Type Testing of Process Valve Packing for Fugitive Emissions

API STANDARD 622
THIRD EDITION, OCTOBER 2018

AMERICAN PETROLEUM INSTITUTE

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Introduction

The purpose of this API standard is to establish a uniform procedure for evaluation of process valve stem packing. The testing approaches defined within this standard provide a method for evaluating packing systems. This testing program shall provide a basis for the comparison of the emissions and life cycle performance of packing.

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.

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Type Testing of Process Valve Packing for Fugitive Emissions

1 Scope

This standard specifies the requirements for comparative testing of valve stem packing for process applications where fugitive emissions are a consideration. Packing(s) shall be suitable for use at service temperatures –29 °C to 538 °C (–20 °F to 1000 °F). Factors affecting fugitive emissions performance that are considered by this standard include temperature, pressure, thermal and mechanical cycling, and corrosion.

This standard is not intended to replace type testing of valve assemblies or valve production testing.

This standard establishes requirements and parameters for the following tests:

a) fugitive emissions;

b) corrosion; and

c) packing material composition and properties.

Test methods apply to packing for use in on-off valves with the following stem motion(s):

a) rising stem;

b) rotating stem; or

c) rising and rotating stem.

2 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this API standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ASME B16.5[1], *Pipe Flanges and Flanged Fittings*

ASME B16.20, *Metallic Gaskets for Pipe Flanges—Ring Joint, Spiral-wound, and Jacketed*

ASTM D512, *Standard Test Methods for Chloride Ion in Water*

ASTM D1179, *Standard Test Methods for Fluoride Ion in Water*

ASTM D4327, *Standard Test Method for Anions in Water by Suppressed Ion Chromatography*

MSS[2] SP-120, *Flexible Graphite Packing System for Rising Stem Steel Valves*

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[1] ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.
[2] Manufacturers Standardization Society, 127 Park St. NE, Vienna, VA 22180-4602, www.msshq.org

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3 Terms and Definitions

For the purposes of this standard, the following definitions shall apply.

3.1
anti-extrusion ring
A ring of packing used at one or both ends of a packing set to prevent extrusion of packing material into clearances.

3.2
ambient temperature
Temperature that is between 15 °C (59 °F) to 40 °C (104 °F).

3.3
axial
In the direction of a shaft or stem axis.

3.4
bolt torque
The amount of twisting or turning effort (expressed as Nm, lbf-ft, or lbf-in.) required to turn the nuts on a gland flange; commonly used to determine the load that a gland flange exerts on a valve packing set.

3.5
braided packing
Packing typically constructed of intertwining strands of synthetic or natural fibers. Strands may consist of yarn or filaments, and may also include metallic materials.

3.6
bushing
Cylindrical spacer used to take up excess space in a stuffing box.

3.7
corrosion inhibitor
An ingredient added to packing that decreases the potential for galvanic corrosion in the stuffing box. Corrosion inhibitors may be classified as either passive or active.

3.8
die-formed packing
A valve stem packing typically constructed from ribbons of graphite tape or braided packing that has been subjected to pre-compression with tooling of a specific geometry. This process changes the shape and density of the material from its original free shape and natural density to a defined shape and higher density.

3.9
emissions
Gaseous leak given off by a piece of equipment. Used in reference to volatile organic hydrocarbons (VOCs) and expressed in parts per million volumetric (ppmv or ppm).

3.10
galvanic corrosion
An electro-chemical reaction that may occur between a metal and a material of a different chemical nobility, such as another metal, carbon, or graphite when both materials are exposed to an electrically conductive media.

3.11
gland
A movable part that is inserted into a stuffing box to compress a packing set or packing ring.

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3.12
gland flange
The component used to retain the gland within the stuffing box and provide compression of the gland into the packing/stem seal to create load. The gland flange shall have two holes to receive the gland bolting. Slots for gland flange bolts shall not be used. The gland and gland flange shall be self-aligning. The gland shall have a shoulder at its outer edge so as to prevent complete entry of the gland into the packing box.

3.13
gland load
The amount of load applied to a packing set.

3.14
gland flange stud
A threaded rod or eye-bolt extending from a valve body against which the gland flange is tightened to compress a packing set.

3.15
leak
Measurable amount of test fluid escaping from the test gland.

3.16
leak rate
The quantity of test fluid passing through (or around) a seal in a given period of time.

3.17
mechanical cycle
A motion of the stem simulating the movement of a valve obturator (such as disc or ball) from the fully closed position to the fully open position, and returning to the fully closed position. See also: stroke.

3.18
packing set
A grouping of individual packing rings designed to fill the cavity of the valve stuffing box, with or without anti-extrusion rings.

3.19
pitting
Surface cavities that occur on a metal as a result of galvanic corrosion. See also: galvanic corrosion.

3.20
rising stem valve
A valve in which the movement of the stem is in an axial direction, with no rotation.

3.21
rotating stem valve
A valve that will fully open or close with a nominal 90° rotation of the stem.

3.22
rising–rotating stem valve
A valve in which the movement of the stem is in the axial direction and also has a 90° rotation to fully open or close.

3.23
static leak measurement
Measurement of leakage taken when the stem is not moving.

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3.24
stem
A metal rod that connects the obturator (such as a disc or ball) of a valve to a handwheel, handle, or actuator.

3.25
stroke
One half of a mechanical cycle starting from either a fully open or fully closed position. See also: mechanical cycle.

3.26
stuffing box
A space into which a compression packing is inserted. Also known as a packing chamber.

3.27
stuffing box diameter
The inside diameter into which packing is inserted; also called the stuffing box bore.

3.28
surface finish
A measure of the roughness of a surface; typically expressed in microinches or micrometers.

4 Fugitive Emissions Test

4.1 Test Fixture

4.1.1 The test stand is constructed as a fixture designed to simulate a typical valve stuffing box. A test arrangement is shown in Figure 1. The test fixture shall orient the stem in a horizontal position and shall be constructed so as not to affect test results. The use of bushings is allowed as necessary. Test stands may be equipped with multiple test fixtures. Construction details shall be done in accordance with Annex A.

