Specification for Fire Test for Valves with Automatic Backseats

API SPECIFICATION 6FC
FOURTH EDITION, MARCH 2009

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Upstream Segment

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Foreword

This specification is under the jurisdiction of the API Committee on Standardization of Valves and Wellhead Equipment.

This standard covers the requirements for testing and evaluating the performance of API 6A and API 6D valves with automatic backseats when exposed to specifically defined fire conditions. For the purpose of this specification, an automatic backseating valve is defined as a manual or actuated valve which allows the stem to effect a backseat against the bonnet and isolate the stem packing, by automatic means, when exposed to a fire.

This standard is not intended to cover end connections. These are covered in API Specification 6FB, *Specification for Fire Test for End Connections*.

Other standards under the jurisdiction of this committee include:

a) API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment;*

b) API Technical Report 6AF, *Technical Report on Capabilities of API Flanges Under Combinations of Load;*

c) API Technical Report 6AF1, *Technical Report on Temperature Derating of API Flanges Under Combination of Loading;*

d) API Specification 6D, *Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves);*

e) API Specification 6FA, *Specification for Fire Test for Valves;*

f) API Specification 6FB, *Specification for Fire Test for End Connections;*

g) API Technical Report 6F1, *Performance of API and ANSI End Connections in a Fire Test According to API Spec 6FA*;

h) API Technical Report 6F2, *Fire Resistance Improvements for API Flanges.*

Conversions of U.S. customary (USC) units to international system (SI) metric units are provided throughout the text of this specification in parentheses, e.g. 6 in. (152.4 mm). SI equivalents have also been included in all tables. USC units are in all cases preferential and shall be the standard in this specification. The factors used for conversion of USC units to SI units were taken from API Publication 2564, and are listed below:

1) Length:

   1 inch (in.) = 25.4 millimeters (mm) exactly

2) Pressure:

   1 pound per = 0.06894757 Bar

   square inch (psi) = 0.006894757 MPa

3) Temperature:

   The following formula was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C):

   °C = 5/9 (°F – 32)

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Shall: As used in a standard, “shall” denotes a minimum requirement in order to conform to the specification.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, D.C. 20005, standards@api.org.

Contents

Specification for Fire Test for Valves with Automatic Backseats

1 Scope

It is the purpose of this document to establish the requirements for testing and evaluating the pressure-containing performance of API 6A and API 6D automatic backseating valves when exposed to fire. The performance requirements of this document are intended to establish standard limits of acceptability regardless of size or pressure rating.

This document establishes acceptable levels for leakage through the test valve and also external leakage after exposure to a fire for a 30-minute time period, both before and after reworking the stuffing box.

The burn period has been established on the basis that it represents the maximum time required to extinguish most fires. Fires of greater duration are considered to be of a major magnitude with consequences greater than those anticipated in this test.

2 Description of Fire Test

2.1 The valve shall be tested in the closed position with water with the stem and bore in the horizontal position.

2.2 The valve will be enveloped in flame having a temperature of 1400 °F to 1800 °F (761 °C to 980 °C) average of two thermocouples, located as shown in Figure 1 or Figure 2. No reading shall be below 1300 °F (704 °C). The test set-up shall include 1.5-in. (38 mm) cube calorimeter blocks made of carbon steel with a thermocouple located in the center of each block (see Figure 3 for calorimeter block configuration). For API 6A valves size 7 1/16-in. and smaller, and API 6D valves size 6 in. (152 mm) and smaller, two blocks shall be located as shown in Figure 1. For larger size valves, three blocks shall be used as shown in Figure 2. Piping upstream of the test valve larger than 1 in. (25 mm) nominal pipe size or one-half of the valve nominal pipe size (whichever is smaller) must be enveloped in flame for a distance of at least 6 in. (152 mm).

2.3 The burn period will be 30 minutes from ignition.

2.4 The end connection piping-to-valve joint leakage (flanged, threaded, or welded) is not considered a part of this test and is not included in the allowable external leakage in 4.2, 4.4 and 4.7. For the test, it may be necessary to modify this joint to eliminate leakage.

