Specification for Fire Test for Check Valves

API SPECIFICATION 6FD
FIRST EDITION, FEBRUARY 15, 1995

STEP
Strategies for Today's Environmental Partnership

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

STEP

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Exploration and Production Department

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CONTENTS

FOREWORD

This Specification is under the jurisdiction of the API Committee on Standardization of Valves and Wellhead Equipment. This edition of Spec 6FD is the first edition and was approved by letter ballot in September 1994.

Other standards under the jurisdiction of this committee include:

API

Spec 6A	Specification for Wellhead and Christmas Tree Equipment.
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.
Bul 6AF	Bulletin on Capabilities of API Flanges Under Combinations of Load.
Bul 6AF1	Bulletin on Temperature Derating of API Flanges Under Combination of Loading.
Bul 6F1	Performance of API and ANSI End Connections in a Fire Test According to API Spec 6FA.
Bul 6F2	Fire Resistance Improvements for API Flanges.

This specification shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution.

IMPORTANT INFORMATION CONCERNING USE OF ASBESTOS OR ALTERNATIVE MATERIALS

Asbestos is specified or referenced for certain components of the equipment described in some API standards. It has been of great usefulness in minimizing fire hazards associated with petroleum processing. It has also been a universal sealing material, compatible with most petroleum 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 U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Health Standard for Asbestos, *29 Code of Federal Regulations* Section 1910:1001; the U.S. Environmental Protection Agency's National Emission Standard for Hazardous Air Pollutants concerning Asbestos, 40, *Code of Federal Regulations* Section 61.140 through 61.156; and the U.S. Environmental Protection Agency (EPA) labeling requirements and phased banning of asbestos products, published at 54 *Federal Register* 29460-29513 (July 12, 1989) 40CFR763.160-179.

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 which can meet the specifications for, and operating requirements of, the equipment to which they would apply.

Safety and health information with respect to particular products or materials can be obtained from the employer, the manufacturer or supplier of that product or material, or the material safety data sheet.

Specification for Fire Test for Check Valves

1 Scope

It is the purpose of this document to establish the requirements for testing and evaluating the pressure containing performance of API Spec 6A and 6D check 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 of 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 its normal operating position, with water as the test medium, and pressurized from the normally downstream end.

2.2 The valve will be enveloped in flame having a temperature of 1400-1800°F (761 to 980°C) average of two thermocouples located as shown in Figure 1 through 4. The test setup shall include $1^1/_2$" (38 mm) cube calorimeter blocks made of carbon steel with a thermocouple located in the center of each block (Refer to Figure 5 for calorimeter block configuration). For API Spec 6A valves size $7^1/_{16}$" and smaller and API Spec 6D valves size 6" and smaller, two blocks shall be located as shown in Figures 1 or 3. For larger size valves, three blocks shall be used, as shown in Figures 2 or 4. Piping upstream of the test valve larger than one inch (25 mm) nominal pipe size or one-half of valve nominal size (whichever is smaller) must be enveloped in flame for a distance of at least six inches (152 mm).

2.3 The burn period shall 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 Paragraphs 4.2, 4.4, and 4.6. For the test, it may be necessary to modify this joint to eliminate leakage.

3 Test Procedure (Refer to Figure 6)

3.1 Open valves (Items 15, 21, 22, 23, 24, and 25). Close valves (Items 16 and 17). Open valves (Items 5 and 6) to flood the system and purge the air.

3.2 Close fill valve (Item 5) and valves (Items 15, 22, 23, 24, and 25). Open the downstream shutoff valve (Item 16) The piping system upstream of the test valve shall be

