Type Testing of Rising Stem Valves Equipped with Graphite Packing for Fugitive Emissions

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

Introduction

The purpose of this standard is to establish a uniform procedure for the evaluation of emission performance of process valves. The testing program will provide a basis for the comparison of the emissions and performance of process valves.

Use of this standard assumes the execution of its provisions is entrusted to appropriately qualified and experienced personnel because it calls for procedures that can be injurious to health if adequate precautions are not taken. This standard refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage of the procedure.

Type Testing of Rising Stem Valves Equipped with Graphite Packing for Fugitive Emissions

1 Scope

This standard specifies the requirements and acceptance criteria (100 ppmv) for fugitive emission type testing of rising and rising-rotating stem valves equipped with packing previously tested in accordance with API 622. Packing shall be suitable for use at service temperatures –29 °C to 538 °C (–20 °F to 1000 °F). The type testing requirements contained herein are based upon elements of EPA Method 21.

Valves larger than NPS 24 or valves greater than class 1500 are outside the scope of this standard.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Standard 602, *Steel Gate, Globe and Check Valves for Sizes DN 100 and Smaller for the Petroleum and Natural Gas Industries*

API Standard 622, *Type Testing of Process Valve Packing for Fugitive Emissions*

ASME B16.34 [1], *Valves—Flanged, Threaded, and Welding End*

EPA Method 21 [2], *Determination of Volatile Organic Compound Leaks*

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1
ambient temperature
Temperature that is between 15 °C to 40 °C (59 °F to 104 °F).

3.2
auxiliary connection
Drain(s), vent(s), or sealant injection port(s).

3.3
bolting torque
The amount of twisting or turning effort (expressed as N-m, ft-lb, or in.-lb) required to tighten a threaded fastener.

3.4
dynamic leak measurement
Measurement of leakage taken while the stem is traveling through an opening and closing cycle.

3.5
EPA Method 21
A leak check method established by the United States Environmental Protection Agency (EPA) for performing emissions measurements on equipment such as valves, pumps, and flanges.

[1] ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org.
[2] U.S. Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, Washington, DC 20460, www.epa.gov.

3.6
emissions
Gaseous leak given off by a piece of equipment used in reference to volatile organic compounds (VOCs) and expressed in parts per million volumetric (ppmv or ppm) for methane.

3.7
leakage
Measurable amount of test medium escaping from the valve.

3.8
manufacturing facility
Location of final assembly, inspection, and testing of the valve selected for evaluation.

3.9
mechanical cycle
A motion of the stem that moves a valve obturator from within one turn of the fully closed position to within one turn of the fully open position and returning to within one turn of the fully closed position.

3.10
obturator
Part of a valve, such as a wedge, disc, or plug, which is positioned in the flow stream to permit or prevent flow.

3.11
Purchaser
A person, group, company, agency, corporation, or designated representative responsible for valve acceptance.

3.12
rising stem valve
Valve in which the movement of the stem is in an axial direction with no rotation.

3.13
rising-rotating stem valve
Valve in which the movement of the stem is in an axial direction with rotation.

3.14
running torque
The amount of torque required to move a valve stem through the packing.

3.15
static leak measurement
Measurement of leakage taken when the stem is not moving.

3.16
stem
Metal rod that connects the obturator of a valve to a handwheel, handle, or actuator.

3.17
thermal cycle
A change in temperature from ambient temperature, to elevated and/or lower temperature(s), and back to ambient temperature.

3.18
type testing
A test conducted to assess the performance of a specific valve design at prescribed temperatures and pressures.

4 Valve Selection and Test Preparation

4.1 The API 622 certificate or test report for the packing in the test valve shall be provided and attached to the API 624 fugitive emissions test report.

4.2 The test valve shall be completely assembled and ready for testing. The test valve shall be randomly selected from manufacturer or distributor stock where such stock is available. For valves not in stock, the manufacturer shall certify that the test valve was not modified in any way to meet type test requirements and is a typical representation of the manufacturer's stock product. Valve selection shall be approved by the purchaser.

4.3 Body-bonnet and gland bolting torque shall be verified to be in accordance with published manufacturer's installation specifications.

