

Throughout your time working in the valve industry you will hear various forms of nomenclature thrown around when talking about valve leakage testing or fugitive emissions testing. An example would be Class VI Zero Leakage. While this doesn't really mean a true 0% leakage rate, it does mean that it complies with the ANSI/FCI 70-2 acceptable leakage rate for Class VI. This document will hopefully help give you a better understanding of what types of testing there are as well as what they are applied to.

ANSI/FCI 70-2

For control valve seat leakage there is ANSI/FCI 70-2 which deals with Class I, II, III, IV, V, and VI acceptable leakage rates. The individual classes determine what type of test is done and what the acceptable seat leakage rate is. Class IV generally refers to metal-seated valves while Class VI refers to resilient or soft-seated valves. Our Accuseal® ball valves, while metal-seated, actually meet the testing requirements for Class VI which is a more stringent requirement that normally only resilient seated valves can obtain.

Class I Valve Leakage – In Class I Valve Leakage there is no shop test done on the valve to determine leakage rates. This class is considered “dust tight”.

Class II Valve Leakage – This classification is intended for double port or balanced single port valve using a metal piston ring seal and metal to metal seats. The testing parameters allow for 0.5% leakage when the valve is in the full open position. The test is completed using air at 45-60 psig.

Class III Valve Leakage – This classification is intended for the same valves in Class II but only allows for 0.1% leakage when fully open. The test itself is the same with air at 45-60 psig

Class IV Valve Leakage – This classification is intended for single port and balanced single port valves with extra tight piston seals and metal to metal seats. Acceptable leakage drops significantly to 0.01%. The testing criteria is the same at 45-60 psig.

Class V Valve Leakage – Used on the same valves as Class IV, but the testing medium is changed to water at 100 psig. Leakage is acceptable up to 5×10^{-4} ml per minute per inch of orifice diameter per psi differential.

Class VI Valve Leakage – This class establishes the maximum allowed seat leakage normally associated with resilient seated valves either unbalanced or balanced single-seat “O” rings or similar gapless seals. Testing is done with air or nitrogen gas at 10-52°C (50-125°F) at the maximum rated differential pressure across the valve plug or 3.5 bar (50 psig) whichever is least. Allowable leakage is per FCI 70-2 Table 2.

FCI 70-2 - Table 2

DN (mm.)	NPS (in.)	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.

API 598

When isolation and/or absolute tight shut-off is required, API 598 is the recommended standard over ANSI/FCI 70-2. For on/off valves, or our gate, globe, and check product lines, we test to API 598. This testing specification refers to the allowable fugitive emissions from the shell, backseat, and closure. The allowable leakage rate varies based on the valve size. Testing can be completed using either liquid or gas with specific leakage tolerances for each. The shell, backseat, and closure are the three parts tested and have individual acceptable leak rates which can be found in Table 6 of API 598.

API 598 Summarized:

What is Tested: Valve Design
 Mechanical Cycles: 310
 Test Fluid: Methane Gas (97% Purity)
 Temperature: 260°C ±2% (500°F ±5%)
 Option Low Temperature: -29°C (-20°F)
 Thermal Cycles: 3
 Pressure: 4,137 kPag (600 PSIG)
 Measurement: Sniffer

To Pass:

Emission less than 100 ppm

API 598 - Table 6

Valve Size		All Resilient Seated Valves	Metal Seated Valves Except Check		Metal Seated Check Valves		
DN (mm)	NPS (in.)		Liquid Test a (drops/minute)	Gas Test (bubbles/minute)	Liquid Test (cc/min)	Gas Test (m ³ /h)	Gas Test (ft ³ /h)
≤ 50	≤ 2	0	0 ^b	0 ^b	6	0.08	3
65	2.5	0	5	10	7.5	0.11	3.75
80	3	0	6	12	9	0.13	4.5
100	4	0	8	16	12	0.17	6
125	5	0	10	20	15	0.21	7.5
150	6	0	12	24	18	0.25	9
200	8	0	16	32	24	0.34	12
250	10	0	20	40	30	0.42	15
300	12	0	24	48	36	0.50	18
350	14	0	28	56	42	0.59	21
400	16	0	32	64	48	0.67	24
450	18	0	36	72	54	0.76	27
500	20	0	40	80	60	0.84	30
600	24	0	48	96	72	1.01	36
650	26	0	52	104	78	1.09	39
700	28	0	56	112	84	1.18	42
750	30	0	60	120	90	1.26	45
800	32	0	64	128	96	1.34	48
900	36	0	72	144	108	1.51	54
1000	40	0	80	160	120	1.68	60
1050	42	0	84	168	126	1.76	63
1200	48	0	96	192	144	2.02	72

a For the liquid test, 1 mL is considered equivalent to 16 drops.

b There shall be no leakage for the minimum specified test duration. For liquid test, 0 drops means no visible leakage per minimum specified test duration. For gas test, 0 bubbles means less than 1 bubble per minimum specified test duration.

API 622

Packing fugitive emission testing has two standards, API 622 and the upcoming API 624. Both methods are EPA Method 21 compliant. API 622 applies to packing only. The test method requires actuated stroking within a test fixture for 1,510 mechanical cycles with 97% minimum purity dry methane test fluid. The graphite packing is measured after the test is complete to determine its resistance to oxidation. If it loses more than 15% of its weight or exceeds 500 ppm, the test is a fail.

API 622 Summarized:

What is Tested: Packing

Mechanical Cycles: 1,510

Rate: 10° to 15° per second

Rotation: 90° ±5°

Test Fluid: Methane Gas (97% Purity)

Temperature: Ambient to 260°C (500°F)

Thermal Cycles: 5

Pressure: 0 to 4,137 kPag (0 to 600 PSIG)

Measurement: Sniffer

To Pass:

Weight loss less than 15%

Emission less than 500 ppm

API 624

API 624 applies to rising stem valves with flexible graphite packing that have API 622 qualified packing. The acceptable fugitive emissions for this test are 100 ppm. The test is conducted with a randomly selected valve as opposed to a test fixture while using methane gas with a minimum purity of 97% as the test fluid. The valve is mechanically cycled 310 times in order to complete the test. As of this writing, API 624 is still awaiting final review from the board.

API 624 Summarized:

What is Tested: Valve Design

Mechanical Cycles: 310

Test Fluid: Methane Gas (97% Purity)

Temperature: 260°C ±2% (500°F ±5%)

Option Low Temperature: -29°C (-20°F)

Thermal Cycles: 3

Pressure: 4,137 kPag (600 PSIG)

Measurement: Sniffer

To Pass:

Emission less than 100 ppm