Valve Inspection and Testing

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1 Scope

1.1 This standard covers inspection, examination, supplementary examinations, and pressure test requirements for resilient-seated, nonmetallic-seated (e.g., ceramic), and metal-to-metal-seated valves of the gate, globe, plug, ball, check, and butterfly types. Resilient seats are considered to be:

a) soft seats, both solid and semisolid grease type (e.g., lubricated plug);

b) combination soft and metal seats (e.g., laminated seat rings);

c) any other type of seat material designed to meet resilient seat leakage rates as specified in Table 5.

This standard supplements the API standards that reference it, but it may also be applied to other types of valves by agreement between the purchaser and the valve manufacturer. See Annex A for information to be specified by the purchaser.

1.2 The inspection requirements pertain to examinations and testing by the valve manufacturer and any supplementary examinations that the purchaser may require at the valve manufacturer's plant. The test requirements cover both required and optional pressure tests at the valve manufacturer's plant or at a facility mutually agreeable to both the manufacturer and the purchaser.

1.3 The following tests and examinations are specified in this standard:

a) shell test;

b) backseat test;

c) low-pressure closure test;

d) high-pressure closure test;

e) double block and bleed high-pressure closure test;

f) visual examination of castings;

g) high-pressure pneumatic shell test.

2 Normative References

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

API Standard 594, *Check Valves: Flanged, Lug, Wafer and Butt-welding*

API Standard 602, *Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries*

API Standard 609, *Butterfly Valves: Double-flanged, Lug- and Wafer-type*

ASME B16.11,[1] *Forged Fittings, Socket-Welding and Threaded*

[1] ASME International, 3 Park Avenue, New York, New York 10016–5990, www.asme.org.

ASME B16.34, *Valves—Flanged, Threaded, and Welding End*

MSS SP-45,[2] *Bypass and Drain Connections*

MSS SP-55, *Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components Visual Method for Evaluation of Surface Irregularities*

MSS-SP-91, *Guidelines for Manual Operation of Valves*

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1
backseat test
A pressure test used to verify leakage past the stem or shaft to bonnet seal (backseat).

3.2
class
A dimensionless number used to designate the pressure-temperature rating of a valve or piping component.

3.3
closure test
A pressure test used to confirm leakage past or through a valve's closure mechanism.

3.4
cold working pressure
CWP
Rated pressure at ambient temperature.

3.5
diameter nominal
DN
An alphanumeric designation of size that is common for components used in a piping system, and that is used for reference purposes. It comprises the letters DN followed by a dimensionless number indirectly related to the physical size of the bore or outside diameter of the end connection as appropriate. The dimensionless number following DN does not represent a measurable value and is not used for calculation purposes, except where specified in ASME B16.34.

3.6
double block and bleed valve
DBB
A single valve with two seating surfaces that, in the closed position, provide a seal against pressure from both ends of the valve with a means of venting/bleeding the cavity between the seating surfaces.

3.7
nominal pipe size
NPS
An alphanumeric designation of size that is common for components used in a piping system, and that is used for reference purposes. It comprises the letters NPS followed by a dimensionless number indirectly related to the physical size of the bore or outside diameter of the end connection as appropriate. The dimensionless size identification number following NPS does not represent a measurable value and is not used for calculation

[2] Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street, NE, Vienna, Virginia 22180–4602, www.mss-hq.com.

purposes, except where specified in ASME B16.34. Prefix NPS usage is applicable to valves bearing class designations.

3.8
shell test
A pressure test in excess of the cold working pressure (CWP) rating of the valve for the purpose of validating the soundness and strength of the valve pressure-containing structures.

3.9
visually detectable leakage
Leakage during a valve pressure test, either through or past a pressure boundary or closure member that is validated by normal vision.

4 Inspection, Examination, and Supplementary Examination

4.1 Inspection at the Valve Manufacturer's Plant

The purchaser shall specify in the purchase order intention to inspect valves and witness tests and examinations at the valve manufacturer's plant. With proper notification per 4.3, the purchaser's inspector shall have access to any part of the plant concerned with manufacture of the valves whenever work on the order is under way. Witnessing may be performed by remote means (video).

4.2 Inspection Outside the Valve Manufacturer's Plant

When the purchaser specifies that the inspection will include pressure-containing parts or components manufactured at locations other than the valve manufacturer's plant, these parts and components shall be subject to the valve purchaser's inspection at the location where they are manufactured. Witnessing may be performed by remote means (video).

4.3 Inspection Notice

When inspection by the purchaser is specified, the valve manufacturer shall notify the purchaser prior to the required valve testing and any specified supplementary inspections or examinations, addressing the notice as stated in the purchase order or as mutually agreed with the purchaser.

4.4 Extent of Inspection

The extent of inspection may be specified in the purchase order and, unless otherwise indicated, will be limited to the following:

a) inspection of the valve during assembly to ensure compliance with the specifications of the purchase order;

b) witnessing of the required and specified optional pressure tests and examinations;

c) witnessing of any supplementary examinations (see 4.6);

d) review of mill records and nondestructive examination records (including specified radiographs).

4.5 Examination

4.5.1 A visual examination shall be performed by the valve manufacturer on all castings of bodies, bonnets, covers, and closure elements to ensure conformance with MSS SP-55.

4.5.2 Each valve shall be examined to ensure compliance with this standard, purchase order requirements, and the referenced product standard (e.g., API Standard 599[1]).

4.5.3 All examinations shall be performed in accordance with written procedures that comply with the applicable standards.

4.6 Supplementary Examination

Supplementary types of examination are required only if specified in the purchase order and only to the extent specified. Magnetic particle, radiographic, liquid penetrant, and ultrasonic examination of castings or forgings shall be in accordance with ASME B16.34 or with the purchaser's own procedures and acceptance criteria, if so specified.

5 Pressure Tests

5.1 Test Location

Pressure tests shall be performed by the valve manufacturer at the valve manufacturer's plant or at a facility mutually agreeable to both the manufacturer and purchaser.

5.2 Test Equipment

The equipment used to perform the required pressure tests shall not apply external forces that affect seat or body seal leakage. If an end-clamping fixture is used, the valve manufacturer shall be able to demonstrate that the test fixture does not affect the seat or body joint sealing capability of the valve being tested. End clamping is allowed for valves designed to function between mating flanges, such as wafer check and wafer butterfly valves.

5.3 Tests Required

5.3.1 The pressure tests listed in Table 1 shall be performed on each valve in accordance with written procedures that comply with this standard.

Table 1—Pressure Tests

Test Description	Size	ASME class	Valve Type					
			Gate	Globe and Parallel Slide Gate	Plug	Butterfly Cat. A[h] and Check	Floating Ball	Butterfly Cat. B[h] and Trunnion Mounted Ball
Shell	All	All	Required	Required	Required	Required	Required	Required
Backseat [a]	All	All	Required	Required	NA	NA	NA	NA
Low-pressure closure	DN (NPS) ≤ DN 100 (NPS 4)	Class ≤ 1500	Required	Optional [b]	Required [f]	Optional [b]	Required	Required
		Class > 1500	Optional [b]		Optional [b]			Optional [b]
	DN (NPS) > DN 100 (NPS 4)	Class ≤ 600	Required		Required [f]			Required
		Class > 600	Optional [b]		Optional [b]			Optional [b]
High-pressure closure [c g]	DN (NPS) ≤ DN 100 (NPS 4)	Class ≤ 1500	Optional [b e]	Required [d]	Optional [b e f]	Required	Optional [b e]	Optional [b e]
		Class > 1500	Required		Required			Required
	DN (NPS) > DN 100 (NPS 4)	Class ≤ 600	Optional [b e]		Optional [b e f]			Optional [b e]
		Class > 600	Required		Required			Required

NA Not applicable

[a] The backseat test is required for all valves that have the backseat feature, except for bellows seal valves.

