Contents

1 Seat Leakage

1.1 PURPOSE

Follow by ANSI/FCI 70-2 establishes a series of seat leakage classes for control valves and defines the test procedures.

1.2 LEAKAGE SPECIFICATIONS & CLASSES

The maximum allowable seat leakage as specified for each class shall not exceed the seat leakage in Table 1 using the test procedure as defined in Section 3. For Classes II through VI each and every valve shall be tested.

1.2.1 Leakage Classes

CLASS I. A modification of any Class II, III or IV valve where design intent is the same as the basic class, but by agreement between user and supplier, no test is required.

CLASS II. This class establishes the maximum permissible leakage generally associated with commercial double seat control valves or balanced single-seat control valves with a piston ring seal and metal-to-metal seats. Use test procedure Type A.

CLASS III. This class establishes the maximum permissible leakage generally associated with Class II, but with a higher degree of seat and seal tightness. Use test procedure Type A.

CLASS IV. This class establishes the maximum permissible leakage generally associated with commercial unbalanced single-seat control valves and balanced single-seat control valves with extra tight piston rings or other sealing means and metal-to-metal seats. Use test procedure Type A.

CLASS V. This class is usually specified for critical applications where the control valve may be required to be closed, without a blocking valve, for long periods of time with high differential pressure across the seating surfaces. It requires special manufacturing, assembly and testing techniques. This class is generally associated with metal seat, unbalanced single-seat control valves or balanced single-seat designs with exceptional seat and seal tightness. Use test procedure Type B using water at the maximum operating differential pressure or Type B1 by using air at the specified conditions.

CLASS VI. This class establishes the maximum permissible seat leakage generally associated with resilient seating control valves either unbalanced or balanced single-seat with "O" rings or similar gapless seals. Use test procedure Type C.

Table 1

Leakage Class	Maximum Seat Leakage	Test Procedure
Class I	See Subject's	None
Class II	0.5% of rated valve capacity	Type A
Class III	0.1% of rated valve capacity	Type A
Class IV	0.01% of rated valve capacity	Type A
Class V	5×10^{-4} ml per minute of water per inch of seat diameter per psi differential	Type B
	5×10^{-12} m^3 per second of water per mm of seat diameter per bar differential	Type B
	4.7 standard ml per minute of air per inch of orifice diameter	Type B1
	11.1×10^{-6} standard m^3 per hour of air per mm of orifice diameter	Type B1
Class VI	See 2 Subject's	

1.3 TEST PROCEDURES

1.3.1 Test Procedure Type A

3.1.1 Test medium shall be clean air or water at 10-51°C (50-125°F).

3.1.2 Pressure of test medium shall be 3-4 bar (45-60 psi) or within +/- 5 percent of the maximum operating differential pressure, whichever is less.

3.1.3 Leakage flow and pressure data shall be accurate to +/- 10 percent of reading.

3.1.4 The test fluid shall be applied to the normal or specified valve body inlet. The valve body outlet may be open to atmosphere or connected to a low head loss measuring device.

3.1.5 The actuator shall be adjusted to meet the operating conditions specified. The full normal closing thrust as applied by air pressure, a spring, or other means shall then be applied. No allowance or adjustment shall be made to compensate for any increase in seat load obtained when the test differential is less than the maximum valve operating differential pressure.

3.1.6 On valve body assemblies made for stock, tested without the actuator, a test fixture should be utilized which applies a net seat load not exceeding the manufacturer's normal expected load under maximum service conditions.

3.1.7 On water test, care shall be taken to eliminate air pockets in the valve body and piping.

3.1.8 The leakage rate thus obtained can then be compared to the calculated values for Classes II, III and IV. See Table 1.

1.3.2 Test Procedure Type B

3.2.1 Test fluid shall be clean water at 10-52°C (50-125°F).

3.2.2 The water test differential pressure shall be within +/- 5 percent of the maximum service pressure drop across the valve plug, not exceeding the maximum operating pressure at room temperature as determined by ANSI B16.1, B16.5, or B16.34, or some lesser pressure by individual agreement. Pressure measurement accuracy is to be in accordance with paragraph 3.1.4

3.2.3 The fluid shall be applied to the normal specified inlet of the valve body. The valve plug shall be opened and the valve body assembly filled completely with water, including outlet portion and any downstream connecting piping, and then stroked closed.

3.2.4 The water test differential pressure as specified in 3.2.2 is then applied with the actuator adjusted to meet the operating conditions specified. The net actuator thrust shall be the specified maximum. Net actuator thrust above the specified maximum is not to be used.

3.2.5 When leakage flow is stabilized, the quantity should be observed over a period of time sufficient to obtain the accuracy under paragraph 3.1.3

3.2.6 The leakage rate thus obtained shall not be greater than the value calculated from the definition of maximum seat leakage for Class V as shown in Table 1. The nominal seat diameter is understood to be the diameter at the point of seating contact to the nearest 2 mm (1/16 inch).

1.3.3 Test Procedure Type B1

3.3.1 Test medium shall be clean air or nitrogen gas at 10-52°C (50-125°F).

3.3.2 Inlet pressure of test medium shall be 3.5 bar, (50 psi).

3.3.3 Leakage flow and pressure data shall be accurate to ±10 percent of reading.

3.3.4 The test fluid shall be applied to the normal or specified valve body inlet, and the outlet connected to a suitable measuring device.

3.3.5 The leakage rate thus obtained shall not be greater than the value calculated from the definition of maximum seat leakage for Class V as shown in Table 1. The orifice diameter is understood to be the diameter at the point of seating contact to the nearest 2 millimeters (1/16 inch).

