INTERNATIONAL STANDARD

ISO 28921-2

First edition
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Industrial valves — Isolating valves for low-temperature applications —

Part 2:
Type testing

Robinetterie industrielle — Robinets d'isolement pour application à basses températures —

Partie 2: Essais de type

Reference number
ISO 28921-2:2015(E)

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Foreword

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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).

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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 Technical Committee ISO/TC 153, *Valves*, Subcommittee SC 1, *Design, manufacture, marking and testing*.

ISO 28921 consists of the following parts, under the general title *Industrial valves — Isolating valves for low-temperature applications*:

— *Part 1: Design, manufacturing and production testing*

— *Part 2: Type testing*

Industrial valves — Isolating valves for low-temperature applications —

Part 2: Type testing

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This International Standard does not purport to address all of the safety issues, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory requirements.

1 Scope

This part of ISO 28921 specifies requirements for the type testing of isolating valves for low-temperature applications to verify the performance of valves at a low temperature from – 50 °C down to – 196 °C.

NOTE Nominal sizes (DN), nominal pipe sizes (NPS), nominal pressure (PN) and Classes are covered in ISO 28921-1.

This part of ISO 28921 does not evaluate valve actuators unless they are integral part of the valve. Valves during testing can be operated manually or an actuator can be used during the testing. The effect of cold gas vapours during testing is taken into consideration in particular if the actuator is mounted directly over the test stand with the cold gases engulfing the actuator.

This part of ISO 28921 does not apply to valves for cryogenic services, designed in accordance with ISO 21011, used with cryogenic vessels.

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 5208, *Industrial valves — Pressure testing of metallic valves*

ISO 28921-1, *Industrial valves — Isolating valves for low-temperature applications — Part 1: Design, manufacturing and production testing*

ASME B31.3, *Process Piping*

EN 13480-2, *Metallic industrial piping — Part 2: Materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 28921-1 and the following apply.

3.1
symmetric seated valve
valve with an internal construction which has a plane of symmetry perpendicular to the axis of the body ends

Note 1 to entry: This is a valve where both seat sealing elements are identical.

3.2
asymmetric seated valve
valve with an internal construction which has no plane of symmetry perpendicular to the axis of the body ends

Note 1 to entry: This is a valve with a single seat offset from the shaft centreline.

3.3
design family
valves of the same type for which the basic design for the outside pressure retaining envelope, in particular the body construction, is the same design for all sizes of the valve range and the same stem movement

Note 1 to entry: Valves of the same type include, for example, gate, globe, ball valves.

Note 2 to entry: Examples of body construction include one piece, two piece or three piece body, bonnet extension.

Note 3 to entry: Examples of stem movement include raising and not rotating.

Note 4 to entry: Valves are considered to be of the same design family if they can all be depicted on one dimensionless cross-sectional drawing, with all the external dimensions added in a table on the same drawing.

3.4
cold working pressure
CWP
maximum fluid pressure assigned to a valve for operation at a fluid temperature up to 38 °C

3.5
operational cycle
motion of the stem that moves a valve obturator from the fully closed position to the fully open position and returns to the fully closed position

Note 1 to entry: For check valves, an operational cycle is when the obturator moves from the closed position to open and back to the closed position.

4 Test conditions

4.1 Valve selection

Inspection and testing under this part of ISO 28921 shall be carried out on a randomly selected production valve of a design family and of a particular material of construction. Size selection shall be at mid-range of the design range, the valve PN or Class shall be selected so that it qualifies all valves of the same PN or Class and all valves of the lower PN or Class as long as the valves are of an identical design. Valves of the same design family and the same materials of construction tested at lower temperature qualify valves for applications at higher temperatures up to ambient temperature.

NOTE The mid-range valve size selected for testing varies with the size range available from the valve manufacturer. For example, if the valve offering of a particular valve design is DN 50, DN 65, DN 80, DN 100, DN 150 and DN 200 or NPS 2, NPS 2 ½, NPS 3, NPS 4, NPS 6 and NPS 8, the mid-range valve selected for testing is DN 80 or DN 100, and for NPS valves, it is NPS 3 or NPS 4. Either of the two sizes is acceptable. Alternatively, the size to be tested can be decided by an agreement between the manufacturer and the purchaser.