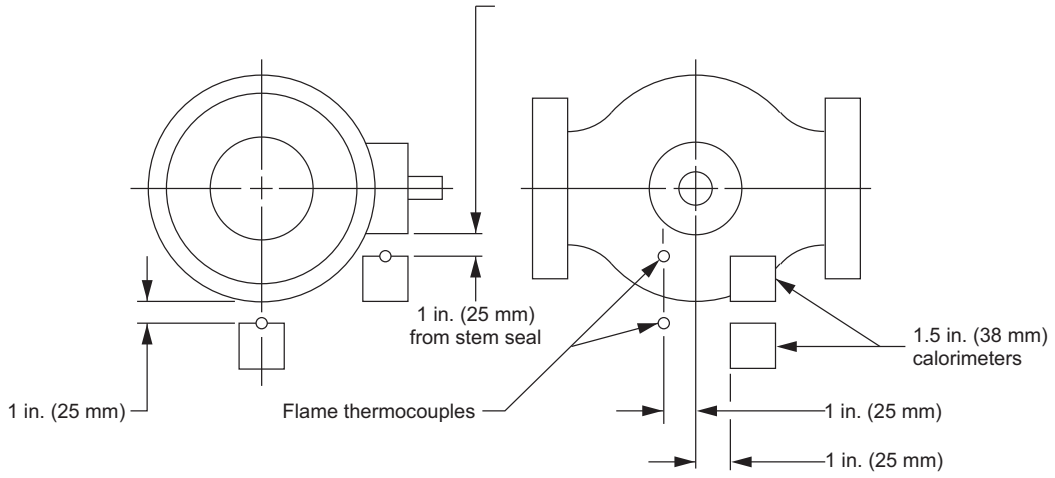


Figure 1—Location of Calorimeters Smaller Valves (See 2.2)

