Specification for Fire Test for Valves

API SPECIFICATION 6FA
THIRD EDITION, APRIL 1999

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Specification for Fire Test for Valves

Upstream Segment

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FOREWORD

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

b. This standard covers the requirements for testing and evaluating the performance of API Spec 6A and 6D valves when exposed to specifically defined fire conditions.

c. This standard is not intended to cover check valves.

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

e. Other standards under the jurisdiction of this committee include:

Spec 6A: *Specification for Wellhead and Christmas Tree Equipment*

Bull 6AF: *Bulletin on Capabilities of API Flanges Under Combinations of Load*

Bull 6AF1: *Bulletin on Temperature Derating of API Flanges Under Combination of Loading*

Spec 6D: *Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves)*

Spec 6FB: *Specification for Fire Test for End Connections*

Spec 6FC: *Specification for Fire Test for Valves with Automatic Backseats*

TR 6F1: *Performance of API and ANSI End Connections in a Fire Test According to API Spec 6FA*

TR 6F2: *Fire Resistance Improvements for API Flanges*

f. Conversions of English units to International System (SI) metric units are provided throughout the text of this specification in parentheses, e.g., 6 in. (152.4 mm). Note that the comma is used as a decimal marker for metric data, SI equivalents have also been included in all tables. English units are in all cases preferential and shall be the standard in this specification. The factors used for conversion of English 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 square inch (psi) = 0,06894757 Bar = 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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Asbestos is specified or referenced for certain components of the equipment described in some API standards. It has been of extreme usefulness in minimizing fire hazards associated with petroleum processing. It has also been a universal sealing material, compatible with most refining fluid services.

Certain serious adverse health effects are associated with asbestos, among them the serious and often fatal diseases of lung cancer, asbestosis, and mesothelioma (a cancer of the chest and abdominal linings). The degree of exposure to asbestos varies with the product and the work practices involved.

Consult the most recent edition of the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor, Occupational Safety and Health Standard for Asbestos, Tremolite, Anthophyllite, and Actinolite, 29 *Code of Federal Regulations* Section 1910.1001; the U.S. Environmental Protection Agency, National Emission Standard for Asbestos, 40 *Code of Federal Regulations* Sections 61.140 through 61.156; and the U.S. Environmental Protection Agency (EPA) rule on labeling requirements and phased banning of asbestos products (Sections 763.160-179).

There are currently in use and under development a number of substitute materials to replace asbestos in certain applications. Manufacturers and users are encouraged to develop and use effective substitute materials that can meet the specifications for, and operating requirements of, the equipment to which they would apply.

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Specification for Fire Test for Valves

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 6D 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.

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 1,400°F–1,800°F (761°C–980°C) average of two thermocouples, located as shown in Figures 1 or 2. No reading shall be below 1,300°F (704°C). The test set-up shall include $1^1/_2$- in. cube calorimeter blocks made of carbon steel with a thermocouple located in the center of each block (refer to Figure 3 for calorimeter block configuration). For API 6A valves size $7^1/_{16}$-in. and smaller, and API 6D valves size 6 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 one in. (25 mm) nominal pipe size or one-half of valve nominal pipe size (whichever is smaller) must be enveloped in flame for a distance of at least six 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 4.6. For the test, it may be necessary to modify this joint to eliminate leakage.