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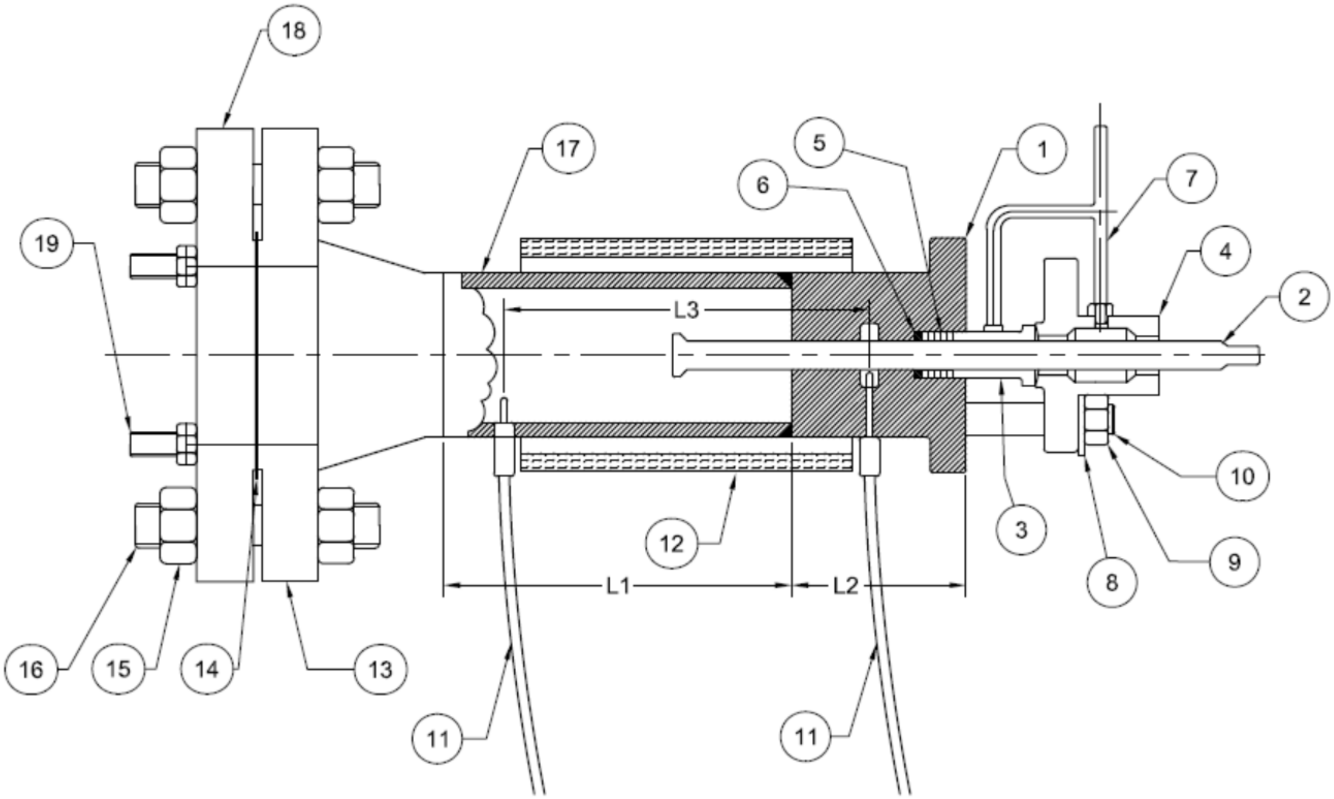

Key

1	bonnet	11	thermocouple
2	stem	12	heating element
3	gland	13	bonnet flange
4	gland flange	14	gasket
5	stem packing	15	flange stud nut
6	bushing	16	bonnet studs
7	leak detection fitting	17	housing
8	washer	18	blind flange
9	gland nut	19	gas inlet and outlet ports
10	gland stud		

Figure 1— Fugitive Emissions Test Fixture

4.1.1.1 Test fixture components and dimensions shall be as follows in Table 1.

Table 1—Test Fixture Dimensions

Item	1/8 in. Packing Fixture	¼ in. Packing Fixture
L1	127.0 mm (5.00 in.)	193.5 mm (7.62 in.)
L2	63.5 mm (2.50 in.)	139.7 mm (5.50 in.)
L3	127.0 mm (5.00 in.)	260.3 mm (10.25 in.)
Gland nuts	ASTM A194 Grade 2H	ASTM A194 Grade 2H

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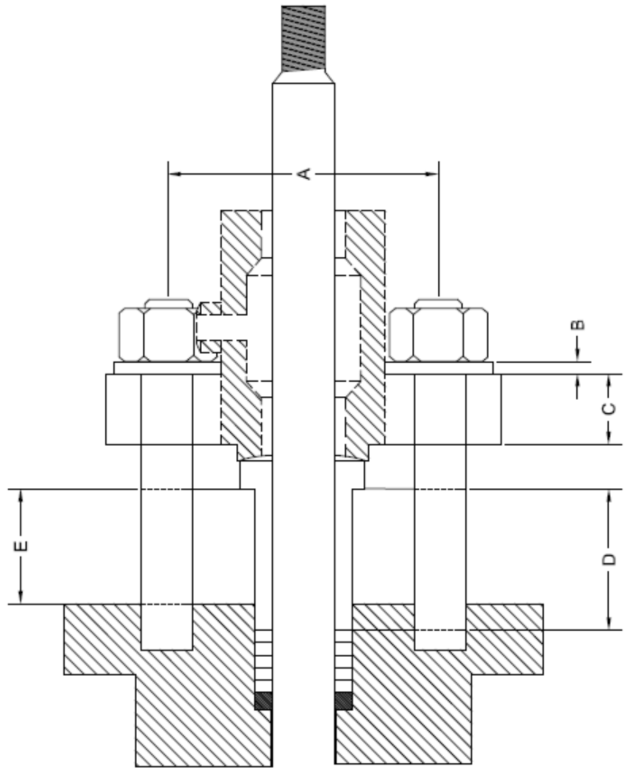

Figure 2—Test Fixture Bonnet

4.1.1.2 Test fixture bonnet dimensions as shown in Figure 2 shall be as follows in Table 2.

Table 2—Test Fixture Bonnet Dimensions

Item	1/8 in. Packing Fixture	1/4 in. Packing Fixture
A	48.79 mm (1.92 in.)	101.60 mm (4.00 in.)
B	3.18 mm (0.125 in.) max.	3.18 mm (0.125 in.) max.
C	25.4 mm (1.00 in.)	38.2 mm (1.50 in.)
D	50.8 mm (2.00 in.)	50.8 mm (2.00 in.)
E	Gland height shall be measured and recorded at beginning and end of test.	Gland height shall be measured and recorded at beginning and end of test.

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4.1.1.3 Test fixture stem/stuffing box dimensions and tolerances shall be as follows in Table 3.

Table 3—Test Fixture Stem/Stuffing Box Dimensions

Item	1/8 in. Packing Fixture	1/4 in. Packing Fixture
Stem diameter	11.05 mm to 11.1 mm (0.434 in. to 0.437 in.)	25.2 mm to 25.4 mm (0.992 in. to1.000 in.)
Stem straightness	Max. 0.04 mm per 300 mm (0.0016 in. per 12 in.)	Max. 0.04 mm per 300 mm (0.0016 in. per 12 in.)
Stem cylindricity	0.04 mm max. (0.0016 in. max.)	0.04 mm max. (0.0016 in. max.)
Stem surface finish	0.40 μm Ra to 0.80 μm Ra (16 μ-in. Ra to 32 μ-in. Ra)	0.40 μm Ra to 0.80 μm Ra (16 μ-in. Ra to 32 μ-in. Ra)
Stuffing box diameter	17.46 mm + 0.06 mm or – 0.0 mm (0.688 in. to 0.690 in.)	38.1 mm + 0.25 mm or – 0.0 mm (1.500 in. to 1.510 in.)
Stuffing box depth	19.05 mm ± 1.57 mm (0.75 in. ± 0.062 in.)	44.5 mm ± 1.57 mm (1.75 in. ± 0.062 in.)
Stuffing box surface finish	3.20 μm Ra + 1.25 μm Ra or – 0.625 μm (125 μ-in. Ra + 50 μ-in. Ra or – 25 μ-in.)	3.20 μm Ra + 1.25 μm Ra or – 0.625 μm (125 μ-in. Ra + 50 μ-in. Ra or – 25 μ-in.)
Gland bottom machined flat	0.15 mm (0.006 in.) max.	0.15 mm (0.006 in.) max.
Gland to stuffing box diametrical clearance	0. 06 mm to 0.19 mm (0.0025 in. to 0.0075 in.)	0.13 mm to 0.38 mm (0.005 in. to 0.015 in.)
Stem to gland (flange) diametrical clearance	0.25 mm to 0.38 mm (0.010 in. to 0.015 in.)	0.5 mm to 0.8 mm (0.020 in. to 0.030 in.)
Gland stud diameter	3/8 in.—16 UNC (2 pieces).	5/8 in.—11 UNC (2 pieces).

