Specification for a Test Procedure for Spiral Wound Gaskets

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The **European Sealing Association** is a pan-European organisation, established in 1992 and representing over 80% of the fluid sealing market in Europe. Member Companies are involved in the manufacture, supply and use of sealing materials, crucial components in the safe containment of fluids during processing and use.

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Foreword

This specification gives details of a test procedure for spiral wound gaskets to be used to seal pipe and other flanges. It has been prepared by the Gasket Division of the Fluid Sealing Association (FSA) in collaboration with the Gasket Division of the European Sealing Association (ESA) and is approved by these organisations as a suitable method of test.

1. Scope

This specification details a test method for measuring emissions from flanges sealed with spiral wound gaskets. These types of gaskets are generally of the types described in FSA/ESA publication 'Gasket Handbook" when used to seal flanges. It gives guidance on the design of test equipment, standard test parameters and reporting criteria. It does **not** specify performance criteria which should be agreed between supplier and customer, but does define 2 leakage classes.

2. References

Attention is drawn to the following documents:

ASME B16.5. Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

ASME B16.20. Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed

API 622. Type Testing of Process Valve Packing for Fugitive Emission

3. Test apparatus

The test apparatus shall be similar to the typical example shown in Appendix C, Figure 1 & 2, and shall consist of a 3" Class 3/4/600 flange, Standard A105 material. The fixture will be enclosed by an aluminium ring that contains emissions within the fixture but allows outside air to be drawn in for the emission measurement device to draw a sample on the outside of the gasket.
There will be connections to pressurize the inside of the gasket and connections for the probe to take measurements.
Clearance between the outside of the flange and the outer ring shall be 1/16 to 1/8 inch (1.5 to 3 mm)
One measuring point, a drilled hole compatible in size with the monitoring equipment shall be used to obtain measurements. (1/4" tube connector) will leave open until actual tests are conducted)
Threaded connections shall be provided for heating element, two thermocouples, a pressure sensing port, and a gas inlet.
Heating elements and insulation as required to maintain temperature.
The flange fixture shall be mounted so the axis of the pipe and flange assembly is horizontal. The measuring shall be at the top of the outer ring. Centering of the containment ring over the flange shall be made by suitable means at the test facility.

4. Pre-Test Procedure

4.1 Inspect the gasket for overall condition. Take photographs of the gasket on each side.

4.2 Measure and record the thickness at four points evenly spaced around the circumference of the gasket.

4.3 Score the outer ring on both sides in the radial direction approximately 90 degrees apart, across the surface of the rings at least .020", 0,5 mm deep starting at a maximum of 1/4 inch (6 mm) from the spiral. (Round robin to verify the procedure.)

5. Installation

5.1 Loading method: A193 Grade B7 bolts (or threaded rod) shall be used with A194 Grade 2H nuts and hardened washers to tighten the flanges and apply the specified load. The bolting pattern shall be a star cross pattern, in the following sequence: 1, 5, 2, 6, 3, 7, 4, and 8. (See Fig. 1.)

