

# Fluid Sealing Association

## STANDARD

FSA-NMG-204-02  
STANDARD TEST METHOD FOR PERFORMANCE  
OF NON-METALLIC FLAT GASKETS IN  
HIGH PRESSURE, SATURATED STEAM

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994 Old Eagle School Road, Suite 1019

Wayne, Pennsylvania 19087-1866

Phone: (610) 971-4850

Fax: (610) 971-4859

<http://www.fluidsealing.com>

Email: [info@fluidsealing.com](mailto:info@fluidsealing.com)

For a complete list of FSA publications, please contact:

Fluid Sealing Association  
994 Old Eagle School Road  
Suite 1019  
Wayne, PA 19087-1866  
Phone: (610) 971-4850  
Fax: (610) 971-4859  
Email: [info@fluidsealing.com](mailto:info@fluidsealing.com)  
or visit our web site at: [www.fluidsealing.com](http://www.fluidsealing.com)

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# FLUID SEALING ASSOCIATION STANDARD

## STANDARD TEST METHOD FOR PERFORMANCE OF NON-METALLIC FLAT GASKETS IN HIGH PRESSURE, SATURATED STEAM

### 1. SCOPE

- 1.1 This test method provides a means of assessing the performance of various non-metallic flat gasket materials in saturated steam service under controlled conditions. It is particularly useful for assessing the performance of non-asbestos gasket materials. While the test is designed primarily for flat gaskets it also can be applied to various form-in-place gasket materials upon modification. When desired, the test may be used as acceptance/rejection criteria when test conditions and/or maximum weight loss (leakage) are agreed to by user and supplier.
- 1.2 This standard may include hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

### 2. REFERENCED DOCUMENTS

- 2.1 American Society for Testing and Materials (ASTM) Standards F104, A193, A194.
- 2.2 American National Standard Institute (ANSI) Standards B16.5, B16.21.
- 2.3 “Torque-Tensioning Part II” - written by Dr. H.E. Trucks (Fastener Technology - December 1987 issue).
- 2.4 ESA/FSA Guidelines for Safe Seal Usage - Flanges and Gaskets Publication No. 009/98 - Recommended Bolt Torquing Sequence.

### 3. APPARATUS

- 3.1 The test equipment shall consist of the following components
  - 3.1.1 **Hot Air Circulating Oven** - Equipped with temperature controls, capable of maintaining temperatures up to 570°F +/- 5°F (299 °C +/- 3°C).
  - 3.1.2 **Scales** - Capable of maintaining an accuracy of +/- 0.1-gram with a nominal capacity of 12kg.

- 3.1.3 **Flange Fixture** - A 2" cast steel 600 Class fixture made from one weld neck flange capped by welding to boiler code and one blind flange. (**Appendix A**) Flange surfaces of 275-325 RMS micro-inches (7.0-8.3 micrometer), flatness range 0.002" (0.05mm). Each fixture should have an identification number.
- 3.1.4 **Flange Protectors** - To help assure safe operation use of standard metal flange protectors is recommended.
- 3.1.5 **Fasteners:**
- Seven (7) 5/8" bolts 4" long per ASTM A193 B7
  - One (1) calibrated bolt modified by the insertion of a calibration pin as detailed in **Appendix A**
  - Eight (8) 5/8" hexagonal nuts per ASTM A194 Grade 4, course thread
  - Sixteen (16) 5/8" hardened steel washers (38-45 HRC), Grade 8
- 3.1.6 **Calibrated Dial Indicator** - Graduated to 0.0001"(0.0025mm) equipped with a 90 degree conical contact point to be used in conjunction with adapter shown in **Appendix A**
- 3.1.7 One (1) calibrated torque wrench with a minimum capacity of 70 ft-lbs (95 N-m).
- 3.1.8 One (1) calibrated torque wrench with a range of 0-200 in-lbs (0-23 N-m).

Note: Fixture and assembly in **Appendix A** may be purchased from:

Alabama Specialty Products, Metal Samples Division  
152 Metal Samples Road, PO Box 8  
Munford, AL 36268  
Phone: 256-358-4202, Fax: 256-358-4515  
Home Page: [www.metalsamples.com](http://www.metalsamples.com)

## 3.2 Preparation of Apparatus

- 3.2.1 Prior to running any tests, the integrity of the assembled test fixture should be checked at a temperature at least 100°F (38°C) higher than the test temperature, without exceeding the temperature/pressure rating for the flange. A standard gasket material approved for these service conditions must be used with water as the test fluid.

