ISO vs. API Standard

presented at the
Valve Manufacturers Association
2011 Technical Seminar
Jacksonville, FL

Rich Davis
Flexitallic LP
Deer Park, TX

ISO 15848-1

ISO 15848-1 Industrial Valves – Measurement, Test and Qualification procedures for fugitive emissions – Part 1: Classification systems and qualification procedures for type testing of valves, covers all types of valves, including; gate, globe, quarter turn and control. Currently, the standard is undergoing a revision, which includes the following attributes…

ISO 15848-1

Resolution 1

- Proposed to require the Total Leak Rate by Vacuum Method for Fugitive emission class A
- Proposed to require the Total Leak Rate by the accumulation (bagging) method for Fugitive emission class B
- Proposed to require the Total Leak Rate by accumulation (bagging) method for Fugitive emission class C
- Proposed to require the Local Leak Rate by sniffing method for Fugitive emission
- Class D (leakage rate equivalent to Class C)
- Where the accumulation (bagging) method is specified the Vacuum method is an acceptable alternative.
- Other comments
  - ***Add appendix defining the accumulation method (or modify appendix A)***
  - ***Create a small working group to prepare the new (or revised) appendix***

ISO-15848-1

Resolution 2

- Use the accumulation method (tape around the body seals) for helium in mbar.l/s measurement of body seals emission.
- The limit is fixed to 10-7 mbar.l.s-1/ mm external diameter.
- Measurement by sniffing ppm methane is unchanged (50 ppm)
- There is no correlation between ppm methane and mbar.l.s-1/ mm dia helium

Resolution 3

- To align with VDI 2440 Class A is modified and increased by a factor 10.
- Other classes remain unchanged

ISO-15848-1

Resolution 4

- The CO1 mechanical cycles for HT conditions is now
  - 50 cycles at RT
  - 50 Cycles at HT
  - 50 cycles at RT
  - 50 cycles at HT
  - 5 cycles at RT
- Total is 205 mechanical cycles
- Total number of cycles for CO2 and CO3 qualification remain unchanged
- At the end of CO1 (or CO2 or CO3) an optional test at LT (-46°C) may be applied applied (5 Mechanical cycles at RT, 50 mechanical cycles at LT, 5 mechanical cycles at RT)

Mechanical cycles at RT, 50 mechanical cycles at LT, 5 mechanical cycles at RT)

Resolution 5

- Unit for the emission in helium conditions is expressed in atm.cm3/s (which is equivalent to 1.013 mbar.l/s)

ISO-15848-1

Resolution 6

- Tightness classes for helium are expressed in atm.cm3/s (which is equivalent to 1.013 mbar.l/s) per mm of stem external diameter
- Suggest to keep both mg/s/m circumference and atm.cm3/s/mm external diameter
- Tightness classes for methane will be expressed in ppmv.

Tightness classes for methane will be proposed by US delegations and circulated for comments to WG10 members (note). The proposal will be sent to the committee once the group has had a chance to review the proposed new standards. These are currently being reviewed by the task group chair.

Resolution 7

- The test pressure in ISO 15848 part 2 is kept at 6 bar

Resolution 8

- The use of flushing method is deleted from this ISO 15848-1 standard

ISO-15848-1

Resolution 9

- The CO1 mechanical cycles for LT conditions is now
  - 50 cycles at RT
  - 50 Cycles at LT
  - 50 cycles at RT
  - 50 cycles at LT
  - 5 cycles at RT
- Total is 205 mechanical cycles
- Total number of cycles for CO2 and CO3 qualification remain unchanged
- In addition to CO1 (or CO2 or CO3) an optional test at HT (manufacturer design upper temperature) may be applied (5 Mechanical cycles at RT, 50 mechanical cycles at HT, 5 mechanical cycles at RT).

A draft proposal will be prepared by NL delegation and circulated for comments to WG10 members

Resolution 10

- WG10 decides to create a working group to propose a draft document defining the procedure for the accumulation (bagging) method to be applied for Class B and Class C measurement.
- Members of this WG are (at the present time but not limited):
  - P. Churm, S. Laforge, B. Merrifield, G. Wodara, Y. Isizaka, M.Hubacek, R. Davis, Hu Jun, E. Sauger.