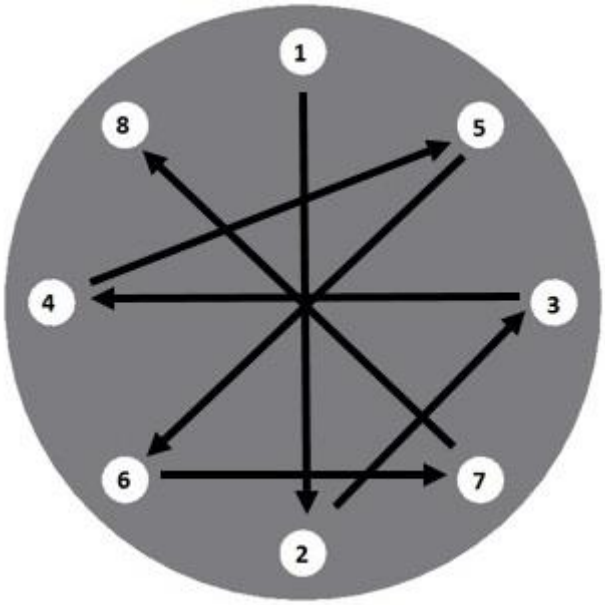


Figure 1. Bolt tightening pattern

5.2 A high grade anti-seize lubricant shall be used for all surface threads, bottom of nut and washer.

5.3 A calibrated torque wrench shall be used.

5.4 New bolts, or rod, nuts, and washers should be used for each test.

5.5 The loading should be sequential starting at 30%, 60% and 100% of required torque, with a final check at 100% of required torque sequentially around the circumference. Conduct successive 360 degrees pass(es) until there is no movement of any of the fasteners.

5.6 The gap between the flanges must be measured at 4 points 90 degrees apart and the variation must not exceed .020" (0,5 mm) (check during the round robin.)

5.7 The torque shall be calculated to achieve the specified load using the following formula: T= KFD.
T: Torque ft.-lb./N.m
K: Nut (Friction) factor
D: Diameter of the bolt ft./m
F: Load lb./N

5.8 The load, torque and anti-seize to be used shall be specified by the manufacturer. (Check after round robin for uniformity of torque.)

6. Test Conditions

6.1 Temperature. Two test temperatures shall be used. Ambient temperature, (maximum of 100^{0}F, 40^{0}C), and 500^{0}F (260^{0}C).

