Fire Test for Soft-Seated Quarter-Turn Valves

API STANDARD 607
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American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

FOREWORD

This standard covers the requirements for testing and evaluating the performance of soft-seated quarter-turn valves when exposed to specifically defined fire conditions. The performance requirements listed in this document establish standard limits of acceptability. The purchaser may wish to establish more stringent requirements to meet his specific applications.

Those testing valves in accordance with this standard are encouraged to submit the data gathered during tests performed, together with their suggested revisions to this standard, to the director of the Refining Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Fire Test for Soft-Seated Quarter-Turn Valves

SECTION 1—GENERAL

1.1 Scope

1.1.1 This standard covers the requirements for testing and evaluating the performance of soft-seated quarter-turn valves when exposed to a fire, as defined in this standard. The procedure applies to all classes and sizes of such valves.

1.1.2 Requirements for more, or less, severe testing may be established by agreement between the manufacturer and the purchaser.

1.1.3 The performance requirements described in this standard establish standard limits of acceptability.

1.1.4 The maximum acceptable leakage rates given in this standard are for the test temperatures and pressures specified. Rates at other temperatures or other pressures may be substantially different.

1.2 Referenced Publication

The latest edition or revision of the following standard shall, to the extent specified in this standard, form a part of this standard.

ANSI[1]

B16.34 *Valves, Flanged and Butt-Welding End—Steel, Nickel Alloy, and Other Special Alloys*

1.3 Basis of Fire Test

This test procedure is intended to simulate circumstances that will impose severe demands on a valve. This intent is met by the test conditions listed in 1.3.1 through 1.3.4.

1.3.1 The valve shall be filled with water and tested in the closed position. This may create substantially higher pressures inside the valve body cavity compared with testing the valve in an open position. The safety provisions recommended in 1.4.7 may be necessary.

1.3.2 The test apparatus shall be arranged or installed to provide a vapor trap that minimizes the cooling effect of the upstream liquid (see Section 2).

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

1.3.4 Potential piping-to-valve end-connection joint leakage (flanged, threaded, or welded) is not evaluated as part of this test and is not included in the allowable external leakage specified in 4.2. For the purposes of this test, it may be necessary to modify these joints to eliminate leakage.

1.4 Test Conditions

1.4.1 The valve shall not be protected with insulating material in any way during the test.

1.4.2 The valve shall be tested with the stem and bore horizontal.

1.4.3 The valve shall be enveloped in flame having a temperature of 1400 to 1800 F (760 to 980 C) for 30 minutes (see 1.4.5 for minimum calorimeter temperature). The flame temperature shall be the average of at least two thermocouple readings with no reading less than 1300 F (705 C). One thermocouple shall be located 1 inch (25 millimeters) beneath the valve body and the other within a 1-inch (25-millimeter) radius of the stem seal as shown in Figures 1 and 2.

1.4.4 The test setup shall include 1½-inch (38-millimeter) cube calorimeter blocks constructed in accordance with Figure 3. The blocks shall be made of carbon steel with the sensing zone of a thermocouple located in the center. For valves NPS 6 and smaller, two blocks shall be located as shown in Figure 1. For valves NPS 8 and larger, three blocks shall be used as shown in Figure 2.

1.4.5 During the 30-minute flame exposure period, the average temperature of the calorimeters shall reach 1200 F (650 C) in 15 minutes or less. During the remainder of the 30-minute test, the calorimeters shall maintain a minimum average temperature of 1200 F (650 C). None of the calorimeters shall have a temperature of less than 1050 F (565 C).

[1]American National Standards Institute, 1430 Broadway, New York, New York 10018.