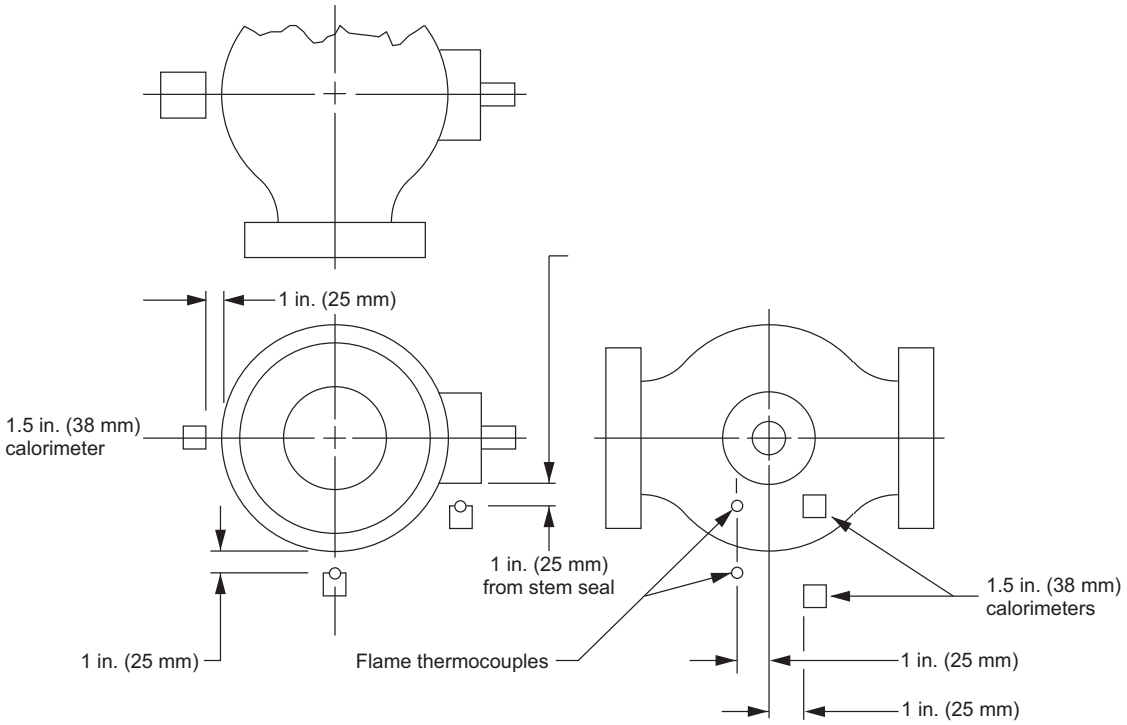


Figure 2—Location of Calorimeters Larger Valves (See 2.2)

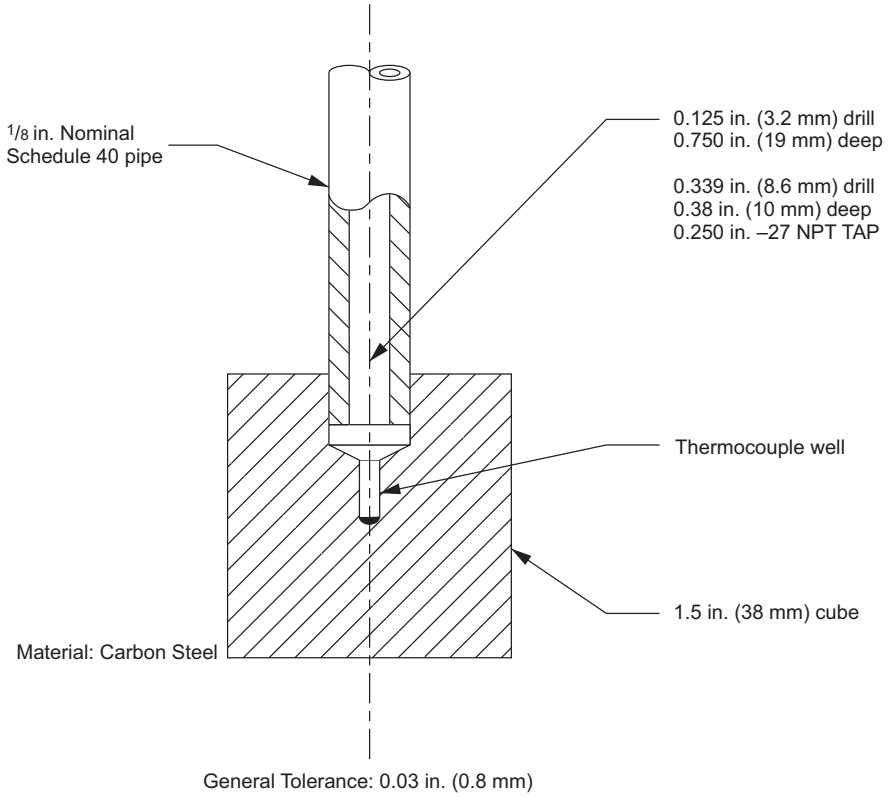


Figure 3—Calorimeter Cube Design (See 2.2)

3 Test Procedure

3.1 Stepwise Procedures (See Figure 4)

3.1.1 Open valve(s) (Item 5 and Item 6) at water source, and any necessary vent valves (Item 17) to flood the system and purge the air. The test valve may have to be placed in the partially open position in order to completely flood the valve body.

3.1.2 Close fill valve (Item 5) and test valve (Item 11), then close vent valves (Item 17). The piping system upstream of the test valve shall be completely water filled and the system downstream shall be drained.

3.1.3 Pressurize the system to the appropriate high test pressure from Table 1. Maintain this pressure during the burn and cooldown period. Momentary pressure losses are permissible, provided their cumulative recovery time is less than two minutes. Record the reading on the calibrated sight gauge (Item 4). Empty the graduated downstream container (Item 19).

