



# Discussion on Fugitive Emissions Standards

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# Emissions Standards

- **API 622 Type Testing of Process Valve Packing for Fugitive Emissions (under revision)**
- **API 624**
- **API 641**

# Why Do We Do Fugitive Emissions Standards?



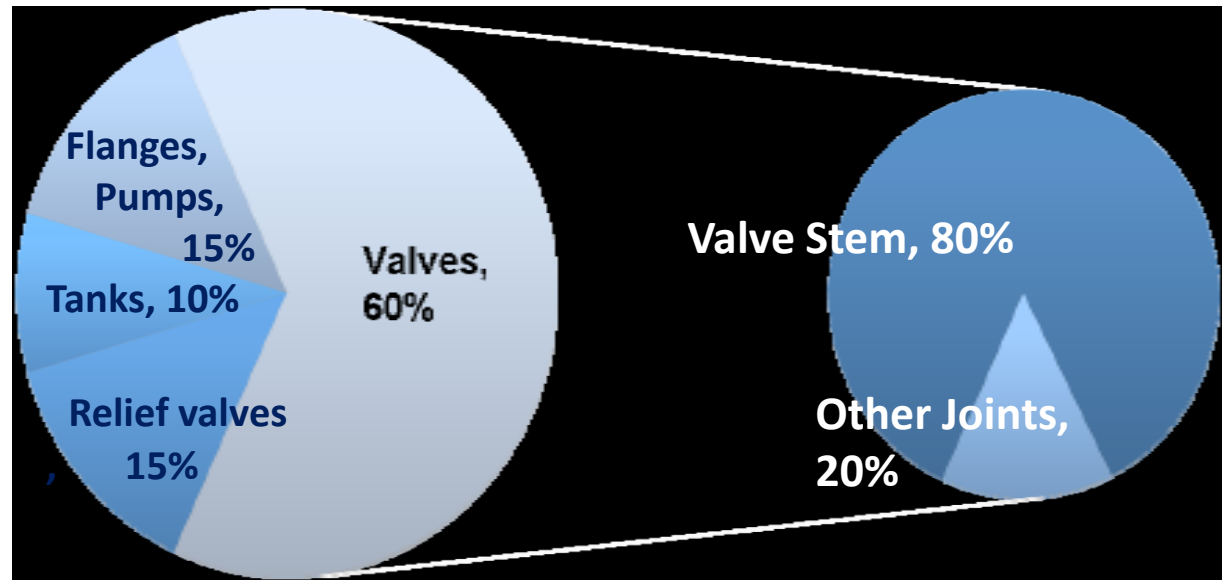
Twin Valves.wmv

# Rich Davis

- A little history:
- Since 1990, I've been involved in the creation and implementation of test standards covering fugitive emissions.
- These included:
  - Chairman ISA SP0093 Fugitive Emissions Valve Test
  - Member API 622 & Revision 1
  - Member ISO 15848-1 & 2
  - Co Chair API 624

# Fugitive Emissions Sources

Valves are considered to account for approximately 60% of Fugitive Emissions of a Refinery