3 Test Procedure

3.1 STEPWISE PROCEDURES (REFER TO FIGURE 4)

3.1.1 Open valve(s) (Item 5 and 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

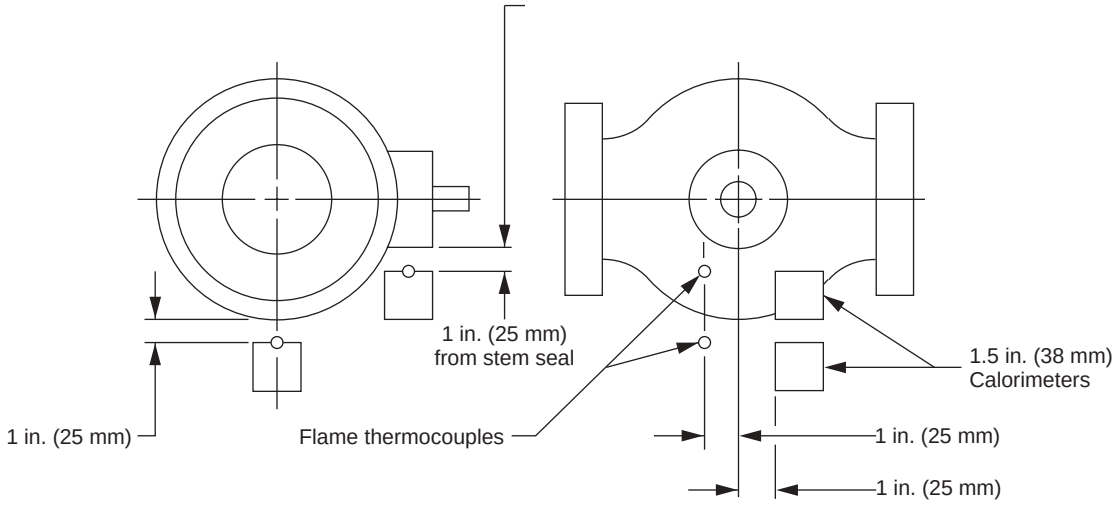


Figure 1—Location of Calorimeters Smaller Valves (Reference 2.2)

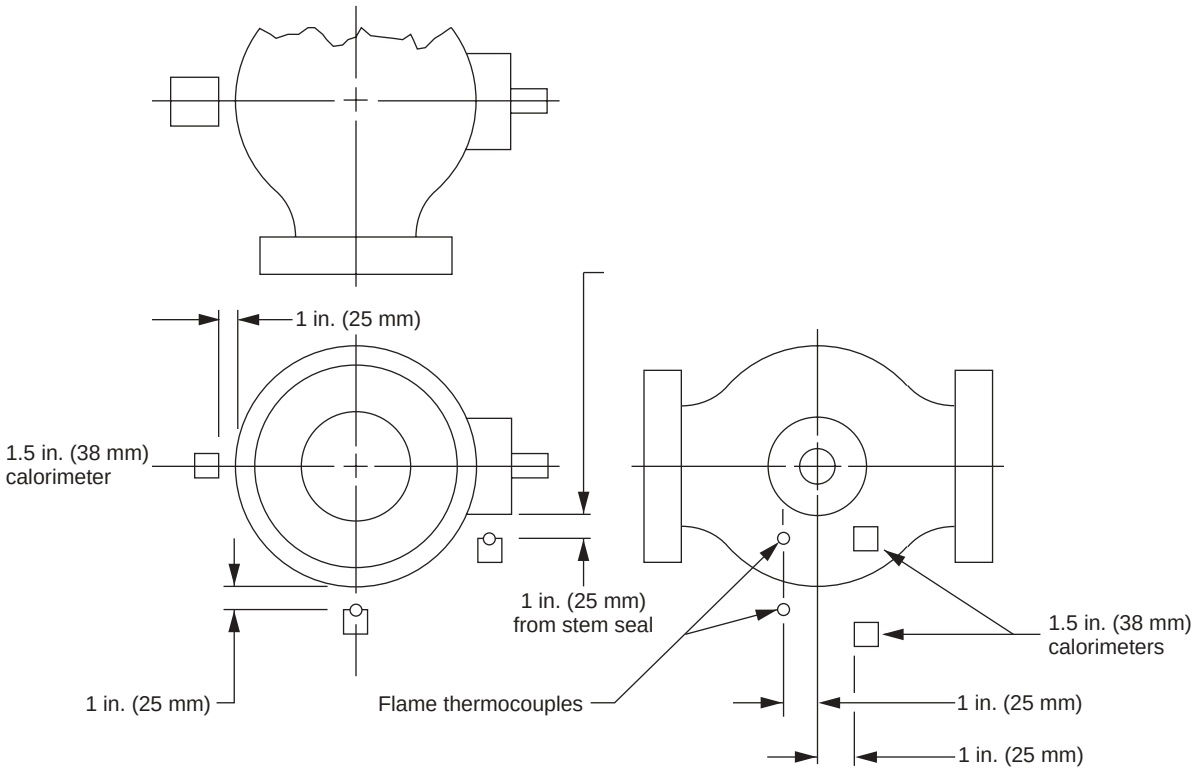


Figure 2—Location of Calorimeters Larger Valves (References 2.2)

burn and cool-down 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 a monitor the flame temperature. The average of two thermocouples (Item 14) must reach 1,400°F (761°C) within two minutes. Maintain the average temperature between 1,400°F–1,800°F (761°C–980°C), with no reading less than 1,300°F (704°C) for the remainder of the burn period.