4.1.2 Mechanical Cycle

The test fixture shall be equipped with an actuator capable of stroking the test stem to simulate the mechanical cycle of a valve as follows.

a) Rising stem
   Rate: 3 mm to 5 mm (0.12 in. to 0.20 in.) per second.
   Stroke (1/8" packing): 25.4 mm ± 3 mm (1 in. ± 0.12 in.)
   Stroke (1/4" packing): 102mm +/- 3 mm (4 in. +/- 0.12 in.)

b) Rotating stem
   Rate: 10° to 15° per second
   Rotation: 90° ± 5°

c) Rising and rotating stem

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4.1.3 External Loads

The actuator(s) shall not apply any transverse forces, such as side load, to the test stem.

4.1.4 Temperature Monitoring

The test fixture(s) shall be equipped with thermocouples for continuously monitoring temperature during thermal cycling.

4.1.4.1 Temperature shall be monitored and recorded at the following two locations:

a) the flow line of the test chamber; and

b) adjacent to the stuffing box.

4.1.4.2 The thermocouple adjacent to the stuffing box shall control the test temperature.

4.1.4.3 The temperature at the flow line thermocouple shall be the reference measurement.

4.1.4.4 The fixture shall be heated using an external heat source, blanket, heating coils, or other suitable equipment.

4.2 Leak Test Equipment Selection and Calibration

4.2.1 Monitoring equipment shall be a flame ionization organic vapor analyzer with an integral data logger or a signal output for data collection. The equipment shall be certified as intrinsically safe for use with the test fluid.

4.2.2 The equipment shall meet the following performance requirements in the flame ionization mode using methane as the test fluid.

a) Maximum variation: ± 1.0 ppmv at 0 ppmv to 100 ppmv.

b) Minimum detectable level: <= 1.0 ppmv.

c) Maximum response time to reach final value (from 0 ppmv to 100 ppmv): 10 seconds.

d) Maximum recovery time to return to 10 % of initial value (from 100 ppmv to 0 ppmv): 10 seconds.

e) Sample flow rate at probe inlet: 0.5 – 1.5 l/min (0.13 – 0.40 gal/min).

4.2.3 The test equipment shall be inspected prior to each use to ensure against fouling of the detector probe.

4.2.4 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 current record of test equipment calibration shall be maintained by the test facility.

4.2.5 A porous or sintered metal/ceramic leak standard or similar device shall be used per the following procedure: Calibration of the leak standard shall be performed annually at a minimum.

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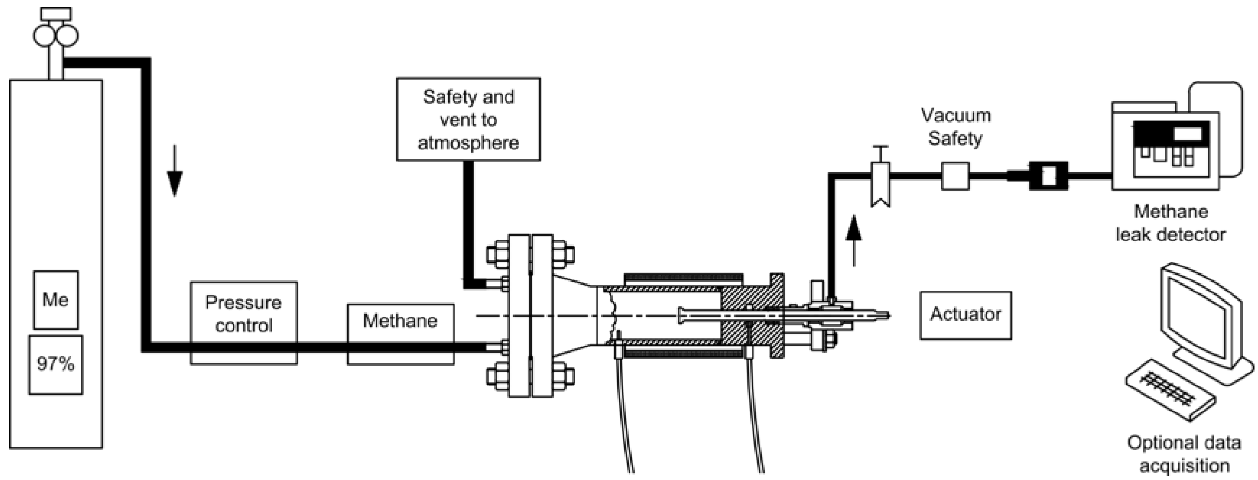

Figure 3—Emission Test Equipment Setup

4.2.5.1 Using a nominal flow rate of 1.00 l/min, a 0.050 ml/min leak standard shall produce by definition a 0.050 / (1.00 liter x 1000 ml/liter) = 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 x 1000 in ppmv.

4.2.5.2 Verify the sampling flow rate of the leakage monitoring device to be in the range of 0.5 to 1.5 l/min with a calibrated flow meter.

4.2.5.3 Verify the flow rate through 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 0.050 ml/min to 0.100 ml/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 shall be sufficient to fill the tubing and fittings used in the calibration setup.

4.2.5.4 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. After stabilization has occurred, calibrate the leakage monitoring device per the manufacturer's instructions using the calculation in 4.2.5.1. Leakage for calibration shall be between 50 ppmv and 100 ppmv. Calibration shall be performed before the start of each test and the results recorded.

4.3 Packing Selection and Installation

4.3.1 Pre-qualification

Packing submitted for type testing shall be certified by the packing manufacturer to be suitable for the conditions indicated in Section 1 of this standard.

4.3.2 Packing Selection

4.3.2.1 Test packing shall be selected from either:

a) a production lot as supplied by the manufacturer; or

b) a distributor stock.

Validation of the selection process shall be provided to the testing facility.

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4.3.2.2 Test packing shall be 3.2 mm (1/8 in.) or 6.3 mm (1/4 in.) cross-section for the test fixture. Packing 3.2 mm (1/8 in.) qualifies 3.2 mm (1/8 in.) to 6.3 mm (1/4 in), and packing 6.3 mm (1/4 in.) qualifies 6.3 mm (1/4 in.) and larger.

