Designation: F3149 – 15 (Reapproved 2021)

Standard Practice for Determining the Maintenance Factor (*m*) and Yield Factor (*y*) Loading Constants Applicable to Gasket Materials and Designs[1]

This standard is issued under the fixed designation F3149; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice will establish criteria for determining loading constants that are referenced in the American Society of Mechanical Engineers (ASME) pressure vessel design (Boiler and Pressure Vessel Code, Section VIII, Divs. 1 and 2). These constants are specific to this design criterion for metallic, semi-metallic, and nonmetallic gaskets.

1.2 *Units*—The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2000 Classification System for Rubber Products in Automotive Applications

F104 Classification System for Nonmetallic Gasket Materials

F868 Classification for Laminated Composite Gasket Materials

2.2 *ASME Standards:*[3]

B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard Boiler and Pressure Vessel Code Section VIII, Divs. 1 and 2

PCC-1 Guidelines for Pressure Boundary Bolted Flange Joint Assembly

2.3 *DIN Standard:*

DIN 3535 Gaskets for Gas Supply[4]

2.4 *FSA Standard:*

FSA G 605:11 Standard Test Method for Determining (*m*) and (*y*) Loading Constants Applicable to Gasket Materials and Designs[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *gasket contact area, A_1, n*—gasket area in contact with the flange surfaces and under load.

3.1.1.1 *Discussion*—The gasket contact area described in this practice can deviate from the effective area described in the ASME pressure vessel design.

3.1.2 *leak rate, n*—volumetric leak rate per inch gasket outside diameter.

3.1.3 *maintenance factor, m, n*—factor that is required to calculate the additional flange fastener preload needed to maintain a seal after internal pressure is applied to a joint.

3.1.4 *surface stress, n*—stress applied to the gasket contact area and equal to the applied load divided by gasket contact area.

3.1.5 *yield factor, y, n*—factor that provides the gasket minimum design seating stress required to seal a joint upon assembly.

[1] This practice is under the jurisdiction of ASTM Committee F03 on Gaskets and is the direct responsibility of Subcommittee F03.40 on Chemical Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from the Fluid Sealing Association, 994 Old Eagle School Rd., #1019, Wayne, PA 19087-1866.

3.1.5.1 *Discussion*—This assumes no pressure and, therefore, a lack of hydrostatic end load effect on the assembly. Reported in psi.

4. Significance and Use

4.1 The gasket factors are a function of leak rate; therefore, this practice generates curves. Constants for use in the ASME Boiler and Pressure Vessel Code, Section VIII, Appendix 2 code calculations are selected from these data. Specific *m* and *y* values can be selected based on a maximum desired leak rate or derived from these data as described in this procedure. This practice addresses the influence of leak rate and gasket thickness on a gasket's ability to provide a seal initially and in operation. This practice is performed at room temperature; therefore, this practice does not account for all conditions, such as high temperature or thermal cycling or both, that bolted flange connections may be subject to in field application.

4.2 This practice determines two general characteristics that are specific to the ASME design criteria. Caution should be exercised when comparing yield and maintenance factors between gasket materials, and it is recommended that the *m* and *y* curves be compared. Selecting a gasket material for use in an application should not be based exclusively on these two general characteristics. Gasket material selection for a given application should consider additional information not described in this practice, which includes, but is not limited to, chemical resistance, thermal resistance, creep relaxation, compressibility, and accommodation of thermal cycling.

4.3 This practice builds upon work conducted in the Fluid Sealing Association (FSA G 605:11). The associated round robin data is provided for reference in Tables 1-4.

5. Apparatus

5.1 The test apparatus is composed of three elements: test fixture, loading technique, and leak measurement.

5.2 The test fixture may use a flange or platen press. The surface finish of the sealing area shall meet rules stated in ASME B16.5 for acceptable surface finish with a roughness of 125 to 250 µin. (3.2 to 6.6 µm).

5.3 Hydraulically loaded flanges or platen presses are acceptable. (The use of manual loading platens is not acceptable.) If a bolted flange fixture is selected, then loading of the fasteners shall be bolt stretch controlled. (The use of torque controlled loading is not acceptable.) Examples of bolt-stretch-controlled loading include the use of calibrated bolts and ultrasonic devices. In addition, bolted flange fixtures shall be assembled per ASME PCC-1 guidance to minimize variability of test results. Such variables include flange parallelism, bolt loading pattern, and multi-stage tightening levels.

5.4 A leak measurement system is required. Leak measurement methods include differential pressure gage, manometer, flowmeter, and mass spectrometry. The test fixture shall have a containment system to capture leakage outside the gasket, except when flow is measured upstream of the fixture.

NOTE 1—If leak rate is measured with a mass spectrometer, the measured leak rate will be higher because of the higher pressure differential across the gasket, especially in the *y* value portion of the test. This is due to the vacuum created at the gasket outside diameter by the mass spectrometer.

6. Test Specimen

6.1 The test specimen should have a gasket width of 0.5 in. (12.7 mm) or greater. The inside and outside diameter of the gasket should be agreed upon between the producer and user.

6.2 The recommended specimen thicknesses are 1/16 and 1/8 in. (1.6 and 3.2 mm).

7. Conditioning

7.1 Condition the gasket in accordance with Classification System F104, Classification F868, or as agreed upon between the producer and user.

7.2 Ensure the flange face is clean and free of defects, scratches, or foreign material, or a combination thereof.

8. Procedure

8.1 *Determining Yield Factor, y:*

8.1.1 Measure and record the initial gasket thickness in inches per the procedure described in Classification F104.

TABLE 1 Fluid Sealing Association (FSA) Round Robin Testing of Polytetrafluorethylene (PTFE), Yield Factor

Yield Factor, *y* (psi)	F104 Type 45 – Glass-Filled PTFE							
	Laboratory 1		Laboratory 2			Laboratory 3		
	Test Specimen 1	Test Specimen 2	Test Specimen 1	Test Specimen 2	Test Specimen 3	Test Specimen 1	Test Specimen 2	Test Specimen 3
500	1.14E-04	5.14E-04	9.52E-03	4.30E-03	1.32E-02	1.27E-02	4.09E-03	1.46E-02
1000	5.14E-06	6.29E-05	1.10E-03	6.83E-04	3.20E-04	9.21E-04	1.41E-03	1.28E-03
1500	1.71E-07	9.86E-06				6.79E-04	6.95E-04	6.30E-04
2000	1.63E-07	9.69E-06				5.49E-04	7.59E-04	3.55E-04
2500	1.51E-07	9.54E-06				1.78E-04	1.62E-04	1.62E-04
3000	1.49E-07	8.86E-06				1.62E-04	1.62E-04	1.62E-04
3500	1.46E-07	9.31E-06				1.62E-04		1.62E-04
4000	1.42E-07	7.71E-06						
4500	1.41E-07	8.69E-06						
5000	1.37E-07	8.66E-06						
5500	1.37E-07	5.43E-06						
6000	1.34E-07	4.57E-06						
Selection of yield factor, *y*, based on 0.00085 cm^3/min per inch OD	500	500	1000	1000	1000	1500	1500	1500