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## **Addendum 1**

*3.1.12: The definition of “date of manufacture” shall be changed to the following:*

The month and year of completion of factory acceptance testing.

*3.1.18: The definition of “flow coefficient” shall be changed to the following:*

The volumetric flow rate of U.S. gallons of water per minute at a temperature of 60 °F (15.6 °C) passing through a valve and resulting in a pressure loss of 1 psi (0.0069 MPa; 0.069 bar).

*4.4.2: The first paragraph shall be changed to the following:*

Full-opening valves shall be unobstructed in the fully opened position and shall have an internal minimum circular opening of the closure member and seat as specified in Table 1.

*5.1.3: The third paragraph shall be changed to the following:*

The design of the pressure balance hole, when equipped, shall have a ratio between the length of the hole and the hole diameter of less than 10 ( $L/D < 10$ ) up to a maximum hole diameter of 0.5 in. (13 mm).

*5.1.4: The section shall be changed to the following:*

Bolting preload torques shall be calculated using an industry-accepted standard, such as API 6A, ASME PCC-1, or EN 1591, with a coefficient of friction on the threads and nut face, based on bolting material, bolting coating, and the type of lubricant applied.

To address variability in bolt stress by torquing, the theoretical bolt stress due to preload shall not exceed 70 % of yield at the allowable temperature.

Where more than one seal of different diameters are used to form the pressure-containing joint, the following requirements apply:

- The gasket or seal diameter used in the bolting calculation and closure flange stress verification shall be the outer seal diameter of the largest seal, or in the case of spiral wound gaskets, the median diameter shall be used.
- Required sealing stress shall be confirmed for all seals and gaskets.
- When verifying the bolt stress at the outer seal diameter of the largest seal, the bolting stress shall not exceed 0.83 of SMYS at test condition (see 10.3).

NOTE      A fire-safe seal may be the largest diameter.

*5.2.3.1.3: The section shall be changed to the following:*

Valves shall be designed to have a maximum parallelism misalignment as follows:

- For valves up to NPS 24 (DN 600) 0.03 in./ft (2.5 mm/m).
- For valves larger than NPS 24 (DN 600) 0.02 in./ft (1.75 mm/m).

*5.2.3.1.4: The last paragraph shall be changed to the following:*

The nut bearing areas on the flange back face shall be parallel to the flange front face within 1°.

*5.4.1: The section shall be changed to the following:*

Except for bare stem valves, the method of operation shall be specified.

When a manual gearbox is provided, the output torque/thrust rating shall be at least 1.5 times the maximum required operating torque/thrust of the valve at minimum and maximum allowable temperatures.

NOTE 1 See K.16 for operating temperatures other than the minimum allowable temperature.

The hand-wheel rotary motion of a manual gearbox or wrench (lever) to close a valve shall be clockwise. Rotary motion of anything other than a manual gearbox or wrench (lever) to close a valve shall be per manufacturer specification.

NOTE 2 Valve operational data may be supplied to the purchaser.

NOTE 3 See L.3 for options related to valve operational data.

*5.4.2.1: The section shall be changed to the following:*

For axial, ball, gate, and plug valves, the maximum force required at the perimeter of the hand-wheel or wrench (lever) to stroke the valve at the breakaway torque or thrust shall not exceed 80 lbf (360 N) when applied against MAWP.

For check valves, the maximum force required at the perimeter of the hand-wheel or wrench (lever) to stroke the valve at zero differential pressure shall not exceed 80 lbf (360 N).

*5.5: The section title and content shall be changed to the following:*

## **5.5 Cavity Relief**

The manufacturer shall determine if the valve design could result in liquid being trapped in the body cavity in the open- and/or closed-valve position.

If liquid trapping is possible, the valve shall be provided with automatic cavity relief.

For valves in gas or multiphase fluid service at temperatures above 250 °F (121 °C), the manufacturer shall determine the need for cavity relief.

For temperatures up to 250 °F (121 °C), the valve cavity relief pressure shall not exceed 33 % differential pressure above the valve pressure rating.

For temperatures above 250 °F (121 °C), the valve cavity relief pressure and higher shell design pressure shall be specified by the manufacturer and the hydrostatic shell test shall conform to 10.3.2 or 10.3.3.

For valves NPS 4 (DN 100) and smaller (based on the closure member), external cavity relief valves and the relief valve port shall be NPS 1/4 (DN 8) or larger.

