AMERICAN NATIONAL STANDARD

CONTROL VALVE SEAT LEAKAGE

ANSI/FCI 70-2-2006

Fluid Controls Institute, Inc.

Sponsor:

Fluid Controls Institute, Inc.
1300 Sumner Ave
Cleveland, Ohio 44115-2851

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Suggestions for improvement of this standard will be welcome. They should be sent to the Fluid Controls Institute, Inc.

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Foreword (This foreword is included for information only and is not part of ANSI/FCI 70-2-2006, *Control Valve Seat Leakage.)*

This voluntary standard has been compiled and issued in the public interest. It is intended to eliminate present misunderstandings and to assist and guide those people involved in the specification, use or manufacture of control valves.

This standard, formerly known as ASME B16.104, was originally adopted on November 24, 1970 as FCI 70-2.

The standard has been revised several times through the years to stay current as the industry and its products have evolved and advanced. The standard was revised by the FCI Control Valve Section in 1998 in order to maintain consistency with the appropriate IEC Standards (IEC 534-4).

The standard was revised in 2003 to add the option to permit low pressure gas testing to determine Class V leakage. During the canvass of the 2003 version, one respondent asked for the standard to be modified to specifically exclude on/off valves used for tight shut-off. The FCI Control Valve and Regulator Section notes that FCI 70-2 has been intended to apply to control valve seat leakage. If line isolation and/or absolute tight shut-off is a normal expectation of the valve application, the FCI Control Valve and Regulator Sections recommend specifying another standard, such as API 598, “Valve Test and Inspection.”

The existence of a Fluid Controls Institute (FCI) standard does not in any respect preclude any member or non-member from manufacturing or selling products not conforming to this standard nor is the FCI responsible for its use.

FCI recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Fluid Controls Institute, Inc., 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851. All constructive suggestions for expansion and revision of this standard are welcome.

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Control Valve Seat Leakage

1. PURPOSE

1.1 This standard establishes a series of seat leakage classes for control valves and defines the test procedures.

2. SCOPE & LIMITATIONS

2.1 Selection of a leakage class is not restricted as to valve design, but acceptable values for various commercially available designs are suggested for each class under Section 4.

2.2 The standard cannot be used as a basis for predicting leakage at conditions other than those specified.

2.3 This standard is similar to IEC 60534-4, except that no provision is made for Class IV-S1 and the standard is applicable for valves with a C_V value less than 0.1. The air leakage test and allowable leak rates for Class V are equivalent to the water test and allowable water leakage rates for a water test performed at a nominal temperature of 60ºF.

3. DEFINITIONS

3.1 Control Valve

3.1.1 A valve with a power positioning actuator for moving a closure member to any position relative to a valve seat or seats in response to and in proportion to an external signal. The energy for a control valve actuator is derived from an independent source.

3.1.2 Control valve body subassemblies on which an actuator is to be mounted at some later date are within the intent of this definition.

3.2 C_V - An experimentally determined valve sizing coefficient. (Ref. ISA S75.01, ISA S75.02 and FCI Standard 84-1).

3.3 Rated Valve Capacity. The quantity of test fluid (air or water) that would pass through the valve at rated travel under the stated pressure conditions as determined by the appropriate equations and manufacturer's ratings.

3.4 Rated Travel. The valve travel at which the manufacturer's rating is established.

3.5 Seat Leakage**.** The quantity of test fluid passing through an assembled valve in the closed position under the test conditions as defined.

4. LEAKAGE SPECIFICATIONS & CLASSES

4.1 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 5. For Classes II through VI each and every valve shall be tested.

4.2 Leakage Classes

4.2.1 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.

4.2.2 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.

4.2.3 CLASS III. This class establishes the maximum permissible leakage generally associated with Class II (4.2.2), but with a higher degree of seat and seal tightness. Use test procedure Type A.

4.2.4 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.

4.2.5 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

TABLE 1		
Leakage Class	**Maximum Seat Leakage**	**Test Procedure**
Class I (See 4.2.1)	See Paragraph 4.2.1	None
Class II (See 4.2.2)	0.5% of rated valve capacity	Type A (See 5.1)
Class III (See 4.2.3)	0.1% of rated valve capacity	Type A (See 5.1)
Class IV (See 4.2.4)	0.01% of rated valve capacity	Type A (See 5.1)
Class V (See 4.2.5)	5×10^{-4} ml per minute of water per inch of seat diameter per psi differential	Type B (See 5.2)
	5×10^{-12} m^3 per second of water per mm of seat diameter per bar differential	Type B (See 5.2)
	4.7 standard ml per minute of air per inch of orifice diameter	Type B1 (See 5.3)
	11.1×10^{-6} standard m^3 per hour of air per mm of orifice diameter	Type B1 (See 5.3)
Class VI (See 4.2.6)	Leakage per Paragraph 5.4.4 as expressed in ml per minute versus seat diameter	Type C (See 5.4)

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.

4.2.6 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.

5. TEST PROCEDURES

Warning: Provisions should be made to avoid overpressuring of measuring devices resulting from inadvertent opening of the valve plug.

5.1 Test Procedure Type A

5.1.1 Test medium shall be clean air or water at 10-51ºC (50-125ºF).

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

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

5.1.4 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 headloss measuring device.

5.1.5 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.

5.1.6 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.

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

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

5.2 Test Procedure Type B

5.2.1 Test fluid shall be clean water at 10-52ºC (50-125ºF).

5.2.2 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 5.1.3.

5.2.3 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.

5.2.4 The water test differential pressure as specified in 5.2.2 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.

5.2.5 When leakage flow is stabilized, the quantity should be observed over a period of time sufficient to obtain the accuracy under paragraph 5.1.3.

5.2.6 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).

5.3 Test Procedure Type B1

5.3.1 Test medium shall be clean air or nitrogen gas at 10-52ºC (50-125ºF).

5.3.2 Inlet pressure of test medium shall be 3.5 barg, (50 psi).

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

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

5.3.5 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).

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.

5.4 Test Procedure Type C - Class VI

5.4.1 Test medium shall be air or nitrogen gas at 10-52ºC (50-125ºF).

5.4.2 Pressure of the test medium shall be the maximum rated differential pressure across the valve plug or 3.5 bar (50 psig) whichever is the least.

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

5.4.4 With the control valve adjusted to meet the operating conditions specified (see paragraphs 5.1.5 and 5.1.6) and with sufficient time allowance for stabilizing flow, the leak rate shall not exceed the values in Table 2.

6. REFERENCES

6.1 “International Electrical Commission (IEC) Standard 60534-4, Industrial Process Control Valves – Inspection and Routine Testing.”