6.2 Test medium. The test medium shall be methane or helium gas (97% minimum purity).

6.3 Size. Standard 3" 3/4/600 flange dimensions with caps welded on the ends.,

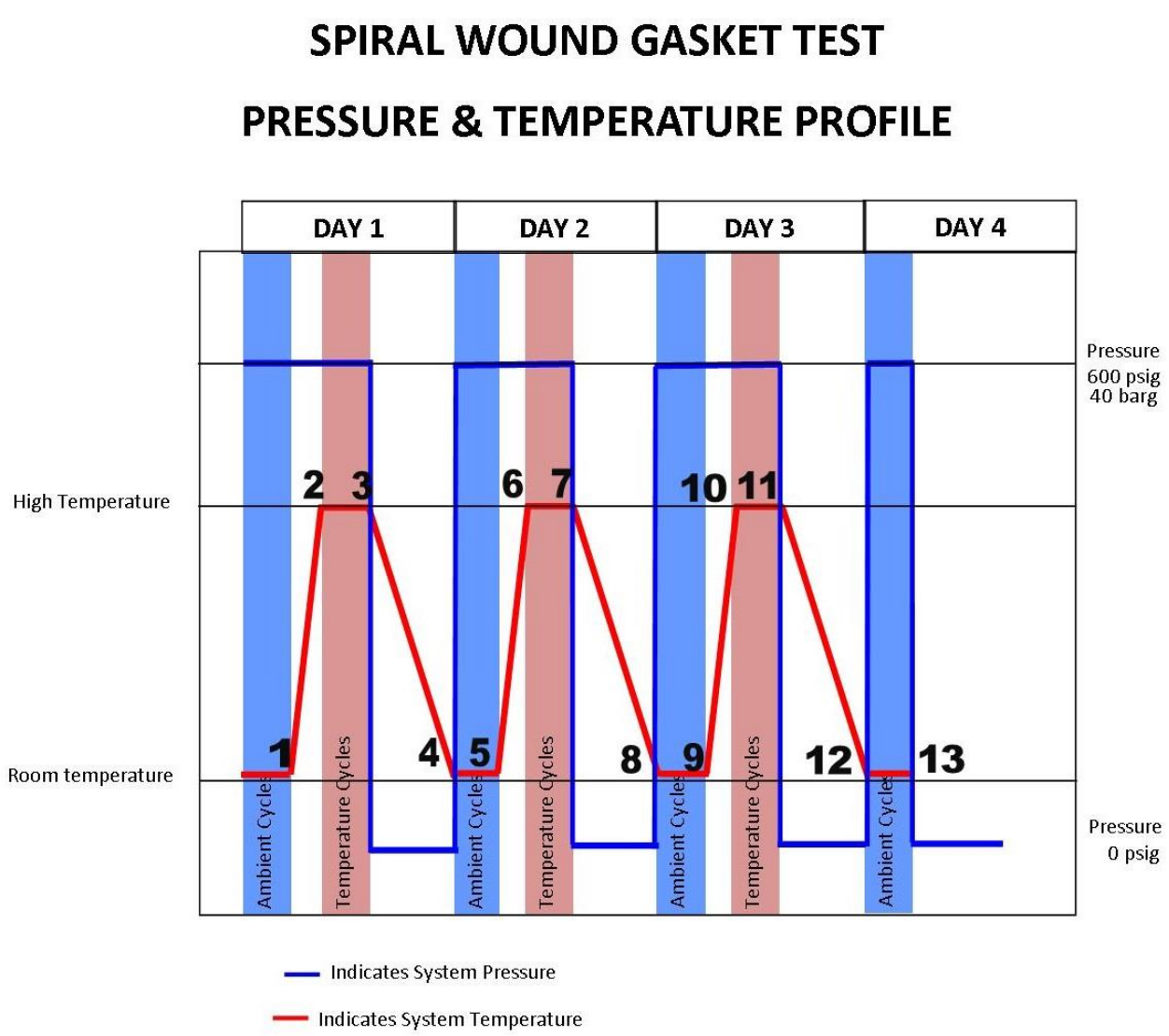
6.4 Dimensions. Per ASME B16.20

6.5 Temperature and Pressure cycles.

1) Ambient temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
2) Release pressure, heat up to 500^{0}F, 260^{0}C, one and one half hour
3) 500^{0}F, 260^{0}C temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig

4) Release pressure and cool to ambient temperature 4 to 20 hours
5) Ambient temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
6) Heat up to 500^{0}F, 260^{0}C under pressure, one and one half hour
7) 500^{0}F, 260^{0}C temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
8) Release pressure and cool to ambient temperature 4 to 20 hours
9) Ambient temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
10) Heat up to 500^{0}F, 260^{0}C under pressure, one and one half hour
11) 500^{0}F, 260^{0}C temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
12) Release pressure and cool to ambient temperature 4 to 20 hours
13) Ambient temperature for a duration of 2 hours at 40 a gauge pressure of 41 bar, 600 psig

Pressure levels to be +/- 5 psi, (0,34 bar); temperature levels to be +/- 5^{0}F, +/- 2,7^{0}C
Ambient temperature between 15 to 40^{0}C 60 to 110^{0}F



6.6 Additional Tests

Any additional tests carried out under different conditions (e.g. other media, higher temperature etc.) shall be reported separately.

7. Test Procedure

7.1 Pre-Test procedure

Inspection

Measurement

Photographs

7.2 Test duration

The test duration will depend on the time used for the cool down periods of steps 4 and 8 and 12 of the temperature/pressure cycles, but a full test is expected to take three and one half days.

7.3 Result recording

7.3.1 Leakage measurement instrumentation

Instrumentation/calibration reference API 622 Section 4.2. Mass spectrometer. Helium?

Figure out during round robin. (PPM calculated from mass flow rate.)

For first high temperature cycle round of testing with emissions not related to leakage. Outgassing could be a problem on high temperature cycle

Before cycling starts take a background measurement, zero out the sensor.

Zero the sensor at the beginning of each elevated temperature cycle.

A measurement is an average of a minimum of 10 readings over a one minute period. Measurements should not deviate by more than 50% unless the leakage is below 10 PPM. An average of the measurements shall be recorded.

7.3.2 Leakage measurements

Three leakage measurements shall be conducted during phases 1, 3, 5, 7, 9, 11, and 13. They shall be taken at the beginning, middle and end of each two-hour period: 5 minutes, 60 minutes and 115 minutes, +/- 5minutes, elapsed time in the cycle.

7.4 Post-test procedure

Inspection

Measurement

Photographs

7.5 Number of tests

A minimum of 2 complete tests shall be carried out for each gasket type.