4.2 Testing criteria and selection of valve design

4.2.1 General

The test valve submitted for this type test shall be subjected to:

— 200 operational cycles for on-off valves;

— three operational cycles only, for check valves.

4.2.2 Representative valve design selection

Valve selected for this type testing shall be representative for each design family of the valve type (e.g. gate, globe, ball valve) and closure member type (e.g. single seated, double seated, unidirectional, bi-directional).

The test valve shall be of the same design as the other valves covered by this type test as far as the body and bonnet configuration is concerned (e.g. one piece or multiple piece body construction, integral or bolted on bonnet and the same gaskets types between those valve parts).

4.2.3 Selection and qualification of sealing elements

The pressure retaining seals and packing in the test valve shall be of the same design and materials of construction as all other valves covered by extension by this type test.

4.3 Requirements for test valve, direction for installation and conditions

4.3.1 Valves designed as symmetric or asymmetric seated valves, intended for the installation in both directions shall be tested in both directions.

4.3.2 Valves designed for unidirectional sealing shall be marked outside the valve body accordingly and shall be tested in one direction only.

4.4 Preparation for low temperature test

4.4.1 General

Valves submitted for low temperature testing shall be internally clean and free of all water, lubricants, sealants and oils unless otherwise agreed upon between the user and the valve manufacturer. ISO 23208 may be used as a guideline for cleaning of valve components as well as assembled valves subjected to low temperature type testing.

4.4.2 Valve tests

Shell and seat testing shall be in accordance with ISO 5208. The shell test pressure shall be 1,1 × CWP if tested with gas or 1,5 × CWP if tested with alcohol or water. The seat closure test pressure shall be at (6 ± 1) bar[1]. After each test is complete, the valve shall be thoroughly dried.

The type testing of valves at low temperature shall be carried out according to the test procedure in Annex A.

An example of a low-temperature type test record is given in Annex C.

4.4.3 Test equipment

4.4.3.1 The cooling medium shall be contained in an insulated stainless steel tank that is open on the top. Each test valve shall be blinded with blind flanges that are equipped with support brackets as necessary and small bore austenitic stainless steel tubing connected to the pressurizing media.

4.4.3.2 Thermocouples shall be attached to the valve body, bonnet and end flange, except that the number of thermocouples may be reduced where the size of the test valve makes the use of multiple thermocouples impracticable. However, in all cases, a minimum of one thermocouple, located in the valve bonnet area and one inside the valve are required. A minimum of one thermocouple shall be provided to monitor the temperature of the cooling medium.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2 (bar is a unit deprecated by ISO).

5 Low temperature testing requirements

5.1 Safety provisions

Low temperature testing is potentially dangerous and test personal shall be aware of this danger and shall receive appropriate training.

All necessary safety measures shall be taken to protect people performing the low temperature testing as well as other personal attending those tests. It is highly recommended to have the test area shielded up by appropriate barriers or to perform the testing in an underground test area with a video camera for the purpose of a visual observation of the test.

5.2 Cooling of the valve

The tested valve shall be installed into the cooling tank and it shall be oriented such that the stem position is vertical. Check valves may be oriented in either the vertical or horizontal disc position.

Cooling begins as the valve is lowered into the test tank and submerged into or sprayed with the cooling medium. Alternatively, if the cooling medium is gas, the cooling begins with the introduction of the gas into the cooling tank.

The valve temperature, as well as the cooling medium temperature and level (if the cooling medium is liquid) shall be continuously monitored and recorded. The test shall begin when the valve temperature is stabilized within the specified test temperature tolerances. See Table 1.

Table 1 — Test temperature

Cooling medium	Test valve temperature
Dry ice, mixed with a heat transfer fluid or cooled by nitrogen	Low temperature at – 50 °C
Nitrogen gas Other medium may be used by agreement between the purchaser and manufacturer	Low temperature of between – 50 °C and – 196 °C
Liquid nitrogen	Low temperature at – 196 °C
NOTE Valves with a minimum design temperature of between – 50 °C and – 196 °C can be tested at – 196 °C, provided the valve materials are suitable.	

5.3 Test gas

Test gas, see Table 2, from a charged bottle is used to provide test pressure on the inlet side of the valve.