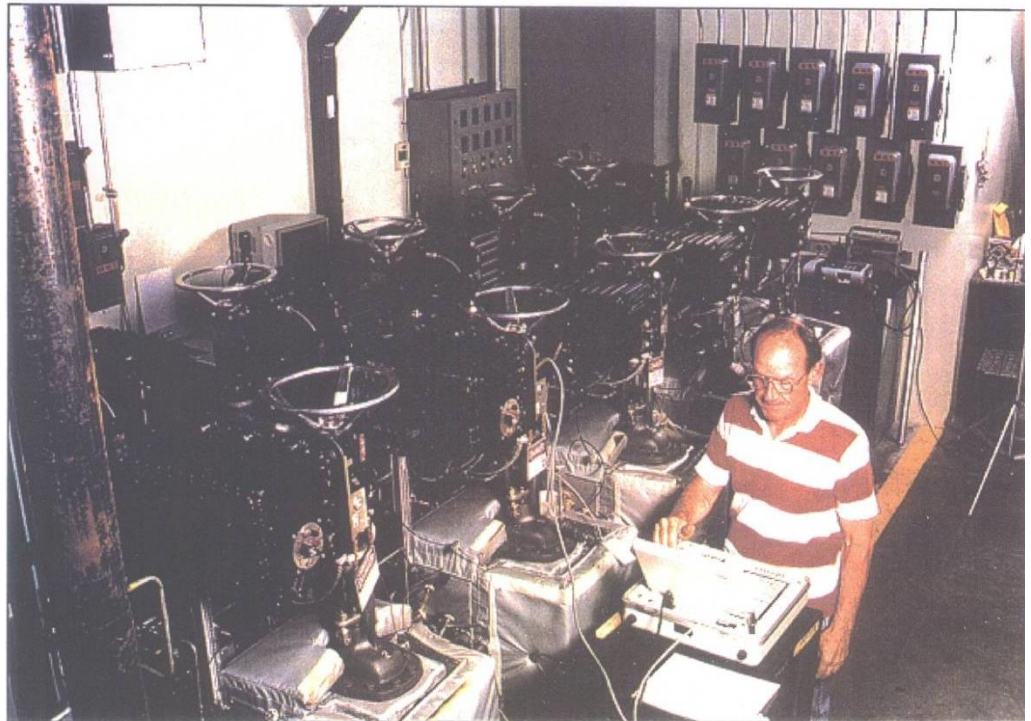


\*Source - Monitoring and Containment of Fugitive Emissions from Valve Stems, University of British Columbia, Vancouver

# History

- Testing started with the Petroleum Environmental Research Forum – 93-20
- About 1993

Figure A7-1  
Valve Test Stand



– Confidential –  
For PERF 93-20 Participants Only

# API 622 Type Testing of Process Valve Packing for Fugitive Emissions (under revision)

- 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  $-29\text{ }^{\circ}\text{C}$  to  $538\text{ }^{\circ}\text{C}$  ( $-20\text{ }^{\circ}\text{F}$  to  $1000\text{ }^{\circ}\text{F}$ ). Factors affecting fugitive emissions performance that are considered by this standard include temperature, pressure, thermal cycling and mechanical cycling and corrosion.

# Graphite Oxidation

- **–20 °F to 1000 °F, exceeds the capabilities of graphite, when exposed to oxygen.**
- The upper temperature can be an issue.
- This is why we require an oxidation analysis in API 622.
- Flexitallic is currently working on a study of graphite and oxidation. We are working to assess oxidation inhibitors and how they work.

# API-622

- Test fixture packing gland dimensions and tolerances are specified.
- The test fixture is arranged to follow the PERF testing. It relays the information obtained in that testing.
- Mechanical cycles = 1510
- 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:
  - Rotating stem:
  - Rate: 10° to 15° per second
  - Rotation: 90° ±5°

# Revision: 1/8" Packing Tests

- We've added a new section to the fixture dimensions and design to allow for testing of 1/8" packing.
- API 602 & 603 valves using narrow section packing have failed the API 624 test and led to this revision of the API 622 test.

# Twisted / Rolled Graphite Packing



Twisted /  
Rolled packing  
doesn't offer  
the same level  
of sealing as  
the cross braid  
packing.