3.1.4 Open fuel supply, establish a fire, and monitor the flame temperature. The average of two thermocouples (Item 14) must reach 1400 °F (761 °C) within two minutes. Maintain the average temperature between 1400 °F to 1800 °F (761 °C to 980 °C), with no reading less than 1300 °F (704 °C) for the remainder of the burn period.

3.1.5 The average temperature of the calorimeters (Item 13) shall reach 1200 °F (650 °C) within 15 minutes of fire ignition. For the remainder of the burn period, the calorimeters shall maintain a minimum average temperature of 1200 °F (650 °C); and none of the calorimeters shall have a temperature less than 1050 °F (565 °C).

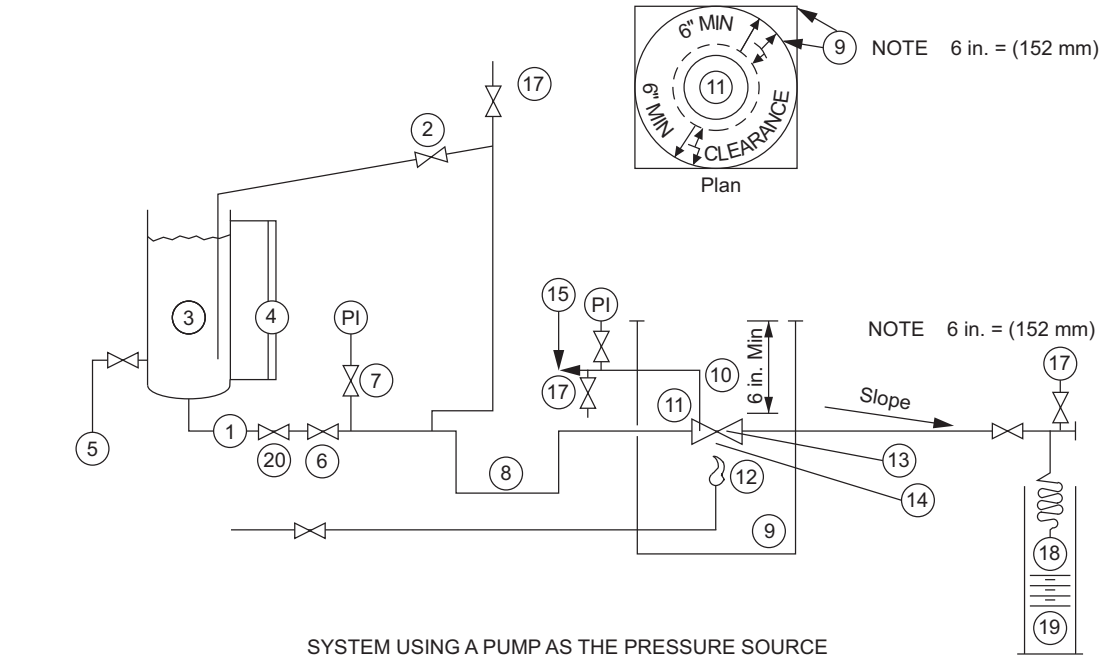
NOTE Impingement of water or steam from external leakage onto flame thermocouples or calorimeters can result in a substantial drop in the indicated temperature of the affected sensor(s), even if no actual drop in flame temperature has occurred. Such drops in indicated temperature(s) shall be noted in the test report. The test may continue with no downward adjustment of the burner controls provided that at least one flame thermocouple and one calorimeter are functioning.