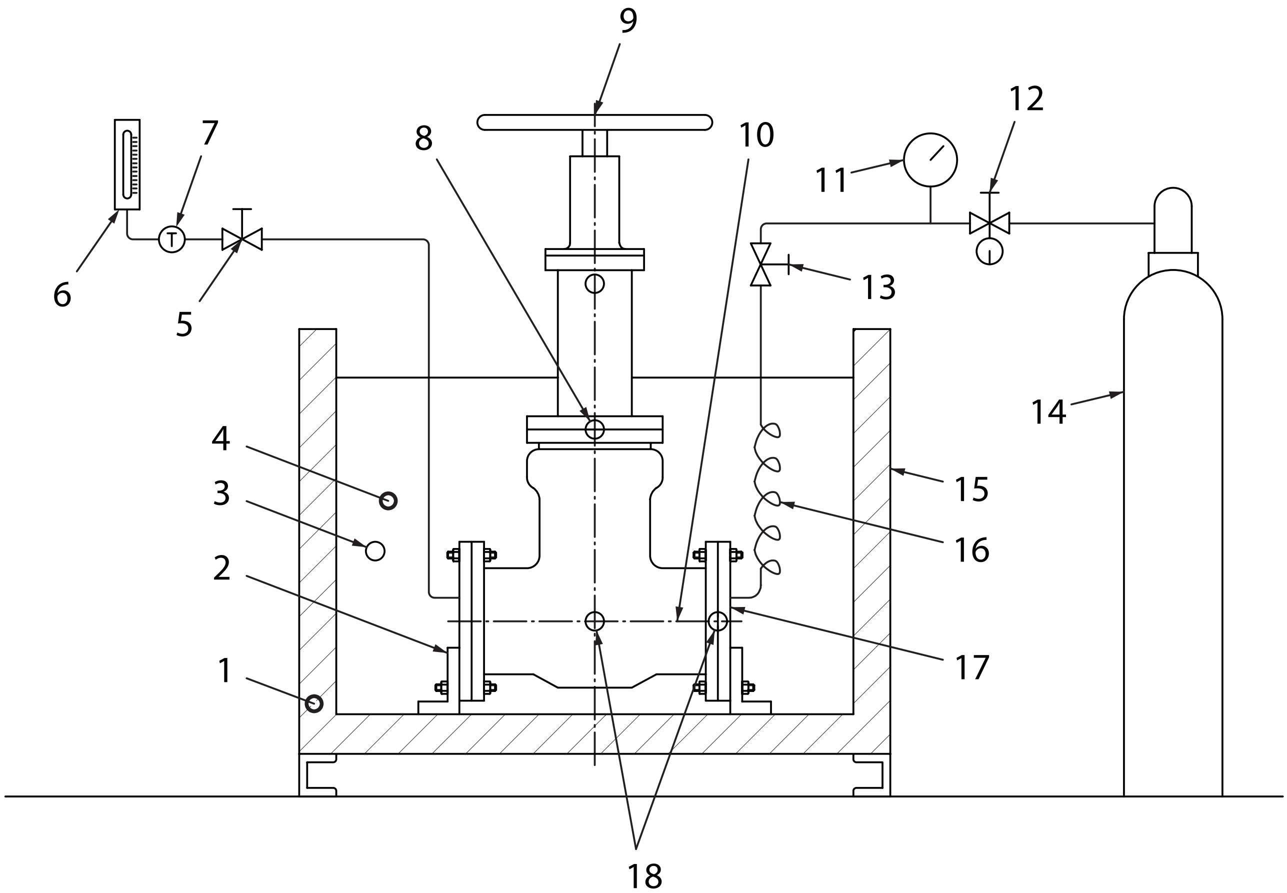
Table 2 — Test gas

Test gas	Test valve temperature
Nitrogen mixed with 10 % helium	Low temperature at – 110 °C and higher
Minimum 97 % pure helium	Any temperature down to – 196 °C

5.4 Equipment

5.4.1 General

A simplified schematic arrangement for immersion cold testing is shown in Figure 1. Its purpose is to facilitate understanding of the standard test. It is not a required arrangement.



Key

1	insulation	10	thermocouple inside valve
2	support bracket	11	pressure gauge
3	cooling medium thermocouple	12	pressure regulator
4	cooling medium	13	isolation valve upstream
5	isolation valve downstream	14	test gas bottle
6	flowmeter	15	tank
7	thermocouple (helium exit temperature)	16	pre-cooling coil
8	thermocouple on body/bonnet flange	17	blind flange
9	test valve	18	optional thermocouple on body and, optionally, on blind flange

Figure 1 — Test set-up

Before commencing the low temperature test, all connections to and from the tested valve shall be verified for tightness. A gas test shall be performed at the maximum valve cold working pressure or maximum seat test pressure, whichever is lower. For external leakage detection, a soap solution or helium leak detector shall be used. Any detected leakage shall be eliminated.