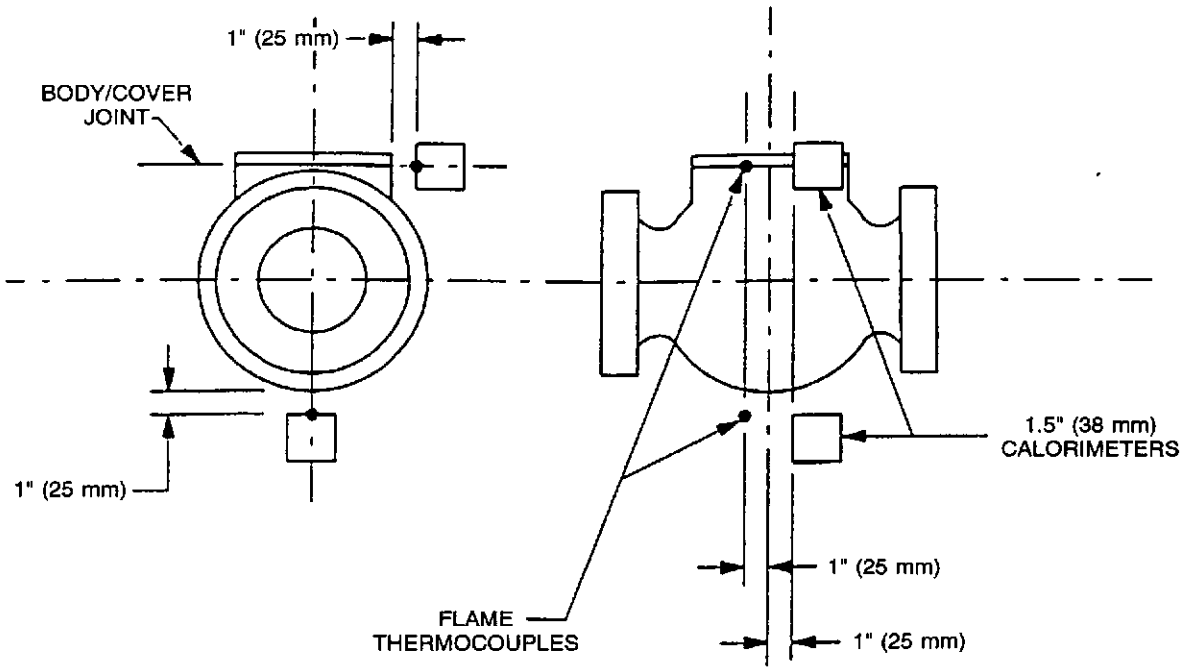


Figure 1—Location of Thermocouples and Calorimeters—Smaller Flanged Check Valves

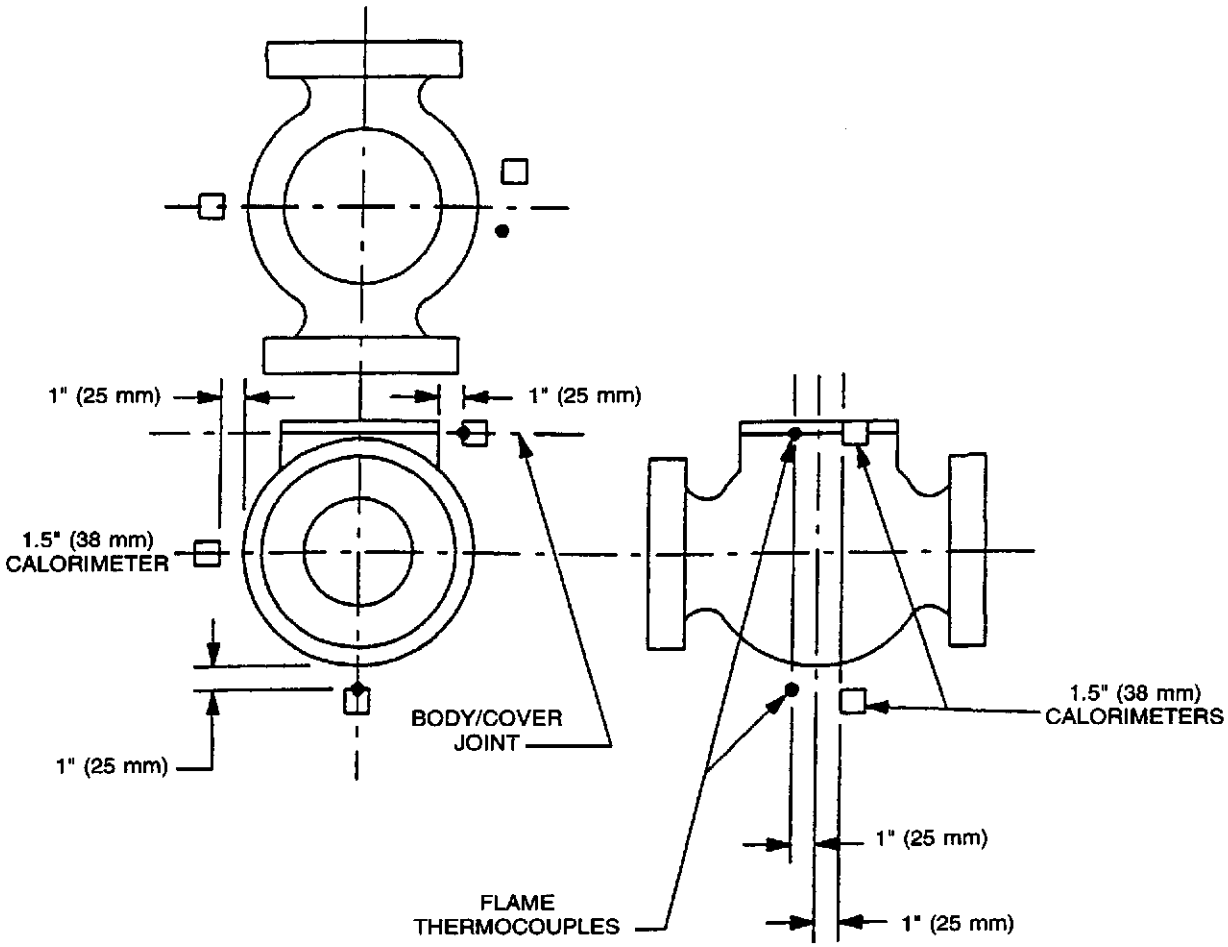