4.3.3 Packing Installation

A laboratory representative or technician shall install the packing according to the manufacturer's standard installation instructions, except that the maximum gland flange stud stress shall not exceed 172,300 kPa (25,000 psi). However, the packing stress (load) during the testing shall not exceed the packing manufacturer's recommended maximum value.

4.3.3.1 Instructions for all packing installations:

a) all test fixture components shall be thoroughly cleaned with acetone or equivalent solvent prior to testing;

b) components shall be inspected for damage prior to assembly;

c) caution shall be taken to avoid contact between the stem and gland;

d) fasteners and washers shall be lubricated;

e) gland (flange) height measured from a specific datum shall be recorded;

f) special preparation of the packing or assembly components is prohibited.

4.4 Test Procedure

4.4.1 Test Fluid

The test fluid used shall be dry methane gas, 97 % minimum purity, subjected to a temperature range from ambient to 260 °C (500 °F) and pressures from 0 kPag to 4137 kPag (0 psig to 600 psig) (see Figure 4).

4.4.2 Mechanical and Thermal Cycling

4.4.2.1 Packing in test rigs shall be subjected to a total of 1510 mechanical cycles and 5 thermal cycles per Figure 4. Mechanical and thermal cycling shall begin with the test fixture at ambient temperature.

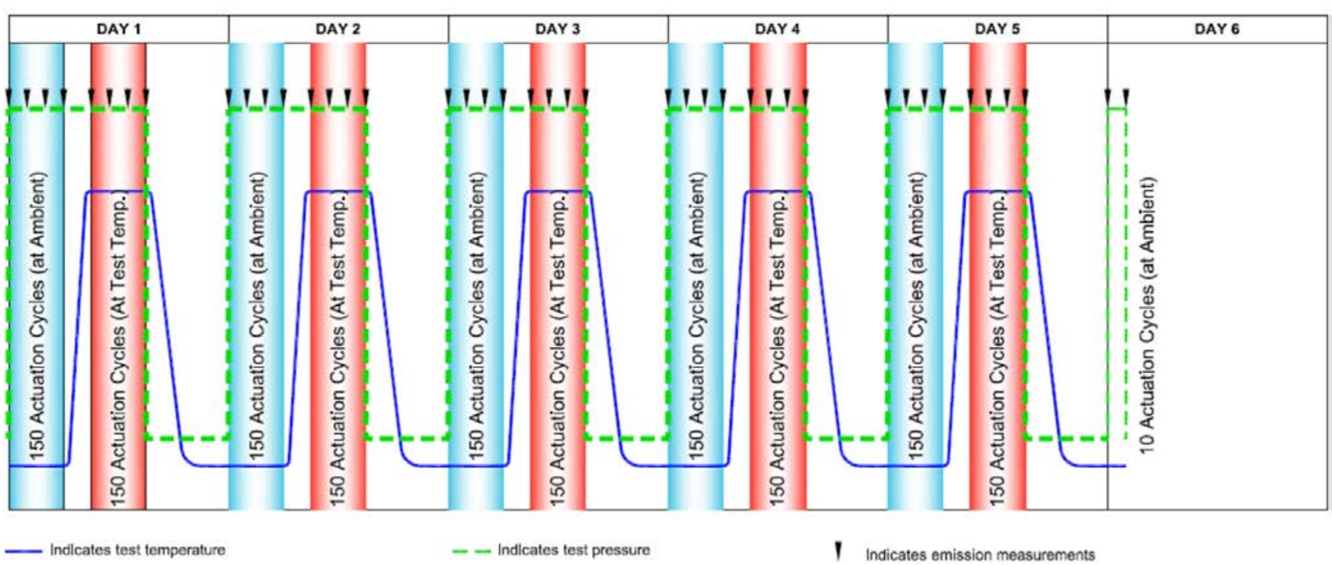

Figure 4—Mechanical and Thermal Cycling Diagram

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4.4.2.2 Test Profile

The following describes the testing cycles in Figure 4.

a) Mechanical cycles for the first 5 days are 300 per day and 10 cycles during the final mechanical cycling day.

b) Thermal cycle per day is 1.

— Pressure may be temporarily reduced during heating and cooling.

— Cycling pressure shall be maintained at 4137 kPag ± 34 kPa (600 psig ± 5 psig).

— Cycles at ambient are 150.

— Cycles at 260 °C ± 3 °C (500 °F ± 5 °F) are 150.

4.4.3 Leak Measurement

4.4.3.1 Leak measurements shall be conducted at the start of each thermal cycle after the first mechanical cycle and at the completion of every 50 mechanical cycles. For each measurement, a minimum of 10 readings shall be taken over a one-minute duration. The average reading shall be calculated and recorded. If any reading is more than 50 percent greater than the average, except for when the average leakage rates are less than 10 ppmv, the readings shall be repeated.

4.4.3.2 The leak detector shall measure the combined flows from the stem outside diameter (OD) and from the gland OD. The probe at the OD may be shielded with foil to eliminate atmospheric conditions. The collection points shall be at the 12 o'clock position above the gland since methane rises, as shown in Figure 5.

4.4.3.3 Leak measurements shall be taken while the stem is in the static condition.

4.4.3.4 The connections to the fixture and methane leak detector shall be made using tubing with an ID no larger than 6.3 mm (1/4 in.).

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

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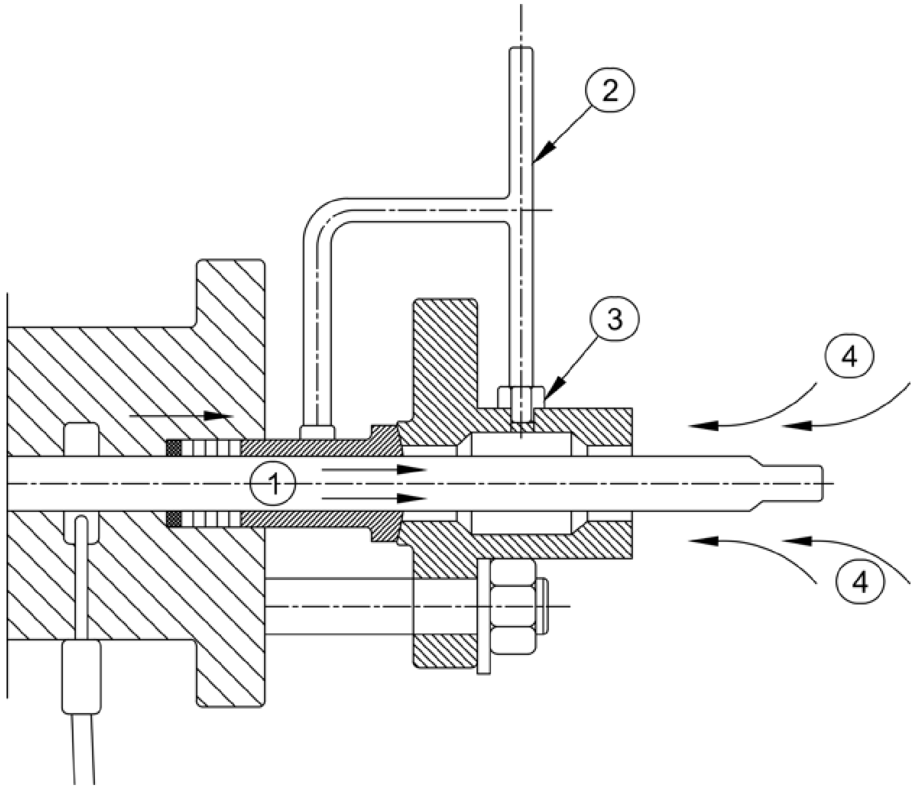

Key

1. Flow from packing area
2. Leak probe tubing for monitoring stem and gland OD leakage
3. Threaded connection
4. Flow from atmosphere

Figure 5—Emission Test Fixture Detail

4.4.4 Recording and Documentation

4.4.4.1 Fugitive emissions test results shall be provided on the Fugitive Emissions Test Report Summary provided in Annex B.1.