The tubing or piping between the test gas bottle and the tested valve as well as the tubing or piping downstream the test valve, shall be selected so the pressure loss of the flowing test gas is minimized.

5.4.2 Test equipment

5.4.2.1 Pressure gauges

Pressure gauges shall have indicating range between 1/3 and 2/3 of the maximum gas test pressure. Accuracy of the gauges shall be within 3 % of the total gauge scale.

5.4.2.2 Cooling tank

Cooling tank shall be adequately sized to accommodate the test valve, there shall be a minimum space of 100 mm between the test valve and the inside walls of the cooling tank. If the cooling media is liquid, there shall be enough space to completely submerge the test valve including part of the extended bonnet so the liquid level is minimum 25 mm above the bonnet to valve bolting.

If the spraying method with cooling medium is used, then the test valve shall be completely sprayed, including the bottom part of the extended bonnet.

5.4.2.3 Flowmeter

Test valve seat leakage shall be measured at the flowmeter, and shall be at standard atmospheric conditions.

Any type of flowmeter may be used, provided it can be calibrated, for example measuring cylinder, gas flowmeter soap film type or flow rotameter.

Some flowmeters (e.g. electronic mass flowmeters) are not affected by pressure or temperature changes. When such a flowmeter is used, test gas pressure and temperature measurements (as well as correction) at the flowmeter is not required.

5.4.2.4 Pressure regulator

The pressure regulator controls the pressure and the flow of test gas flowing to the test valve.

5.4.3 Instruments calibration

All instruments (flowmeter, pressure gauges, torque wrench, etc.) shall be calibrated.

6 Information to be supplied by the purchaser

See Annex B.

Annex A
(normative)

Test procedure for type testing of valves at low temperature

A.1 General

The following procedure covers the testing for sealing and operability of valves at one of the following temperatures:

a) valve tests at – 196 °C;

b) valve tests at – 50 °C;

c) an alternative temperature of between – 50 °C and – 196 °C may be used.

The test temperature shall not be less than the minimum design temperature of the valve. For low temperature suitability of metallic materials, use ASME B31.3 or EN 13480-2.

A.2 Test procedures

A.2.1 Testing flow chart

See Figure A.1.