1/8" Cross Section Packing Possible construction

# API-622 Weight Loss Testing

## Graphite Foil Weight Loss Test Procedure

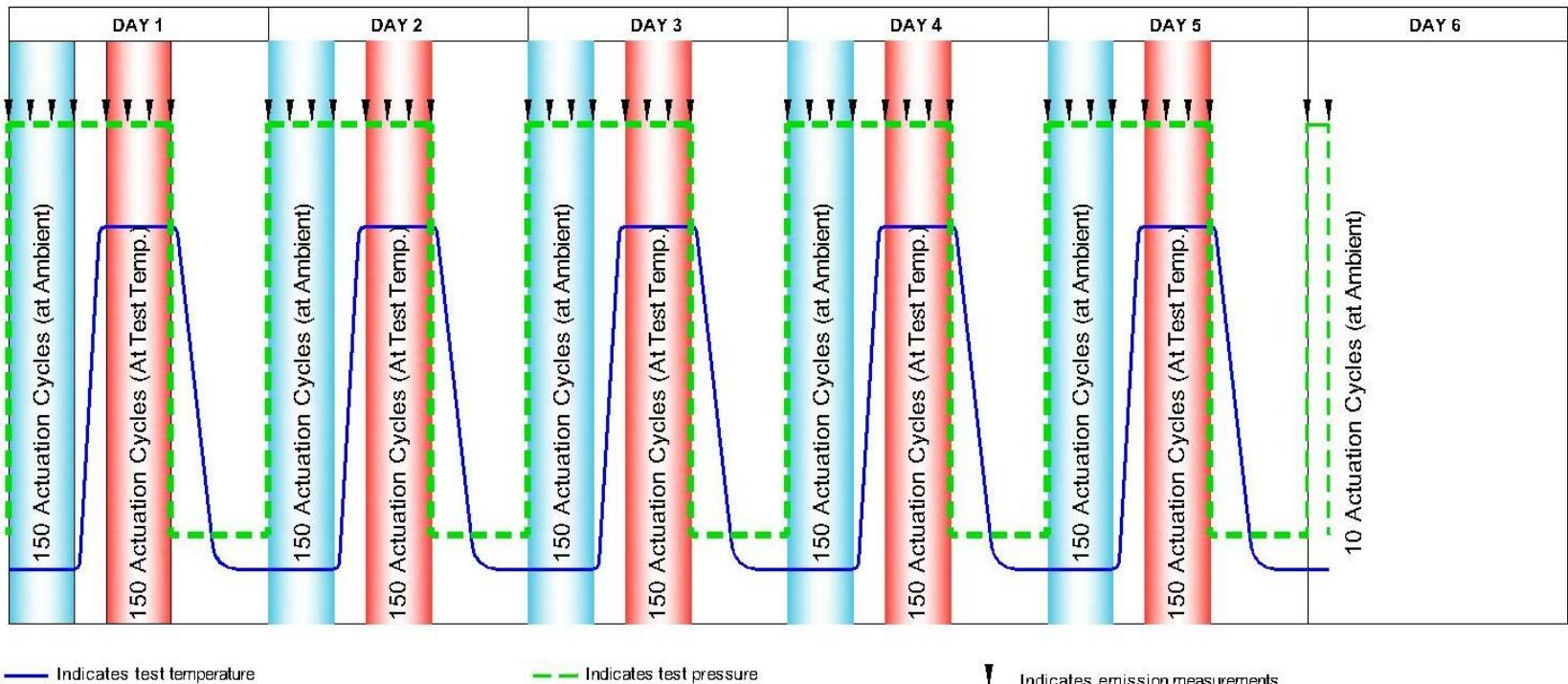
- Conducted in a controlled environment using suitable testing equipment.
- Flexible graphite sample size shall be between 0.5 grams and 3.5 grams.
- Three samples shall be tested. Record weight of each sample.
- Samples shall be preconditioned for one hour at 150°C (302°F) with a ramp up speed of 10°C (18°F) per minute.
- After one hour, the samples shall continue ramping up at 10°C (18°F) per minute to the final test temperature of 593°C (1100°F).

# API-622 Weight Loss Testing

- This test temperature shall be held for 24 hours and then cooled.
- Weigh samples after cooling and record weight. TGA testers can weigh samples without being removed from the heat source which is acceptable.
- Determine the percent weight loss of each sample and record.
- Average the results and a weight loss greater than 15% is not acceptable.
- Note: This test method also follows an established testing standard, FSA-G-604-07, issued by the Fluid Sealing Association.

# Test Procedure

- 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 to 4,137 kPag (0 to 600 psig).