Figure 2—Location of Thermocouples and Calorimeters—Larger Flanged Check Valves

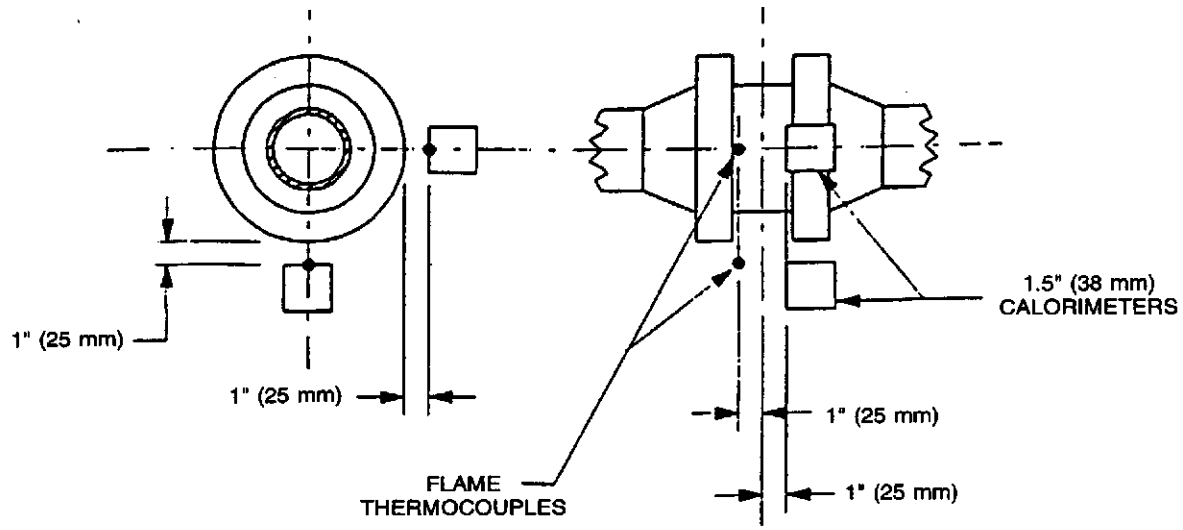


Figure 3—Location of Thermocouples and Calorimeters—Smaller Wafer Type Check Valves