[b] When an "optional" test is specified by the purchaser, the test shall be performed in addition to the required tests.

[c] The high-pressure closure test of resilient-seated valves may degrade subsequent sealing performance in low-pressure service.

[d] For power-operated and manually-operated gear-actuated globe valves, including nonreturn-type globe valves, the high-pressure closure test shall be performed at 110 % of the design differential pressure used for sizing of the operator.

[e] For valves specified to be double block and bleed (DBB), a double block and bleed successive high-pressure closure test (see 6.6) is required unless specified otherwise by the purchaser.

[f] For lubricated plug valves, the high-pressure closure test is mandatory and the low-pressure closure test is optional.

[g] In the case where both high- and low-pressure closure testing is to be performed, refer to 6.4.6.

[h] Butterfly Category A and Category B definition according to API 609.

5.3.2 At the manufacturer's option, the backseat test for valves that have the backseat feature may be either a high-pressure or low-pressure test unless stated otherwise in the purchase order.

5.4 High-pressure Closure Test

The high-pressure closure test is required for several valve types, as shown in Table 1. For the valve types for which the high-pressure closure test is optional (according to Table 1), the valves are still required to be able to pass the test (as a test of the design of the valve closure structure). Results of tests confirming the capacity of the valve design to pass the high-pressure closure test shall be supplied when requested in the purchase order (see Table 3, footnotes b and c for calculation of test pressure). DBB testing per 6.6 or 6.7 satisfies the high-pressure closure test requirement in lieu of the testing method indicated in 6.5.

5.5 High-pressure Pneumatic Shell Test

When specified in the purchase order, a high-pressure pneumatic shell test shall be performed. This test shall be performed after the hydrostatic shell test, using appropriate safety precautions. The pneumatic shell test pressure shall be 110 % of the maximum allowable pressure at 38 °C (100 °F) or as specified in the purchase order. Visible leakage is not allowed.

5.6 Test Fluid

5.6.1 For shell, high-pressure backseat, and high-pressure closure tests, the test fluid shall be air, nitrogen, inert gas, kerosene, water, or a noncorrosive liquid with a viscosity not higher than that of water. Unless otherwise specified in the purchase order, the test fluid temperature shall be within the range 5 °C (41 °F) to 38 °C (100 °F).

5.6.2 For the low-pressure closure and low-pressure backseat tests, the test fluid shall be air, nitrogen, or inert gas.

5.6.3 When air or gas is used for closure, shell, or backseat tests, the valve manufacturer shall be capable of demonstrating the adequacy of the method of leakage detection.

5.6.4 Water used for any test can contain water-soluble oil and/or corrosion inhibitor. When specified by the purchaser, a wetting agent and/or an antifreeze (e.g., glycol) shall be included in the water. For testing of austenitic stainless-steel valves, water with chloride content not exceeding 50 ppm shall be used. The valve manufacturer shall be able to document the chloride content.

5.7 Test Pressures

5.7.1 The shell test pressure shall be as listed in Table 2.

5.7.2 Backseat and closure test pressures shall be as listed in Table 3.

5.8 Test Duration

For each type of test, the required test pressure shall be maintained for at least the minimum time specified in Table 4.

Table 2—Shell Test Pressures [d]

Valve Type	ASME class	Shell Test Pressure (Minimum)	
		Bar Gauge	Pounds per Square Inch Gauge (psig)
Ductile iron	150	26	400
	300	66	975
Gray iron			
DN 50 to 300 (NPS 2 to 12)	125	25	350
DN 350 to 1200 (NPS 14 to 48)		19	265
Gray iron			
DN 50 to 300 (NPS 2 to 12)	250	61	875
DN 350 to 600 (NPS 14 to 24)		37	525
Steel and nonferrous alloys			
Flanged	150 to 2500	[b]	[b]
Butt weld	150 to 4500	[b]	[b]
Threaded [a] and socket weld	800	[c]	[c]
	150 to 4500	[b]	[b]

[a] ASME B16.34 limits threaded-end valves to class 2500 and lower.

[b] Per ASME B16.34, the hydrostatic shell test pressure shall be $1^1/_2$ times the pressure rating at 38 °C (100 °F), rounded off to the next higher bar (25 psig). The attachment of hubs, flanges, or other end connections with ambient working pressures lower than the primary valve assembly will require lower test pressures.

[c] For class 800 valves, the hydrostatic shell test pressure shall be $1^1/_2$ times the pressure rating at 38 °C (100 °F), rounded off to the next higher bar (25 psig)—see API Standard 602 for pressure/temperature ratings.

[d] Shell test pressure for API Standard 609 Category A valves shall be $1^1/_2$ times the maximum CWP of the valve.

Table 3—Backseat and Closure Test Pressures

Test	Test Pressure [d]	
	Bar Gauge	Pounds per Square Inch Gauge (psig)
Valves Except Butterfly and Check		
High-pressure closure and backseat [a]	[b]	[b]
Low-pressure closure and backseat [a]	5.5 ± 1.5	80 ± 20
Butterfly Valve		
High-pressure closure	[c]	[c]
Low-pressure closure	5.5 ± 1.5	80 ± 20
Check Valve		
High-pressure closure		
Class 125 (cast iron)		
DN 50 to 300 (NPS 2 to 12)	14	200
DN 350 to 1200 (NPS 14 to 48)	11	150
Class 250 (cast iron)		
DN 50 to 300 (NPS 2 to 12)	35	500
DN 350 to 600 (NPS 14 to 48)	21	300
Class 150 (ductile iron)	17	250
Class 300 (ductile iron)	44	640
Carbon, alloy, stainless steel, and special alloys	[b]	[b]
Low-pressure closure (see Table 1)	5.5 ± 1.5	80 ± 20

[a] The backseat test is required for all valves that have the backseat feature, except for bellows seal valves.

[b] 110 % of maximum allowable pressure at 38 °C (100 °F) in accordance with the applicable purchase specification.

[c] 110 % of design differential pressure at 38 °C (100 °F) in accordance with the applicable purchase specification.

[d] Single values shown are minimum test pressures. Values with a tolerance indicate both minimum and maximum test pressures.

Table 4—Duration of Required Test Pressure

Valve Size		Minimum Test Duration (Seconds) [a]			
DN	NPS	Shell	Backseat (for Valves with Backseat Feature)	Closure Check Valves (API 594)	Closure Other Valves [b]
≤ 50	≤ 2	15	15	60	15
65 to 150	$2^1/_2$ to 6	60	60	60	60
200 to 300	8 to 12	120	60	120	120
350 to 600	14 to 24	300	60	120	120
> 600	>24	600	120	240	240

[a] The test duration is the period of inspection after the valve is fully prepared and is under full pressure.

[b] Test duration value provided is for each seat sealing direction (e.g., unidirectional).

5.9 Test Leakage

5.9.1 Shell, Stem Seals, and Backseat

5.9.1.1 Where no visually detectable leakage is permitted, the following definitions apply:

a) If the test fluid is a liquid, there shall be no visible evidence of drops or wetting of the external surfaces of the test valve.

b) If the test fluid is air, nitrogen, or inert gas, no leakage will be revealed by the established detection method.

5.9.1.2 For shell tests, visually detectable leakage through the pressure boundary walls and any fixed body joint is not permitted.