3.1.6 Record instrument readings (Item 7, Item 13, Item 14 and Item 15) every 30 seconds during the burn period.

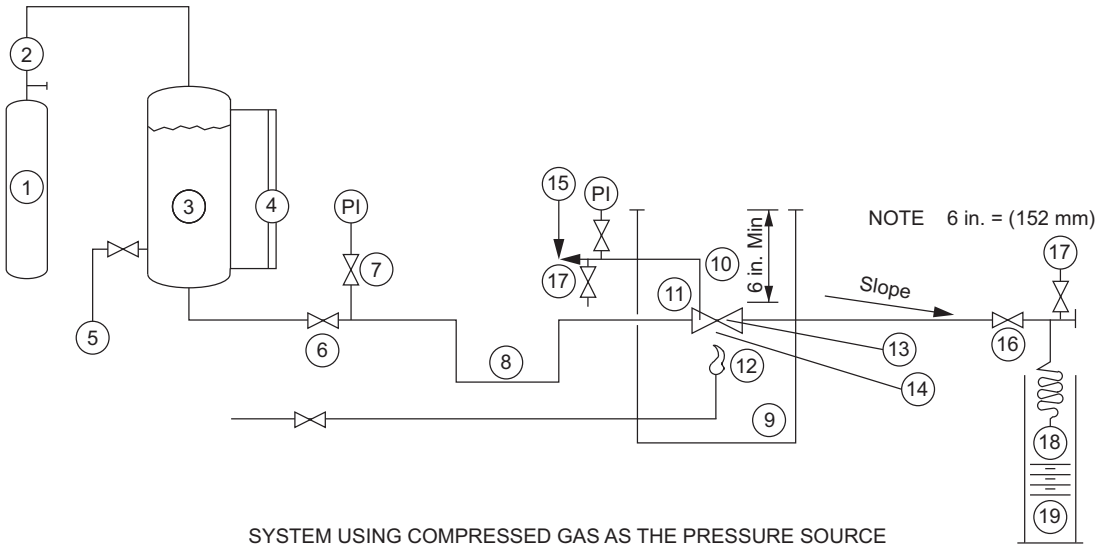
Table 1—Test Pressure During Fire Test

	Valve Rating			High Test Pressure			Low Test Pressure		
	Class	(PN) [a]		psi	(bar)	(MPa)	psi	(bar)	(MPa)
Spec 6D Valves	150	(20)	—	210	(14.5)	(1.5)	29	(2.0)	(0.2)
	300	(50)	—	540	(37.2)	(3.7)	50	(3.4)	(0.34)
	400	(64)	—	720	(49.6)	(5.0)	70	(4.8)	(0.48)
	600	110	—	1080	(74.5)	(7.5)	105	(7.2)	(0.72)
	900	(150)	—	1620	(111.7)	(11.2)	—	—	—
	1500	(260)	—	2700	(186.2)	(18.6)	—	—	—
	2500	(420)	—	4500	(310.3)	(31.0)	—	—	—
	psi	(bar)	(MPa)	psi	(bar)	(MPa)			
Spec 6A Valves	2000	(138)	(13.8)	1500	(103.4)	(10.3)	—	—	—
	3000	(207)	(20.7)	2250	(155.1)	(15.5)	—	—	—
	5000	(345)	(34.5)	3750	(258.6)	(25.9)	—	—	—
	10000	(690)	(69.0)	7500	(517.1)	(51.7)	—	—	—
	15000	(1034)	(103.5)	11,250	(775.7)	(77.6)	—	—	—
	20000	(1379)	(138.0)	15,000	(1034.2)	(103.5)	—	—	—

[a] PN is the pressure class designation utilized in ISO (International Standards Organization) documents. Tolerance on all test pressures is ±10 %.



SYSTEM USING A PUMP AS THE PRESSURE SOURCE



SYSTEM USING COMPRESSED GAS AS THE PRESSURE SOURCE

Key

1 pressure source
2 pressure regulator and relief
3 vessel for water
4 calibrated sight gauge
5 water supply
6 shutoff valve
7 pressure gauge
8 piping arranged to provide vapor trap
9 enclosure for test—horizontal clearance between any part of the valve and the closure shall be a minimum of 6 in. (152 mm)
10 minimum height of enclosure shall be 6 in. (152 mm) above the top of the valve
11. test valve mounted horizontally with stem in horizontal position
12 fuel gas supply to burners (see 2.2)
13 calorimeter—1.5 in. (38 mm) cubes (see 2.2)
14 flame temperature thermocouple (see 2.2)
15 pressure gauge and relief valve (if required—see 6.2) connected to center cavity of valve
16 shutoff valve
17 vent valve
18 condenser
19 calibrated container
20 check valve