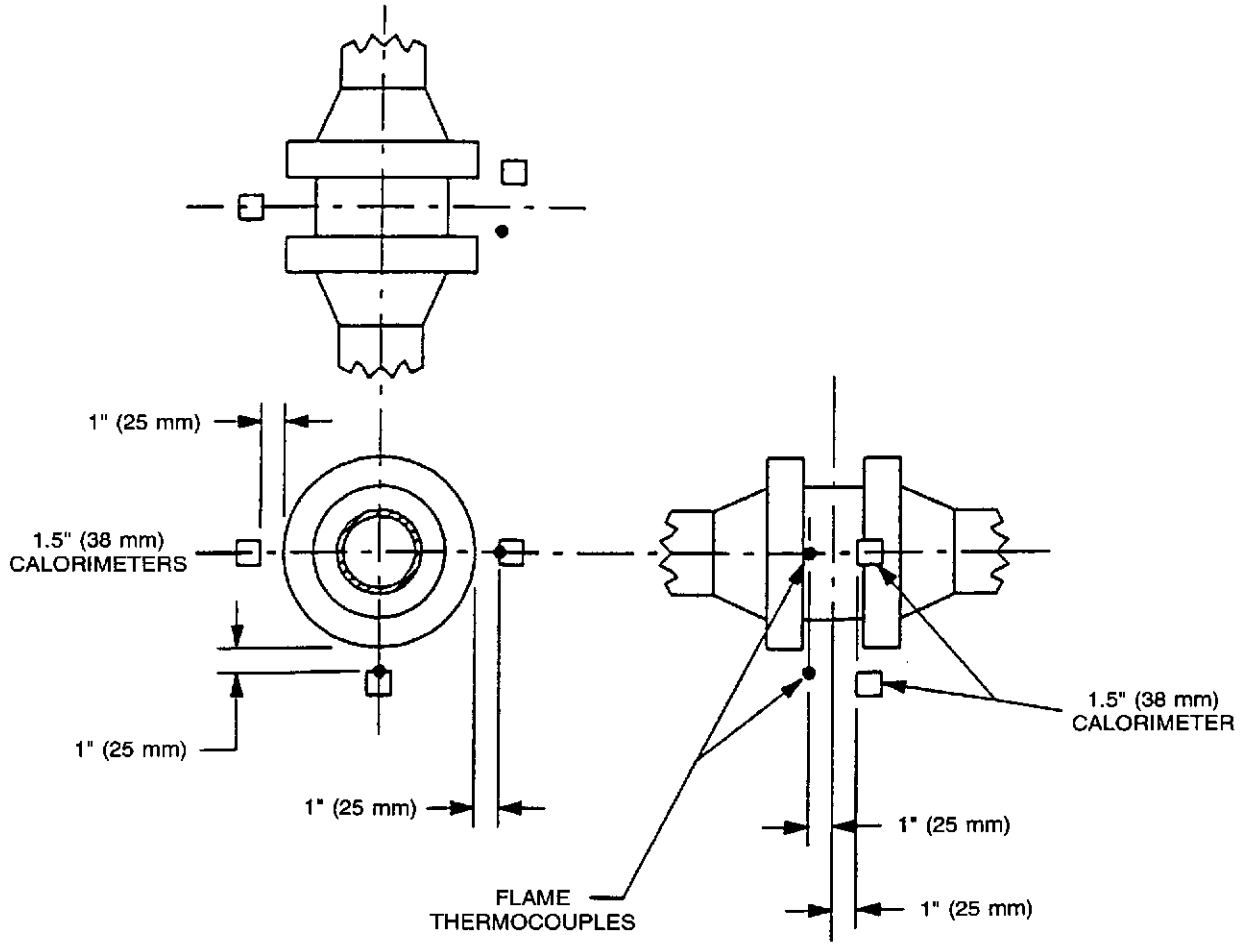


Figure 4—Location of Thermocouples and Calorimeters—Larger Wafer Type Check Valves

pletely water filled and the system downstream shall be drained.

3.3 Pressurize the system to the appropriate high test pressure from Table 1. Maintain this pressure during the 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).

3.4 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 1400-1800°F (761-980°C), with no reading less than 1300°F (704°C) for the remainder of the burn period.

3.5 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) with no reading 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 and provided that at least one flame thermocouple and one calorimeter are functioning.

3.6 Record instrument readings (Items 7, 13, and 14) at least every 30 seconds during the test period.

3.7 At the end of the burn period (30 minutes from ignition), shutoff the fuel supply.

3.8 Immediately determine and record the amount of water collected in the calibrated container (Item 19) to establish the total through valve seat leakage. Continue collecting water in the calibrated container for use in establishing the external leakage rate.

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

Table 1—Test Pressure During Fire Test

	Class	Valve Rating (PN*)		High Test Pressure psi	(bar)	(MPa)	Low Test Pressure 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)	11250	(775,7)	(77,6)	—	—	—
	20000	(1379)	(138,0)	15000	(1034,2)	(103,5)	—	—	—

Note: Tolerance on all test pressures is ± 10%.
*"PN" is the pressure class designation utilized in ISO (International Standards Organization) documents.