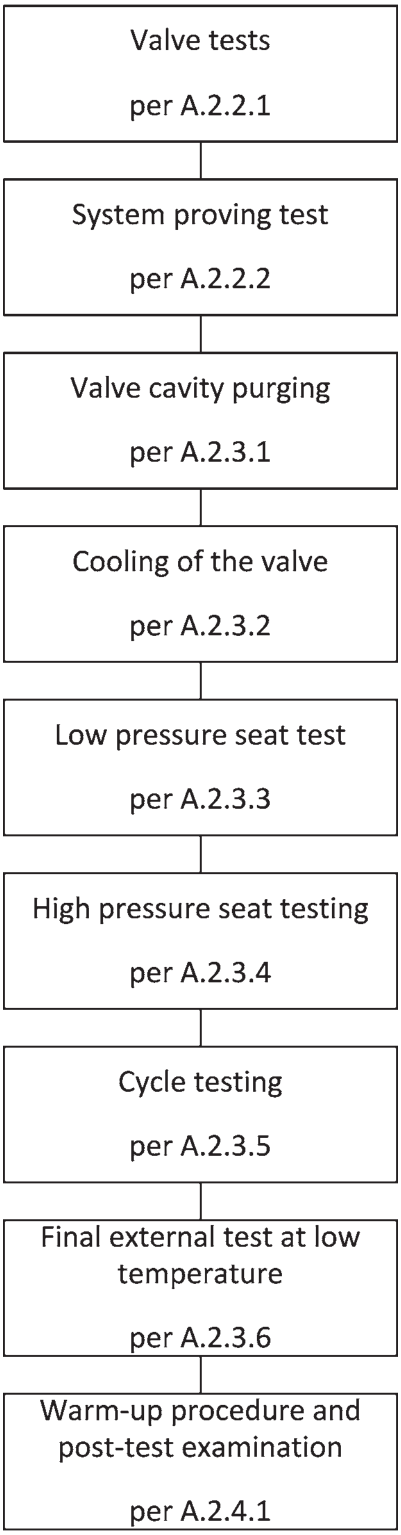


Figure A.1 — Testing flow chart

A.2.2 Ambient temperature test

A.2.2.1 Valve tests

Shell and seat testing shall be in accordance with ISO 5208. The shell test pressure shall be 1,1 × CWP if tested with gas or 1,5 × CWP if tested with alcohol or water. The seat closure test pressure shall be at (6 ± 1) bar[1]). For soft seated valves, the seat leakage rate shall be in accordance with ISO 5208, Rate A. For metal seated valves, it shall be according to the valve manufacturer's standard. After each test is complete, the valve shall be thoroughly dried.

A.2.2.2 System proving test

A.2.2.2.1 Test pressure

A system proving test shall be performed at the maximum valve cold working pressure or maximum seat test pressure, whichever is lower.

A.2.2.2.2 Test procedure

The test valve as well as all the connected tubing or piping shall be inspected for leakage while pressurized to CWP. For external leakage detection, a soap solution or helium leak detector shall be used.

During this test the test valve shall be in full open position except for check valves, the valve shall be in closed position and the pressure shall be applied in the normal flow direction. Any detected leakage shall be eliminated.

A.2.3 Low-temperature test

A.2.3.1 Valve cavity purging

A purge of test gas at a supply pressure of (2 ± 0,5) bar[1]) shall continuously flow through during cool down. Metal seated valves shall be in a half-open position, while for soft seated ball valves the closure member shall be in the fully open position and shall only be operated for cavity purging. For check valves, the test gas flow shall be in a direction to open the obturator.

A.2.3.2 Cooling of the valve

If the cooling media is liquid, the test valve shall be slowly submerged in the coolant to a depth such that the level of the coolant covers at least the top of the valve body to bonnet joint. For check valves, the entire valves shall be submerged in the coolant.

If the spraying method with cooling medium is used, then the test valve shall be completely sprayed, including the valve body to bonnet joint.

If the cooling media is cold gas, the valve shall be installed in the cooling tank so that the valve body and the body to bonnet joint are exposed to the cold gas. During the valve cooling, the purge of test gas shall be maintained.

A.2.3.3 Low-pressure seat test

When the test valve is at the designated test temperature, the purge of the test gas shall be turned off. The test valve shall be operated to the full open position, and pressurized to (2 ± 0,5) bar[1]) with the test fluid.

With the downstream isolation valve open (see Figure 1) and test gas flowing through the valve, the valve shall be then closed and the (2 ± 0,5) bar[1]) pressure shall be re-established. The valve shall be then fully opened and closed five times, while each time, the gas pressure upstream of the test valve shall be re-established.

The closing and opening torque shall be measured and recorded during the first and the fifth operation cycle.

After completion of the last open-close cycle and after the pressure and leakage stabilization has occurred, the seat leakage shall be measured and recorded.

For check valves, the seat leakage shall be measured across the closed obturator applying the pressure in the reverse direction to the normal flow and there is no need to operate the valve.

A.2.3.4 High-pressure seat testing

The high-pressure seat test shall be performed and recorded in four equal pressure increments, beginning with the first increment at a quarter of the valve allowable cold working pressure or maximum operating pressure when specified. The last increment shall be equal to the allowable CWP. Except for actuated valves where the actuator size is specified and selected for operation at a differential pressure less than CWP, the high-pressure seat test may be reduced based on the specified differential pressure. The seat test pressure may also be limited by the valve design, the seat test pressure may be reduced based on the valve manufacturer`s standard.

During each pressure increment, enough time shall be allowed to stabilize the pressure and the test temperature (see Clause A.5). The seat leakage as well as the valve seating and unseating torque shall be measured and recorded during each pressure increment.

For check valves, the seat leakage shall be measured across the closed obturator applying the pressure in the reverse direction to the normal flow and there is no need to operate the valve.

A.2.3.5 Cycle testing

A.2.3.5.1 Operation of the valve against full differential pressure

After the last pressure incremental test above, the test valve shall be closed, pressurized to CWP, the downstream valve opened to depressurize the downstream tubing or piping. The test valve shall be operated from full close to full open position five times, after each venting of the test gas, the full differential pressure across the test valve shall be re-established. The seat leakage shall be measured and recorded after the first and the fifth cycle.