5.9.1.3 For backseat tests, visually detectable leakage is not permitted.

5.9.1.4 For valves with adjustable stem seals, leakage through the stem seals during the shell test shall not be cause for rejection when tested at prescribed pressure and duration. However, the manufacturer shall demonstrate that the stem seals are capable of retaining pressure at least equal to the 38 °C (100 °F) valve rating without visible leakage.

5.9.1.5 For valves with nonadjustable stem seals (O-rings, fixed single rings, and the like), visually detectable leakage during the shell test is not permitted.

5.9.2 Closure

5.9.2.1 For both the low-pressure closure test and the high-pressure closure test, visual evidence of leakage through the disc, behind the seat rings, or past the shaft seals (of valves that have this feature) is not permitted and structural damage is not permitted [plastic (permanent) deformation of resilient seats and seals is not considered structural damage]. The allowable rate for leakage of test fluid at the seat-sealing surface interface, for the duration of the tests, is listed in Table 5.

5.9.2.2 The allowable leakage rate for closure tests of valves with nonmetallic (e.g., ceramic) seat materials shall be equal to that specified in Table 5 for a metal-seated valve of equivalent size and type.

Table 5—Maximum Allowable Leakage Rates for Closure Tests [c]

Valve Size		All Resilient-seated Valves[b]	Metal Seated Valves Except Check				Metal Seated Check Valves		
DN (mm)	NPS (in.)		Liquid Test [a] (drops/min)	Liquid Test (ml/min)	Gas Test [a] (bubbles/min)	Gas Test (ml/min)	Liquid Test (ml/min)	Gas Test (m^3/h)	Gas Test (ft^3/h)
≤ 50	≤ 2	0	0 [b]	0 [b]	0 [b]	0 [b]	6	0.08	3
65	$2^1/_2$	0	5	0.31	10	0.10	7.5	0.11	3.75
80	3	0	6	0.38	12	0.12	9	0.13	4.5
100	4	0	8	0.50	16	0.16	12	0.17	6
125	5	0	10	0.63	20	0.20	15	0.21	7.5
150	6	0	12	0.75	24	0.24	18	0.25	9
200	8	0	16	1.00	32	0.32	24	0.34	12
250	10	0	20	1.25	40	0.40	30	0.42	15
300	12	0	24	1.50	48	0.48	36	0.50	18
350	14	0	28	1.75	56	0.56	42	0.59	21
400	16	0	32	2.00	64	0.64	48	0.67	24
450	18	0	36	2.25	72	0.72	54	0.76	27
500	20	0	40	2.50	80	0.80	60	0.84	30
600	24	0	48	3.00	96	0.96	72	1.01	36
650	26	0	52	3.25	104	1.04	78	1.09	39
700	28	0	56	3.50	112	1.12	84	1.18	42
750	30	0	60	3.75	120	1.20	90	1.26	45
800	32	0	64	4.00	128	1.28	96	1.34	48
900	36	0	72	4.50	144	1.44	108	1.51	54
1000	40	0	80	5.00	160	1.60	120	1.68	60
1050	42	0	84	5.25	168	1.68	126	1.76	63
1200	48	0	96	6.00	192	1.92	144	2.02	72

[a] For the liquid test, 1 mL is considered equivalent to 16 drops. For the gas test, 1 mL is considered equivalent to 100 bubbles.

[b] There shall be no leakage for the minimum specified test duration (see Table 4). For a liquid test, 0 drops means no visible leakage per minimum specified test duration. For a standard gas test, 0 bubbles means less than 1 bubble per minimum specified test duration. For a high-pressure pneumatic closure test, refer to 5.4.

[c] Leakage rates for sizes above DN 1200 (NPS 48) shall be calculated by the following formulas:

Liquid test for metal seated valves except check: 2 x NPS (drops/min)

Gas test for metal seated valves except check: 4 x NPS (bubbles/min)

Liquid test for metal seated check valves: 3 x NPS (cc/min)

Gas test for metal seated check valves: 0.042 x NPS (m^3/h)

Gas test for metal seated check valves: 1.5 x NPS (ft^3/h)

5.9.2.3 As an alternative, displacement measuring devices may be used, provided that the detectable leakage rate is equivalent to that given in Table 5, the valve manufacturer shall demonstrate and validate that the procedure yields results equivalent to the requirements of this standard, and the device has been accepted by agreement between the purchaser and the manufacturer.

5.9.2.4 When volumetric devices (bubblers) such as shown in Figure 1 are used to measure leakage, the test duration shall not begin until flow through the test tubing is established and stabilized. The device shall be calibrated to yield results equivalent to the units per minute listed in Table 5.

5.9.2.5 The tube end shall be cut square and smooth with no chamfers or burrs, and the tube axis shall be perpendicular to the surface of the water (see Figure 1).

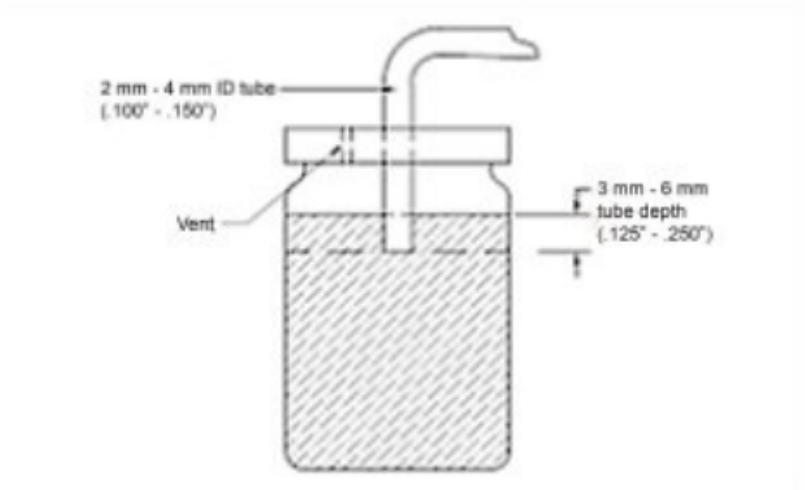

Figure 1—Volumetric Device

5.9.2.6 Leakage rates shall be based upon the DN (NPS) of the valve regardless of whether the valve is full or reduced bore.

6 Pressure Test Procedures

6.1 General

6.1.1 Valves designed to permit emergency or supplemental introduction of an injectable sealant to the seat area shall be tested with the injection system empty and not in use, except for lubricated plug valves.

6.1.2 When a liquid is used as the test fluid, the valve shall be essentially free from trapped air during the test.

6.1.3 Required protective coatings, such as paint, which can mask surface defects, shall not be applied to any surface before inspection or pressure testing (phosphatizing and similar chemical conversion processes used to protect valve surfaces are acceptable even if applied before the tests, provided that they will not seal off porosity).

6.1.4 When closure testing valves, the valve manufacturer's test procedure shall ensure that excessive force is not used to close the valve. The applied force may be determined from the appropriate figures in MSS SP-91[9] and shall be made available to the purchaser or testing facility upon request. The use of a supplemental leveraging device to aid in achieving a passing leakage rate is acceptable, provided that the applied force does not exceed the manufacturer's documented value. Where the manufacturer does not document or otherwise make available the maximum permissible force for valve closure, the test procedure shall restrict the use of supplemental leveraging devices.

6.2 Backseat Test

6.2.1 The backseat test is required for all valves (except for bellows seal valves) that have the backseat feature and shall be performed by applying pressure inside the assembled valve with the valve ends closed, the valve fully open, and the packing gland loose or packing not installed. If the backseat test is performed after the shell test, the packing shall be installed and/or packing glands retightened after the backseat test.