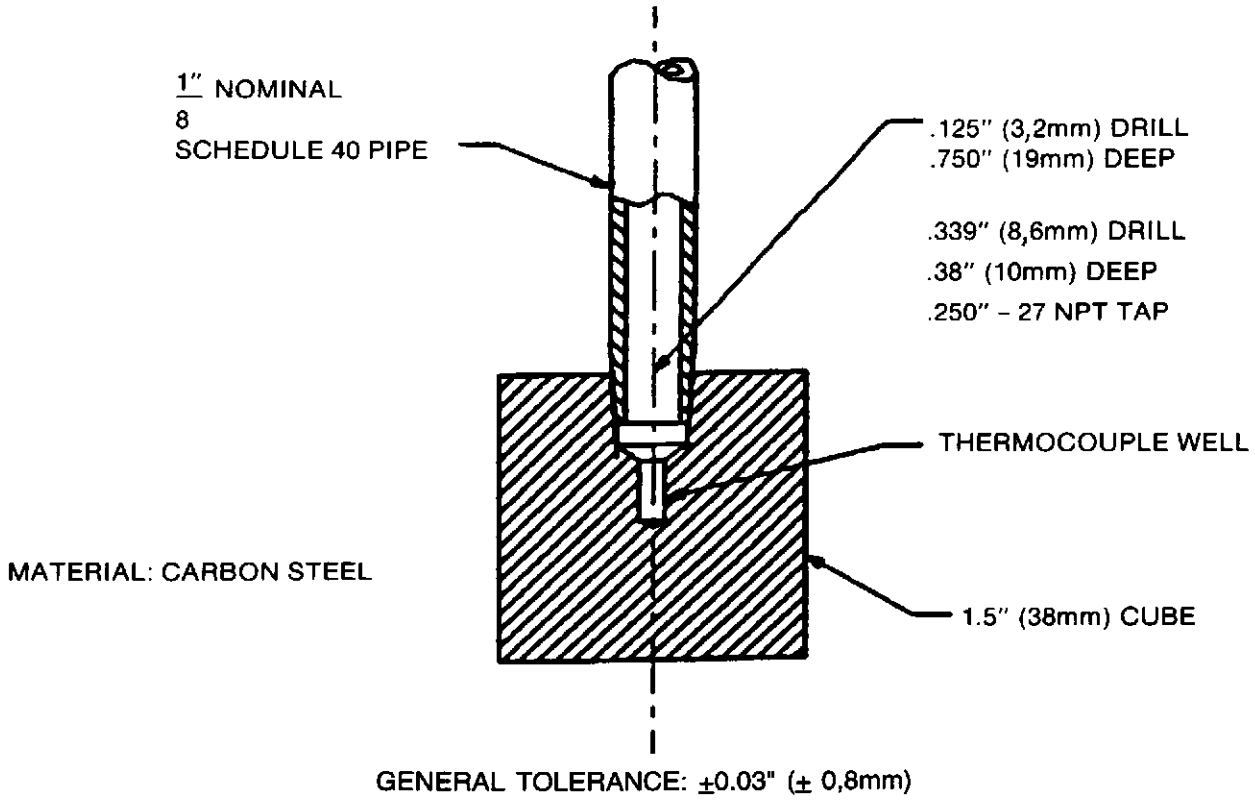
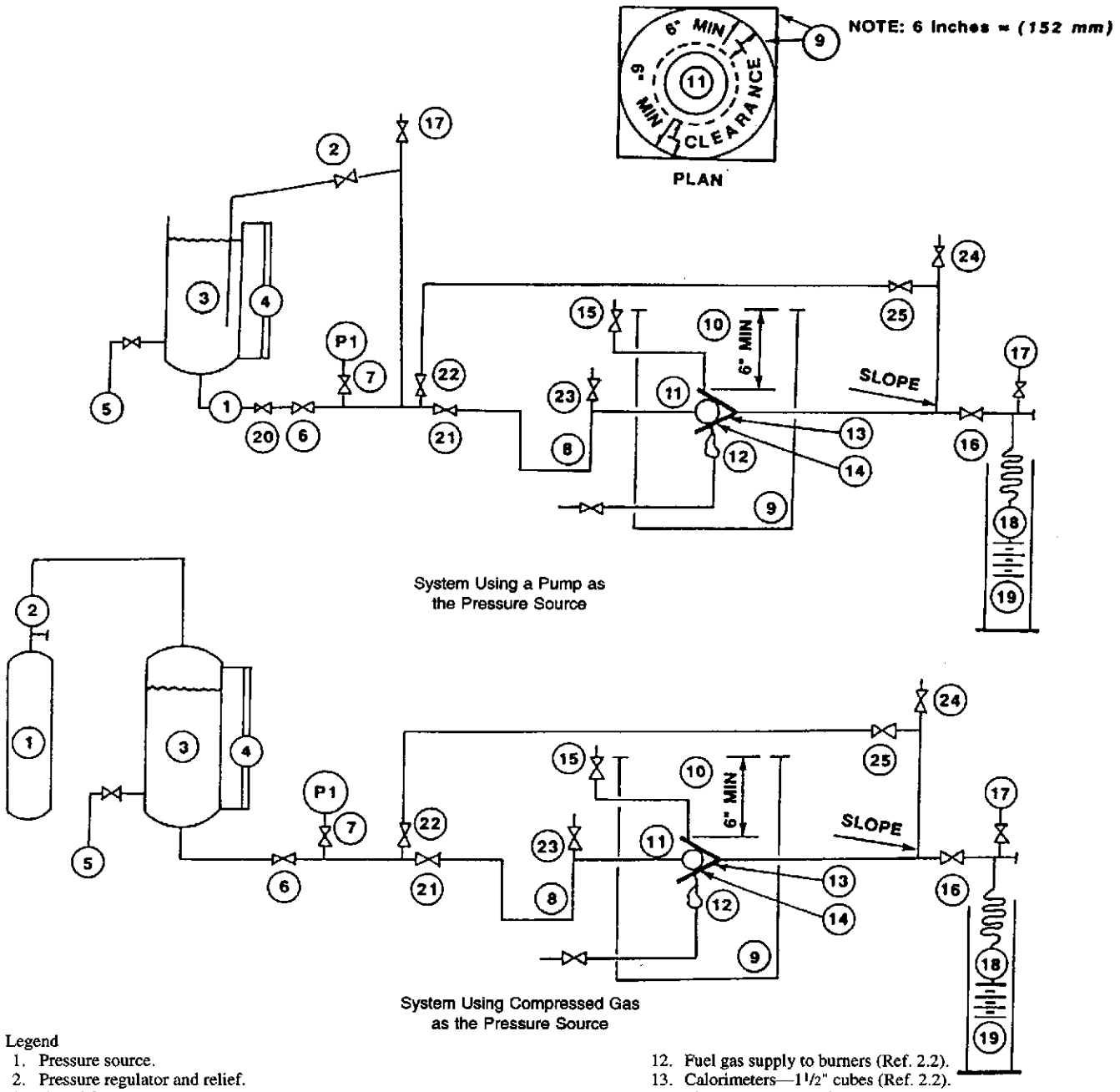