4.4 All pre-test activities to the valve shall be documented on the Fugitive Emissions Test Report in Annex A.

4.5 As a safety precaution, the air in the valve cavity shall be purged with an inert gas prior to starting the testing.

5 Type Testing

5.1 The test medium used shall be methane 97 % minimum purity.

Caution—Methane used during testing is a pressurized flammable gas which requires that appropriate safety measures be taken.

5.1.1 Testing of valves is potentially hazardous and it is essential that the safety of personnel be given prime consideration. Given the nature of this test, hazardous release of pressurized gas could occur. Adequate shields or barriers in the area of the test enclosure and other appropriate means for the protection of personnel shall be provided.

5.1.2 The test facilities shall be designed to ensure that all the test conditions are conducted in a safe and protected environment. It is the responsibility of the testing facility to analyze the hazards resulting from the pressure and temperatures and take proper safety precautions. All applicable safety regulations shall be complied with.

5.1.3 All equipment shall have appropriate certification that verifies its suitability to withstand the minimum and maximum pressures and temperatures in the testing environment.

5.1.4 Hoses or pipes used for inlet and outlet supply of methane shall be suitable for maximum pressures and temperatures. Where hoses are used, appropriately designed restraints shall be used to prevent hose detachment from the test rig in the event that a blow-out occurs.

5.1.5 All testing shall be in accordance with local and national codes and regulations.

5.2 The stem orientation for a test valve shall be vertical.

5.3 Valves shall be subjected to a total of 310 mechanical cycles and 3 thermal cycles per Figure 1. Mechanical cycling shall begin with the valve at ambient temperature. An optional low temperature test at –29 °C (–20 °F) may be performed if requested by the purchaser (see Figure 1).

5.4 The valve shall be heated using an internal heat source or an external heat source such as electric heating blanket, coils, or other suitable equipment or an appropriate internal heat source.

5.5 The elevated test temperature shall be 260 °C (500 °F) ±5 percent.

5.6 The test pressure shall be the lower of 41.4 barg (600 psig) or the maximum allowable pressure at 260 °C (500 °F) per ASME B16.34 for the applicable material group and shall be held constant throughout the test.