API-622

API 622 Type Testing of Process Valve Packing for Fugitive Emissions

API-622

- Packing(s) shall be suitable for use at service temperatures –29°C to 538°C (–20 °F to 1000 °F).
- 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:
  - Fugitive emissions
  - Corrosion
  - Packing material composition and properties

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

- Rising stem
- Rotating stem

- One of the single most important factors concerning the revision to the testing method was the removal of paragraph 1.4. With this removal, the test is no longer considered as an alternative to ISO 15848-1. However, as we will discuss later on in this document, the API has initiated a program to begin a new test, API 624, which will take the place of the ISO document.

API-622

1.4 (Removed) Packing tested to this standard may or may not perform the same when used in a manufacturer's valve. Performance to a specified emission limit may be confirmed by re-testing the packing in an actual valve in accordance with Section 4.4 of this Standard.

Definitions:

- **3.1 active inhibitor**
  A type of galvanic corrosion inhibitor providing a sacrificial anode.
- **ambient temperature**
  temperature that is between 60°F to 40°C (110°F).
- **axial**
  In the direction of a shaft or stem axis.
- **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. Two primary braid configurations are square and interbraided or interlocking.

API-622

- **3.6 bolt torque**
  The amount of twisting or turning effort (expressed as Nm, ft-lb or in-lb) required to turn the nuts on a gland flange, commonly used to describe the load that a gland flange exerts on a valve packing set.
- **3.21 mechanical cycle**
  A motion of the stem simulating the movement of a valve obturator from the fully closed position to the fully open position, and returning to the fully closed position. See also, "stroke."
- **3.23 packing set**
  A grouping of individual packing rings designed to fill the cavity of the valve stuffing box.
- **3.26 quarter-turn valve**
  valve that will fully open or close with a nominal 90° rotation of the stem.
- **3.29 stem**
  metal rod that connects the internal closure obturator (such as a disc or ball) of a valve to a handwheel, handle or actuator.

API-622

- Test fixture packing gland dimensions and tolerances shall be as follows:
- The test fixture is arranged to follow the PERF testing. It relays the information obtained in that testing.
- 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:
  - Rotating stem:
  - Rate: 10° to 15° per second
  - Rotation: 90° ±5°

API-622

External Loads

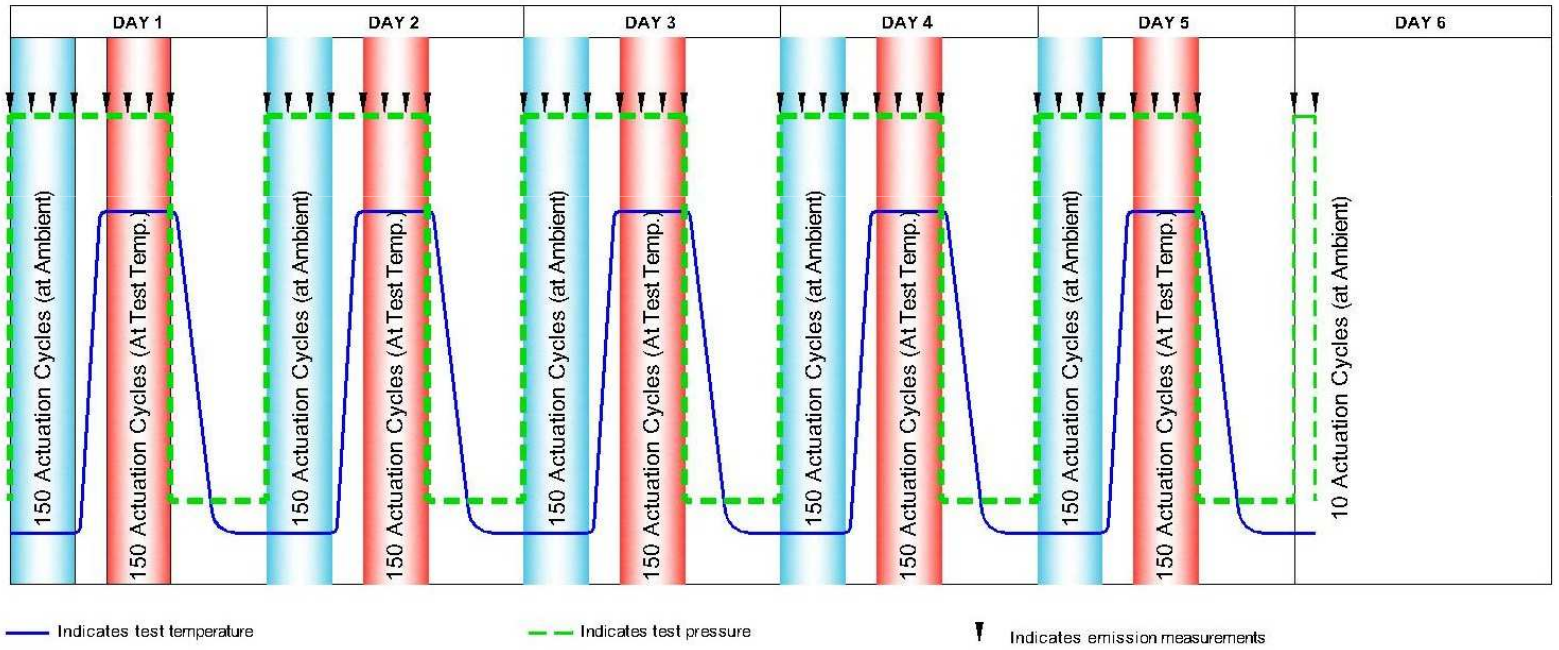
- The thermocouple adjacent to the stuffing box shall control the test temperature
- The temperature at the flow line thermocouple shall be the reference measurement.