6.2.2 For valves DN 100 (NPS 4) and smaller, the backseat test may be combined with the shell test when volumetric devices are used to monitor leakage. When tested by this method, the packing shall be loose and the backseat can be tested visually at the same time (e.g., soap test). The valve shall pass the test if there is no visible leakage. The manufacturer shall be responsible for demonstrating that the packing has no visible leakage at the valve's rated pressure at 38 °C (100 °F).

6.2.3 The successful completion of the backseat test shall not be construed as a recommendation by the valve manufacturer that, while the valve is pressurized, the valve may be repacked or packing may be replaced.

6.3 Shell Test

Except as provided in 6.2.2, the shell test shall be made by applying the pressure inside the assembled valve with the valve ends closed, the valve partially open, and any packing gland tight enough to maintain the test pressure, thereby (except for bellows seal valves) testing the stuffing box.

6.4 Low-pressure Closure Test

6.4.1 The low-pressure closure test shall be performed with the seat sealing surface interface clean and free from oil, grease, and sealant. If necessary to prevent galling, the sealing surfaces may be coated with a film of oil that is not heavier than kerosene. This requirement does not apply to a valve that uses a lubricant as its primary seal (e.g., lubricated plug valves).

6.4.2 Any leakage at the seat sealing surface interface, behind the seat ring, or through the disc on the open side of the valve shall be detected when bubbles are observed coming from the closure (disc, seat, and seat ring), covered with water or leakage that is channeled to a volumetric device for measurement.

6.4.3 When closure testing gate, plug, and downstream seated ball valves (such as floating ball valves), a method of testing seat leakage shall be used that fills and fully pressurizes the body cavity to the test pressure between the seats and the bonnet area, as applicable, with the test fluid. This will ensure that no seat leakage can escape detection because of gradual filling of these volumes during the test period. For a valve that has only one seat and no center cavity (e.g., a butterfly valve), the pressure shall be applied to the side of the valve for which closure is being tested.

For a valve designed to close against pressure from either direction (e.g., gate valve), the pressure shall be applied successively to each side of the closed valve with the other side at atmospheric pressure to check for leakage at the atmospheric side of the closure. For a globe valve, pressure shall be applied in one direction, with the pressure applied under the disc.

For a valve designed to close against pressure from one direction only and so marked, the pressure shall be applied on the pressure side of the valve only. For a check valve, the pressure shall be applied on the downstream side.

A closure test is required only in one direction for butterfly valves furnished with encapsulation or resilient internal liners and designed for use with class 125 or class 150 flanges (API Standard 609, Category A valves). For other resilient-seated butterfly valves (API Standard 609, Category B valves), the closure test is required in both directions. For butterfly valves with a preferred flow direction, the closure test in the nonpreferred direction shall be based on the reduced differential pressure rating in that direction.

6.4.4 Trapping test air or gas in the body cavity between the seats of a one-piece (solid or flexible) wedge gate valve and subsequently covering the seats with water or coating them with soap or a similar solution does not constitute an acceptable low-pressure closure test.

6.4.5 If a tapped connection is made in the body cavity to permit testing procedures, the connection shall be in accordance with MSS SP-45 and shall be fitted before shipment with a solid pipe plug (in accordance with ASME B16.11), the material composition of which is equivalent to that of the valve shell.

6.4.6 In the case where both high- and low-pressure closure testing is to be performed, the manufacturer should perform the high-pressure closure test before low-pressure testing is performed.

NOTE The high-pressure closure test of resilient-seated valves may degrade subsequent sealing performance in low-pressure service.

6.5 High-pressure Closure Test

The procedure for the high-pressure closure test shall be the same as the procedure for the low-pressure closure test except that, in the case of a liquid test, leakage shall be detected when drops, not bubbles (as described in 6.4), are observed. Optional DBB closure tests shall be as described in 6.6 and/or 6.7 in lieu of 5.4. In the case where the purchaser has not specified which optional test is desired, the closure test in 6.6 shall be performed.

6.6 Double Block and Bleed Successive High- pressure Closure Test

With the valve unseated and partially open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and excess cavity test fluid drained out through an opening in the bottom of the valve (Position “G” per ASME B16.34). Where operational considerations do not allow for an opening in the bottom of the valve, an alternative opening location may be specified by the purchaser, and the valve shall be tested in a position that results in the alternative opening location being at the bottom of the valve during test. Testing in all positions and specifically in alternative positions will require procedures that meet the requirement of 6.1.2.

The pressure shall be applied successively to each side of the closed valve with the other side at atmospheric pressure and leakage into the body cavity shall be checked through an opening in the bottom of the valve. Test duration for each seat shall be no less than the values provided in Table 4. Maximum allowable leakage rates shall be per Table 5.

6.7 Double Block and Bleed Simultaneous High-pressure Closure Test

With the valve unseated and partially open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and excess cavity test fluid drained out through an opening in the bottom of the valve (Position “G” per ASME B16.34). Where operational considerations do not allow for an opening in the bottom of the valve, an alternative opening location may be specified by the purchaser, and the valve shall be tested in a position that results in the alternative opening location being at the bottom of the valve during test. Testing in all positions—specifically in alternative positions—will require procedures that meet the requirement of 6.1.2.

The pressure shall be applied simultaneously from both sides of the closure through the valve bore, and leakage into the body cavity shall be checked through an opening in the bottom of the valve. The test duration for both seats simultaneously shall be no less than twice (2 ×) the values provided in Table 4. Maximum allowable leakage rates shall be per Table 5.

NOTE This test is the same as referenced as double block and bleed (DBB) in API 6D [8].

7 Valve Certification and Retesting

7.1 Certificate of Compliance

When specified by the purchaser, the valve manufacturer shall submit to the purchaser a certificate of compliance as required in the purchase order.

7.2 Retesting

A completed valve does not require retesting unless inspection by the purchaser is specified in the purchase order. This retesting may be waived by the purchaser’s inspector upon written certification by the manufacturer that the valve has been inspected, tested, and examined for conformance with the requirements of this standard. Painted valves need not have paint removed for retesting. Stored valves shall be commercially cleaned before retesting and before shipment.

7.3 Material Test Report

Where material test reports (MTRs) are requested with the purchase order for specific valve components, the manufacturer may transcribe data produced by other organizations, provided that:

— the manufacturer accepts responsibility for the accuracy and authenticity of the data and maintains a file containing the test report from the originator of the data;

— the manufacturer shall certify (on the MTR) the source of the data and the location of the file containing the test report from the originator of the data.

Annex A
(informative)

Information to Be Specified by the Purchaser

Information to be specified by the purchaser:

1) Deviations from this standard should be specifically stated in the purchase order.

2) If this standard is used for valves not covered by this standard, the purchaser will specify the extent to which the standard is to be applied.

3) If required, the following will be specified in the purchase order:

   a) inspections by the purchaser at the valve manufacturer's plant (see 4.1);

   b) inspections by the purchaser outside the valve manufacturer's plant (see 4.2);

   c) address for inspection notices (see 4.3);

   d) any supplementary examination required (see 4.6);

   e) type of backseat test (see 5.3.2);

   f) optional low-pressure closure test (see Table 1 and 6.4);

   g) optional high-pressure closure test (see Table 1, 5.4, and 6.5);

   h) optional high-pressure pneumatic shell test (see 5.5);

   i) optional DBB successive high-pressure closure test with optional drain location (see 6.6);

   j) optional DBB simultaneous high-pressure closure test with optional drain location (see 6.7);

   k) test fluid (see 5.6);

   l) use of a wetting agent in the test water (see 5.6.4);

   m) certificate of compliance (see 7.1);

   n) components for which MTRs are requested (see 7.3).