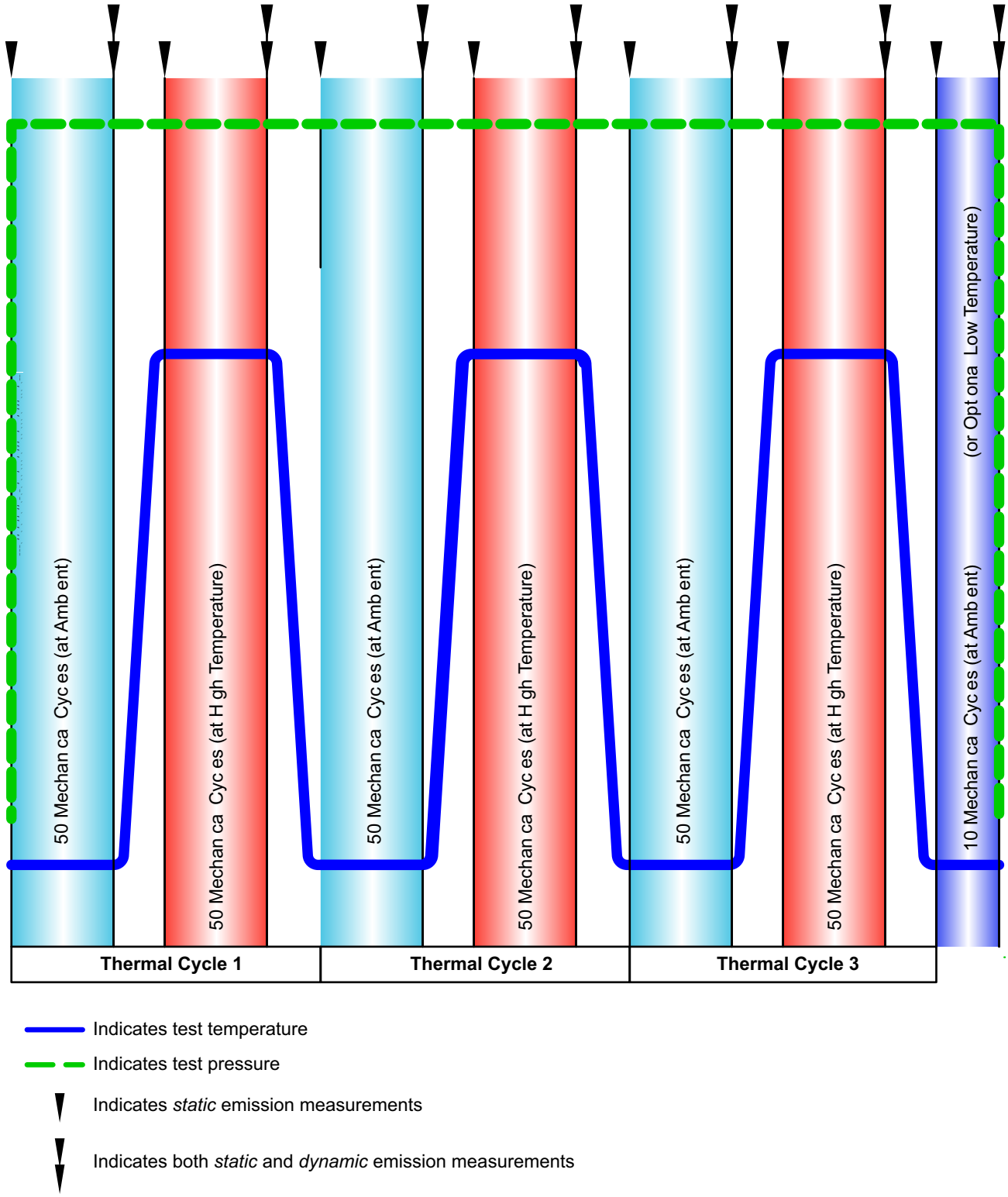

Figure 1—Valve Cycling

5.7 The test valve may be equipped with a method of actuation capable of mechanically cycling the valve. The method of actuation should not impose additional side loads on the stem or packing. Running torque values shall be recorded on the first and last cycle of testing.

5.8 Static and dynamic stem leakage measurements shall be taken. See Figure 1.

5.8.1 Leak measurements shall be conducted in still air. Shielding potential leak paths from environmental impacts with a foil enclosure shall be employed during testing. The foil enclosure shall include the stem outside diameter and packing outside diameter.

5.8.2 Leak measurements of the body-bonnet connection and auxiliary connections shall be sniffed. Leakage from body-bonnet and auxiliary connections can affect leak measurement readings and shall be corrected prior to continuation of the test and noted in the report. The detector probe speed shall be approximately 25 mm (1 in.) per second for the bonnet. The instrument shall be adjusted to compensate for the background methane level.

5.8.3 The static/dynamic leakage shall be recorded after a time delay of twice the response time of the instrument.

5.9 The valve shall be equipped with thermocouples for monitoring the temperature during testing. The temperature shall be monitored and recorded at two locations (see Figure 2).

5.9.1 TC-1—affixed to the stuffing box. The thermocouple affixed to the stuffing box shall control the test temperature.

5.9.2 TC-2—at the external body adjacent to the flow path shall be a reference measurement.

5.9.3 TC-2—shall be equal to or greater than TC-1.

5.10 Packing adjustment during type testing is not permitted.

6 Acceptance Criteria

The Fugitive Emissions Test Report in Annex A shall indicate “pass” when the measured leakage throughout the test does not exceed 100 ppmv.

7 Leak Test Equipment and Calibration

7.1 Monitoring equipment shall be as described below capable of providing on-board data logging with digital readout. The equipment shall be certified as intrinsically safe for use with the test medium. Data logging may also be performed with a separate data acquisition system.

7.2 The equipment shall meet the following performance requirements in the flame ionization mode:

a) Maximum variation: ±2 % at 100 ppmv.

b) Minimum detectable level (defined as 2× the peak noise): 300 ppb hexane.

c) Maximum response time to reach final value: 3 seconds.

d) Maximum recovery time to return to 10 % of initial value: 5 seconds.

e) Sample flow rate at probe inlet: 0.8 to 1.51 l/min (0.21 to 0.40 gal/min).