Figure 5—Calorimeter Cube Design



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 enclosure shall be a minimum of 6 inches (152 mm).
10. Minimum height of enclosure shall be 6 inches (152 mm) above the top of the valve.
11. Test valve mounted in its normal operating position.
12. Fuel gas supply to burners (Ref. 2.2).
13. Calorimeters—1 1/2" cubes (Ref. 2.2).
14. Flame temperature thermocouples (Ref. 2.2).
15. Vent valve on test valve body cavity.
16. Shutoff valve.
17. Vent valve.
18. Condenser.
19. Calibrated container.
20. Check valve.
21. Shutoff valve.
22. Shutoff valve.
23. Vent valve.
24. Vent valve.
25. Shutoff valve.

Figure 6—Schematic of Suggested Systems for Fire Test for Check Valves

3.10 This step is required only for API Spec 6D valves with ratings of class 600 and lower. Decrease the test pressure to the low test pressure value shown in Table 1. Measure and record the through valve and external leakages over a 5-minute period.

3.11 Decrease the test pressure to 1% or less of the valve's rated room temperature pressure.

3.12 While maintaining the test pressure of Step 3.11, vent air or steam at vent valves (Items 15 and 23).

3.13 Close the downstream shutoff valve (Item 16).

3.14 Open valves (Items 22, 24, and 25) to water fill and purge air from the downstream piping, then close the vent valve (Item 24).

3.15 Close the shutoff valve (Item 21), to isolate the pressure source from the upstream end of the test valve (Item 11).

3.16 Open the upstream vent valve (Item 23). Verify that the test valve has unseated, by observation of steady flow through the vent valve, then close the vent valve.