# Revision of Leak Detection Device Specifications

- The original standard laid out specific details of the leak detection equipment that could only be fulfilled by a TVA-1000 leak detector.
- The revision of this section will permit the use of a wider range of newer leak detection devices.
- An Example: Phoenix PHX21

# API-622

## Lubricant Content

- PTFE content shall be established by determining the % total fluorine in the packing, and comparing with a base fluorine percentage of 76, as follows:
- Determine total percent of fluorine content using ASTM D1179 or ASTM D4327.
- Place the evaporation dish in a hot-air oven set between 100°C – 121°C (212°F – 250°F) for 30 minutes. Cool the evaporation dish to room temperature in a desiccator.
- Note: A reference test method for Soxhlet Extraction can be found in ASTM C613.


# API 622 Corrosion Test

## 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.

# API 622 Test Report

- Mechanical testing
- Leak test results – no adjustments allowed
- Oxidation test results – nothing greater than 15%.
- Lubricant, Leachables and PTFE results.
- Density test results
- Photos



# **API 624 Type Testing of Rising Stem Valves Equipped with Graphite Packing for Fugitive Emissions**

# API-624

- This API 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 Standard 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 greater than class 1500 are outside the scope of this standard.

# API-624 Valve Selection & Pre-test

- The test valve shall be completely assembled and ready for testing. 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.

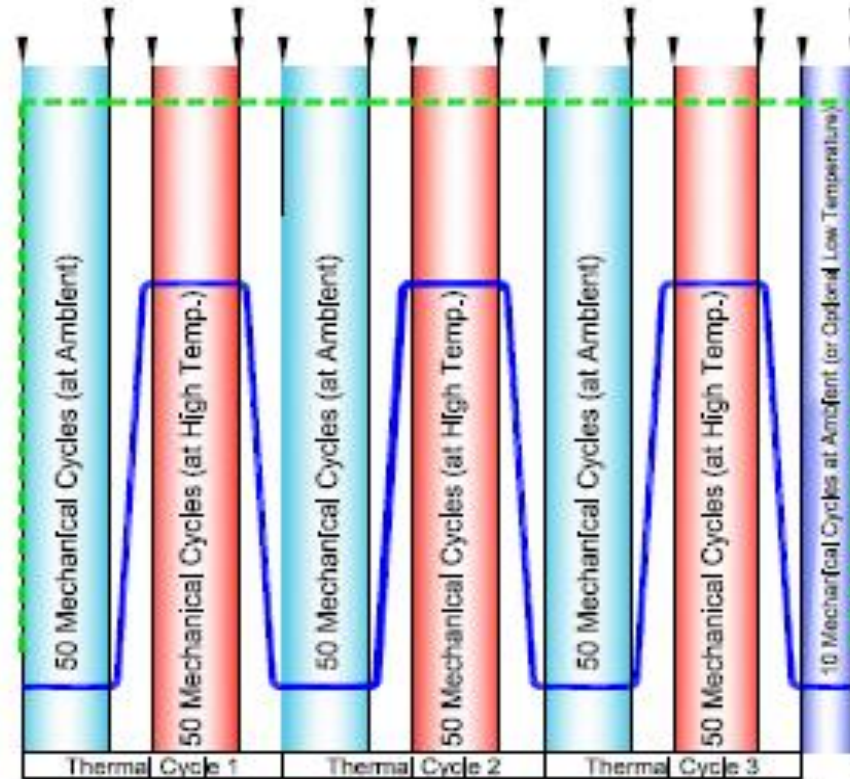
# Position - Safety - Gas

- The stem orientation for a test valve shall be vertical
  - This has created some problems with some lubricants.
- As a safety precaution, the air in the valve cavity shall be purged with an inert gas prior to starting the testing.
- The test medium used shall be either methane gas, 97% minimum purity.

# API-624 Type Testing

- Valves are subjected to a total of 310 mechanical cycles and 3 thermal cycles.
- Mechanical cycling shall begin with the valve at ambient temperature.
- An optional low temperature test at  $-29^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$ ) may be performed if requested by the purchaser.
- The elevated test temperature shall be  $260^{\circ}\text{C} \pm 2$  percent ( $500^{\circ}\text{F} \pm 5$  percent).
- The test pressure shall be the lower of 600 psig or the maximum allowable pressure at  $500^{\circ}\text{F}$  per ASME B16.34 for the applicable material group and shall be held constant throughout the test.