7.3 The test equipment shall be inspected prior to each use to ensure against fouling of the detector probe. This shall be done per EPA Method 21 using an external calibration gas with a known methane concentration.

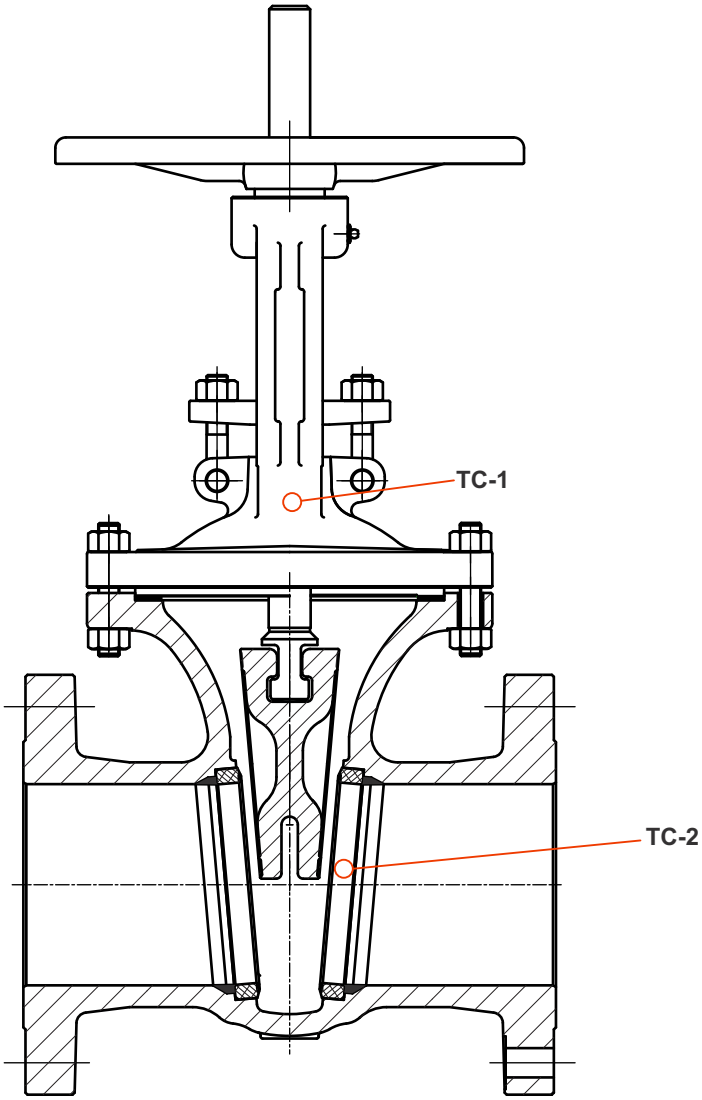

Figure 2—Temperature Locations

To increase accuracy of readings between different measuring instruments and testers, the leakage device shall be calibrated to known leak rate standards daily prior to testing. A record of test equipment calibration shall be maintained by the test facility.

A porous or sintered metal/ceramic leak standard or similar device shall be used per the following procedure (see Figure 3):

a) Verify the sampling flow rate of the leakage monitoring device to be in the range of 0.5 to 1.5 l/min (0.13 to 0.40 gal/min) with a calibrated flow meter.

b) Verify the flow rate of the calibrated standard leak at a regulated differential pressure using 97 % minimum purity test gas. The calibrated standard leak shall be in the range of 0.025 to 0.075 ml/min (6.6×10^{-6} to 1.98×10^{-5} gal/min) of methane. The inverted beaker technique may be used with a sufficient amount of time to collect a measurable amount of sample. The test time should also be sufficient to fill the tubing and fittings used in the calibration setup.