Figure 4—Schematic of Suggested Sytems for Fire Test for Valves

3.1.7 At the end of the burn period (30 minutes), shut off the fuel.

3.1.8 Immediately determine the amount of water collected in calibrated container (Item 19) to establish total through valve seat leakage. Continue collecting water in the calibrated container (Item 19) for use in establishing the external leakage rate. If the test valve is of the upstream sealing type, the volume of water that is trapped between the upstream seat seal and the downstream seat seal, when the valve is closed, shall be determined before the test is started and identified in the test report. It is assumed that during the test this volume of water would move through the valve, past the downstream seat seal and be collected in the calibrated container. Since this volume has not actually leaked past the upstream seat seal, it may be deducted from the total volume measured in the downstream calibrated container when determining the through valve leakage.

NOTE If the total volume collected downstream during the burn and/or cooldown is less than the body cavity volume, the through leakage can be assumed to have been zero.

3.1.9 Cool the valve (or allow to cool) to 212 °F (100 °C) or less. Record reading on sight gauge (Item 4), and calibrated container (Item 19). Cooling may, at the manufacturer's option, be natural or forced.

3.1.10 The following low-pressure test is required only for API 6D valves with ratings of Class 600 and lower. Decrease the test pressure to the low test pressure value shown in Table 1. Measure the through valve and external leakage over a 5-minute period.

3.1.11 If the step in 3.1.10 was performed, increase pressure on test valve to the high test pressure value in Table 1.

3.1.12 Verify that backseating has occurred by monitoring for (and measuring) leakage at a test port above the backseat, for a period of 5 minutes.

3.1.13 Vent pressure.

NOTE Venting pressure is a change made for safety reasons, and may be omitted at the manufacturer's option, or for previously-qualified valve designs.

3.1.14 Rework the stuffing box as required. Rework shall be limited to replacement of packing and eutectic washer with parts of the same design and materials. Rework of the stuffing box may include the cleaning out of charred or burnt packing, and light honing or polishing of the sealing area of the stem and stuffing box.

3.1.15 Reapply pressure.

3.1.16 Open the test valve against the high test pressure differential. The valve shall be moved to a partly open (approximately half-way) position. Close the shutoff valve (Item 16). Vent the piping and test valve body cavity to remove air or steam.

3.1.17 Measure and record external leakage for a period of 5 minutes after valve is in the open position at high test pressure.

3.2 Test Adjustments

The stuffing box may be reworked per 3.1.13. No other part of the test valve may be adjusted during the test period. The test system may be adjusted during the test period to keep the test within the limits specified herein.

4 Performance Requirements

4.1 Through Leakage (High Test Pressure)—During Burn Period

The maximum through seat (does not include bonnet and stem) leakage shall not be greater than the value shown below (see 3.1.8.):

Burn Period 30 minutes

Rate 400 ml/in./min [1] (15.7 ml/mm/min)

4.2 External Leakage (High Test Pressure)—During Burn and Cooldown Period (Valve in Closed Position)

The maximum external leakage, not including seat leakage, shall not be greater than the value shown below (see 3.1.8 and 3.1.9):

Test Duration 30 minutes plus time to cool down to 212 °F (100 °C)

Rate 100 ml/in./min [1] (3.9 ml/mm/min)

4.3 Through Leakage (Low Test Pressure)—After Cooldown

The maximum through seat (does not include bonnet and stem) leakage shall not be greater than the value shown below (see 3.1.10):

Test Duration 5 minutes

Rate 40 ml/in./min [1] (1.6 ml/mm/min)

4.4 External Leakage (Low Test Pressure)—After Cooldown (Valve in Closed Position)

The maximum external leakage not including seat leakage shall not be greater than the value shown below (see 3.1.10):

Test Duration 5 minutes

Rate 20 ml/in./min [1] (0.8 ml/mm/min)

4.5 External Leakage (High Test Pressure)—During the Backseat Test and Rework of the Stuffing Box

After draining any water which may have entered the stuffing box before backseating was complete, no leakage is acceptable (see 3.1.12 and 3.1.13):

4.6 Operation of Test Valve After Fire Test

The valve shall be capable of being unseated from the closed position against high test pressure differential (see Table 1). The valve shall be moved to the open position one time (as specified in 3.1.14).