# API 624



- Indicates test temperature
- - - Indicates test pressure
- ↑ Indicates static emission measurements
- ↑ Indicates both static and dynamic emission measurements

# API 624

- Leak Measurement
- Packing leakage measurements around the full circumference of the stem OD and packing OD and the highest reading shall be recorded. Static and dynamic stem leakage measurements shall be taken.
  - This is typically done using aluminum foil surrounding the stem.
- Leak measurements shall be sniffed using a detection probe. (This is often done using an aluminum foil)
- Packing adjustment during type testing is not permitted.

# API 624 Valves Qualified

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

# API 624 Valves Qualified

- Any change in valve sealing system design, packing material, packing manufacturer, or packing type/model requires a requalification.
- If the location of the valve manufacturing facilities is different than what is listed on the API 624 certificate, the purchaser may request re-qualification.



# **API 641 Type Testing of Quarter- turn Valves for Fugitive Emissions**

# API 641 Scope

- This standard specifies the requirements and acceptance criteria for fugitive emission type testing of quarter-turn valves. The type testing requirements contained herein are based upon elements of EPA Method 21.
- Valves larger than NPS 24 and valves greater than ASME B16.34 class 1500 are outside the scope of this standard. Valves with a pressure rating at ambient temperature less than 6.89 barg (100 psig) are outside the scope of this standard. Repacking or resealing of valves is outside the scope of this standard.

# Valve Selection & Test Preparation

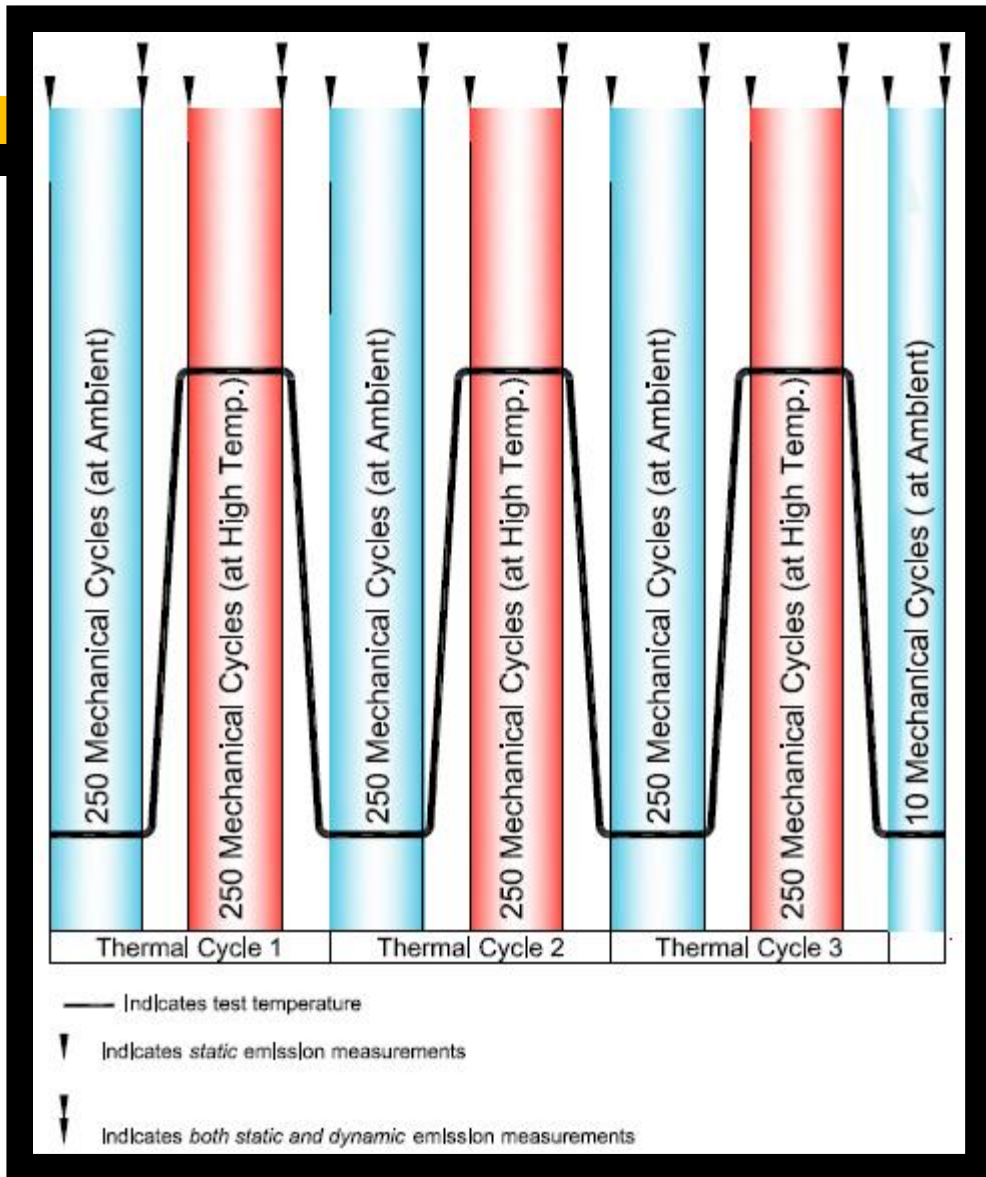
- The test valve shall be fully assembled, tested to applicable industry standards, and ready for fugitive emissions testing. The test valve shall be randomly selected from manufacturer or distributor stock, where such stock is available. For valves not in stock, the manufacturer shall certify that the test valve was not modified in any way to meet type test requirements and is a typical representation of the manufacturer's stock product.