3.1.5 The average temperature of the calorimeters (Item 13) shall reach 1,200°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 1,200°F (650°C) and none of the calorimeters shall have a temperature less than 1,050°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 temperatures 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 (Items 7, 13, 14, and 15) every 30 seconds during the burn period.

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.

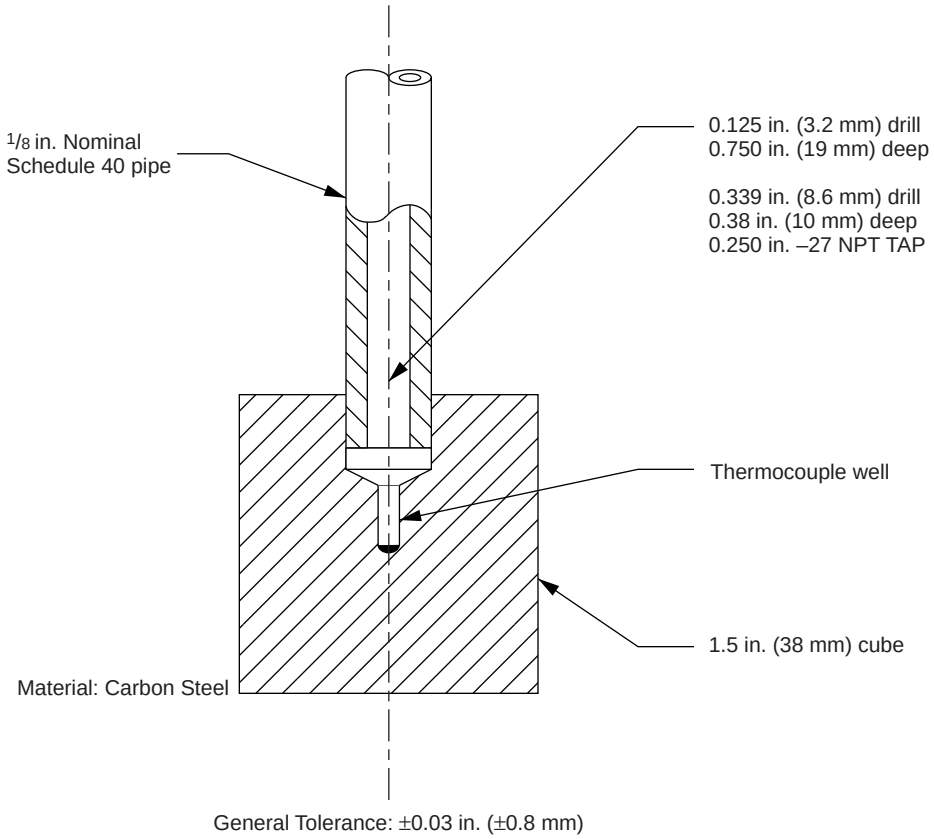


Figure 3—Calorimeter Cube Design (Reference 2.2)

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 valve shown in Table 1. Measure the through valve and external leakage over a 5 minute period.

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

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

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

3.2 TEST ADJUSTMENTS

The test system, excluding the test valve, 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 leakage shall not be greater than the value shown below (refer to 3.1.8):

Burn Period	30 minutes
Rate	400 ml/in./min[1]
	(15.7 ml/mm/min)

[1]Leakage rates are milliliters per inch of nominal valve size per minute (milliliters per millimeter of nominal valve size per minute), averaged over the duration of the particular test 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	150	(20)	–	210	(14,5)	(1,5)	29	(2,0)	(0,2)
Valves	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	2000	(138)	(13,8)	1500	(103,4)	(10,3)	–	–	–
Valves	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)	11250	(775,7)	(77,6)	–	–	–
	20000	(1379)	(138,0)	15000	(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%.