Bibliography

[1] API Standard 599, *Metal Plug Valves—Flanged, Threaded, and Welding Ends*

[2] API Standard 600, *Steel Gate Valves—Flanged and Butt-welding Ends, Bolted Bonnets*

[3] API Standard 603, *Corrosion-resistant, Bolted Bonnet Gate Valves—Flanged and Butt-welding Ends*

[4] API Standard 608, *Metal Ball Valves—Flanged, Threaded, and Welding Ends*

[5] API Standard 623, *Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets*

[6] API Recommended Practice 591, *Process Valve Qualification Procedure*

[7] API Recommended Practice 621, *Reconditioning of Metallic Gate, Globe, and Check Valves*

[8] API Specification 6D, *Specification for Pipeline Valves*

[9] MSS SP-91, *Guidelines for Manual Operation of Valves*

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阀门检验和试验

API STD 598-2023

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目录

阀门检验和试验

1 范围

1.1　本标准涵盖了闸阀、截止阀、旋塞阀、球阀、止回阀和蝶形阀的弹性密封、非金属密封（如陶瓷密封）和金属对金属密封的检查、检验、补充检验和压力试验要求。弹性密封被认为是：

a） 固体和半固体润滑脂类软密封（如油封式旋塞阀）；

b） 软密封和金属密封的组合（如层压密封环）；

c） 符合表5中规定的弹性密封泄漏率的任何其他类型的密封材料。

本标准是对参考本标准的*API*标准的补充，但经买方和阀门制造商同意，本标准也适用于其他类型的阀门。买方指定的信息见附录*A*。

1.2　检查要求涉及阀门制造商的检验和试验以及买方可能要求在阀门制造商工厂进行的任何补充检验。试验要求包括在阀门制造商工厂或制造商和买方共同同意的设施进行必需和可选的压力试验。

1.3　本标准规定了以下试验和检验：

a） 壳体试验；

b） 上密封试验；

c） 低压密封试验；

d） 高压密封试验；

e） 双截断和排放高压密封试验；

f） 铸件外观检验；

g） 高压气体壳体试验。

2 引用标准

以下引用标准对于本标准的应用是必不可少的。对于注明日期的引用标准，仅引用的版本适用。对于未注明日期的引用标准，其最新版本（包括任何修订版）适用。

API STD 594	法兰式、凸耳式、对夹式和对焊止回阀
API STD 602	石油 石化和天然气工业用*DN* 100（*NPS* 4）及以下尺寸的闸阀、截止阀和止回阀
API STD 609	法兰式、凸耳式和对夹式蝶阀
*ASME B*16.11	锻造配件 套管焊接和螺纹
*ASME B*16.34	法兰、螺纹和焊接端阀门

$MSS\ SP-45$	旁路和排水连接
$MSS\ SP-55$	阀门、法兰、管件和其他管道部件用铸钢件质量标准表面不规则性评定的目视方法
$MSS\ SP-91$	阀门手动操作指南

3 术语和定义

就本标准而言，适用以下术语和定义。

3.1 上密封试验 *backseat test*

用于验证阀杆或轴在阀盖密封（上密封）处泄漏的压力测试。

3.2 等级 *Class*

用于指定阀门或管道部件的压力—温度额定值的无量纲数值。

3.3 密封试验 *closure test*

用于确认通过或通过阀门密封泄漏的压力试验。

3.4 冷态工作压力 *cold working pressure*（*CWP*）

在环境温度下的额定压力。

3.5 公称直径 *diameter nominal*（*DN*）

管道系统中使用的元件常用的字母数字尺寸名称，用于参考目的。它包括字母*DN*，后跟一个无量纲数字，该数字与孔的物理尺寸或端部连接的外径（视情况而定）间接相关。*DN*后面的无量纲数字不代表可测量值，也不用于计算目的，除非*ASME B*16.34中有规定。

3.6 双截断和排放阀门 *double block and bleed valve*（*DBB*）

具有两个或多个密封副的阀门，在关闭位置时，通过密封副体腔进行排气 / 排空，由阀门的两端压力提供密封。

3.7 公称管径 *nominal pipe size*（*NPS*）

管道系统中使用的元件常用的字母数字尺寸名称，用于参考目的。它包括字母*NPS*，后跟一个无量纲数字，该数字与孔的物理尺寸或端部连接的外径（视情况而定）间接相关。*NPS*后面的无量纲数字不代表可测量值，也不用于计算目的，除非*ASME B*16.34中有规定。前缀*NPS*的使用适用于带有*Class*名称的阀门。

3.8 壳体试验 *shell test*

超过阀门冷工作压力（*CWP*）额定值的压力试验，以验证阀门承压结构的稳固性和强度。

3.9 可见泄漏 *visually detectable leakage*

阀门压力试验期间，由正常目视检验观察到通过压力边界和密封元件的泄露。

4 检查、检验和补充检验

4.1 在阀门制造商工厂进行检查

买方应在采购订单中明确表示，将在阀门制造商的工厂进行阀门检查和检验。根据4.3的规定，只要有适当的通知，买方检验员应有权力进入工厂中检查与阀门制造有关的任何部分。可以通过远程方式（视频）进行见证。

4.2 在阀门制造商工厂外进行检查

当买方规定检查将包括在阀门制造商工厂以外的其他地点制造的承压零件或部件时，这些零件和部件应在其制造地点接受阀门买方的检查。可以通过远程方式（视频）进行见证。

4.3 检查通知

当规定由买方进行检查时，阀门制造商应在要求的阀门试验和任何规定的检验或补充检验之前通知买方，并按照采购订单中的规定或与买方共同商定的通知。

4.4 检查范围

检查范围可在采购订单中规定，除非另有说明，否则将限于以下情况：

a） 在组装过程中检查阀门，以确保符合采购订单的规格；

b） 检查所需和指定的可选压力试验和检验；

c） 检查任何补充检验（见4.6）；

d） 检查工厂记录和无损检验记录（包括指定的射线照片）。

4.5 检验

4.5.1 阀门制造商应对阀体、阀盖、阀盖和密封元件的所有铸件进行目视检验，以确保符合$MSS\ SP-55$。

4.5.2 每个阀门都应进行检验，以确保符合本标准、采购订单要求和参考产品标准（例如，$API\ STD\ 599$ [1]）。

4.5.3 所有检验均应按照符合适用标准的书面程序进行。

4.6 补充检验

只有在采购订单中规定的情况下，才需要补充检验类型，并且只在规定的范围内进行。铸件或锻件的磁粉、射线、液体渗透和超声波检验应符合$ASME\ B16.34$的要求，如有规定，应符合买方自己的程序和验收标准。

5 压力试验

5.1 试验地点

压力试验应由阀门制造商在阀门制造商的工厂或制造商和买方双方共同同意的设施上进行。

5.2 试验设备

用于进行所需压力试验的设备不应施加影响密封或阀体密封泄漏的外力。如果使用端部夹紧结构，阀门制造商应能够证明试验夹具不会影响被试验阀门的密封或阀体接头密封能力。对于设计用于配合法兰之间的阀门，如对夹式止回阀和对夹式蝶阀，允许进行端部夹紧。