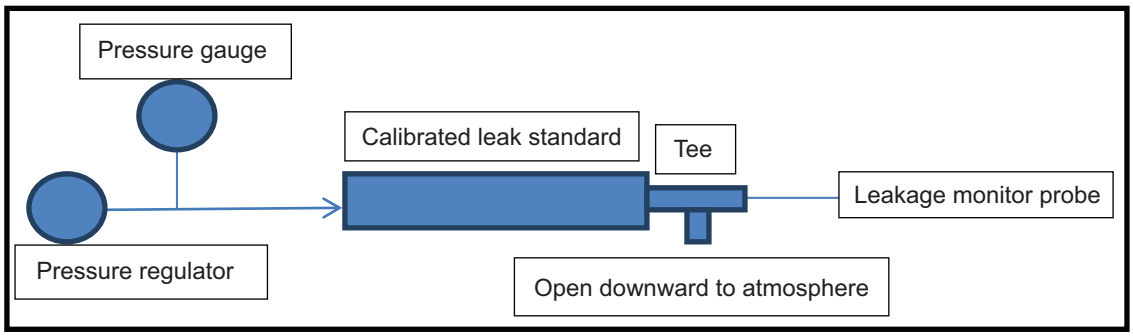

Figure 3—Calibration Setup

c) After the flow rate is verified and it is ensured that the test gas has completely saturated the calibrated leak standard, the leakage monitor probe shall be attached to the tee fitting connected to the standard.

d) Using a nominal flow rate of 1.00 l/min (0.26 gal/min), a 0.05 ml/min (1.32×10^{-5} gal/min) leak standard shall produce by definition a 0.05 / (1.00 liter × 1000 ml/liter) = 0.005 % [1.32×10^{-5} / 0.26 = 0.005 %] concentration of test gas by volume or 50.0 ppmv concentration. Therefore, the reading of the leakage monitor shall be tuned to be the verified flow rate of the leak standard in ml/min times 1000 in ppmv.

7.4 The emissions leak test system shall conform to all local and governmental safety standards and shall be equipped with pressure relief valve(s)/rupture disc(s) and vents as required.

8 Post-test Inspection

8.1 Valve shall be disassembled and components including stem, packing, stem nut, gland follower, and stuffing box shall be inspected and the condition documented.

8.2 Sealing components shall be photographed in accordance with 9.2.

9 Recording and Documentation

9.1 As a minimum, test results shall be provided as defined by the Fugitive Emissions Test Report provided in Annex A. In addition, photographic evidence shall be recorded as defined in 9.2.

9.1.1 Leak measurements shall be recorded at established intervals as detailed in 5.8.

9.1.2 Leakage rate units of measurement for methane shall be [ppmv].

9.2 Photographic evidence shall be documented as indicated in 9.2.1 through 9.2.3.

9.2.1 Valve marking and tagging.

9.2.2 Pre- and post-test valve external stuffing box area.

9.2.3 Post-disassembly valve components:

a) stem packing area,

b) stem threads,

c) stem nut,

d) stem bushing,

e) packing gland follower,

f) stuffing box interior,

g) packing rings and spacers.

9.3 The testing facility shall issue a test certificate stating that the valve was tested in accordance with API 624.

9.4 All completed test reports are considered to be confidential and proprietary and shall not be copied or distributed without prior approval from the manufacturer.

10 Valves Qualified

10.1 All valves of the same basic design as the test valve may be deemed to have been type tested, subject to the following additional limitations.

10.1.1 For API 602 valves, a NPS 3/4 class 800 test valve may be used to qualify all valves NPS 1 and smaller valves up to and including class 800. For API 602 valves, a NPS 1 1/2 class 800 test valve may be used to qualify all valves NPS 1 1/4 through NPS 2 1/2 up to and including class 800.

10.1.2 For API 602 valves, a NPS 3/4 class 1500 test valve may be used to qualify all valves NPS 1 and smaller in class 1500. For API 602 valves, a NPS 1 1/2 class 1500 test valve may be used to qualify all valves NPS 1 1/4 through NPS 2 1/2 in class 1500.

10.1.3 For all other valves:

10.1.3.1 NPS 4 qualifies all smaller diameters and one diameter larger and one pressure class lower than the test valve.

10.1.3.2 For valves larger than NPS 4, the test valve qualifies valves from two nominal sizes smaller to one nominal size larger and one pressure class lower than the test valve.