3.17 Increase the pressure at the source (Item 1) to the high test pressure shown in Table 1. Verify pressurization of the entire test valve body by briefly opening the body cavity vent valve (Item 15), and observing flow.

3.18 Measure and record the external leakage over a 5-minute period while at the high test pressure.

3.19 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—DURING BURN PERIOD (HIGH TEST PRESSURE)

The maximum through seat leakage shall not be greater than the value shown below (Ref. 3.8):

Burn Period	30 minutes
Rate	400 ml/in/min*
	(15.7 ml/mm/min)

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

The maximum external leakage shall not be greater than the value shown below (Ref. 3.9):

Test Duration	30 Minutes plus time to cool-down to 212°F (100°C)
Rate	100 ml/in/min*
	(3.9 ml/mm/min)

4.3 THROUGH LEAKAGE—AFTER COOL-DOWN (LOW TEST PRESSURE)

The maximum through seat leakage shall not be greater than the value shown below (Ref. 3.10):

Test Duration	5 Minutes
Rate	40 ml/in/min*
	(1.6 ml/mm/min)

4.4 EXTERNAL LEAKAGE—AFTER COOL-DOWN (LOW TEST PRESSURE)

The maximum external leakage shall not be greater than the value shown below (Ref. 3.10):

Test Duration	5 Minutes
Rate	20 ml/in/min*
	(0.8 ml/mm/min)

*Note: Leakage rates are milliliters per inch of nominal valve size per minute (milliliters per millimeter of nominal valve size per minute), average over the duration of the particular test period.

4.5 OPERATION OF VALVE AFTER FIRE TEST

The valve shall be capable of being unseated from the closed position one time (Ref. 3.16).

4.6 EXTERNAL LEAKAGE—OPEN POSITION (HIGH TEST PRESSURE)

With the test valve unseated, measure and record the external leakage, per Paragraph 3.18. The leakage shall not be greater than 200 ml/in/min (8 ml/mm/min).

4.7 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, and body joint and seal, may be qualified, subject to the following limitations:

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

4.7.2 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 (Ref. Table 3).

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

4.7.4 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 purchaser's review on request.

6 Safety Considerations

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.

7 Equipment Marking

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

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Table 2—Qualification of Other Size Valves (Ref. 4.7.1)

Size of Test Valve		Other Valve Sizes Qualified	
NPS	DN*	NPS	DN*
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 24 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

*"DN" is the size designation utilized in ISO (International Standards Organization) documents.

Table 3—Qualification of Other Pressure Rating Valves (Ref. 4.7.2)

Rating of Test Valve			Other Valve Ratings Qualified			
Class	PN*	Bar	Class or psi	PN*	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, 10000 API 6A	420 N/A	N/A 69.0	N/A 690
psi	MPa	Bar	psi or Class	PN*	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, 10000 API 6A, 2500 API 6D	N/A 420	34.5, 69.0 N/A	345, 690 N/A
10000 API 6A	69.0	690	10000, 15000, 20000 API 6A	N/A	69.0, 103.5 138.0	690, 1 034, 1 379
15000 API 6A	103.5	1 034	15000, 20000 API 6A	N/A	103.5, 138.0	1 034, 1 379
20000 API 6A	138.0	1 379	20000 API 6A	N/A	138.0	1 379

*"PN" is the pressure class designation utilized in ISO (International Standards Organization) documents.

APPENDIX A—CONVERSIONS OF ENGLISH UNITS TO SI METRIC UNITS

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 are listed below:

Table A-1—SI Units

Quanity	U.S. Customary	SI Unit
Length	1 inch (in.)	25,4 millimetres (mm) exactly
Pressure	1 pound per square inch (psi)	0,06894757 Bar 0,006894757 MPa
Temperature	The following formula was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C): °C = 5/9 (°F -32)	

In addition to the above conversions, the designations PN for nominal pressure and DN for nominal size are sometimes used. For the purpose of this specification, the PN designations relate to pressure classes, and the DN designations relate to NPS, or nominal pipe sizes, as follows:

Class 150 = PN 20 Class 300 = PN 50
Class 400 = PN 64 Class 600 = PN 110
Class 900 = PN 150 Class 1500 = PN 260
Class 2500 = PN 420

NPS 2 = DN 50 NPS 2½ = DN 65
NPS 3 = DN 80 NPS 4 = DN 100

For NPS 4 and greater listed sizes, multiply the NPS by 25 to obtain the DN, except that there is no equivalent DN for NPS 36.

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