# Safety Considerations for Type Testing

- The test medium used shall be methane 97% minimum purity.
- The valve may be de-pressured between thermal cycles.
- All testing shall be in accordance with local and national codes and regulations.
- Purge the partially open valve with methane gas to eliminate air in the valve cavity prior to starting the testing.

# Type Testing

Currently a total of  
1510 mechanical  
cycles and 3  
thermal cycles



# Valve Groups; Valve Temperature Rating

Valve pressure rating at 260°C (500°F) is $\geq$ 41.1 barg (600 psig)	Valve pressure rating at 260°C (500°F) is $<$ 41.1 barg (600 psig) and $\geq$ 6.89 barg (100 psig)	Valve with a temperature rating $\geq$ 260°C (500°F) and does not comply with the requirements of Group A or Group B
Group A (see 8.7.1)	Group B (see 8.7.2)	Group C (see 8.7.3)
NOTE: Valves with a pressure rating less than 6.89 barg (100 psig) at ambient temperature are outside the scope of this standard		

# Valve Groups; Valve Temperature Rating

- *Pa valve pressure at ambient temperature*
- *Pe valve pressure at elevated temperature*
- *Te valve elevated temperature*
- *Ta ambient temperature*
- **For Group A valves**
- *Te = 260°C (500°F)*
- *Pe = 41.4 barg (600 psig)*
- *Pa = 41.4 barg (600 psig)*

# Valve Groups; Valve Temperature Rating

- For Group B valves
- $T_e = 260^{\circ}\text{C}$  ( $500^{\circ}\text{F}$ )
- $P_e = \text{Valve Pressure rating at } 260^{\circ}\text{C} (500^{\circ}\text{F})$
- $P_a = \text{Valve Pressure rating at ambient temperature or } 41.4 \text{ barg} (600 \text{ psig}), \text{ whichever is less}$

# Valve Groups; Valve Temperature Rating

- For Group C valves
- $T_e$  = *Maximum temperature rating of the valve at 6.89 barg (100 psig) or 500F, whichever is lower.*
- $P_e$  = *6.89 barg (100psig)*
- $P_a$  = *Valve Pressure rating at ambient temperature or 41.4 barg (600 psig), whichever is less*