For valves larger than NPS 4 (DN 100) (based on the closure member), external cavity relief valves and the relief valve port shall be NPS 1/2 (DN 15) or larger.

NOTE 1 If a relief valve fitted to the cavity is required, the purchaser may specify provisions to facilitate in-service testing.

NOTE 2 Cavity relief testing and functionality may be demonstrated by tests in I.7.

5.8: *The section shall be changed to the following:*

Ball, check, gate, and plug valves shall have electric resistance between the closure member and the valve body and between the stem/shaft and the valve body not exceeding  $10\Omega$  when measured using a direct current power source not to exceed 12V.

NOTE See L.5 for information on optional testing of electrical resistance.

6.1.3: *The section shall be changed to the following:*

All forged material shall be formed using a hot-working practice and heat treatment that produces a wrought (no cast dendritic elements) structure throughout the material.

All forged pressure-containing material shall have a minimum forging reduction ratio of 3:1. The forging ratio shall be included as part of the material certifications.

NOTE See API 20B or API 20C for guidance.

6.8: *The section shall be changed to the following:*

### **6.8.1 General**

Heat-treating using batch or continuous type furnaces for pressure-containing parts, pressure-controlling parts, and TCs shall be performed with equipment that is used to process production parts meeting the requirements of this specification. These requirements shall not apply to surface coatings or localized PWHT.

### **6.8.2 Furnace Requirements**

#### **6.8.2.1 General**

The heat-treatment supplier shall define the temperature range for each operation.

Automatic controlling and recording instruments shall be used.

Thermocouples shall be placed in the furnace working zone(s) and protected from furnace atmospheres by means of suitable protective devices.

#### **6.8.2.2 Instrument Accuracy**

The controlling and recording instruments used for the heat-treatment processes shall be accurate to  $\pm 1\%$  of their full-scale range.

#### **6.8.2.3 Instrument Calibration**

Temperature-controlling and recording instruments shall be calibrated at least once every three months.

#### **6.8.2.4 Batch-type Furnaces**

Heat treatment of production parts shall be performed with heat-treating equipment that satisfies one of the following:

- calibrated in accordance with 6.8.2.2 and 6.8.2.3 and heat-treat batch-type furnaces that have been surveyed in accordance with Annex H; or
- calibrated and surveyed in accordance with SAE AMS2750 and Table 7.

**Table 7—Heat Treatment Thermal Uniformity Survey (TUS) Requirements**

Heat Treatment Type	Furnace Classes				
	Class 1 TUS Tolerance ±5°F (±3°C)	Class 2 TUS Tolerance ±10°F (±6°C)	Class 3 TUS Tolerance ±15°F (±8°C)	Class 4 TUS Tolerance ±20°F (±10°C)	Class 5 TUS Tolerance ±25°F (±14°C)
Normalizing	X	X	X	X	X
Annealing	X	X	X	X	X
Solution annealing	X	X	X	X	X
Austenitizing	X	X	X	X	X
Tempering	X	X	X	—	—
Precipitation hardening	X	X	X	—	—
Aging	X	X	X	—	—
Stress relieving	X	X	X	—	—

NOTE The symbol “—” is used to show actions that are not applicable.

The temperatures within each batch-type furnace shall be surveyed within one year prior to use of the furnace for heat treatment.

#### 6.8.2.5 Continuous-type Furnaces

Heat treatment of production parts shall be performed with continuous-type furnaces that satisfy the following:

- operated, maintained, modified, and repaired in conformance with SAE AMS2750 or SAE AMS-H-6875;
- surveyed in conformance with Annex H.

#### 6.8.3 Furnace Repairs

When a furnace is repaired or rebuilt, a new temperature survey shall be carried out before the furnace is used for heat treatment, unless the following conditions apply:

- Repairs return the furnace to the condition it was in at the time of the previous furnace survey and calibration; or
- Repairs do not affect the temperature tolerance of the furnace.

The SAE AMS2750 sections on furnace modifications and furnace repairs shall be used to determine whether a new furnace survey is required. All furnace repairs and modifications shall be documented, and the responsible Quality Assurance organization shall determine whether an additional furnace survey and calibration is required based on the repairs or modifications in conformance with SAE AMS2750 or SAE AMS-H-6875.