Packing Selection and Installation

- **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.
- 4.3.2.2 Test packing shall be 6.3 mm (1/4 in.) cross-section for the test fixture. Validation of a random selection process shall be provided to the testing facility. Packing in production shall be pulled from standard production line. Random selection not applicable for Prototype material.

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).



API-622

Mechanical and Thermal Cycling

- Packing in test rigs shall be subject to a total of 1510 mechanical cycles and 5 thermal cycles per Figure 2. Mechanical and thermal cycling shall begin with the test fixture at ambient temperature. The testing will be performed as described below.

Test Profile

- Test duration of 5 days.
- 300 mechanical cycles per day.
- 1 temperature cycle per day.
- Pressure stays at 4,137 kPag ±34kPa (600 psig ±5 psig)
- 150 cycles at ambient
- 150 cycles at 260°C ±3°C (500°F ±5°F)
- Reduce the pressure to zero at the end of each day (thermal cycle).
- Minimum daily cycling is to be divided up as follows:
  - 3 hours for ambient cycling at pressure.
  - Max. 2 hours to bring up to temperature (no cycling during this time).
  - 3 hours for at high temperature cycling.
  - Daytime or Overnight cool down with no cycling during this period
- This test procedure requires a maximum of 8 hours of monitoring per day.

API-622

Leak Measurement

- Leak measurements shall be conducted initially at the start of each day and at the completion of every 50 cycles. A minimum of ten (10) readings shall be taken over a one (1) minute duration. The average reading shall be calculated and recorded. For the stem static leakage measurement, if any reading is more than fifty percent (50%) greater than the average, the readings shall be repeated.
- The leak measurement shall be conducted using a fixed detection probe located at the 12 o'clock position directly above the potential leak point as per Figure 3.
- Leak measurements shall be taken while the stem is in the static and dynamic condition. Dynamic condition measurements shall be taken on the opening and closing cycles and the average of both shall be recorded.

API-622

- The connection to the fixture and methane leak detector shall be made using tubing having the same inside diameter as the standard leak probe and connected as shown in Figures 3 and 4.
- Adjustment of the packing is currently being debated. This question leaves the committee with a wide range of opportunity. To run the packing without any adjustment offers the test reviewer an opportunity to consider a packing with no adjustments. While a packing with adjustment may be seen as less productive. This condition is not without comment from both the end user and the manufacturer.

Packing Adjustment

- At the option of the packing manufacturer, one adjustment may be made if the leak rate performance exceeds established regulatory requirements.
- Mechanical cycling shall be discontinued during a necessary adjustment.
- The gland flange height shall be measured and recorded before and after gland adjustment is made.
- Continue test.
- For safety concerns, the test should end if leakage exceeds 500 ppm after the one adjustment.

API-622

Recording and Documentation

- Fugitive emissions test results shall be provided on the Fugitive Emissions Test Report Summary provided in Appendix A.
- A) Leak measurements, static and dynamic, shall be recorded at the beginning of the test and at established intervals throughout the test, as required per Figure 2.
- B) The packing adjustment shall be recorded and the cycle number noted along with the gland bolt torque prior to the adjustment. The gland bolt torque is for information only.