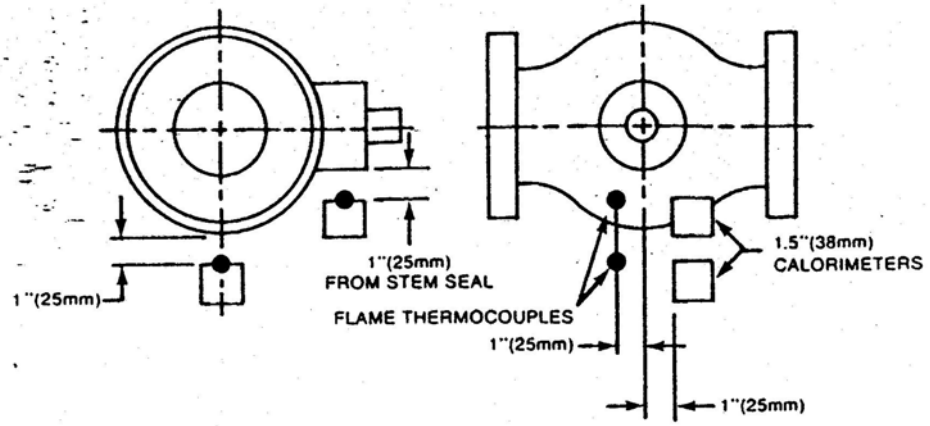


Figure 1—Installation of Temperature Measurement Sensors (NPS 6 and Smaller)

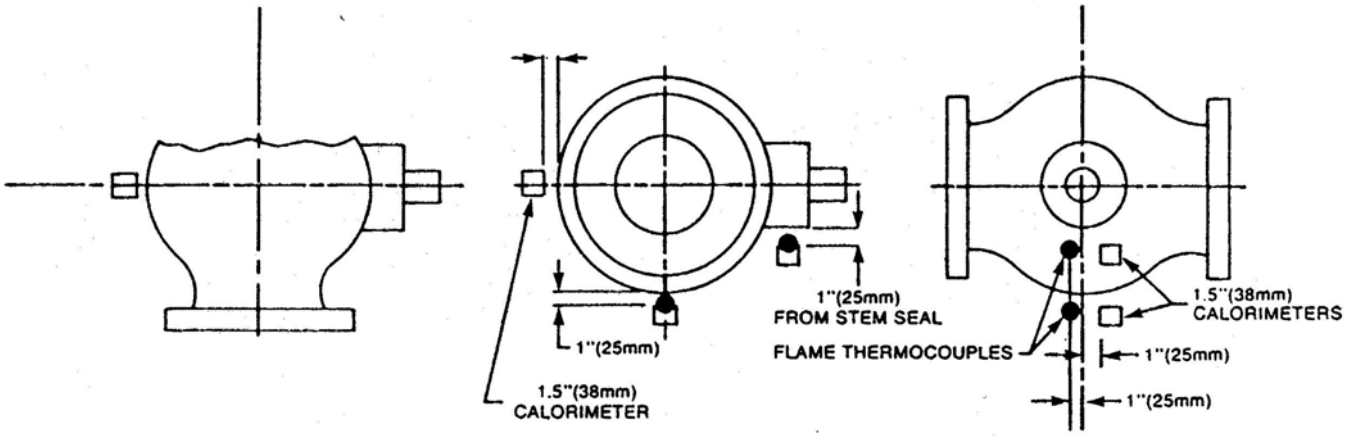


Figure 2—Installation of Temperature Measurement Sensors (NPS 8 and Larger)

1.4.6 For upstream-sealing valves (for example some trunnion-mounted valves), the volume of liquid trapped in the cavity at the beginning of the test may be deducted from the liquid collected in the calibrated container during the fire-burning period, since this is not through-valve leakage. The volume of liquid trapped in the cavity (when the valve is closed and in the test position) shall be determined before the test is started and shall be identified in the test report. Also, the report shall state whether the valve is of the upstream-sealing type.

1.4.7 In the interest of safety for the personnel conducting the test and because of environmental considerations, the following requirements are included in this procedure:

1. All test equipment, and the test valve itself, shall be clean and in good operating condition.
2. Water shall be used as the test medium.
3. Personnel shields shall be provided.
4. Gaseous fuel shall be used.

Also, the use of a supplemental pressure relief valve to protect the valve body cavity from rupture is recommended (see 4.3).