3.2.2 The maximum use temperature for the fixture with Saturated Steam is 563°F (295°C). Therefore, if a test temperature is not specified this maximum should be used as the default. However, any temperature that does not exceed this limit may be used if agreed upon by the user and supplier.

3.2.3 Follow the steps in **Section 9 - Procedure** for one cycle whose minimum is 24 hours. Make sure that the gasket is acceptable for that temperature/pressure.

#### **4. TEST SPECIMEN**

4.1 The test specimen shall be a Class 600 2" (50mm) ring gasket - It is recommended that a 1/16" (1.5mm) thick gasket be used. However, other thickness' can be used if agreed to by user and supplier.

1. Reference ANSI B16.21 Table 8 for gasket dimensions.
2. Reference ASTM F104 for thickness tolerance.
3. Preconditioning of the test gasket is not necessary since this test is designed for shelf stock gaskets.

#### **5. FLANGE LIMITS**

5.1 Ensure that the test pressure never exceeds the pressure/temperature rating of the flange class.

##### **Class 600 Cast Steel**

@ 400°F (205°C) - Limited to 1,270 psig (88.6 bar) or (8.87 MPa)

@ 500°F (260°C) - Limited to 1,200 psig (83.8 bar) or (8.38 MPa)

@ 600°F (316°C) - Limited to 1,095 psig (76.6 bar) or (7.66 MPa)

@ 700°F (371°C) - Limited to 1,065 psig (74.5 bar) or (7.45 MPa)

#### **6. TEST LIMITS**

6.1 Below are listed some temperature/pressure properties for saturated steam from the steam table:

400°F (205°C) – generates 235 psig (16.2 bar) or (1.62 MPa)

450°F (232°C) – generates 405 psig (27.9 bar) or (2.79 MPa)

500°F (260°C) – generates 665 psig (45.8 bar) or (4.58 MPa)

540°F (282°C) – generates 945 psig (65.1 bar) or (6.51 MPa)

550°F (288°C) – generates 1035 psig (71.3 bar) or (7.13 MPa)

563°F (295°C) – generates 1145 psig (78.9 bar) or (7.89 MPa)

## 7. BOLT TORQUE GUIDELINES

- 7.1 The recommended assembly torque is 65 +/- 5 ft-lbs (88 +/- 7 N-m) which produces a gasket stress of approximately 11,000 psi (75.8 MPa). This calculation is based on the use of molybdenum disulfide grease as the bolt lubricant (**Section 8.1**).
- 7.2 We suggest reviewing the article “Torque - Tensioning Part II” by Dr. H. E. Trucks found in Fastener Technology dated December 1987.
- 7.3 Various assembly torques can be used provided there is an agreement between testing parties and provided the gasket stress is never less than 4350 psi (30 MPa).

## 8. BOLT LUBRICANT

- 8.1 High temperature resistant molybdenum disulfide grease *Crown No.67041* manufactured by North American Professional Products. Material may be purchased directly from the manufacturer or from their 1,000 distributors in the U.S.

### **North American Professional Products**

91 Caldari Rd.

Concord, Ontario, Canada

L4K 3Z9

Phone: (800) 461-3131 or (905) 669-9855

## 9. PROCEDURE

- 9.1 A minimum of two test assemblies is recommended per gasket type tested.
- 9.2 Ensure that the flange assembly has been thoroughly cleaned and that the exposed surfaces of the flanges are free of all residues from previous tests. Inspect for nicks, scratches or serious defects. Recondition when required.  
  
*Caution: It is important that the flanges are checked to ensure that the surfaces remain within the correct roughness and flatness range.*
- 9.3 Ensure that the bolts, nuts, and washers are not damaged, and that the nut can be freely assembled to the bolt.
- 9.4 Cut standard ANSI 2" Class 600 ring gaskets.
- 9.5 Clean bolt threads, nuts, and washers with an organic solvent. Then lubricate bolts, nuts, and washers. Do not lubricate the dial indicator adapter assembly or the part of the calibrated bolt that it will contact since the presence of lubricants on

these components can adversely affect bolt elongation readings. Do not coat gasket or flanges with any kind of release material.