4.2 EXTERNAL LEAKAGE (HIGH TEST PRESSURE)—DURING BURN AND COOL-DOWN PERIOD (VALVE IN CLOSED POSITION)

The maximum external leakage shall not be greater than the value shown below (refer to 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 COOL-DOWN

The maximum through seat leakage shall not be greater than the valve shown below (refer to 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 COOL-DOWN (VALVE IN CLOSED POSITION)

The maximum external leakage shall not be greater than the value shown below (refer to 3.1.10):

Test Duration	5 minutes
Rate	20 ml/in./min[1] (0.8 ml/mm/min)

4.5 OPERATION OF TEST VALVE AFTER FIRE TEST

The valve shall be capable of being unseated from the closed position against high test pressure differential (Table 1). The valve shall be moved to the open position one time (as specified in 3.1.12).

4.6 EXTERNAL LEAKAGE—OPEN POSITION

With the test valve in the open position the external leakage (as determined in 3.1.13) shall not be greater than 200 ml/in./min (8 ml/mm/min).

4.7 PRESSURE RELIEF PROVISION

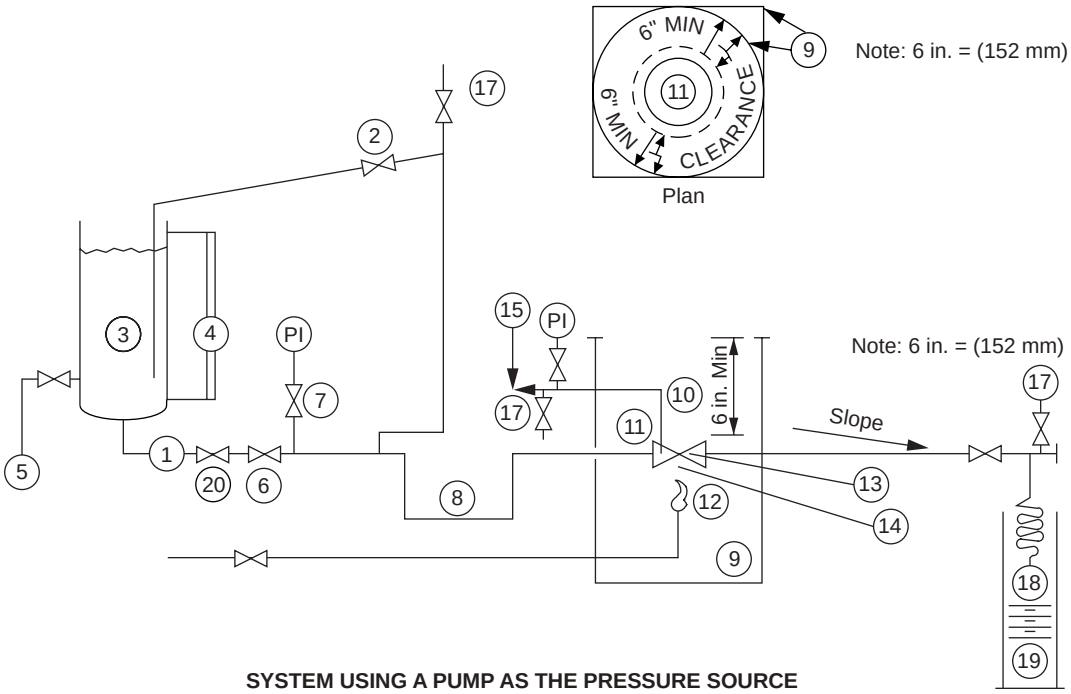
The valve fails the test if the pressure relief valve identified in the provision of 6.2 activates. However, if the relieving device activates in the test valve which normally includes the pressure relieving device as standard, the test shall continue and any leakage through this device shall be counted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