1.4.8 The test pressure for steel valves rated per ANSI B16.34 shall be as shown in Table 1. Other valves shall be tested at 75 percent of the allowable cold working pressure of the valve.

1.4.9 Following the cooling-down period, valves with a cold working pressure of 1595 pounds per square inch (110 bar) or lower shall be subjected to a low pressure test. The test pressures for steel valves rated per ANSI B16.34 shall be those in Table 2. Other valves shall be

Table 1—Test Pressure During Fire Test

Rating Equivalent to ANSI B16.34 Standard Class	Test Pressure (see note)		
	pounds per square inch	megapascals	bar
150	210	1.5	15
300	540	3.7	37
400	720	5.0	50
600	1080	7.5	75
900	1620	11.0	110
1500	2700	19.0	190
2500	4600	32.0	320

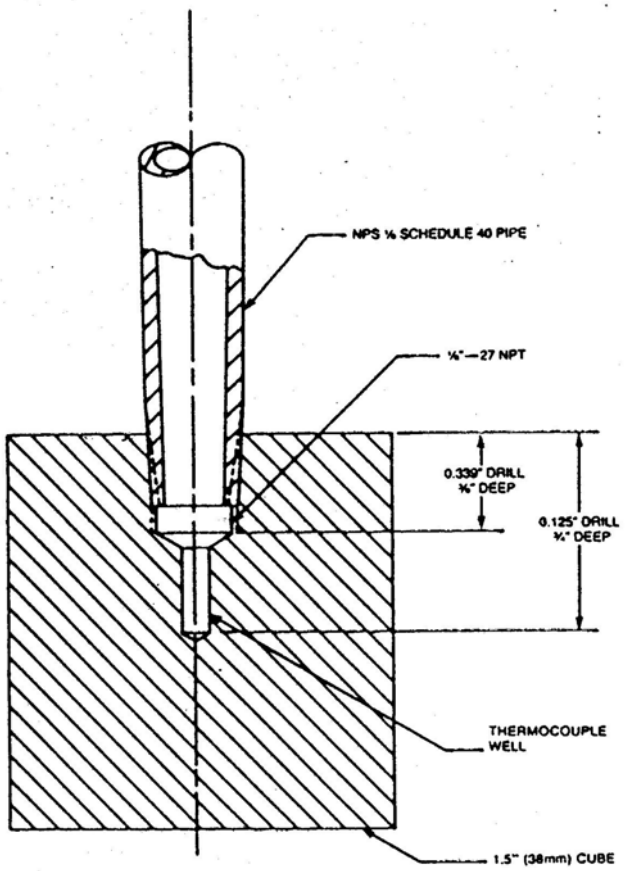
NOTE: The test pressure may vary by ± 10 percent during the test.

Table 2—Test Pressure After Cooling-Down Period

Rating Equivalent to ANSI B16.34 Standard Class	Test Pressure (see note)		
	pounds per square inch	megapascals	bar
150	29	0.20	2.0
300	50	0.35	3.5
400	70	0.48	4.8
600	105	0.72	7.2

NOTE: The test pressure may vary by ± 10 percent during the test.

tested at 7 percent of the cold working pressure or 29 pounds per square inch (2 bar), whichever is greater.



Material: Carbon steel.

Figure 3—Calorimeter Cube Design

SECTION 2—TEST APPARATUS

Typical arrangements of the fire test equipment are shown in Figures 4 and 5. Other means may be used to pressurize the system, provided that the alternative sources meet the other requirements of this standard and assure adequate safety.