#### 6.8.4 Furnace Calibration and Survey Records

Records of furnace calibration and surveys shall be maintained for a period not less than five years. The minimum records of furnace calibration/survey shall be a certificate of conformance in accordance with Annex H.

7.5.3.2: *The second bullet shall be changed to the following:*

- Surface porosity and exposed slag shall not be permitted on or within 1.77 in. (45 mm) of sealing surfaces.

7.10: *The section title and content shall be changed to the following:*

### **7.10 NDE of Welds Joining Pipe Pups to the Valve**

For all pressure-containing pipe pup-to-valve welds, surface NDE shall be performed using at least one of the following methods:

- Magnetic particle testing on weld bevels of weld ends after machining, prior to welding, and of the final weldment shall conform to ASME BPVC, Section V, Article 7, and acceptance shall conform to ASME BPVC, Section VIII, Division 1, Appendix 6.
- Penetrant testing on weld bevels of weld ends after machining, prior to welding, and of the final weldment shall conform to ASME BPVC, Section V, Article 6, and acceptance shall conform to ASME BPVC, Section VIII, Division 1, Appendix 8.

For all pressure-containing pipe pup-to-valve welds, volumetric NDE examination shall be performed using at least one of the following methods:

- Radiographic testing on 100 % of the welds in accordance with ASME BPVC, Section V, Article 2, and acceptance shall conform to ASME BPVC, Section VIII, Division 1, UW-51 for linear indications and ASME BPVC, Section VIII, Division 1, Appendix 4, for rounded indications.
- Ultrasonic testing on 100 % of the welds in accordance with ASME BPVC, Section V, Article 4, and acceptance shall conform to ASME BPVC, Section VIII, Division 1, Appendix 12.

NOTE See L.8 for additional requirements for NDE for weld end connectors.

12.1: *The first paragraph shall be changed to the following:*

Valve body marking shall conform to the requirements of Table 11. Check valves shall be marked with an arrow indicating the direction of flow.

Table 11: The table shall be changed as indicated by the red boxes:

Item No.	Marking	Section	Format Example	
1	Manufacturer's name <sup>a, c</sup>	— <sup>e</sup>	Per manufacturer requirements	
2	Unique serial number <sup>b</sup>	14.1	Per manufacturer requirements	
3	ASME Pressure Class Rating <sup>b</sup> or Intermediate Pressure Rating <sup>b</sup>	4.3.1	150, 300, 600, 900, 1500, or 2500	
		4.3.2	PN155, 2250 psi	
4	Body/end-connector material designation <sup>b, f, g, j</sup>	6	Material grade	
5	Body/end-connector melt identification <sup>f, g</sup>	— <sup>e</sup>	Cast or heat number	
6a	Nominal valve size <sup>b, d</sup>	Full-opening valves: nominal valve size	4.4.2	8 or DN 200
6b		Reduced-opening valves with circular opening: <sup>d</sup>	4.4.3	8 × 6 or DN 200 × 150 or 8R x bore or DN 200R x bore
6c		Reduced-opening valves with noncircular opening	4.4.4	8R (DN200R)
7	SMYS (units) of valve ends <sup>h</sup>	5.1	SMYS 40 KSI or SMYS 276 MPa	
8	Ring joint groove number <sup>i</sup>	— <sup>e</sup>	R49	
9	Flow direction (for check valves only)	12.1	→ or ←	

<sup>a</sup> Shall be on *either* the body or the nameplate at a minimum; may be on both.  
<sup>b</sup> Shall be on *both* the body and the nameplate.  
<sup>c</sup> Additional use of trademark/brand names with the manufacturer's name is optional.  
<sup>d</sup> Bore may be marked in in. or (mm).  
<sup>e</sup> No specific document reference identified.  
<sup>f</sup> When the body is manufactured from more than one type of material, all materials of the body and end connector shall be identified—MSS SP-25 gives guidance on marking.  
<sup>g</sup> Body includes body/end connector.  
<sup>h</sup> On body weld ends only.  
<sup>i</sup> On flange OD.  
<sup>j</sup> Where the grade and class does not uniquely identify the material specification, the material specification, grade, and class shall be marked. Example: A516-70 or A537 CL2.

Table 13: The table shall be changed as indicated by the red boxes:

...

9	Body/end connector material designation <sup>a, f, h</sup>	6.1	Material grade
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...