9.6 Assemble the fixture as follows:

- i) Put the empty weld neck flange on the scale and tare it.
- i) Pour 125 ml of water in the flange and record the exact weight of water ( $W_w$ ).
- iii) Tare the scale and center the gasket onto the raised face of the weld neck flange and record gasket weight ( $G_w$ ).
- iv) Put the blind flange carefully on the weld neck flange and install the bolts, washers, and nuts finger tight.
- v) Install the dial indicator assembly (dial indicator mounted on adapter) over the calibrated bolt with a calibrated torque wrench set to 40 in-lbs (4.6 N-m) and zero the dial. Lock the dial indicator in the zero position, then remove the dial indicator assembly carefully.
- vi) Using a calibrated torque wrench, torque the bolt according to the FSA recommended cross pattern (see ESA/FSA Guidelines for Safe Seal Usage), in three increments of 20+/-5 ft-lbs (27+/-7N-m) and finally one cycle at 65 +/-5 ft-lbs (88+/-7 N-m). Then torque each bolt consecutively in a counter-clockwise pattern at 65 ft-lbs (88 N-m) doing the first bolt a second time.
- vii) The tightening process must be complete in 15 minutes.
- viii) Ten minutes after completing the tightening process shown in Paragraph vi), torque again with the FSA cross pattern to 65 ft-lbs (88 N-m). Finally, tighten each bolt consecutively in a counter-clockwise pattern to 65 ft-lbs (88 N-m) doing the first bolt a second time.
- ix) Re-install the dial indicator assembly over the calibrated bolt using a calibrated torque wrench set to 40 in-lbs (4.6 N-m). Take the reading and record this value as  $L_o$ . Remove the dial indicator assembly carefully.
- xi) Install the flange protector, weigh the assembly, and record the weight as  $W_t$ .

NOTE: A separate dial indicator assembly (dial indicator mounted on adapter) will be required for each calibrated bolt used in the test.

- 9.7 Place the test rigs in the oven and raise the temperature so the test temperature is reached no sooner than in 30 minutes. Ideally, a temperature rate-of-rise of 1°C/min. is preferred.

NOTE: The test can be run with the steam in contact with the gasket by locating the fixture in the oven with the liquid chamber down (steam phase). Or, the gasket can be in contact with the test liquid by reversing the fixture and the liquid chamber will be up (wet phase).

NOTE: The “Weekly Steam Cycle” in **Appendix B** is suggested. This weekly cycle consists of two cycles allowing time for the technician to take all the measurements in a normal 5-day working week.

- 9.8 After the indicated time at the chosen temperature, cool down the oven to room temperature no sooner than 30 minutes. Ideally, a cool down rate of 1°C/min. is preferred.
- 9.9 Remove the test rig from the oven and weigh it. Record the weight as  $W_r$ .
- 9.10 Repeat the Steps 9.7, 9.8 and 9.9 for a minimum of 10 cycles and 1000 hours. Test hours will include the ramp up time for the fixture and the time held at temperature but not the cool down time. If the “Weekly Steam Cycle” in **Appendix B** is followed, a seven (7) week test will comprise 1064 hours.

NOTE: Cycles can vary from the above provided there is an agreement between testing parties. However, any change from the above default schedule must be noted in the report.

- 9.11 After the final cycle is completed, measure and record the weight of the fixture, install the dial indicator adapter as in Step 9.6 - ix), take the reading, and record as  $L_r$ .
- 9.12 Dismantle the fixture and record any relevant observations.

## 10. CALCULATION

- 10.1 Water loss

$W_{\%}$ : Water loss in percent  
 $W_w$ : Initial water weight  
 $W_t$ : Initial total assembly weight  
 $W_r$ : Assembly weight after each cycle



$$W_{\%} = \frac{W_i - W_f}{W_w} \times 100$$

NOTE: Weight loss due to the gasket and the lubricant should be determined by running a dry test for a few cycles. Results should be used to confirm what affect they have on precision of  $W_{\%}$ .