4.4.4.2 Leak measurements shall be recorded at the beginning of the test and at established intervals throughout the test, as required per Figure 4 and Section 4.4.3.1.

4.4.4.3 Gland height shall be measured and recorded at the beginning and end of the test.

5 Corrosion Test

5.1 Corrosion Test Overview

The corrosion test provides methods for evaluation of "cold" and "hot" corrosion caused by the packing. It also provides a means for evaluating the effect of inhibitor systems and valve stem metallurgy combinations with respect to corrosion rate and weight loss. The test fixture is designed to test one ring of $^1/_4$" packing or two rings of $^1/_8$" packing.

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5.2 Pre-Test Requirements

Packing sets submitted for corrosion testing shall have an accompanying materials analysis providing details for each style of packing contained in the set. Details shall include:

a) primary material used in manufacture;

b) type of corrosion inhibitor(s);

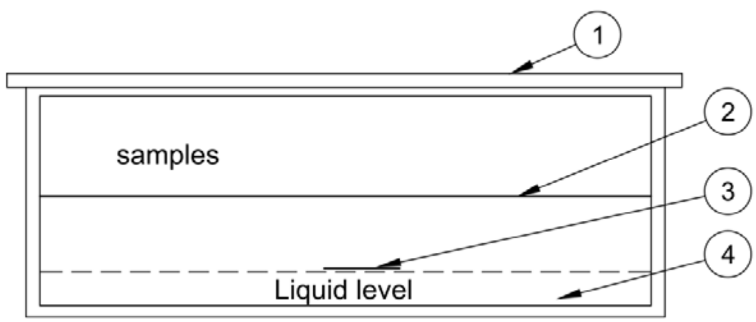
c) inhibitor content by weight;

d) method of application and distribution of inhibitors in or on the packing (such as active or passive); and

e) packing test specimen size shall be identical to that required for leak testing.

5.3 Ambient Corrosion Testing

5.3.1 The ambient corrosion testing vessel shall consist of an enclosure large enough for containment of several sample fixtures. The enclosure shall be equipped with a shelf or rack suspended above a liquid bath as shown in Figure 6.



Key

1. Lid with perimeter seal
2. Shelf
3. Liquid level depth mark
4. Liquid level $^{1}/_{2}$ in. deep

Figure 6—Corrosion Test Vessel

5.3.2 The compression fixture shall be as shown in Figure 7.

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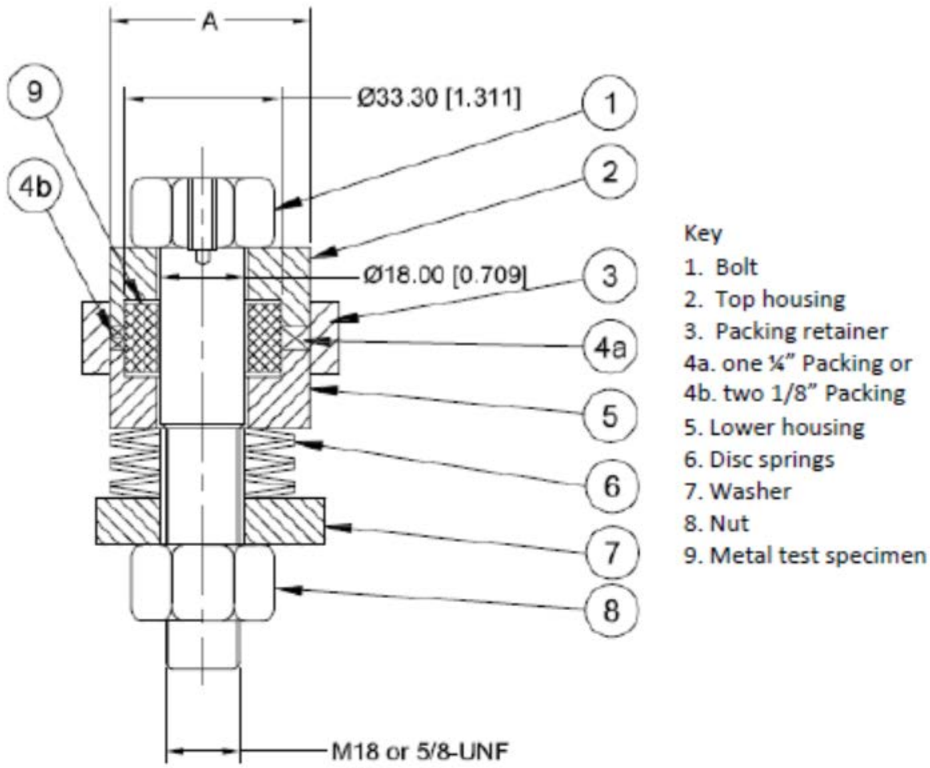

	1/8" Test Fixture	1/4" Test Fixture
A	39.6 mm (1.56 in)	46.0 mm (1.81 in)
Note: Clearance between the metal housings and specimens should be below .25mm (.01 in)		

Figure 7—Compression Test Fixture
1/4" and 1/8" Packing Configuration

5.3.3 Prior to the start of corrosion testing, the compression fixture shall be:

a) cleaned in an ultrasonic acetone bath; and

b) adjusted so the spring washers provide a 30 MPa (4350 psi) ± 0.69 Mpa (100 psi) compressive stress on the test packing.

5.3.4 Prior to assembly of the test set, packing samples shall be wetted by soaking in de-mineralized water for 24 hours, creating a damp environment at ambient temperature, 22 °C ± 11 °C (72 °F ± 52 °F).

5.3.5 The test vessel shall be filled to a level of 1.27 cm (0.5 in.).

5.3.6 Test samples shall be assembled on the compression fixtures and placed into the ambient corrosion test vessel.

5.3.7 The test packing shall be installed around a test specimen (metal ring), representing the valve stem material being evaluated.

a) Sample steel rings shall be machined from metal rods having the same properties as the finished valve stem. A common material selection is 410 stainless steel (13 % chrome).

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b) Nominal dimensions of the machined sample shall be according to MSS SP-120.

c) Nominal finish shall be 0.4 µm R_a to 0.8 µm R_a (16 µ-in. R_a to 32 µ-in. R_a).