<p><sup>a</sup> Shall be on <i>either</i> the body or the nameplate, at a minimum; may be on both.</p> <p><sup>b</sup> Shall be on <i>both</i> the body and the nameplate.</p> <p><sup>c</sup> Additional use of trademark/brand names with the manufacturer's name is optional.</p> <p><sup>d</sup> Bore may be marked in in. or (mm).</p> <p><sup>e</sup> No specific document reference identified.</p> <p><sup>f</sup> When the body is manufactured from more than one type of material, all materials of the body and end connector shall be identified.</p> <p><sup>g</sup> MSS SP-25 gives guidance on marking.</p> <p><sup>h</sup> Where the grade and class does not uniquely identify the material specification, the material specification, grade, and class shall be marked. Example: A516-70 or A537 CL2.</p>
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14.1: The 5<sup>th</sup> bullet shall be changed to the following:

- visual inspection records;

Annex B: The title for the Figure B.12 in the introduction of the Annex shall be changed to the following:

Figure B.12—Check Valve (Short Pattern, Single-plate Wafer-type)

Figure B.8: The following note shall be added to the Figure:

NOTE: See applicable table in Annex C.

Figure B.9: The following note shall be added to the Figure:

NOTE: See applicable table in Annex C.

Figure B.12: The following note shall be added to the Figure:

NOTE: See applicable table in Annex C.

Table C.2: For Class 150, the row for NPS 20 shall be changed to the following:

...

20	500	36.00 (914)	39.00 (991)	36.50 (927)	—	—	—
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...

Table C.3: For Class 2500, the row for NPS 6 shall be changed to the following:

...

6	150	36.00 (914)	36.50 (927)	16.93 (430)
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...

Table C.4: The footnotes shall be changed to the following:

...

<sup>1</sup> See Figure B.8 and Figure B.9. <sup>2</sup> Tolerances on standard face-to-face and end-to-end dimensions shall be ±0.06 in. (±1.5 mm) for valve sizes smaller than NPS 12 (DN 300), and ±0.12 in. (±3.0 mm) for valve sizes NPS 12 (DN 300) and larger.
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Table E.1: The Gate Valve section of the table shall be changed as indicated by the red box:

...

Gate:				
Slab and/or through-conduit	Pressure energized—downstream sealing only/fixed seats (Note 1)	No (Note 2)	No	No
Slab and/or through-conduit DIB-1	Pressure energized—upstream and downstream sealing (Note 1)	Yes	Yes (Note 3)	Yes (Note 3)
Expanding DIB-1	Mechanically energized	Yes	Yes (Note 3)	Yes (Note 3)

...

F.7: The section shall be changed to the following:

## F.7 Testing Medium

### F.7.1 General

The testing medium shall be a fluid that remains in the liquid or gaseous state throughout the testing temperature range. Water with or without additives, gas, hydraulic fluid, or other mixtures of fluids may be used as the test medium.

### F.7.2 Substitution of Gas

The manufacturer may substitute gas for liquid if hydrostatic testing is specified, provided the testing method and acceptance criteria for gas testing are used.



Table F.1: The table shall be changed to the following:

Design Validation	Reference Section
Hydrostatic body pressure test	F.17.1
Hydrostatic seat pressure test	F.17.2
Force or torque measurement (initial test)	F.18
Dynamic (open/close cycling) pressure test at ambient temperature	160 cycles per F.19
Dynamic (open/close cycling) pressure gas test at maximum temperature	20 cycles per F.20
Gas body test at maximum rated temperature	F.21
Gas seat test at maximum rated temperature	F.22
Low-pressure seat test at maximum rated temperature	F.23
Dynamic (open/close cycling) pressure gas test at minimum temperature	20 cycles per F.20
Gas body test at minimum rated temperature	F.21
Gas seat test at minimum rated temperature	F.22
Low-pressure gas seat test at minimum rated temperature	F.23
Gas body shell gas pressure and temperature cycling	F.24
Gas body test at ambient temperature	F.25
High-pressure gas seat test at ambient temperature	F.26
Low-pressure gas seat test at ambient temperature	F.27
Final force or torque measurement (final test)	F.18
Post-test examination	F.16

F.17: The section title shall be changed to the following:

## **F.17 Pressure Testing at Ambient Temperature**

F.17.2: The section title and content shall be changed to the following:

### **F.17.2 Hydrostatic Seat Pressure Test**

Hydrostatic seat testing shall conform to 10.4.