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[1] Leakage rates are milliliters per inch of nominal value size per minute (milliliters per milliliter of nominal value size per minute), averaged over the duration of the particular test period.

4.7 External Leakage—Open Position

With the test valve in the open position the external leakage (as determined in 3.1.15) shall not be greater than 200 ml/in./min (8 ml/mm/min).

4.8 Pressure Relief Provision

The valve fails the test if the pressure relief valve identified in the provision of 6.2 activates. However, if the relieving device activates in the test valve, which normally includes the pressure relieving device as standard, the test shall continue and any leakage through this device shall be counted as external leakage.

4.9 Tests Required

In lieu of testing each size and pressure rating of a given valve design, other valves of the same basic design as the test valve and same nonmetallic materials with respect to the seat to closure member seal, seat to body seal, stem seal, and body joint and seal, may be qualified, subject to the following limitations.

4.9.1 One test valve may be used to qualify valves larger than the test valve, not exceeding twice the size of the test valve (see Table 2). A size 16 valve will qualify all larger sizes.

4.9.2 One test valve may be used to qualify valves with higher pressure ratings but no greater than twice the pressure rating of the test valve (see Table 3).

Table 2—Qualification of Other Size Valves (See 4.9.1)

Size of Test Valve		Other Valve Sizes Qualified	
NPS	DN [a]	NPS	DN [a]
2 in. API 6D 1 13/16, 2 1/16 API 6A	50	2, 2 1/2, 3, 4 API 6D 1 13/16, 2 1/16, 2 9/16, 3 1/8, 4 1/16 API 6A	50, 65, 80, 100
2 9/16 API 6A 2 1/2 API 6D	65	2 9/16, 3 1/8, 4 1/16, 5 1/8 API 6A 2 1/2, 3, 4 API 6D	65, 80, 100, 125
3 API 6D 3 1/8 API 6A	80	3, 4, 6 API 6D 3 1/8, 4 1/16, 5 1/8, 7 1/16 API 6A	80, 100, 125, 150
4 API 6D 4 1/16 API 6A	100	4, 6, 8 API 6D 4 1/16, 5 1/8, 7 1/16 API 6A	100, 125, 150, 200
5 1/8 API 6A	125	5 1/8, 7 1/16, 9 API 6A 6, 8, 10 API 6D	125, 150, 200, 250
6 API 6D 7 1/16 API 6A	150	6, 8, 10, 12 API 6D 7 1/16, 9, 11 API 6A	150, 200, 250, 300
8 API 6D	200	8, 10, 12, 14, 16 API 6D 9, 11 API 6A	200, 250, 300, 350, 400
9 API 6A	N/A	9, 11 API 6A 8 through 16 API 6D	250 through 400
10 API 6D	250	10 through 20 API 6D 11 API 6A	250 through 500
11 API 6A	N/A	11 API 6A 10 through 20 API 6D	300 through 500
12 API 6D	300	12 through 24 API 6D	300 through 600
14 API 6D	350	14 through 28 API 6D	350 through 700
16 API 6D	400	16 and larger API 6D	400 and larger

[a] DN is the size designation utilized in ISO (International Standards Organization) documents.