Compression test fixture components

- Metal test specimen
- Prior to the start of corrosion testing, the compression fixture shall be:
  - Cleaned in an ultrasonic acetone bath
  - Adjusted so as to provide a 30 MPa (4350 psi) ±0.69 Mpa (100 psi) compressive stress on the test packing.
  - Prior to assembly of 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 ±20°F).
  - The test vessel shall be filled to a level of 1.27 cm (0.5 in).
  - Test samples shall be assembled on the compression fixtures and placed into the ambient corrosion test vessel.

API-622

- The test packing shall be installed around a test specimen (metal ring), representing the valve stem material being evaluated.
- 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).
- Nominal dimensions of the machined sample shall be according to MSS SP-120.
- Nominal finish shall be 0.4 – 0.8 µm R_a (16 – 32 µ-in. R_a).
- A decision about the final pressure shall be made ahead of this testing resolution.

High-Temperature Corrosion Testing

- Prior to the start of corrosion testing, the compression fixture shall be adjusted so as to provide a 30 Mpa (4350 psi) compressive stress on the test packing.
- Packing samples shall be subjected to de-mineralized water at a test temperature of 149°C ±17°C (300°F, ±30°F). The water pressure shall be maintained at 45 barg ±2.25 bar (650 psig ±32.5 psi).

API-622

Corrosion Test Reporting

- Photographic record of each sample at 100X and 200X magnification.
- Descriptive report on the estimated degree of stem/shaft pitting in ten percent (10%) increments of the surface area, which shall include the mean pit depth and the maximum pit depth.
- Descriptive report on the estimated degree of adhesion in ten percent (10%) increments of surface area.

Packing Materials Test

- Random selection does not apply to testing of prototype material.

API-622

Graphite Foil

- 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).
- 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.

API-622

Braided Packing Ring

- Conducted in an oven with full exposure to air (Oxygen-rich environment).
- 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.
- Lastly, the Lubricant Content is to be evaluated per the new attachment of ASTM D4327 and ASTM C613. This will enable a more accurate level of lubricant content.

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-624

Type Testing of Process Valves Leak Performance Fugitive Emissions and Seat Leakage.

API-624

- This API Standard specifies the requirements for comparative testing of rising stem valves 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).
- Acceptance criteria are beyond the scope of this document and are subject to agreement between the manufacturer and the end user or when superseded by local ordinance.

API - 624

1.1 The following external leak paths of the valve assembly shall be checked for leakage:

- Stem (static & dynamic)
- Body-bonnet connection
- c. Gland
- d. Auxiliary Connection
- e. Stuffing box

API-624

Checking of Body

- Test methods apply to valve packing for use in on-off valves with the following stem motion(s):
  - Rising stem
  - Rising rotating stem
- The test for fugitive emissions is based upon elements of EPA Method 21.
- Shell test in accordance with API 598 shall be performed.
- Any leakage at the body bonnet connection is cause for rejection. Leakage through auxiliary connections is not cause for rejection, if the leak can be mitigated by additional torquing.