Test duration shall be a minimum of 1 hour.

When a valve is provided with self-relieving function, a test according to I.7 shall be performed.

F.23: The section title shall be changed to the following:

### **F.23 Low-pressure Gas Seat Test at Maximum/Minimum Rated Temperature**

*F.24: The section title shall be changed to the following:*

## **F.24 Gas Body Shell Pressure and Temperature Cycling**

*F.28: The section shall be deleted entirely*

*H.1: The section title shall be changed to the following*

## **H.1 Temperature Survey-for Batch-type Furnaces**

### **H.1.1 Method**

*H.1.1: The NOTE shall be changed to the following:*

NOTE Alternative recognized industry standards, such as SAE AMS 2750 or SAE AMS-H-6875, may be used if the furnace thermal uniformity survey (TUS) and furnace instrument calibration requirements in 6.8 are satisfied.

*H.1.2: The following section shall be added:*

### **H.1.2 Furnace Survey Temperature Tolerance**

#### **H.1.2.1 Austenitizing, Normalizing, Annealing or Solution Annealing Furnaces**

The temperature at any point in the working zone of a furnace used for austenitizing, normalizing, annealing, or solution annealing shall not vary by more than  $\pm 25$  °F ( $\pm 14$  °C) from the furnace set-point temperature after the furnace working zone has been brought up to temperature. Before the furnace set-point temperature is reached, none of the temperature readings shall exceed the set-point temperature by more than the temperature tolerance.

#### **H.1.2.2 Tempering, Aging, or Stress-relieving Furnaces**

Furnaces that are used for tempering, aging (sometimes called “precipitation hardening”), and/or stress-relieving shall not vary by more than  $\pm 15$  °F ( $\pm 8$  °C) from the furnace set-point temperature after the furnace working zone has been brought up to temperature. Before the furnace set-point temperature is reached, none of the temperature readings shall exceed the set-point temperature by more than the temperature tolerance.

*H.2: The section title and content shall be changed to the following:*

## **H.2 Temperature Survey for Continuous-type Furnaces**

Furnaces used for continuous heat treatment shall be temperature surveyed in conformance with procedures specified in SAE AMS 2750 or SAE AMS-H-6875.

Table I.2: The "PT3" row of the table shall be changed to the following:

...

PT3	All sealing surfaces	ASME BPVC, Section V, Article 6	No relevant rounded or relevant linear indications in pressure-contact sealing surfaces shall be permitted <sup>a</sup>
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...

I.6.1: Item a) shall be changed to the following:

a) open-to-closed with the bore pressurized and

- 1) the cavity at atmospheric pressure for valves with no pressure balance hole, for valves with an upstream seat; or
- 2) cavity at test pressure for valves with pressure balance hole, or downstream seated valve;

I.7.2.2: Item c) shall be changed to the following:

c) Pressurize both sides of the valve and the valve cavity simultaneously, up to 1.0 times MAWP.

I.8.2.1: The second bullet shall be changed to the following:

- Method 2: Valves shall have a high-pressure gas shell test performed using nitrogen, with a minimum of 1 % helium tracer measured using a mass spectrometer.

I.8.2.2: The second bullet shall be changed to the following:

- Method 2: When using a mass spectrometer, a maximum of 0.27 cc/min of nitrogen + helium gas mixture per 1 % of helium shall be permitted when measured at each mechanical joint.

EXAMPLE For 1 % helium gas mixture, the allowable leakage is 0.27 cc/min. For 3 % helium gas mixture, the allowable leakage is 0.81 cc/min. For 10 % helium gas mixture, the allowable leakage is 2.7 cc/min.

Table I.6: The row for item 8 shall be changed as indicated by the red box:

...

8	NDE records	X	X	X
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...

K.16: The section shall be added:

## K.16 Method of Operation

When specified by the purchaser, manual gearbox output torque/thrust of at least 1.5 times the maximum required operating torque/thrust shall be based on a temperature other than the minimum temperature specified.