# Valve Groups; Valve Temperature Rating < 260°C (500°F)

Valve pressure rating at its maximum rated temperature is $\geq 41.1$ barg (600 psig)	Valve Pressure rating at its maximum rated temperature is < 41.1 barg (600 psig) and $\geq 6.89$ barg (100 psig)	Valve with a temperature rating < 260°C (500°F) and does not comply with the requirements of Group D or Group E
Group D (see 8.8.1)	Group E (see 8.8.2)	Group F (see 8.8.3)
NOTE: Valves with a pressure rating less than 6.89 barg (100 psig) at ambient temperature are outside the scope of this standard		

# Valve Groups; Valve Temperature Rating < 260°C (500°F)

- For Group D valves
- $T_e = \text{Maximum temperature rating of valve}$
- $P_e = 41.4 \text{ barg (600 psig)}$
- $P_a = 41.4 \text{ barg (600 psig)}$

# Valve Groups; Valve Temperature Rating < 260°C (500°F)

- For Group E valves
- $T_e$  = *Maximum temperature rating of valve*
- $P_e$  = *Valve pressure rating at maximum temperature rating of valve*
- $P_a$  = *Valve pressure rating at ambient temperature or 41.4 barg (600 psig), whichever is less*

# Valve Groups; Valve Temperature Rating < 260°C (500°F)

- For Group F valves
- $T_e = \text{Maximum temperature rating of the valve at 6.89 barg (100 psig)}$
- $P_e = 6.89 \text{ barg (100 psig)}$
- $P_a = \text{Valve Pressure rating at ambient temperature or 41.4 barg (600 psig), whichever is less}$

# Valve Groups; Valve Temperature Rating < 260°C (500°F)

- The elevated test temperature, test pressure while at the elevated test temperature, and test pressure while at ambient temperature shall be as follows for any valve tested per this standard.
- The elevated test temperature shall be equal to the value established for variable *Te per section 8.7 or 8.8*
- The test pressure while at the elevated test temperature shall be the value established for variable *Pe per section 8.7 or 8.8*.
- The test pressure while at ambient temperature shall be the value established for variable *Pa per section 8.7 or 8.8*.

# Actuation

- The test valve may be equipped with a method of actuation capable of mechanically cycling the valve.
- For torque-seated valves with offset stems, the closing torque shall be set to the manufacturer's published torque used for seat closure at the corresponding maximum test pressure.
- Running torque values shall be recorded at approximately mid-stroke on the first and last mechanical cycle of testing.

# Test Overview

- One stem seal adjustment is allowed during valve testing and shall be noted on the Fugitive Emissions Test Report in Annex A.
- Packing gland torque values are to be recorded prior to disassembly. Valve shall be disassembled and components including stem, stem seal, gland follower, and stem seal chamber shall be inspected and the condition documented.
- The Fugitive Emissions Test Report in Annex A shall indicate “pass” when the measured leakage does not exceed 100 ppmv.

# Leak Test Equipment and Calibration

- Similar to the new API 622
- The test equipment shall be inspected prior to each use to ensure against fouling of the detector probe.

# Valves Qualified

- Valves of the same quarter-turn design as the test valve may be deemed to be a qualified, subject to the following additional limitations:
- The value for  $T_e$ , as determined by section 8.7 or 8.8, is not greater than the value for  $T_e$  of the test valve.
- The value for  $P_e$ , as determined by section 8.7 or 8.8, is not greater than the value for  $P_e$  of the test valve.
- The value for  $P_a$ , as determined by section 8.7 or 8.8, is not greater than the value for  $P_a$  of the test valve.

# Valves Qualified

- Stem diameter is between one-half to two times the test valve;
- The stem seal is of the same material, design, sealing stress, shape and construction, independent of the seal size;
- The dimensions of the overall seal set height is between 75% and 125% of the test valve;
- The type of motion, the type of obturator, the type of obturator support, the type of offset, and the type of stem support is identical;
- Tolerance classes (grades) and surface finish specifications of all valve components which affect sealing performance are identical.
- Any change in valve sealing system design including, but not limited to, stem seal material, stem seal manufacturer, or stem seal model requires a requalification.



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**THANK YOU**