7.6 Test completion

Documentation

8. Reporting

8.1 Record all test data on a seal test report form (an example is shown in Appendix A) and graphically (an example is shown in Appendix B)

Measure bolt length before and after test as a measure of bolt load in addition to torque measurements. Measure before torqueing, and before and after test. Check torque specified vs. load. Modify test report to include length of bolt if procedure is adopted after round robin. Measuring method is to drill countersink hole at end of bolt/stud and then place a ball bearing in depression for measurement.

8.2 Leakage Class.

There shall be 2 leakage classes,

1) Less than 25 PPM (methane). X cc/min – 10^{-x} mg/s (Helium)

2) Less than 100 PPM. X cc/min – 10-x mg/s (Helium)

Check after initial round robin.

If any reading exceeds the highest leakage class, the test shall be suspended. (No re-torque allowed).

8.3 Extrapolation to different size flanges? Will need to check after round robin. Per inch/mm of circumference Linear extrapolations? Ratio of diameter pipe size to test size.

8.4 Publishing of results

When publishing results, the average results for a minimum of two tests shall be reported and the following data must be included:

Standard reference (i.e. FSA GDxxx.2016) and Issue Number

Gasket type

Test duration

Test conditions

Leakage class achieved

Load and torque specified

8.3 The complete test report shall be made available to users on request.

Appendix A
Gasket Test report according to FSA GDXXX/2017

Test Start Date: _____. Report No: _____ .

Test End Date: _____. Performed by: _____ .

Customer: _____.

Pre-Test Information

Photographs

Description Of Gasket to be tested: _____.

Manufacturer Name / Trademark: _____.

Gasket Marking: _____.

Visual Condition of test specimen: _____.

Centering ring ☐

Outside Diameter: _____.

Thickness: _____.

Material: _____.

Inner Ring ☐

Inside Diameter: _____.

Thickness: _____.

Material: _____.

Spiral Wound Sealing Element

Outside Diameter: _____, _____, _____, _____,

Inside Diameter: _____, _____, _____, _____,

Thickness : _____, _____, _____, _____,

Winding Material: _____. Filler Material:_____.

Pre-Test information

Recommended load by the manufacturer (F) : _____ *lbs / N* Nut Friction Factor (K) : _____.

Bolt Diameter (D): _____. Bolt Torque calculated with formula T=KFD : _____ ft lbs /Nm

Test information

Cycle	*Reading 1*	*Reading 2*	*Reading 3*	*Average Leakage*	*Temperature °F/°C*	*Pressure psig/ bar gauge*	*Gap Between Flanges*
Initial	0	0	0	0.00	Ambient	600/41	
1	0	3	5	2.67	Ambient	600/41	
3	0	0	0	0.00	500/260	600/41	
5	3	3	3	3.00	Ambient	600/41	
7	3	3	3	3.00	500/260	600/41	
9	5	6	5	5.33	Ambient	600/41	
11	5	3	3	3.67	Ambient	600/41	
13	5	6	10	7.00	500/260	600/41	