This test requirement does not apply to check valves.

A.2.3.5.2 Operation of the valve without differential pressure

The test valve as well as the valve downstream shall be closed, the CWP inside the valve shall be re-established and the test valve shall be operated 180 times from full closed to full open. The speed of operation shall be established based upon manufacturer’s recommendation.

This test requirement does not apply to check valves.

A.2.3.5.3 Last operational cycles

After the last valve cycle above, the test valve shall be closed, the CWP pressure upstream the test valve re-established, the downstream valve shall be opened and the seat leakage shall be measured. If the seat leakage is acceptable, the test valve shall be cycled five times with full CWP across the valve. During the last operational cycle, the seat leakage as well as the valve torque shall be measured and recorded.

For check valves, the obturator shall be moved from closed position to open three times by reversing the gas flow and after the third cycle, the seat leakage shall be measured.

A.2.3.6 Final external test at low temperature

After completion of the high-pressure tests, depressurized valve shall be operated five times by opening and closing through its full stroke. The operating force shall not exceed 360 N, except for manual valves, the maximum initial force required for valves seating or unseating shall not exceed 1 000 N.

The test valve shall be partially opened, pressurized to the allowable CWP or specified differential pressure and the designated test temperature shall be re-established.

The test valve shall be pressurized for at least 15 min prior to lifting it from the cooling tank.

After the temperature and pressure has stabilized, the valve shall be closed, removed from the cooling tank and checked for external leakage.

For check valves, the tested valve and the connected piping between isolation valve and thermocouple (see items 5 and 7 in Figure 1) shall be pressurized to CWP and the entire assembly shall be lifted out of the cooling tank for the external leakage test.

The valve external leakage for the valve packing and the outside perimeter of the bonnet shall not exceed 50 ppmv[2)] or $1,78 \times 10^{-6}$ $mbar \cdot l \cdot s^{-1}$ per millimetre stem diameter for the packing, and $1,78 \times 10^{-7}$ $mbar \cdot l \cdot s^{-1}$ per millimetre seal diameter for the bonnet or body joint.

For the measurement of the external leakage, the leakage shall at no time throughout the duration of the test be higher than the above specified limits for more than 10 s.

A.2.4 Warm-up procedure and post-test examination

A.2.4.1 After the external leakage test, the test valve shall be de-pressurized and shall be allowed to warm up to ambient temperature. A forced warming-up is not permitted. Except for soft seated ball valves, for which the closing member shall be in fully open position, the closure member shall be in the half open position.

A.2.4.2 After successful testing, the valve shall be disassembled and all internal parts inspected for any signs of internal damage or galling. All finding shall be carefully recorded and photographed.

A.3 Test temperatures

A.3.1 Ambient temperature

The test is performed at between 5 °C and 40 °C.

A.3.2 Low temperature

A.3.2.1 Test is performed at –196 °C ± 5 °C.

A.3.2.2 Test is performed at –50 °C ± 5 °C.

A.3.2.3 When an alternative test temperature of between – 50 °C and – 196 °C is specified, all the remaining requirements of this part of ISO 28921 shall be met.

A.4 Test pressures

A.4.1 Low-pressure seat test

The test is performed at (6 ± 1) bar[1)] during the seat test according to ISO 5208 and (2 ± 0,5) bar[1)] during the low-temperature seat test (see A.2.3.3).

A.4.2 Incremental high-pressure seat test

The actual gas pressure during the seat test shall stabilize within ± 1 bar[1)] for valves up PN 40 (Class 300) and ± 3 bar[1)] for higher pressure valves.

2) ppmv means parts per million in volume; 1 ppmv = 1 ml/m^3 = 1 cm^3/m^3 (ppmv is a unit deprecated by ISO).

A.5 Duration of seat test

The duration of each seat test shall be at least:

— 3 min for valves DN 10 to DN 400, NPS 3/8 to NPS 16;

— 5 min for valves DN 450 or NPS 18 and larger.

Each time the test valve is pressurized and after the pressure and temperature have stabilized, there shall be a waiting period prior to the start of seat testing of equal to or longer than the minimum required duration of the seat test.