SECTION 3—TEST PROCEDURE

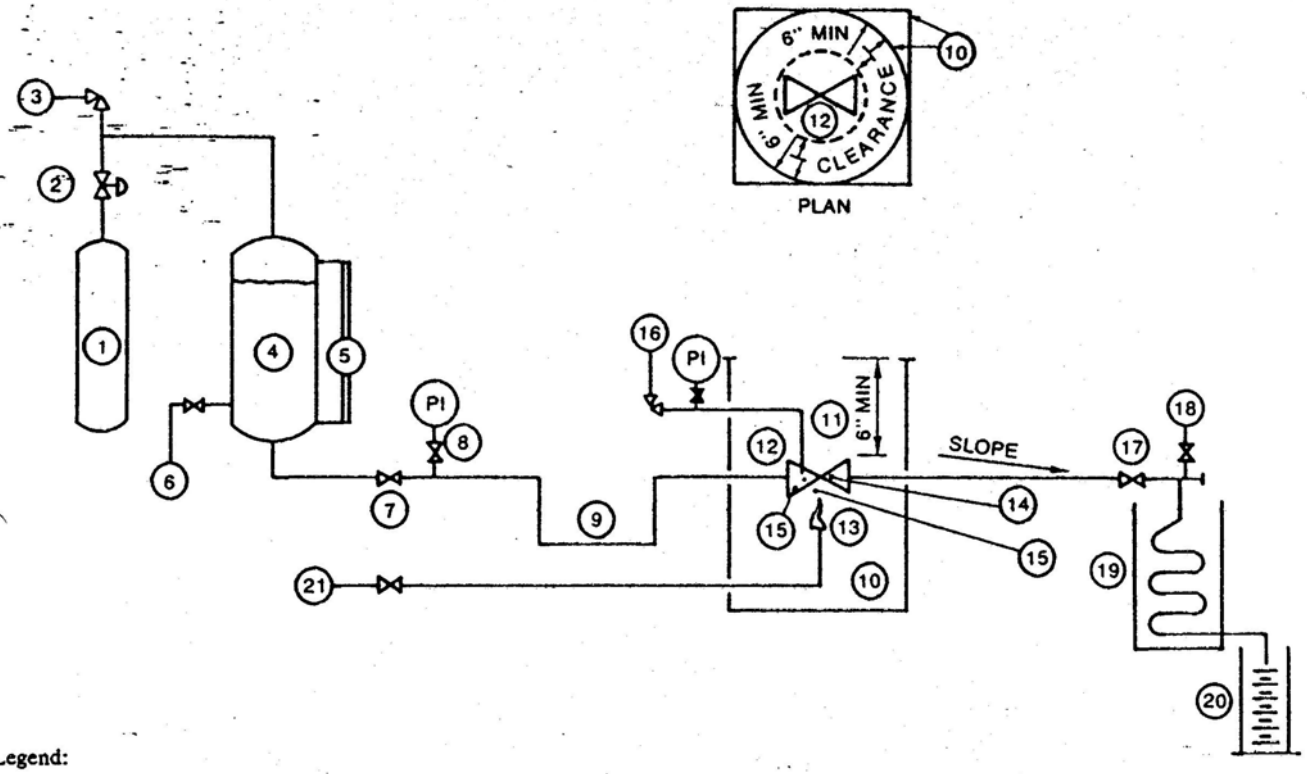
3.1 Stepwise Procedure for Fire Test

To perform the fire test, follow the stepwise test procedure described in 3.1.1 through 3.1.10. Figures 4 and 5 are referred to throughout the procedure.

3.1.1 Open the valve or valves at the water source, and any necessary vent and drain valves, to flood the system and purge the air. Turn the test valve to the half-open position during the flood and purge operation to ensure that the body cavity will become filled with water.

3.1.2 Close all drain and vent valves, close the test valve, and close the fill valve or valves. The test valve and the system upstream of the test valve shall be completely water filled, and the system downstream shall be drained.