Test Results

Maximum leakage through the test : 10 PPMv

Average leakage through the test : 3.9 PPMv

Leakage Class achieved during test : Class I

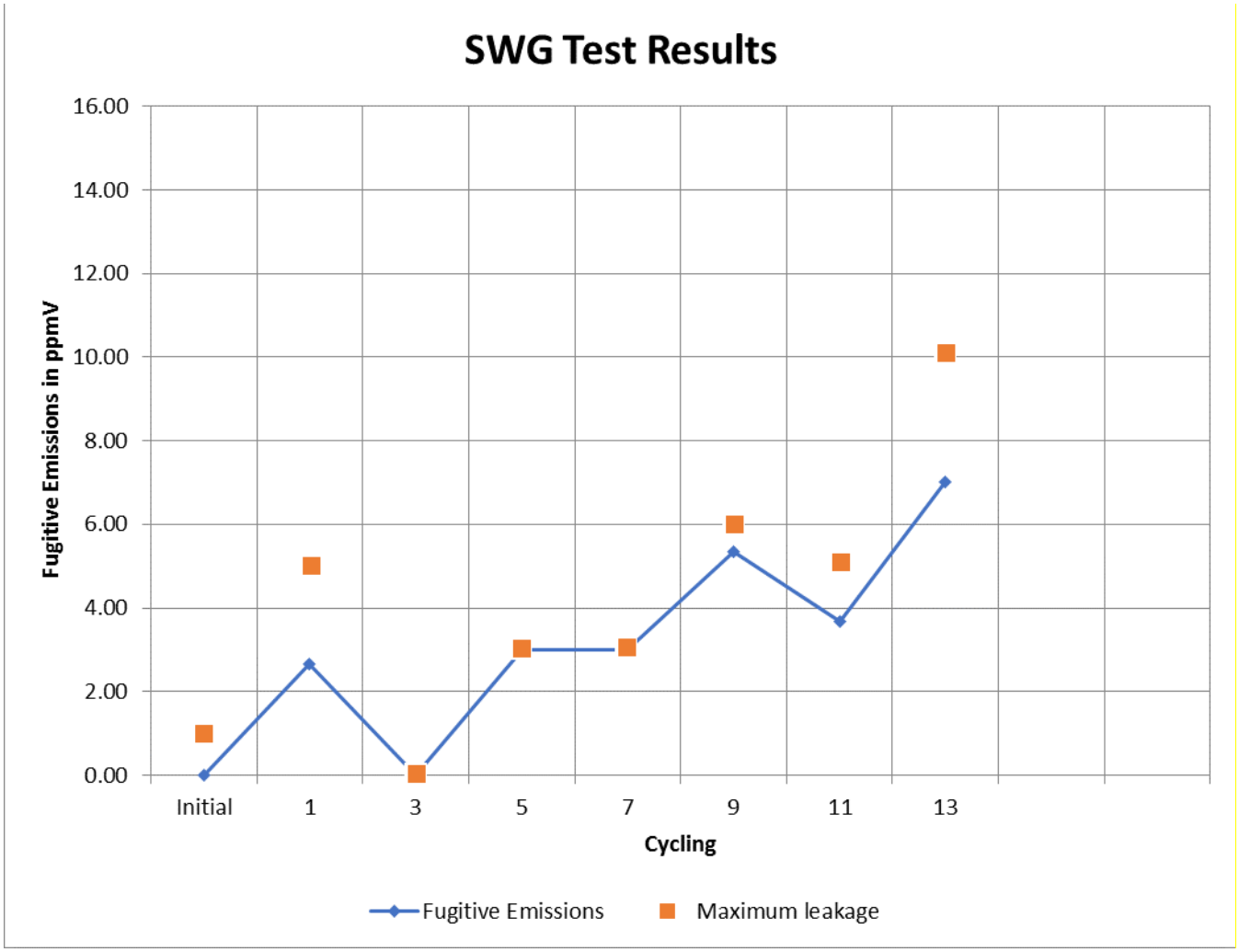
Bolt torque at end of test:_____

% Final Compression: _____

Photographs

Appendix B