5.3 所需试验

5.3.1 应根据符合本标准的书面程序对每个阀门进行表 1 中列出的压力试验。

表1—压力试验

试验项目	规格	压力等级	阀门类型					
			闸阀	截止阀和平板闸阀	旋塞阀	蝶阀（类A^h）和止回阀	浮动球阀	蝶阀（类B^h）和固定式球阀
壳体	全部	全部	必需	必需	必需	必需	必需	必需
上密封a	全部	全部	必需	必需	NA	NA	NA	NA
低压密封	DN（NPS）≤ $DN100$（NPS）	$Class \leq 1500$	必需	可选b	必需f	可选b	必需	必需
		$Class > 1500$	可选b		可选b			可选b
	DN（NPS）> $DN100$（NPS）	$Class \leq 600$	必需		必需f			必需
		$Class > 600$	可选b		可选b			可选b
高压密封c g	DN（NPS）≤ $DN100$（NPS）	$Class \leq 1500$	可选b e	必需d	可选b e f	必需	可选b e	可选b e
		$Class > 1500$	必需		必需			必需
	DN（NPS）> $DN100$（NPS）	$Class \leq 600$	可选b e		可选b e f			可选b e
		$Class > 600$	必需		必需			必需

NA 不适用

a 所有具有上密封特征的阀门都需要进行上密封试验，波纹管密封阀门除外。

b 当买方指定“可选”试验时，除了要求的试验之外，还应进行该试验。

c 弹性密封阀门的高压密封试验可能会降低低压应用中的后续密封性能。

d 对于电动和手动齿轮驱动的截止阀，包括止回式截止阀，执行机构设计规格应在高压密封试验压差的110%下能够正常运行。

e 对于指定为双截断和排放（DBB）的阀门，除非买方另有规定，否则需要进行双截断和排放同时高压密封试验（见6.6）。

f 对于润滑旋塞阀，高压密封试验是强制性的，低压密封试验是可选的。

g 如果同时进行高压和低压密封试验，请参见6.4.6。

h 根据API 609定义蝶阀类A和类B。

5.3.2 除非采购订单中另有规定，否则制造商可选择对具有上密封功能的阀门进行高压或低压上密封试验。

5.4 高压密封试验

如表1所示，有几种阀门类型需要进行高压密封试验。对于高压密封试验是可选的阀门类型（根据表1），仍然要求阀门能够通过试验（作为阀门密封结构设计的试验）。当采购订单中有要求时，应提供证明阀门设计通过高压密封试验能力的试验结果（见表3，脚注b和c，用于计算试验压力）。根据6.6或6.7进行的DBB试验满足高压密封试验要求，而不是6.5中规定的试验方法。

5.5 高压气体壳体试验

当采购订单中规定时，应进行高压气体壳体试验。本试验应在水压壳体试验后进行，并采取适当的安全预防措施。气体壳体试验压力应为38℃ （100°F）或采购订单中规定的最大允许压力的110%。不允许有可见泄露。

5.6 试验介质

5.6.1 对于壳体、高压上密封和高压密封试验，试验介质应为空气、氮气、惰性气体、煤油、水或粘度不高于水的无腐蚀性液体。除非采购订单中另有规定，否则试验介质温度应在5℃（41°F）至38℃ （100°F）范围内。

5.6.2 对于低压密封和低压上密封试验，试验介质应为空气、氮气或惰性气体。

5.6.3 当使用空气或气体进行密封、壳体或上密封试验时，阀门制造商应能够证明泄漏检验方法的充分性。

5.6.4 用于任何试验的水都可能含有水溶性油或腐蚀抑制剂。当买方指定时，水中应加入润湿剂或防冻剂（例如乙二醇）。对于奥氏体不锈钢阀门的试验，应使用氯化物含量不超过50 ppm的水。阀门制造商应能够记录氯化物含量。

5.7 试验压力

5.7.1 壳体试验压力如表2所示。

5.7.2 上密封和密封试验压力应如表3所示。

5.8 试验持续时间

对于每种类型的试验，要求的试验压力应至少保持表4中规定的最短时间。

表2—壳体试验压力[d]

阀门类型	压力等级	壳体试验压力（最小）	
		Bar	lb/in^2（$psig$）
球墨铸铁	150	26	400
	300	66	975
灰铸铁			
$DN50\sim300$（$NPS2\sim12$）	125	25	350
$DN350\sim1200$（$NPS14\sim48$）		19	265
灰铸铁			
$DN50\sim300$（$NPS2\sim12$）	250	61	875
$DN350\sim600$（$NPS14\sim24$）		37	525
钢和非铁合金			
法兰连接	150～2500	b	b
对接焊连接	150～4500	b	b
螺纹[a]和承插焊	800	c	c
	150～4500	b	b

a $ASME\ B16.34$将螺纹连接阀门限制在$Class$ 2500及以下。

b 根据$ASME\ B16.34$，壳体试验压力应为38℃（100℉）时额定压力值的1.5倍，四舍五入至下一个更高的bar（25 $psig$）。在环境工作压力低于主阀组件的情况下，连接法兰、螺纹或其他端部连接将需要较低的试验压力。

c 对于$Class$ 800，壳体试验压力应为38℃（100℉）时额定压力值的1.5倍，四舍五入至下一个更高的bar（25 $psig$）。压力—温度额定值参见$API\ STD$ 602。

d $API\ STD$ 609 A类阀门的壳体试验压力应为阀门最大冷态工作压力（CWP）的1.5倍。

表3—上密封和密封试验压力

试验	试验压力 [d]	
	Bar	lb/in^2（$psig$）
除蝶阀和止回阀外的阀门		
高压密封和上密封 [a]	b	b
低压密封和上密封 [a]	5.5 ± 1.5	80 ± 20
蝶阀		
高压密封	c	c
低压密封	5.5 ± 1.5	80 ± 20
止回阀		
高压密封		
$Class$ 125（铸铁）		
DN50～300（NPS2～12）	14	200
DN350～1200（NPS14～48）	11	150
$Class$ 250（铸铁）		
DN50～300（NPS2～12）	35	500
DN350～600（NPS14～24）	21	300
$Class$ 150（球墨铸铁）	17	250
$Class$ 300（球墨铸铁）	44	640
碳钢、合金钢、不锈钢和特殊合金钢	b	b
低压密封（见表1）	5.5 ± 1.5	80 ± 20

a 除了波纹管密封阀门外，所有具有上密封特性的阀门都要求进行上密封试验。

b 根据适用的采购规范，在38℃（100℉）下最大允许压力的110%。

c 根据适用的采购规范，在38℃（100℉）下设计压差的110%。

d 显示的单个值为最小试验压力。带有公差的值表示最小和最大试验压力。

表4—所需的试验压力持续时间

阀门通径		最小测试持续时间（秒）[a]			
DN	***NPS***	**壳体**	**上密封（适用于具有上密封功能的阀门）**	**密封止回阀（*API* 594）**	**密封其他阀门 [b]**
≤ 50	≤ 2	15	15	60	15
65～150	2½～6	60	60	60	60
200～300	8～12	120	60	120	120
350～600	14～24	300	60	120	240
> 600	> 24	600	120	240	240

a 试验持续时间是阀门完全准备好并处于全压状态后的检验时间。

b 提供的试验持续时间值适用于每个密封元件密封方向（例如单向）。

5.9 试验泄漏

5.9.1 壳体，阀杆密封和上密封

5.9.1.1 如果不允许有可见泄漏，则适用以下定义：

a） 如果试验介质是液体，试验阀门的外表面不应有可见的滴落或润湿迹象。

b） 如果试验介质是空气、氮气或惰性气体，则通过既定的检验方法不会发现泄漏。

5.9.1.2 对于壳体试验，通过压力边界壁和任何阀体接头不允许有可见泄漏。

5.9.1.3 对于上密封试验，不允许有可见泄漏。

5.9.1.4 对于带有可调节阀杆密封的阀门，当在规定的压力和持续时间下进行试验时，壳体试验期间通过阀杆密封的泄漏不应成为拒收的原因。然而，制造商应证明阀杆密封能够保持至少等于38℃ （100℉）阀门额定值的压力，且无可见泄漏。