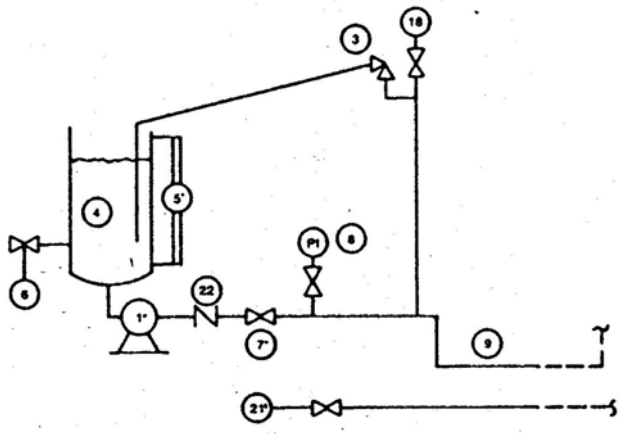
3.1.3 Pressurize the system to the test pressure spec-



Legend:

1. Pressure source.
2. Pressure regulator.
3. Relief valve.
4. Vessel for water.
5. Calibrated sight gage (or similar device).
6. Water supply.
7. Shutoff valve.
8. Pressure gage.
9. Piping, arranged to provide vapor trap.
10. Enclosure for test. [The horizontal clearance between any part of the valve and the enclosure shall be a minimum of 6 inches (152 millimeters).]
11. Minimum height of the enclosure shall be 6 inches (152 millimeters) above the top of the valve.
12. Test valve and stem mounted horizontally.
13. Fuel gas burner.
14. Calorimeter cubes.
15. Flame temperature thermocouples.
16. Pressure gage and relief valve, connected to center cavity of valve (optional).
17. Shutoff valve.
18. Vent valve.
19. Condenser.
20. Calibrated container.
21. Fuel gas inlet.

Figure 4—Typical Fire Test System Using Compressed Gas as the Pressure Source



Legend:

1. Pressure source.
3. Relief valve.
4. Vessel for water.
5. Calibrated sight gage (or similar device).
6. Water supply.
7. Shutoff valve.
8. Pressure gage.
9. Piping, arranged to provide vapor trap.
18. Vent valve.
21. Fuel gas inlet.
22. Check valve.

NOTE: A pump, with appropriate control devices, may be used as a pressure source provided that the system delivers a reasonably non-pulsating pressure.

Figure 5—Typical Fire Test System Using a Pump as the Pressure Source

ified in 1.4.8, then check the entire system carefully for leaks and eliminate them.

3.1.4 Maintain the specified test pressure during the test. (A one-time momentary pressure loss of 50 percent of the test pressure is permissible during the test provided that the pressure recovers within 2 minutes.)

3.1.5 Open the shutoff valve (Figure 4, Item 17). Record the amount of water in the vessel (Item 4). Empty the calibrated container (Item 20).

3.1.6 Open the fuel supply valve and establish the fire. The burn period will be 30 minutes from ignition. Maintain the test conditions as stipulated in 1.4.3 through 1.4.5.

3.1.7 Record instrument readings (Items 8, 14, 15, and 16) at least every 2 minutes for the duration of the test.

3.1.8 Close the fuel supply valve at the end of the test period.

3.1.9 Immediately record the amount of water collected in the calibrated container (Item 20) to establish total through-valve leakage. Continue to record the water being collected (for use in calculating external valve leakage) until the amount of water in the vessel (Item 4) is recorded as specified in 3.1.10.

3.1.10 Allow the test valve metal to cool to 212 F (100 C) or less, then record the amount of water in the vessel (Item 4).

3.2 Low Pressure Test

Lower the test pressure to the pressure specified in 1.4.9. Measure the through-valve and external leakage over a 5-minute period.

NOTE: Only valves with a cold working pressure of 1595 pounds per square inch (110 bar) or lower shall be subjected to this low pressure test.

3.3 Operational Test

After completing all the appropriate static leakage tests (3.1.9, 3.1.10, and 3.2 as applicable), pressurize the system to the pressure specified in 1.4.8. Close the shut-off valve (Item 17) and operate the test valve against test pressure to the full open position. The external leakage shall be measured over a 5-minute period and shall be recorded separately in the test report (see 4.2).

NOTE: The tests in 3.2 and 3.3 are completely separate from the fire exposure tests in which data were recorded during the burning and cool-down periods.

3.4 Test Adjustments

No adjustments may be made to the test valve during the fire, low-pressure, or operational test.