## 10.2 Bolt Elongation

$L_{\%}$ : Bolt elongation loss in percent

$L_o$ : Initial bolt elongation

$L_f$ : Final bolt elongation

$$L_{\%} = \frac{L_o - L_f}{L_o} \times 100$$

## 11. REPORT

11.1 Report the following information on the form attached as **Appendix C**

11.1.1 Gasket identification and thickness under "Product Description".

11.1.2 Initial bolt torque in ft. lbs. and calculated gasket stress in psi under "Comments".

11.1.3 Indicate wet or steam phase under "Condition".

11.1.4 Total number of cycles and total hours

11.1.5 Temperature of the oven.

11.1.6 Weight loss at each cycle

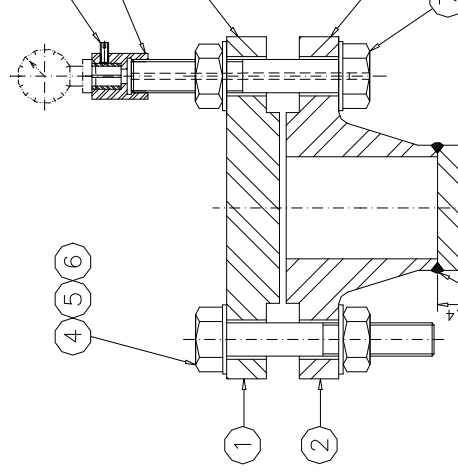
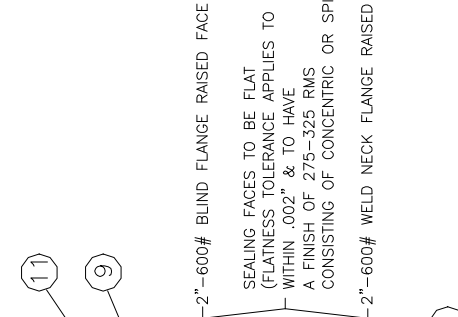
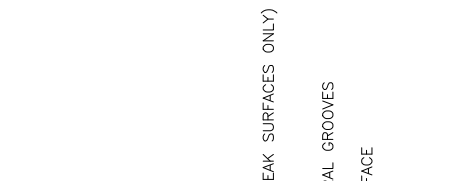
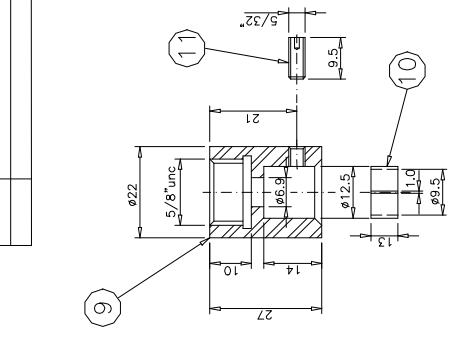
11.1.7 Bolt elongation loss in percent

11.1.8 General observations under "Comments".

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# APPENDIX A FSA STEAM TEST FIXTURE

REV. NO.	DESCRIPTION	DATE	APPR. BY
1	INITIAL	07/30/01	J.C.V.



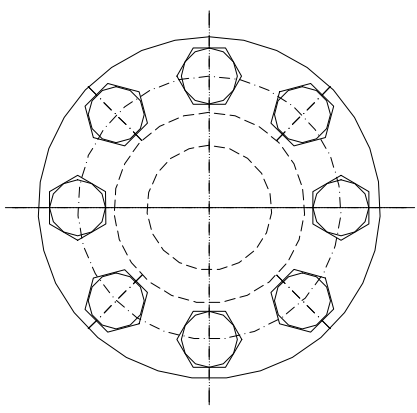
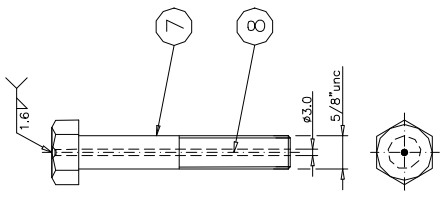
SEALING FACES TO BE FLAT  
(FLATNESS TOLERANCE APPLIES TO PEAK SURFACES ONLY)  
WITHIN .002" & TO HAVE  
A FINISH OF 275-325 RMS  
CONSISTING OF CONCENTRIC OR SPIRAL GROOVES

POS	DESCRIPTION	QUANT	MATERIAL	DIMENSION
11	SET SCREW	01	ASTM A.193-B7	
10	SPLIT BUSHING	01	SPRING STEEL	
9	ADAPTER	01	CARBON STEEL	
8	PIN	01	CARBON STEEL	
7	CALIBRATED BOLT	01	ASTM A.193-B7	5/8"UNC x 4"
6	FLAT WASHER	16	HARDENED STEEL	5/8" - 38/45 HRC GRADE 8
5	HEX NUT	08	ASTM A.194-2H	5/8"-11 UNC-2B
4	BOLT	07	ASTM A.193-B7	5/8"-11 UNC-2A x 4"
3	WELD CAP	01	ASTM A-105	2" 600#
2	WELDING NECK FLANGE	01	ASTM A-105	2" - CLASS 600 - ASME'B16.5
1	BLIND FLANGE	01	ASTM A-105	2" - CLASS 600 - ASME'B16.5

