of the material of the valve operating device, only the valve operating device to stem interface and the valve operating device itself 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 conforming to this document shall be durably and legibly marked in service with:

a) coded identification of this document, i.e. "ISO B" where a leak tightness test at 0,5 bar was carried out and "ISO B1" where no leak tightness test at 0,5 bar was carried out (see Table 4);