Table 3—Qualification of Other Pressure Rating Valves (See 4.9.2)

Rating of Test Valve			Other Valve Ratings Qualified			
Class	PN [a]	Bar	Class or psi	PN [a]	MPa	Bar
150 API 6D	20	N/A	150; 300 API 6D	20, 50	N/A	N/A
300 API 6D	50	N/A	300; 400; 600 API 6D	50, 64, 110	N/A	N/A
400 API 6D	64	N/A	400; 600 API 6D	64, 110	N/A	N/A
600 API 6D	110	N/A	600; 900 API 6D 2000; 3000 API 6A	110, 150 N/A	N/A 13.8, 20.7	N/A 138, 207
900 API 6D	150	N/A	900; 1500 API 6D 3000 API 6A	150, 260 N/A	N/A 20.7	N/A 207
1500 API 6D	260	N/A	1500; 2500 API 6D 5000 API 6A	260, 420 N/A	N/A 34.5	N/A 345
2500 API 6D	420	N/A	2500 API 6D 10,000 API 6A	420 N/A	N/A 69.0	N/A 690
psi	MPa	Bar	psi or Class	PN [a]	MPa	Bar
2000 API 6A	13.8	138	2000; 3000 API 6A 900; 1500 API 6D	N/A 150, 260	13.8, 20.7 N/A	138, 207 N/A
3000 API 6A	20.7	207	3000; 5000 API 6A 1500; 2500 API 6D	N/A 260, 420	20.7, 34.5 N/A	207, 345 N/A
5000 API 6A	34.5	345	5000; 10,000 API 6A 2500 API 6D	N/A 420	34.5, 69.0 N/A	345, 690 N/A
10,000 API 6A	69.0	690	10,000; 15,000; 20,000 API 6A	N/A	69.0, 103.5 138.0	690, 1034, 1379
15,000 API 6A	103.5	1 034	15,000; 20,000 API 6A	N/A	103.5, 138.0	1034, 1379
20,000 API 6A	138.0	1 379	20,000 API 6A	N/A	138.0	1379

[a] PN is the pressure class designation utilized in ISO (International Standards Organization) documents.

4.9.3 The nominal size of the test valve is determined by the size of the end connections.

4.9.4 Valves with asymmetric internal or external body construction (exclusive of the end connections), and/or asymmetric seats and closure mechanism, intended for bi-directional installation shall be qualified by conducting the test procedure twice, once in each direction of potential installation. Asymmetric valves intended for single direction installation shall be marked accordingly and shall be tested in the direction of recommended installation.

4.9.5 Valves shall not be protected with insulation material of any form during testing, except where such protection is part of the design of the component.

5 Certification

Records of the test upon which certifications are based shall be available for purchasers review at his request.

6 Safety Considerations

6.1 Personnel Protection

Because of the possible design of the test valve and the nature of the test program, the potential may exist for a hazardous rupture of the pressure boundary components. Protection for test personnel shall be provided.

6.2 Pressure Relief Provision

Provision of a pressure relief valve to atmosphere to protect the body cavity of double-seated valves against potential rupture shall be considered. Determination of the set pressure is the responsibility of the test valve manufacturer. The set pressure shall be low enough to preclude rupture of the valve at expected test temperatures.

7 Equipment Marking

In addition to the marking requirements specified in API 6A or API 6D, valves which have been qualified by this specification shall be permanently marked:

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Shipping (U.S. Orders) – Orders shipped within the U.S. are sent via traceable means. Most orders are shipped the same day. Subscription updates are sent by First-Class Mail. Other options, including next-day service, air service, and fax transmission are available at additional cost. Call 1-800-854-7179 for more information.

Shipping (International Orders) – Standard international shipping is by air express courier service. Subscription updates are sent by World Mail. Normal delivery is 3-4 days from shipping date.

Rush Shipping Fee – Next Day Delivery orders charge is $20 in addition to the carrier charges. Next Day Delivery orders must be placed by 2:00 p.m. MST to ensure overnight delivery.

Returns – All returns must be pre-approved by calling the IHS Customer Service Department at 1-800-624-3974 for information and assistance. There may be a 15% restocking fee. Special order items, electronic documents, and age-dated materials are non-returnable.

THERE'S MORE WHERE THIS CAME FROM.

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