5.9.1.5 对于带有不可调节阀杆密封件（*O*形圈、固定单环和类似的）的阀门，在壳体试验期间不允许有可见泄漏。

5.9.2 密封

5.9.2.1 对于低压密封试验和高压密封试验，不允许阀瓣、密封环背面或轴密封（具有此功能的阀门）有可见泄漏，也不允许出现结构性损坏[弹性密封和密封件的塑性（永久）变形不被视为结构性损坏]。表5列出了试验期间密封表面界面处试验介质的允许泄漏率。

5.9.2.2 非金属（如陶瓷）密封材料阀门密封试验的允许泄漏率应等于表5中规定的同等尺寸和类型的金属密封阀门的泄漏率。

表5—密封试验的最大允许泄漏率

阀门通径		所有弹性密封阀门[b]	金属密封阀门，止回阀除外				金属密封止回阀		
DN（*mm*）	*NPS*（*in.*）		液体试验[a]（滴/分）	液体试验（ml/min）	气体试验[a]（气泡/分）	气体试验（ml/min）	液体试验（ml/min）	气体试验（m^3/h）	气体试验（ft^3/h）
≤ 50	≤ 2	0	0[b]	0[b]	0[b]	0[b]	6	0.08	3
65	2½	0	5	0.31	10	0.10	7.5	0.11	3.75
80	3	0	6	0.38	12	0.12	9	0.13	4.5
100	4	0	8	0.50	16	0.16	12	0.17	6
125	5	0	10	0.63	20	0.20	15	0.21	7.5
150	6	0	12	0.75	24	0.24	18	0.25	9
200	8	0	16	1.00	32	0.32	24	0.34	12
250	10	0	20	1.25	40	0.40	30	0.42	15
300	12	0	24	1.50	48	0.48	36	0.50	18
350	14	0	28	1.75	56	0.56	42	0.59	21
400	16	0	32	2.00	64	0.64	48	0.67	24
450	18	0	36	2.25	72	0.72	54	0.76	27
500	20	0	40	2.50	80	0.80	60	0.84	30
600	24	0	48	3.00	96	0.96	72	1.01	36
650	26	0	52	3.25	104	1.04	78	1.09	39
700	28	0	56	3.50	112	1.12	84	1.18	42
750	30	0	60	3.75	120	1.20	90	1.26	45
800	32	0	64	4.00	128	1.28	96	1.34	48
900	36	0	72	4.50	144	1.44	108	1.51	54
1000	40	0	80	5.00	160	1.60	120	1.68	60
1050	42	0	84	5.25	168	1.68	126	1.76	63
1200	48	0	96	6.00	192	1.92	144	2.02	72

a 对于液体试验，1 mL相当于16滴。对于气体试验，1 mL相当于100个气泡。

b 在规定的最短试验持续时间内，不应出现泄漏（见表 4）。对于液体试验，0 滴意味着在规定的最短试验持续时间内没有可见的泄漏。对于标准气体试验，0个气泡意味着在规定的最短试验持续时间内小于1个气泡。对于高压气体密封试验，参考5.4。

c *DN* 1200（*NPS* 48）以上尺寸的泄漏率应通过以下公式计算：

金属密封阀门的液体试验（止回阀除外）：$2 \times NPS$（滴/分）

金属密封阀门的气体试验（止回阀除外）：$4 \times NPS$（气泡/分）

金属密封止回阀的液体试验：$3 \times NPS$（cc/min）

金属密封止回阀的气体试验：$0.042 \times NPS$（m^3/h）

金属密封止回阀的气体试验：$1.5 \times NPS$（ft^3/h）

5.9.2.3 作为替代方案，可使用位移测量装置，前提是可检验泄漏率等于表5中给出的泄漏率，阀门制造商应证明并验证该程序产生的结果与本标准的要求相当，且该装置已通过买方和制造商之间的协议验收。

5.9.2.4 当使用如图1所示的容积装置（起泡器）测量泄漏时，试验持续时间应在通过试验

管道的流量建立并稳定后开始。应对装置进行校准，以产生相当于表5中所列单位每分钟的结果。

5.9.2.5 管道端部应切割成方形，光滑无倒角或毛刺，管道轴向应垂直于水面（见图1）。

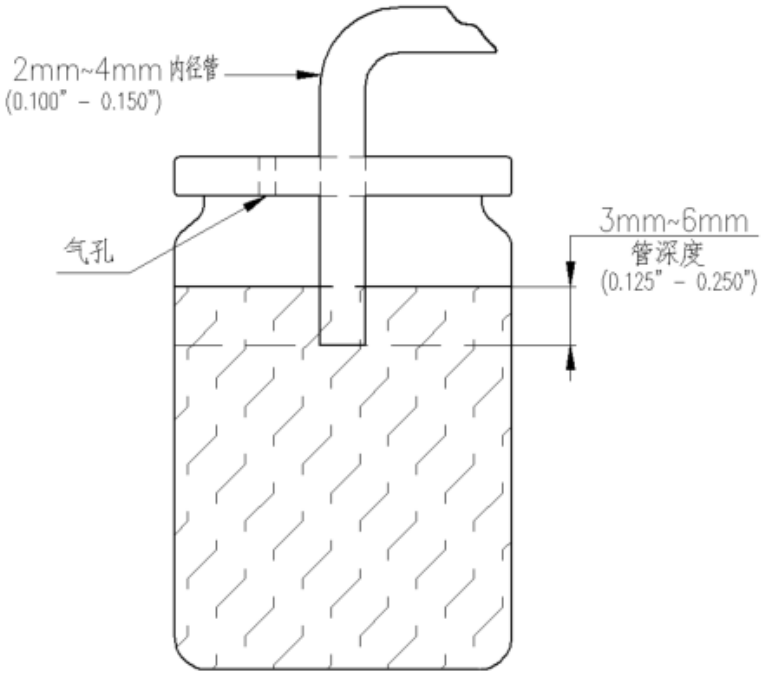

图1—容积装置

5.9.2.6 泄漏率应基于阀门的公称通径DN（NPS），无论阀门是全通径还是缩径。

6 压力试验程序

6.1 概述

6.1.1 用于在密封区域紧急或补充引入可注射密封胶的阀门，应在注射系统处于空状态且不使用的情况下进行试验，润滑旋塞阀除外。

6.1.2 当使用液体作为试验流体时，阀门在试验过程中应基本上没有滞留空气。

6.1.3 在检验或压力试验之前，不得在任何表面上涂敷所需的保护涂层，如可掩盖表面缺陷的油漆（即使在试验之前涂敷，也可接受用于保护阀门表面的磷化和类似化学转化工艺，前提是它们不会密封孔隙）。

6.1.4 当阀门密封试验时，阀门制造商的试验程序应确保密封阀门时不会使用过大的力。所施加的力可根据$MSS\ SP-91$[9]中的适当值确定，并应根据要求提供给买方或试验机构。使用辅助杠杆装置来帮助实现通过泄漏率是可接受的，前提是所施加的力不超过制造商的记录值。如果制造商没有记录或以其他方式提供阀门密封的最大允许力，则试验程序应限制使用补充杠杆装置。

6.2 上密封试验

6.2.1 所有具有上密封特征的阀门（波纹管密封阀除外）都需要进行上密封试验，应在阀门端关闭、阀门完全打开、填料压盖松动或未安装填料的情况下，通过在组装好的阀门内施加压力来进行上密封试验。如果上密封试验在壳体试验后进行，则应在上密封试验后安装填料或重新紧固填料压盖。