The same minimum duration applies to the actual seat test.

A.6 Direction of seat test

For globe, gate, ball and butterfly valves, the seat test is conducted in the normal or preferred flow direction for the valve.

For check valves, the seat test is conducted in the reverse flow direction of the valve.

For valves with bidirectional sealing, each sealing direction shall be tested separately unless otherwise agreed to by the purchaser.

A.7 Allowable seat leakage rates

The maximum allowable seat leakage shall be in accordance with Table A.1.

Table A.1 — Maximum allowable seat leakage rate per millimetre of nominal seat diameter

<table>
<tr><th rowspan="2">Valve PN — Class</th><th colspan="2">Allowed seat leak
mm^3/s x DN</th></tr>
<tr><th>Gate, globe, butterfly and ball valve</th><th>Check valve</th></tr>
<tr><td>PN 16 — Class 150</td><td rowspan="3">50</td><td rowspan="4">250</td></tr>
<tr><td>PN 25 and PN 40 — Class 300</td></tr>
<tr><td>PN 100 and PN 160 — Class 600,
Class 800 and Class 900</td></tr>
<tr><td>PN 250 — Class 1 500</td><td>100</td></tr>
</table>

Annex B
(informative)

Information to be supplied by the purchaser

a) Valve product specification.

b) Nominal size of valve (DN or NPS).

c) Nominal pressure (PN or Class).

d) Cryogenic bonnet extension when other than specified in ISO 28921-1.

e) Type of valve seat (metal/metal or metal/soft).

f) Special cleaning requirements when necessary.

g) Alternative low test temperature when necessary.

Annex C
(informative)

Low-temperature type test record

Valve drawing or figure number:		Test number:	
		Test date:	

Valve type/size/Class:			

Product family range qualified by this test:	

Ambient seat test and system proving test:

Shell test gas or liquid:		Shell test pressure (bar):	

Seat test pressure (bar):	(6 ± 1) barg	Duration of seat test (min):		Corrected seat leak rate (mm^3/s):	
System proving test pressure (bar):		Duration (min):		Allowed seat leak rate (mm^3/s):	

Low temperature test:

Purge gas supply pressure:	(2 ± 0,5) barg	Valve position during purge (half or fully open):	

Cooling medium:		Valve stabilization temperature (°C):		Time:	

	Cycle	Opening torque (Nm)	Closing torque (Nm)
Valve stroked 5 times record operating torques	1st		
	5th		

Low pressure seat test pressure (bar):		Duration (min):		Corrected seat leak (mm^3/s):	
				Allowed seat leak (mm^3/s):	

High pressure seat test:

Valve test temperature (°C):	

Increment	Test pressure (bar)	Duration (min)	Seating torque (Nm)	Unseating torque (Nm)	Measured seat leak (mm^3/s)	Corrected seat leak (mm^3/s)
1st						
2nd						
3rd						
4th						

Cycle testing:

Operation of the valve against full differential pressure:

Valve test temperature (°C):

Cycle	Test pressure (bar)
1st	
2nd	
3rd	
4th	
5th	

After 1st cycle: Measured seat leak (mm^3/s): Corrected seat leak (mm^3/s):

After 5th cycle: Measured seat leak (mm^3/s): Corrected seat leak (mm^3/s):

Operation of the valve without differential pressure:

Valve test temperature (°C): Test pressure (bar):

Speed of operation (s): (if required)

Number of full closed to full open cycles: 180

Measured seat leak (mm^3/s): Corrected seat leak (mm^3/s): Allowed seat leak (mm^3/s):

Number of full closed to full open cycles against full pressure: 5

Measured seat leak (mm^3/s): Corrected seat leak (mm^3/s):

Opening torque (Nm): Closing torque (Nm):

Final external test at low temperature:

Number of full closed to full open cycles:	5	Maximum operating force (N):	
Test pressure (bar):		Valve stabilization temperature (°C):	
Valve stabilization pressure (bar):		Time:	
Measured external leakage at stem diameter:		Measured external leakage at bonnet and body joint:	
Allowed external leakage at stem diameter:		Allowed external leakage at bonnet and body joint:	

Post-test examination:

Visual examination or comments:	**PASS (✓)**	
	FAIL (X)	

Tested by

Approved by

NOTE Drawing of the tested valve, as well as a bill of materials of construction, needs to be attached to this report.

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