Typical Graphical Representation of Results



Appendix C – Test Fixture

Assembled fixture

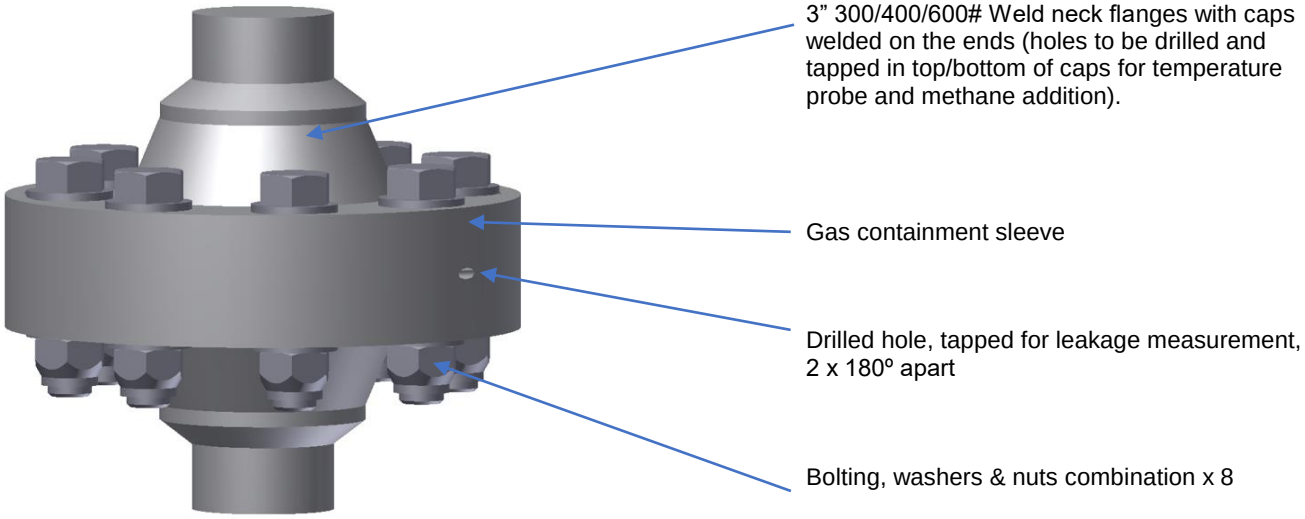


Figure 1 Typical Test Arrangement (Schematic)

Exploded Assembly view of Fixture

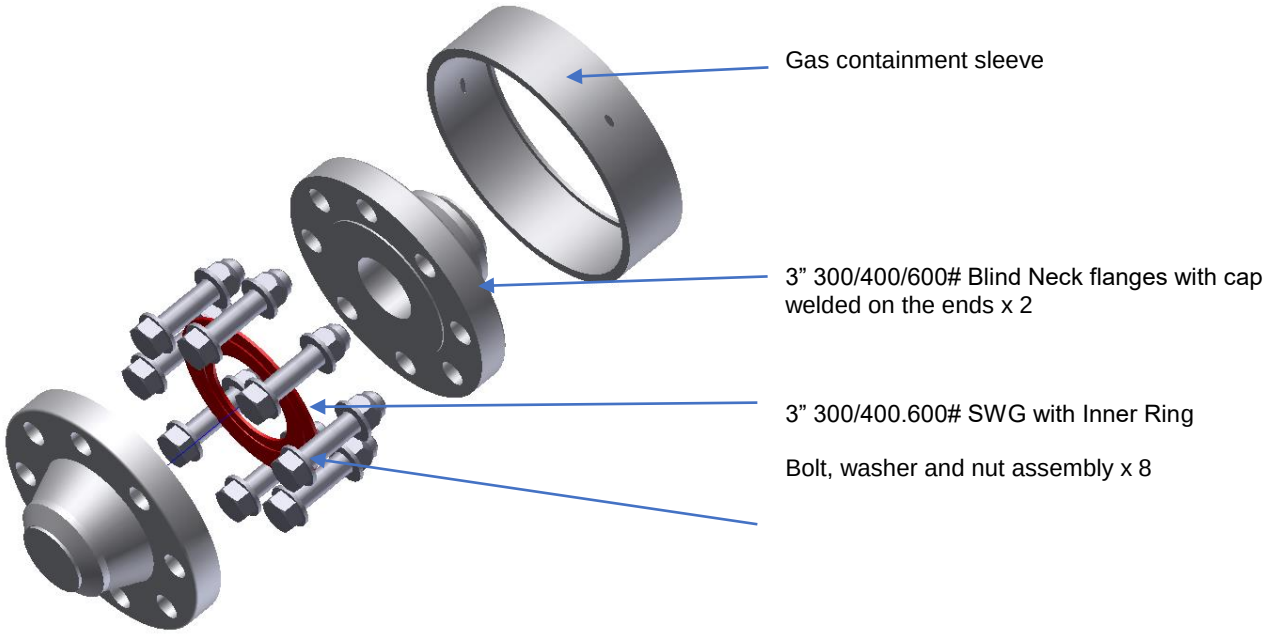


Figure 2 Typical Test Apparatus (Schematic)