6.2.2 对于$DN100$（$NPS\,4$）及以下的阀门，当使用容积装置监测泄漏时，上密封试验可与壳体试验相结合。当采用该方法进行试验时，填料应松动，同时可目视检验上密封（例如肥皂试验）。如果没有可见泄漏，阀门应通过检验。制造商应负责证明填料在38℃ （100℉）的阀门额定压力下无可见泄漏。

6.2.3 当阀门被加压时，可以重新包装阀门或更换填料不应被阀门制造商解释为上密封试验的成功。

6.3 壳体试验

除6.2.2中规定的情况外，壳体试验应通过在已组装的阀门内部施加压力，阀门端部密封、阀门部分打开且填料密封盖足够保持试验压力，从而（波纹管密封阀除外） 检验填料函。

6.4 低压密封试验

6.4.1 低压密封试验应在密封表面界面清洁且无油、油脂和密封剂的情况下进行。如果需要防止磨损，可以在密封表面涂一层不重于煤油的油。该要求不适用于使用润滑剂作为主要密封的阀门（例如，润滑旋塞阀）。

6.4.2 任何发生在密封表面界面、密封环背面或通过阀门开启一侧的阀瓣的泄漏，当观察到气泡从被水覆盖的密封元件（阀瓣、密封表面界面和密封环背面）中流出时，这些气泡应引导至容积装置进行测量。

6.4.3 当密封试验闸阀、旋塞阀和下游密封球阀（如浮阀球阀）时，应采用试验密封泄漏的方法，将试验介质在阀体体腔注满并充分加压至密封和阀盖部位之间的试验压力（如适用）。这将确保在试验期间，不会因为逐渐填充这些容积而出现密封泄漏。对于只有一个密封且没有中心腔的阀门（如蝶阀），压力应施加在阀门的一侧，以试验其密封情况。

对于设计为双向密封的阀门（如闸阀），压力应依次施加到密封阀门的每一侧，另一侧处于大气压力下，以检查密封装置大气侧的泄漏。对于截止阀，应从阀瓣下方一个方向施加压力。

对于配备封装或弹性内衬且设计用于$Class\ 125$或$Class\ 150$（$API\ STD\ 609$，A类阀门）的蝶阀，只需在一个方向上进行密封试验。对于其他弹性密封蝶阀（$API\ STD\ 609$，B类阀门），需要在两个方向进行密封试验。对于具有首选流向的蝶阀，非参考方向的密封试验压力应按减小的差压额定值在该方向进行。

6.4.4 将试验空气或气体滞留在整体式（实心或柔性）楔形闸阀密封之间的体腔中，然后用水覆盖密封元件或用肥皂或类似溶液覆盖密封元件将不构成可接受的低压密封试验。

6.4.5 如果在阀体体腔内进行螺纹连接以允许试验程序，则该连接应符合$MSS\ SP-45$的要求，并应在装运前用实心管塞（符合$ASME\ B16.11$的要求）固定，其材料成分与壳体的材料成分相同。

6.4.6 如果同时进行高压和低压密封试验，制造商应在进行低压试验之前进行高压密封试验。

请注意 弹性密封阀门的高压密封试验可能会降低低压应用中的后续密封性能。

6.5 高压密封试验

高压密封试验的程序应与低压密封试验的程序相同，除了在液体试验的情况下，泄露的检验应为观察到液滴而不是气泡（如6.4所述）。可选的*DBB*密封试验应如6.6和6.7中所述，代替5.4。如果买方未指定所需的可选试验，则应进行6.6中的密封试验。

6.6 双截断和排放高压密封试验

当阀门未关闭且部分打开时，阀门及其体腔应完全充满试验介质。然后关闭阀门，并通过阀门底部的开口（*ASME B*16.34中的位置“*G*”）排出多余的体腔试验介质。如果操作考虑不允许在阀门底部开口，则买方可指定替代的开口位置，并且在试验期间，阀门的试验位置应使阀门的另一个打开位置位于阀门底部。所有位置的试验，特别是替代位置的试验需要符合6.1.2要求的程序。

压力应依次施加到密封阀门的每一侧，另一侧为大气压力，并应通过阀门底部的开口检验进入体腔的泄漏。每个密封元件的试验持续时间不得小于表4中提供的值。最大允许泄漏率应符合表5。

6.7 双截断和排放同时进行高压密封试验

当阀门未关闭且部分打开时，阀门及其体腔应完全充满试验介质。然后关闭阀门，并通过阀门底部的开口（*ASME B*16.34中的位置“*G*”）排出多余的体腔试验介质。如果操作考虑不允许在阀门底部开口，则买方可指定替代的开口位置，并且在试验期间，阀门的试验位置应使阀门的另一个打开位置位于阀门底部。所有位置的试验，特别是替代位置的试验需要符合6.1.2要求的程序。

应通过阀门端部从密封装置的两侧同时施加压力，并通过阀门底部的开口检验向阀体体腔的泄漏。两个密封元件同时进行的试验持续时间应不小于表4中规定值的两倍（2×）。最大允许泄漏率应符合表5。

请注意 这个试验与*API 6D*中的双截断和排放（*DBB*）相同。

7 阀门证书和重复试验

7.1 合格证书

当买方指定时，阀门制造商应向买方提交采购订单中要求的合格证书。

7.2 重复试验

除非采购订单中规定了买方的检验，否则完成的阀门不需要重新试验。买方检验员可在制造商书面证明阀门已进行检查、检验和试验，以符合本标准要求后，放弃该重新试验。涂漆阀门无需去除油漆进行重新试验。储存的阀门应在重新试验前和装运前进行商业清洗。

7.3 材料试验报告

如果特定阀门部件的采购订单要求提供材料试验报告（*MTR*），制造商可转录其他组织

附录*A*—由买方指定的信息

（参考性）

由买方指定的资料：

1） 与此标准的偏差应在采购订单中明确说明。

2） 如果本标准用于本标准未涵盖的阀门，则买方将指定本标准的适用范围。

3） 如有需要，采购订单中将详细说明以下内容：

a） 买方在阀门制造商的工厂进行的检查（见4.1）；

b） 由买方在阀门制造商工厂外进行检查（见4.2）；

c） 通知检查地址（见4.3）；

d） 任何需要的补充检验（见4.6）；

e） 上密封试验类型（见5.3.2）；

f） 可选低压密封试验（见表1和6.4）；

g） 可选高压密封试验（见表1、5.4和6.5）；

h） 可选高压气体壳体试验（见5.5）；

i） 可选*DBB*高压密封试验，可选则排放位置（见6.6）；

j） 可选*DBB*同时高压密封试验，可选则排放位置（见6.7）；

k） 试验介质（见5.6）；

l） 在试验水中使用润湿剂（见5.6.4）；

m） 合格证书（见7.1）；

n） 要求材料试验报告（*MTR*）的部件。

参考文献

[1]	*API STD* 599	金属旋塞阀：法兰 螺纹和对焊连接
[2]	*API STD* 600	钢制闸阀：法兰和对焊连接 螺栓连接阀盖
[3]	*API STD* 603	耐腐蚀螺栓连接阀盖闸阀：法兰和对焊连接
[4]	*API STD* 608	金属球阀：法兰 螺纹和对焊连接
[5]	*API STD* 623	钢制截止阀：法兰和对焊连接 螺栓连接阀盖
[6]	*API RP* 591	过程阀门认证程序
[7]	*API RP* 621	金属闸阀、截止阀和止回阀的修复
[8]	*API Spec* 6*D*	管道阀门规范
[9]	*MSS SP* − 91	阀门手动操作指南