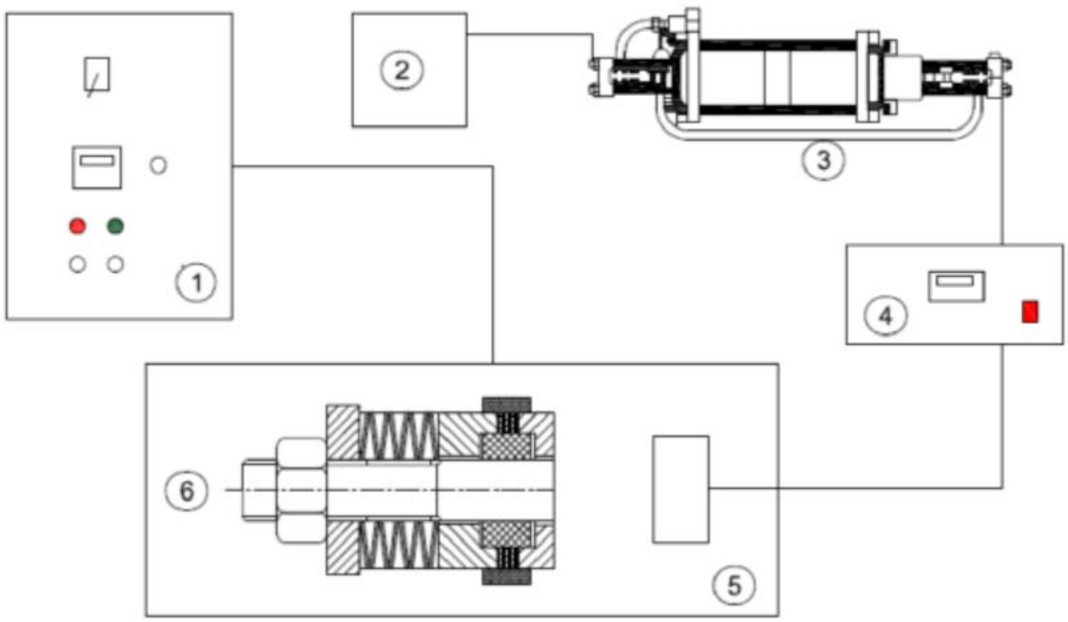
5.3.8 The duration of the test shall be 28 days.

5.4 High Temperature Corrosion Testing

5.4.1 The high temperature corrosion test rig shall provide a heated chamber for multiple individual test fixtures containing samples of metal and packing as shown in Figure 8.

5.4.2 The material of construction of the test rig shall be carbon steel and as noted in Section 5.3.

5.4.3 The housing shall be equipped with electric heating elements or a heater blanket that surrounds the outer periphery of the device and allows for insertion of multiple test fixtures as shown in Figure 8.



Key

1.	Temperature control	4.	Pressure control
2.	Water	5.	Heating system
3.	Booster pump	6.	Test rig

Figure 8—High Temperature Corrosion Test System

5.4.4 Prior to the start of corrosion testing, the compression fixture shall be adjusted so as to provide a 30 Mpa (4350 psi) ± 0.69 Mpa (100 psi) compressive stress on the test packing.

5.4.5 Packing samples shall be submerged in demineralized water at a test temperature of 149 °C ± 17 °C (300 °F ± 30 °F). The water pressure shall be maintained at 45 bar ± 2.25 bar (650 psig ± 32.5 psi). Air-over-water pressurization is permitted as long as samples are submerged in the water.

5.4.6 The duration of the test shall be 35 days.

5.5 Corrosion Test Reporting

Corrosion test data shall be reported on the corrosion test data sheets provided in Annex B.2 and Annex B.3. The report shall include the following information:

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a) photographic record of each sample at 100X and 200X magnification;

b) descriptive report on the estimated degree of stem pitting in 10 % increments of the surface area;

c) descriptive report on the estimated degree of adhesion in 10 % increments of surface area.

6 Packing Materials Test

The packing materials test considers weight loss, density, lubricant content, and leachables as per the procedures outlined below. For new configurations, test packing shall be selected at random from a minimum production lot as supplied by the manufacturer. For existing configurations, test packing shall be provided by a blind selection of production product from the manufacturer's normal distribution network. Validation of the random or the blind selection of process shall be provided to the testing lab. Random selection does not apply to testing of prototype material.

6.1 Graphite Packing Ring Weight Loss Test Procedure

The percent weight loss of each sample and the weight loss of the packing rings shall be determined as follows.

a) Conduct in an oven with full exposure to air (oxygen-rich environment).

b) Select three test rings of a sample packing set. If the packing set is comprised of more than one type of packing ring, each type shall be tested.

c) Record weight.

d) Preheat oven to 150 °C (302 °F).

e) Place sample in oven for one hour.

f) Remove samples, cool to room temperature, and record weight.

g) Increase oven temperature to 260 °C (500 °F) and repeat step e) and step f).

h) Increase temperature to 538 °C (1000 °F) in 56 °C (100 °F) increments, repeating step e) and step f) after each increase.

i) Determine the percent weight loss of each sample and record.

6.2 Density

Packing density shall be determined by dividing the sample weight by the sample volume, with the sample volume determined as follows:

a) Braided packing volume shall be determined by measuring the sample length, width, and thickness:

$$Volume = Median\ Length \times Width \times Thickness \tag{1}$$

b) Die-formed packing (ring form) volume shall be determined by the following equation:

$$Volume = \left[\left(Ring OD^2 - Ring\ ID^2 \right) \times Ring\ Thickness \times \pi \right] / 4 \tag{2}$$

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where

OD is the outside diameter;

ID is the inside diameter.

6.3 Lubricant Content

6.3.1 Polytetrafluoroethylene (PTFE) Content

PTFE content shall be established by determining the percentage total fluorine in the packing and comparing with a base fluorine percentage of 76, as follows:

a) Determine total percent of fluorine content using ASTM D1179 or ASTM D4327.

b) Divide total percent of fluorine as obtained in a) by 0.76 to obtain the approximate percent of PTFE content.

6.3.2 Wet Lubricant

Wet lubricant percentage shall be determined by dividing the weight of the lubricant extract by the original sample weight and multiplying by 100. The procedure shall be as follows.

a) Cut samples into short lengths, and record the total sample weight (approximately 15 grams is required).

b) Place cut samples into an extraction thimble and insert thimble into Soxhlet extraction unit that is nearly filled with a solvent, such as methylene chloride.

c) Turn on water flow through the condenser and bring the methylene chloride to a moderate boil through the use of the "low" setting on a hot plate. Extract for approximately 16 hours.

d) Record the weight of a dry evaporation dish.

e) Pour the methylene chloride extract solution into the dry evaporating dish and evaporate over a steam bath. Continue to pour the extract solution from the flasks into the dish until all the methylene chloride has been evaporated.

f) Place the evaporation dish in a hot-air oven set between 100 °C and 121 °C (212 °F to 250 °F) for 30 minutes. Cool the evaporation dish to room temperature in a desiccator.

g) Record the weight of the evaporation dish and lubricant extract.

h) Calculate the lubricant weight by subtracting the weight of the dry evaporation dish in step d) from the combined weight in step g).