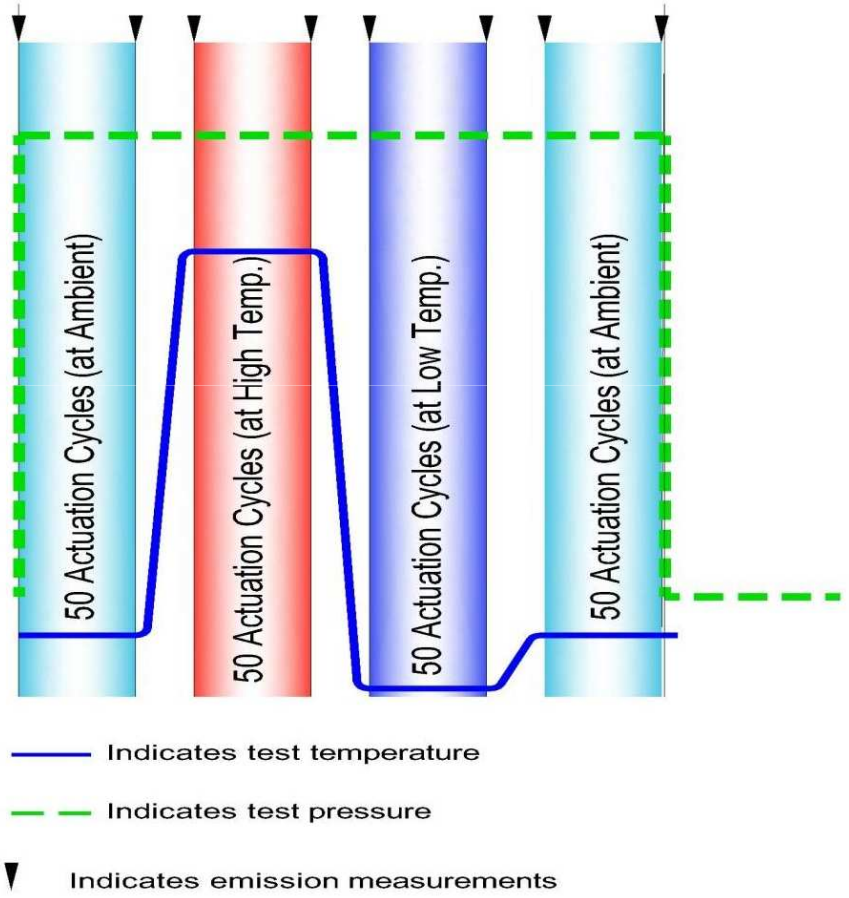
API-624

- Fugitive Emissions Test
- The stem orientation for a test valve shall be horizontal.
- The test fluid used shall be methane gas, 97% minimum purity.
- Valves shall be subject to a total of 205 mechanical cycles and 2 temperature cycles
- Mechanical and thermal cycling shall begin with the valve at ambient temperature. An optional low temperature test (-29C -20F) may be performed if requested by the purchaser.
- Stem orientation for the low temperature test may be vertical. (5 Mechanical cycles at room temperature, 50 mechanical cycles at low temperature, 5 mechanical cycles at ambient).

API-624

Fugitive Emissions Test

- The valve shall be heated using an external heat source, blanket, heating coils or other suitable equipment
- Elevated test temperature shall be 500F +/-5 percent.
- Test pressure shall be in accordance to 500F rating in ASME B16.34.



API-624

Leak Measurement

- Leakage rate shall be measured initially and at the end of every thermal cycle.
- Measurements shall be taken at the stem OD and packing OD, the body bonnet connection and any auxiliary connections. Stem leak measurements shall be taken while the stem is in the static and dynamic condition.
- Leak measurement shall be conducted using a detection probe.
- The leak measurement of the stem and body bonnet connection shall be performed using a bagging technique. Leak measurement for auxiliary connections shall be sniffed.

API-624

Leakage Measurement

- Currently reads:
  - Once testing has commenced, any leakage from body bonnet or auxiliary connection shall constitute a failure of the test.

API-624

- LEAK TEST EQUIPMENT SELECTION AND CALIBRATION
- Monitoring equipment shall be a flame ionization vapor analyzer capable of providing on-board data logging with digital readout. The equipment shall be certified as intrinsically safe for use with thetest fluid.

API 624

Packing Adjustment

- At the option of the manufacturer, one adjustment may be made if the leak rate performance exceeds agreement between the manufacturer and the end user or when superseded by local ordinance.
- The test shall end if leakage exceeds the agreed upon leakage rate after the one adjustment.
- Adjustment shall not exceed the valve manufacturers packing gland bolt torque values.
- Mechanical cycling shall be discontinued during a necessary adjustment.

API-624

Test Valve Selection

- In order to insure the test valves were not made specifically for the test, a random sampling feature shall be incorporated into the program. The qualification facility personnel shall select the test valve randomly from the manufacturer or distributor stock. Alternatively, the purchaser may choose to select the valve to be tested.
- When a valve has been successfully tested, it shall qualify one size smaller and two sizes larger based on the diameter.
- The standard may include an acceptance certificate in an appendix

API 624

Pressure class qualification groupings shall be as defined below:

Group 1:	Class 600 qualifies classes 150, 300, 600
Group 2:	Class 1500 qualifies classes 900 and 1500
Group 3:	Class 2500 qualifies **only** class 2500

We have discussed to add Series 800 to Group 1

QUESTIONS & ANSWERS