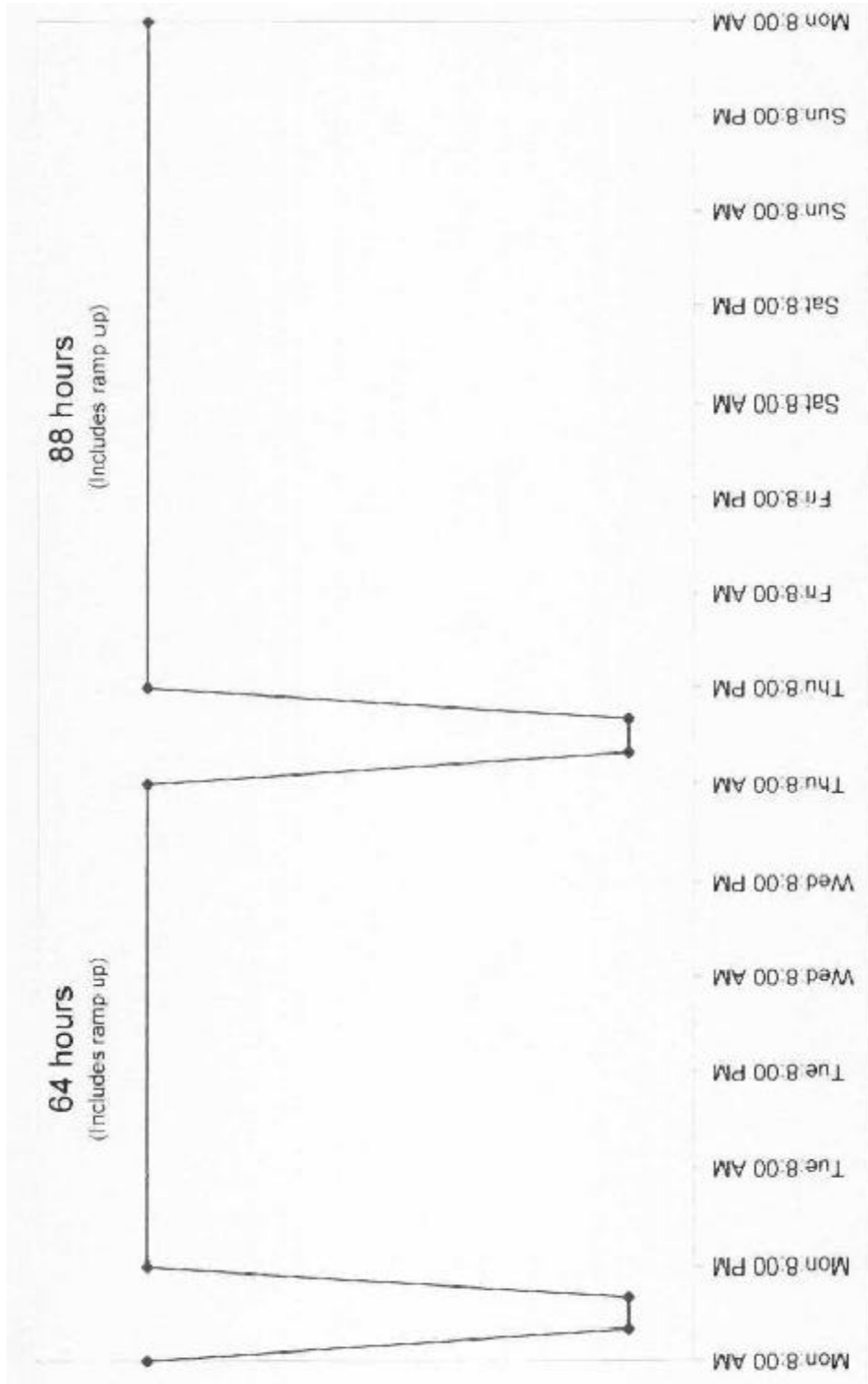
DATE	APPROVED BY	SCALE
07/10/01	J.C.V.	#

TITLE STEAM TEST FIXTURE  
REF. #

DWG No. FSA-NMG-204-DWG1  
REV. 1



# APPENDIX B WEEKLY STEAM CYCLE



# APPENDIX C

## FSA STEAM TEST STATUS WORK SHEET

<b>Product description</b>	
Lab #	
Condition (Wet or Steam)	
Fixture	
Calibrated bolt #	
Gasket weight ( <b>G<sub>w</sub></b> )	g
Water weight ( <b>W<sub>w</sub></b> )	g
Total weight ( <b>W<sub>t</sub></b> )	g
Initial bolt elongation ( <b>L<sub>0</sub></b> )	in

<b>TEST #:</b>
Oven #
Date started
Comments:

**NOTE:** The following data is recorded after each cycle.

Cycle #	Date	Cumulative Time Hours	Temp.  °C	Weight <b>W<sub>r</sub></b> g	Bolt Elongation <b>L<sub>f</sub></b> in	Water loss <b>W%</b> %	Bolt Elongation Loss : <b>L%</b> %	Comments
1								
2								
3								
4								
5								
6								
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