NOTE A reference test method for soxhlet extraction can be found in ASTM C613.

6.4 Leachables

Leachable testing shall be per the following:

a) Packing submitted for testing shall contain a corrosion inhibitor.

b) Chloride testing shall be per ASTM D512 (normative reference).

c) Leachable fluoride testing shall be per ASTM D1179 or ASTM D4327.

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d) Proof of testing and analysis shall be maintained and provided with the final test report.

6.5 Packing Materials Test Reporting

Packing material test data shall be reported on the material test data sheet in Annex B.4.

7 Packing Qualified

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

When the location of the packing manufacturing facility is different than what is listed on the API 622 certificate, a requalification is required.

8 Reporting Requirements

An acceptable API 622 packing report shall consist of the following tables in Annex B:

e) the fugitive test report in Table B.1 when the measure leakage does not exceed 100 ppmv for static leakage with zero stem seal adjustments;

f) a completed ambient and high temperature corrosion test data sheet (found in Tables B.2 and B.3);

g) a completed material test data sheet (found in Table B.4).

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Annex A
(normative)

Emissions Test Fixture Construction

A.1 The test fixture shall be constructed to simulate a Class 300 DN 50 (NPS 2), minimum 0.10 m (4 in.) for the $^{1}/_{8}$ in. test fixture, and DN 100 (NPS 4), minimum 0.19 m (7.62 in.) for the $^{1}/_{4}$ in. test fixture.

A.2 Flanges shall be carbon steel according to PT rating as per B16.5.

A.2.1 Class 300 DN 50 (NPS 2) per ASME B16.5 minimum for the $^{1}/_{8}$ in. fixture.

A.2.2 Class 300 DN 100 (NPS 4) per ASME B16.5 minimum for the $^{1}/_{4}$ in. fixture.

A.3 Gaskets shall be spiral wound type.

A.3.1 Class 300 DN 50 (NPS 2) per ASME B16.20, with flexible graphite for the $^{1}/_{8}$ in. fixture.

A.3.2 Class 300 DN 100 (NPS 4) per ASME B16.20, with flexible graphite for the $^{1}/_{4}$ in. fixture.

A.4 The body of the test fixture shall be made from NPS 2 ($^{1}/_{8}$ in. fixture) and NPS 4 ($^{1}/_{4}$ in. fixture) carbon steel seamless pipe having Schedule 80 minimum pipe schedule.

A.5 The body of the assembly shall provide sufficient clearance to enable movement of the shaft.

A.5.1 0.10 m (4 in.) minimum for the $^{1}/_{8}$ in. fixture.

A.5.2 0.19 m (7.62 in.) minimum for the $^{1}/_{4}$ in. fixture.

A.6 The gland shall be ASTM A216 Grade WCB or from A105 or other suitable carbon steel materials.

A.7 Stem shall be ASTM A182 Grade F6a Rc15-28.8 (200-275 HB).

A.8 Gland bolts and studs: ASTM A193 Grade B7.

A.9 Gland nuts: ASTM A194 Grade 2H.

A.10 Heating shall be provided by external heating blankets or coils.

A.11 Insulation may be applied to the body, flanges, and gland areas.

A.12 A primary measurement thermocouple shall be positioned to monitor temperature of the fixture body.

A.13 A reference measurement thermocouple shall be positioned as dimensioned in Figure 1.

A.14 The emissions measuring equipment shall be coupled to the modified gland (flange) using flexible tubing with an identical inside diameter as that of the detection probe tubing supplied with the detector.

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Annex B
(normative)

Test Forms

B.1 Fugitive Emissions Test Report Summary

Record testing data and readings from Section 4.4 on this form.

Table B.1— Fugitive Emissions Test Report Summary

API Standard 622 **Fugitive Emissions Test Report Number** ____________

Testing Profile: Check One ☐ Rotating ☐ Rising		Manufacturer: ______________ Description: ______________ ______________
Testing Facility: ______________ Technician: ______________ Witness: ______________ Start Date: ________ Completion: ________		Source: ________ Date: ________ ☐ Manufacturer ☐ Distributor Packaged: ______________ ______________
Initial Gland Nut Torque		Indicate New or Current: ☐ New ☐ Current
lbf-ft	______________	
lbf-in.	______________	
Nm	______________	
Notes concerning installation instructions: ______________ ______________ ______________		

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Testing Profile Details (Testing Data)		
Test Segment	Leak Measurement Static	Reference Temperature at Stuffing Box
Day 1 Start, Ambient 0 – 150 cycles P = _________	____________________ ____________________ ____________________ ____________________ ____________________	____________________ ____________________ ____________________ ____________________ ____________________
Elevated Temperature 151 – 300 cycles P = _________	____________________ ____________________ ____________________ ____________________ ____________________	____________________ ____________________ ____________________ ____________________ ____________________
Day 2 Start, Ambient 301 – 450 cycles P = _________	____________________ ____________________ ____________________ ____________________ ____________________	____________________ ____________________ ____________________ ____________________ ____________________
Elevated Temperature 451 – 600 cycles P = _________	____________________ ____________________ ____________________ ____________________ ____________________	____________________ ____________________ ____________________ ____________________ ____________________
Day 3 Start, Ambient 601 – 750 cycles P = _________	____________________ ____________________ ____________________ ____________________ ____________________	____________________ ____________________ ____________________ ____________________ ____________________

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Elevated Temperature 751 – 900 cycles P =__________	__________ __________ __________ __________ __________	__________ __________ __________ __________ __________
Day 4 Start, Ambient 901 – 1050 cycles P = _________	__________ __________ __________ __________ __________	__________ __________ __________ __________ __________
Elevated Temperature 1051 – 1200 cycles P =__________	__________ __________ __________ __________ __________	__________ __________ __________ __________ __________
Day 5 Start, Ambient 1201 – 1350 cycles P = _________	__________ __________ __________ __________ __________	__________ __________ __________ __________ __________
Elevated Temperature 1351 – 1500 cycles P =__________	__________ __________ __________ __________ __________	__________ __________ __________ __________ __________
Day 6 Start, Ambient 1501 – 1510 cycles P = _________	__________ __________ __________ __________ __________	__________ __________ __________ __________ __________

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Emissions Testing Report Summary	
Test Number:	Test Date:
Packing Material:	Style Number:
Packing Manufacturer:	Source of Sample:
Test Packing Cross-section:	Laboratory Name:
	Location of Test:
Gland OD and ID (at the packing): OD = ID =	Gland Bolt Diameter = Packing Material:
Number of Mechanical Cycles:	Packing Compression % of Free Height =
	Final Torque on Gland Nuts (each side) = _______/_______
Number of Thermal Cycles:	Test Results Pass [ ] Fail [ ]
Maximum Test Pressure:	
Packing Configuration: Number of rings tested: Check the following: ☐ Ring shape (square, circular, vee) ☐ Solid or split ☐ Braided ☐ Die formed ☐ Spool stock ☐ Wire or other reinforcement ☐ Corrosion inhibitor and type ☐ Other: ______________________________	Show sketch or picture of packing installation. Define each ring:

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B.2 Ambient Temperature Corrosion Test Data Sheet

Record testing data and results from Section 5.3 on this form.