4.8 TESTS REQUIRED

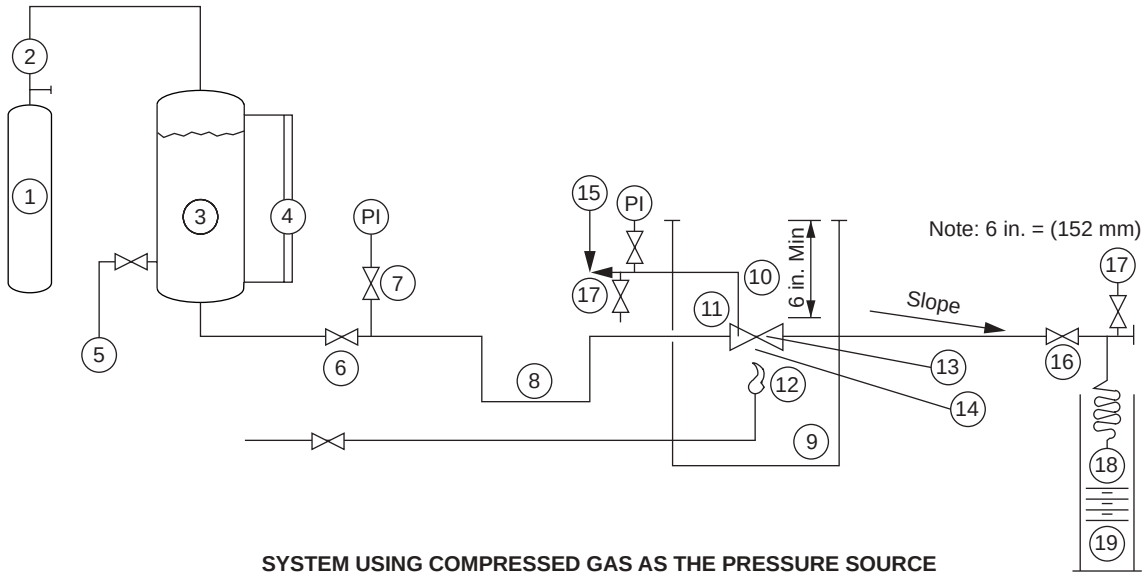
In lieu of testing each size and pressure rating of a given valve design, other valves of the same basic design as the test valve and same nonmetallic materials with respect to the seat to closure member seal, seat to body seal, stem seal and body joint and seal, may be qualified, subject to the following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

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

4.8.2 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 (refer to Table 3).



SYSTEM USING A PUMP AS THE PRESSURE SOURCE



SYSTEM USING COMPRESSED GAS AS THE PRESSURE SOURCE

Legend

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 (Ref. 2.2).
13. Calorimeter—1 1/2 in. cubes (Ref. 2.2).
14. Flame temperature thermocouple (Ref. 2.2).
15. Pressure gauge and relief valve (if required—Ref. 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 Systems for Fire Test for Valves

Table 2—Qualification of Other Size Valves
(refer to 4.8.1)

Size of Test Valve		Other Valve Sizes Qualified	
NPS	DN[a]	NPS	DN[a]
2" 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.

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

4.8.4 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.

4.8.5 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 certification are based shall be available for purchaser's 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 PROVISIONS

Provision of a pressure relief valve to atmosphere to protect the body cavity of double-seat 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 Section 6A or 6D, valves which have been qualified by this specification shall be permanently marked:

6FA

Table 3—Qualification of Other Pressure Rating Valves
(refer to 4.8.2)

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; 2 000; 3 000 API 6A	110, 150 N/A	N/A 13.8, 20.7	N/A 138, 207
900 API 6D	150	N/A	900; 1 500 API 6D; 3 000 API 6A	150, 260 N/A	N/A 20.7	N/A 207
1 500 API 6D	260	N/A	1 500; 2 500 API 6D; 5 000 API 6A	260, 420 N/A	N/A 34.5	N/A 345
2 500 API 6D	420	N/A	2 500 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
2 000 API 6A	13.8	138	2 000; 3 000 API 6A; 900; 1 500 API 6D	N/A 150, 260	13.8, 20.7 N/A	138, 207 N/A
3 000 API 6A	20.7	207	3 000; 5 000 API 6A; 1 500; 2 500 API 6D	N/A 260, 420	20.7, 34.5 N/A	207, 345 N/A
5 000 API 6A	34.5	345	5 000;10 000 API 6A; 2 500 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, 1 034 1379
15 000 API 6A	103.5	1 034	15 000; 20 000 API 6A	N/A	103.5, 138.0	1 34, 1 379
20 000 API 6A	138.0	1 379	20 000 API 6A	N/A	138.0	1 379

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

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1220 L Street, Northwest
Washington, D.C. 20005-4070
202-682-8000

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