L.3: The NOTE shall be changed to the following:

NOTE  $K_v$  is related to the flow coefficient  $C_v$ , expressed in USC units of U.S. gallons of water per minute at 60 °F (15.6 °C), resulting in a 1 psi pressure drop as given by Equation (2):

*L.9: The last bullet shall be changed to the following:*

- Acceptance criteria shall be per the requirements of 10.4.1, except that for the metal-to-metal seat test, the leakage rate shall not be more than two times ISO 5208, Rate C.

*L.10: The NOTE and the last bullet shall be changed to the following:*

NOTE Some valve types (e.g., slab gate valves) can require the balancing of the upstream and valve cavity pressure during the downstream seat test, in which case only one end of the valve shall be open to atmosphere.

- Acceptance criteria shall be per the requirements of 10.4.1, except that for the metal-to-metal seat test, the leakage rate shall not be more than two times ISO 5208, Rate C.

*L.11: The last bullet shall be changed to the following:*

- Acceptance criteria shall be per the requirements of 10.4.1, except the metal-to-metal seat test, the leakage rate shall not be more than two times ISO 5208, Rate C.

*L.12: The section shall be changed to the following:*

When specified, valves required for double isolation and bleed (DIB) operations shall be tested. The testing shall be performed as follows:

- a) Test fluid shall be hydrostatic test fluid that conforms to 10.1.2 or nitrogen gas, as specified.
- b) The following steps shall be performed. For DIB-1 valves, follow steps 1 through 9. For DIB-2 valves, follow steps 1 through 8.
  - 1) With the valve partly open, fill the valve with test medium and pressurize to valve MAWP.
  - 2) Close the valve.
  - 3) Reduce pressure on the downstream side of the valve to zero and monitor cavity pressure.
  - 4) Monitor leakage between the cavity and downstream side.
  - 5) Reduce pressure in the cavity to zero and monitor upstream pressure and monitor leakage to the downstream side.

NOTE For steps 5, 6, and 7, the pressure changes are done at a rate that minimizes the likelihood of rapid seat movement.

- 6) Reintroduce pressure into the cavity up to 145 psi (10 bar) and monitor leakage to the downstream side.
  - 7) Reduce pressure in the cavity to zero and monitor leakage to the downstream side.
  - 8) With the cavity and downstream side vented to zero, measure upstream seat performance by monitoring leakage at the cavity port.
  - 9) Repeat steps 1 through 8 on the opposite side of the valve.
- c) Leakage for soft-seated valves shall not exceed ISO 5208, Rate A (no visible detectable leakage for the duration of the test at test pressure).

- d) For metal-seated valves, the leakage rate shall not exceed ISO 5208, Rate C; however, for valves tested with gas, the leakage rate shall not exceed ISO 5208, Rate D.

*L.18: The section shall be changed to the following:*

When specified, a production material hardness test on all metallic pressure-containing and pressure-controlling parts for sour service shall be required. The maximum hardness shall be per NACE MR0175/ISO 15156 requirements.

The method of hardness testing shall be performed in accordance with the following:

- For HBW hardness measurements, testing shall be performed in accordance with ASTM E10 or ISO 6506-1.
- For HRC hardness measurements, testing shall be performed in accordance with ASTM E18 or ISO 6508-1.
- Portable hardness measurements shall be performed in accordance with ASTM E110.

Hardness testing shall not be performed on the sealing surfaces of finished machined parts.

Results of the production hardness testing shall be reported and records maintained (see 14.1).

NOTE This hardness test may be performed by the supplier on the material provided and reported on the material test report.

*Table L.1: The table shall be changed as indicated in the red box:*

Nominal Pipe Size	Duration (minutes)
4 (DN 100) and below	5
6 (DN 150) to 10 (DN 250)	10
12 (DN 300) to 18 (DN 450)	15
20 (DN 500) and above	30

*L.20.2.1: The second bullet shall be changed to the following:*

- Method 2: Valves shall have a high-pressure gas shell test performed using nitrogen with a minimum of 1 % helium tracer measured using a mass spectrometer.

*L.20.2.2: The second bullet shall be changed to the following:*

- Method 2: When using a mass spectrometer, a maximum of 0.27 cc/min of nitrogen + helium gas mixture shall be permitted when measured at each mechanical joint.

EXAMPLE For 1 % helium gas mixture, the allowable leakage is 0.27 cc/min. For 3 % helium gas mixture, the allowable leakage is 0.81 cc/min. For 10 % helium gas mixture, the allowable leakage is 2.7 cc/min.