SECTION 4—PERFORMANCE REQUIREMENTS

4.1 Through-Valve Leakage

4.1.1 The maximum seat leakage (not bonnet joint, stem, or body joint) shall be 400 milliliters per NPS valve size per minute for the fire-burning period of the test.

4.1.2 After the cooling-down period, the maximum seat leakage during the low pressure test (as applicable) described in 3.2 shall be 40 milliliters per NPS valve size per minute.

4.2 External Leakage

4.2.1 External leakage includes leakage at the stem, bonnet joint, and body joint, but does not include leakage at the piping-to-valve end connections.

4.2.2 Maximum external leakage shall be 100 milliliters per NPS valve size per minute for the total test period including the cooling-down period.

4.2.3 After the cooling-down period, the maximum external leakage during the low pressure test (as applicable) as described in 3.2 shall be 20 milliliters per NPS valve size per minute.

4.2.4 After operating the valve as described in 3.3, the maximum external leakage shall be 200 milliliters per NPS valve size per minute.

NOTE: The maximum allowable leakage rates
Table 3.

4.3 Pressure Relief Provisio

The test is void if the supplemental pressure relief valve described in 1.4.7 is activated. If the design of the test valve includes an externally discharging relief device that relieves during the test, the test is not void;

Table 3—Maximum Allowable Leakage Rates (in milliliters per NPS per minute)

Test Period	Through Valve	External
Fire burn period (30 minutes)	400	—
Fire burn and cool-down period	—	100
Low pressure test after cool-down (5 minutes)	40	20
High pressure test after opening valve (5 minutes)	—	200

16 DROPS EQUAL 1 CC

however, all discharge through the device shall be considered external leakage.

NOTE: Qualification based on the use of an external relief device must be so stated in the final test report.

4.4 Valve Qualification

In lieu of testing each size and class of a given valve design, other valves of the same basic design as the test valve and of the 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 limitations in 4.4.1 through 4.4.4.

4.4.1 One test valve may be used to qualify valves larger than the test valve, not exceeding twice the size of the test valve, except that an NPS 16 valve will qualify all larger sizes (see Table 4).

4.4.2 One test valve may be used to qualify valves with higher pressure ratings no greater than twice the pressure rating of the test valve (see Table 5).

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

4.4.4 Valves with asymmetrical closure elements intended for bi-directional installation shall be qualified by conducting the test procedures twice, once in each direction of potential installation.

Table 4—Qualification of Other Valve Sizes

Size of Test Valve (NPS)	Valve Sizes Qualified (NPS)
¼	¼, ⅜, ½
⅜	⅜, ½, ¾
½	½, ¾, 1
¾	¾, 1, 1¼, 1½
1	1, 1¼, 1½, 2
1¼	1¼, 1½, 2, 2½
1½	1½, 2, 2½, 3
2	2, 2½, 3, 4
2½	2½, 3, 4
3	3, 4, 6
4	4, 6, 8
6	6, 8, 10, 12
8	8, 10, 12, 14, 16
10	10, 12, 14, 16, 18, 20
12	12, 14, 16, 18, 20, 24
14	14, 16, 18, 20, 24, 26, 28
16	16 and larger

Table 5—Qualification of Other Pressure Rating Valves

Rating of Test Valve (Class)	Valve Pressure Ratings Qualified (Class)
150	150, 300
300	300, 400, 600
400	400, 600, 800
600	600, 800, 900
800	800, 900, 1500
900	900, 1500
1500	1500, 2500
2500	2500

4.4.5 Valves intended for single direction installation shall be marked accordingly and shall be tested in the direction of marking.

4.5 Certification

4.5.1 Records of the tests upon which certification is based shall be available for the purchaser's review upon request.

4.5.2 When a purchase order stipulates fire-tested valves, valves qualified by fire testing as specified in the second or third editions of Standard 607 may be supplied until December 1, 1988. After that date, all certified valves must meet all the requirements of the third edition of Standard 607.