3.3.6 Test medium shall be air or nitrogen gas at 10-5°C (50-125°F).
Pressure of the test medium shall be the maximum rated differential pressure across the valve plug or 3.5 bar (50 psi) whichever is the least.

3.3.7 The test fluid shall be applied to the normal or specified valve body inlet, and the outlet connected to a suitable measuring device.

3.3.8 With the control valve adjusted to meet the operating conditions specified (see paragraphs 3.1.5 and 3.1.6) and with sufficient time allowance for stabilizing flow, the leak rate shall not exceed the values in Table 2.

Table 2

Nominal Seat Diameter Millimeters (Inches)	ml per Minute	Bubbles per Minute*
≤ 25 (≤ 1)**	0.15	1**
38 (1.5)	0.30	2
51 (2)	0.45	3
64 (2.5)	0.60	4
76 (3)	0.90	6
102 (4)	1.70	11
152 (6)	4.00	27
203 (8)	6.75	45
250 (10)	11.1	-
300 (12)	16.0	-
350 (14)	21.6	-
400 (16)	28.4	-

*Bubbles per minute as tabulated are a suggested alternative based on a suitable calibrated measuring device, in this case, a 6 mm (0.25 inch) O.D. x 1 mm (0.032 inch) wall tube submerged in water to a depth of from 3 to 6 mm (0.125 to 0.25 inch). 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. Other apparatus may be constructed and the number of bubbles per minute may differ from those shown as long as they correctly indicate the flow in ml per minute.

**If the valve seat diameter differs by more than 2 mm (0.08 inch) from one of the values listed, the leakage rate may be obtained by interpolation assuming that the leakage rate varies as the square of the seat diameter.

2 Valve Shutoff Classifications

Often when commissioning or troubleshooting automatic control valves, there's a discovery that the control valve, even though fully closed, doesn't fully shut off the flow of process fluid through the plug and seat. Although closed, there is an "allowable leakage rate" as part of each control valve's specification. Industry standards have been established for the control valve's regarding the amount of permissible leakage of the process fluid through the valve's seat. Specifically, ANSI Standard 70-2 provides the outline for six shutoff classifications.

Shutoff classifications are determined by a percentage of a test fluid (usually water or air) that passes through the valve, as part of valves rated capacity. Shutoff classifications range from ANSI Class I, where the valve does not require tight shutoff, to ANSI Class VI, where shutoff must be completely or nearly bubble tight. The following briefly describes each shutoff classification and maximum leakage rates for each.

2.1 Types of Shutoff Classifications

ANSI Class I – The ANSI Class I shutoff is an open classification that does not require a test, while allowing for a specified agreement between the user and the valve manufacturer as for the required leakage. Class I shutoff is also known as **dust tight** shutoff.

ANSI Class II – The ANSI Class II shutoff is 0.5 percent of rated valve capacity and is associated with double ported seats or pressure balanced trims where metal piston rings and metal-to-metal seat surfaces are used.

ANSI Class III – The ANSI Class II shutoff is 0.1 percent of rated valve capacity and is associated with the same type of valves listed in Class II, but used for applications that require improves shutoff.

ANSI Class IV – The ANSI Class IV shutoff is 0.01 percent of rated valve capacity and is associated with single seated valves with metal-to-metal seating surfaces. ANSI Class IV shutoff is the industry standard.

ANSI Class V – The ANSI Class V shutoff is defined as 0.0005 cm2/min per inch of orifice diameter per pound per square inch (psi) differential. Class V is unique in that it is the only shutoff classification where the allowable seat leakage is allowed to vary according to the orifice diameter and the differential pressure (pressure drop).

This shutoff classification is necessary for those applications where a throttling or control valve is used as a blocking valve that is required to stay closed for lengthy periods against a high pressure drop.

ANSI Class VI – The ANSI Class VI shutoff is commonly referred to as bubble tight shutoff and is associated with metal-to-elastomer soft seating surfaces or metal-to-metal seat with extremely high seating loads. Class VI is independent of the pressure differential.

Both ANSI Classes V and VI were developed for throttling valve where shutoff is a primary focus.

3-shell test for body valves

Hydrostatic shell test pressure shall be according to the design code or standard for the valve body or, alternatively, shall be not less than 1,5 times the 20 °C rated pressure, whichever is appropriate.

3.1 Test procedure

The body ends shall be sealed in such a way that all cavities pressurized in service shall be simultaneously subjected to the test pressure for not less than the duration stated in Table 3.

Table3

Nominal size(inch)	Duration(second)
2≤	15
2 ½ to 8	60
10≥	180

During this test, the control valve shall be in the partially or fully open position.

By agreement with the purchaser, hydrostatic tests may be conducted on components. If hydrostatic tests are conducted on the individual components, the full assembled valve shall be subjected to an air test at a pressure not to exceed 6 bar.

3.2 Acceptance criteria

Visually detectable leakage from any external surface of the shell is not permitted.

Unless otherwise specified in the appropriate valve product standard, leakage from the stem seal is permitted at the shell test pressure provided that there is no visually detectable leakage when the test pressure is reduced to 1,1 times the allowable pressure at room temperature.

If equipment such as a volume lost measurement device is used for the test, the manufacturer shall be capable of demonstrating the equivalency of the system with the requirements of this standard.

3.3 Exclusions from hydrostatic test

Welded-on fittings (nipples, reducers and /or expanders) shall not be considered as part of the valve assembly and, therefore, need not be included in the hydrostatic test. If it is not practical to hydrostatically test the valve alone, the valve plus fitting assembly may be tested at the valve hydrostatic pressure provided the fittings are adequate to sustain the said pressure. If agreed upon between manufacturer and purchaser, the valve may be retested after the fittings are welded on at a pressure in accordance with the applicable piping specifications.