Table B.2— Ambient Temperature Corrosion Test Data Sheet

API Standard 622 **Ambient Corrosion Testing: Materials Qualification and Functional Testing Report**

Product Manufacturer:	Materials Analysis: Laboratory: ____________________ Test Number: __________________	Date: _________________________
Pre-Qualification Analysis Information		
Primary Material of Manufacture:	Corrosion Inhibitor(s)	Inhibitor Volume by Weight
Corrosion Testing Facility:	Test Technician:	Date Start/Complete:
Ambient Corrosion Testing:	Load Stress:	S_____ C_____
Metal Sample Description	Observations	
1.		S_____ C_____
2.		S_____ C_____
3.		S_____ C_____
4.		S_____ C_____
5.		S_____ C_____
6.		S_____ C_____
7.		S_____ C_____
8.		S_____ C_____

All reports shall include the following:

1. Microscopic view photographic record of results. Magnification levels of 100X and 200X.
2. Descriptive report on the degree of stem and shaft pitting that occurred.
3. The percent of surface area pitting in 10 % increments.
4. Descriptive report on the degree of adhesion in 10 % increments of surface area.

For tests having greater numbers of samples than provided for on this form, the testing lab shall fill in a separate form for each sample tested.

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B.3 High Temperature Corrosion Test Data Sheet

Record testing data and results from Section 5.4 on this form.

Table B.3—High Temperature Corrosion Test Data Sheet

API Standard 622

**High Temperature Corrosion Testing:
Materials Qualification and Functioning Testing Report**

Product Manufacturer:	Materials Analysis: Laboratory: ____________________ Test Number:____________________	Date: __________________________
Pre-Qualification Analysis Information		
Primary Material of Manufacture:	Corrosion Inhibitor(s):	Inhibitor Volume by Weight:
Corrosion Testing Facility:	Test Technician:	Date Start/Complete:
Ambient Corrosion Testing:	Load Stress:	S_____ C_____
Metal Sample Description	Observations	
1.		S_____ C_____
2.		S_____ C_____
3.		S_____ C_____
4.		S_____ C_____
5.		S_____ C_____
6.		S_____ C_____
7.		S_____ C_____
8.		S_____ C_____
All reports shall include the following: 1. Microscopic view photographic record of results. Magnification levels of 100X and 200X. 2. Descriptive report on the degree of stem and shaft pitting that occurred. 3. The percent of surface area pitting in 10 % increments. 4. Descriptive report on the degree of adhesion in 10 % increments of surface area.		
For tests having greater numbers of samples than provided for on this form, the testing lab shall fill in a separate form for each sample tested.		

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B.4 Materials Test Report

Record testing data and readings from Section 6 on this form.

Table B.4—Material Test Report

API Standard 622 **Graphite Packing Test Report**

Testing Laboratory:		Technician:	Date:
Product Name/Model:	Base Composition of Material: ☐ Graphite Purity ☐ Ash Content ☐ Sulphur ☐ Chloride ☐ Fluoride ☐ Corrosion Inhibitor ☐ Oxidation Inhibitor	Source: ☐ Manufacturer ☐ Distributor Nominal Thickness Density	Date:
Indicate New or Current Product:	☐ New ☐ Current		

Graphite Weight Loss Testing	
Measurement Equipment Name and Manufacturer(s):	
Calibration Dates on Equipment:	
Start Sample Weight: Sample # 1	Initial Sample Weight:
Weight after 1 hour preconditioning at 150 °C (302 °F).	Dried Sample Weight: Variation, weight __________% of initial weight
Weight after 24 hours at 538 °C (1000 °F).	Final Sample Weight: Variation, weight __________% of dried sample weight
Start Sample Weight: Sample # 2	Initial Sample Weight:
Weight after 1 hour preconditioning at 150 °C (302 °F).	Dried Sample Weight: Variation, weight __________% of initial weight
Weight after 24 hours at 538 °C (1000 °F).	Final Sample Weight: Variation, weight __________% of dried sample weight
Start Sample Weight: Sample # 3	Initial Sample Weight:
Weight after 1 hour preconditioning at 150 °C (302 °F).	Dried Sample Weight: Variation, weight __________% of initial weight
Weight after 24 hours at 538 °C (1000 °F).	Final Sample Weight: Variation, weight __________% of dried sample weight
Average weight loss of three samples.	Variation, weight __________% of initial weight

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Packing Materials Test Report
(separate test report required for different packing ring requirements)

Testing Laboratory:		Technician:	Date:
Product Name/Model:	Base Composition of Material:	Source: ☐ Manufacturer ☐ Distributor Packaged:	Date:
Indicate New or Current Product:	☐ New ☐ Current	Description of Product: ☐ Die-formed ☐ Braided ☐ Other: ____________________	
Weight Loss (Oven) Testing:			
Measurement Equipment Name and Manufacturer(s):			
Calibration Dates on Oven Recorders:			
Calibration Dates on Weighing Equipment:			
Start Sample Weight:			
Weight after one hour at 149 °C (300 °F).		Variation, weight __________%__________	
Weight after one hour at 260 °C (500 °F).		Variation, weight __________%__________	
Weight after one hour at 315 °C (600 °F).		Variation, weight __________%__________	
Weight after one hour at 371 °C (700 °F).		Variation, weight __________%__________	
Weight after one hour at 427 °C (800 °F).		Variation, weight __________%__________	
Weight after one hour at 482 °C (900 °F).		Variation, weight __________%__________	
Weight after one hour at 538 °C (1000 °F).		Variation, weight __________%__________	

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<table>
<tr><td colspan="4">Packing Density</td></tr>
<tr><td colspan="2">Calibration Date:</td><td colspan="2">Braided Construction Volume:
$V_{bc} = Median\ L \times W \times T$</td></tr>
<tr><td colspan="2">Sample Weight:</td><td colspan="2">Die Formed Packing Ring Volume:
$V_{df} = [\left(OD^2 - ID^2\right) \times Thickness \times \pi] \ / \ 4$</td></tr>
<tr><td colspan="4">Density = Sample Weight / Sample Volume =</td></tr>
<tr><td colspan="4">Lubricant Content</td></tr>
<tr><td colspan="2">Packing Lubricant Content:</td><td colspan="2">Volume Percentage:</td></tr>
<tr><td colspan="4">Leachables</td></tr>
<tr><td>ASTM D 512 Chlorides</td><td>Value:</td><td>Lab Name:</td><td>Date:</td></tr>
<tr><td>ASTM D 1179 or ASTM D 4327 Fluorides</td><td>Value:</td><td>Lab Name:</td><td>Date:</td></tr>
<tr><td colspan="2">Corrosion Inhibitor:</td><td colspan="2">Type(s):</td></tr>
<tr><td colspan="4">Certification of Selected Process:</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
</table>

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