10.1.4 Annex B provides a list of valves that may be tested to qualify to this standard.

10.2 Any change in valve stem sealing system design including, but not limited to, packing material, packing manufacturer, or packing type/model requires a requalification.

10.3 If the location of the valve manufacturing facilities is different than what is listed on the API 624 certificate, the purchaser may request requalification.

11 Valve Marking

Valves qualified by this standard shall be clearly and permanently marked as “API 624”.

Annex A
(normative)

Fugitive Emissions Test Report

<table>
<tr><td colspan="3">API Std 624 Fugitive Emissions Testing Report Number: _____</td></tr>
<tr><td colspan="2">Valve Stem Type (check one):

( ) Rising ( ) Rising-Rotating</td><td>Manufacturer & Location:
Valve Size, Class, & Type:
API/ASME Design Standard(s):</td></tr>
<tr><td>Packing Description:
Manufacturer:
Model/Type:

Gland follower exposed length:
Stuffing box depth:</td><td>Number of rings:
OD:
ID:
Stack height:

Gland follower insertion depth:</td><td>Body material:

Stem material:

Body-bonnet gasket material:</td></tr>
<tr><td>Testing Facility:

Technician:

Witness:

Start Date:</td><td>Completion Date:</td><td>Valve Selection (check one): Date Selected:
( ) Manufacturer
( ) Distributor
( ) Purchaser
Selected by:</td></tr>
<tr><td colspan="2">Gland nut recommended torque:

Body-bonnet bolting recommended torque:</td><td>Body-bonnet connection:

Type: ( ) Bolted
( ) Welded
( ) Pressure Seal
( ) Other _____</td></tr>
<tr><td colspan="3">Pre-test Preparations & Adjustments (see Section 4.3):</td></tr>
<tr><td colspan="3">Notes:</td></tr>
</table>

API 624 Testing Data						
Test Segment	**Cycle**	**Temperature @ TC1**	**Temperature @ TC2**	**Static Leak Measurement**	**Dynamic Leak Measurement**	**Other Leak Measurement (specify)**
Ambient Temperature 0 to 50 cycles P = _____ T = _____	0					
	50					
Elevated Temperature 51 to 100 cycles P = _____ T = _____	51					
	100					
Ambient Temperature 101 to 150 cycles P = _____ T = _____	101					
	150					
Elevated Temperature 151 to 200 cycles P = _____ T = _____	151					
	200					
Ambient Temperature 201 to 250 cycles P = _____ T = _____	201					
	250					
Elevated Temperature 251 to 300 cycles P = _____ T = _____	251					
	300					
Ambient (or Low) Temperature 301 to 310 cycles P = _____ T = _____	301					
	310					

Running Torque Value: First Cycle: _____ Last Cycle:_____

Pass ( ) Fail ( )

Lab Representative Signature: _____ Date: _____

Witnessed By: _____ Date: _____

Annex B
(informative)

Suggested Valves for Testing

Table B.1—Size and Class to be Tested for Each Gate Valve Made in Accordance with API 602

NPS	Class
3/4 in.	800
1 1/2 in.	800
3/4 in.	1500
1 1/2 in.	1500

Table B.2—Size and Class to be Tested for Each Globe Valve Made in Accordance with API 602

NPS	Class
3/4 in.	800
1 1/2 in.	800
3/4 in.	1500
1 1/2 in.	1500

Table B.3—Size and Class to be Tested for Each Gate Valve Made in Accordance with API 600

NPS	Class
4 in.	150
4 in.	600
4 in.	1500
12 in.	150
12 in.	600
12 in.	1500
20 in.	150
20 in.	600

Table B.4—Size and Class to be Tested for Each Gate Valve Made in Accordance with API 603

NPS	Class
3/4 in.	150
1 1/2 in.	600
4 in.	150
4 in.	600
12 in.	150
12 in.	600
20 in.	150
20 in.	600

Table B.5—Size and Class to be Tested for Each Globe Valve Made in Accordance with API 623

NPS	Class
4 in.	150
4 in.	600
4 in.	1500
12 in.	150
12 in.	600
12 in.	1500

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