Designation: F36 – 15

Standard Test Method for Compressibility and Recovery of Gasket Materials[1]

This standard is issued under the fixed designation F36; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers determination of the short-time compressibility and recovery at room temperature of sheet-gasket materials, form-in-place gaskets, and in certain cases, gaskets cut from sheets. It is not intended as a test for compressibility under prolonged stress application, generally referred to as "creep," or for recovery following such prolonged stress application, the inverse of which is generally referred to as "compression set." Also, it is not intended for tests at other than room temperature. A resiliency characteristic (the amount recovered expressed as a percentage of the compressed thickness) may also be calculated from the test data where desired.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3297 Practice for Molding and Machining Tolerances for PTFE Resin Parts (Withdrawn 1997)[3]

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F104 Classification System for Nonmetallic Gasket Materials

3. Apparatus

3.1 The testing machine[4] shall consist of the following components:

3.1.1 *Anvil*—A hardened and ground surface of 31.7 mm (1.250 in.) minimum diameter.

3.1.2 *Penetrator*—A steel cylinder of diameter (within ± 0.025 mm (0.001 in.)) specified for the type of material being tested, with the cylinder end hardened and ground. Penetrator diameters for various types of gasket materials are as shown in Table 1, unless otherwise specified.

3.1.3 *Dial*—An indicating dial, or dials, graduated in 0.025 mm (0.001 in.) to show the thickness of the specimen during the test. Readings shall be estimated to the nearest 0.002 mm (0.0001 in.).

3.1.4 *Preload*—A preload which shall include the weight of the penetrator itself and added weights to give the value specified within ±1 %. Preloads for various types of gasket materials are as shown in Table 1, unless otherwise specified.

3.1.5 *Loading Device*— A device for applying a specified major load to the upper end of the penetrator, which may consist of an arrangement of dead weights, a hydraulic cylinder, an air cylinder, or any other device capable of applying the major load at a slow uniform rate and to an accuracy of ±1 %. The major load shall be in addition to the specified preload. Major loads for various types of gasket materials are as shown in Table 1, unless otherwise specified.

4. Test Specimen

4.1 The test specimen in Procedures A through K, inclusive, as described in Table 1, shall have a minimum area of 6.5 cm^2 (1 $in.^2$) in the form of a square, except in the case of cork composition, and cork and cellular rubber materials, which shall have a test specimen in the form of a circle 6.5 cm^2 in area. The test specimen shall consist of a single ply or a number of superimposed plies sufficient to give a minimum nominal thickness of 1.6 mm (1⁄16 in.)[5] for all materials except cork composition, cork and rubber materials, and cork and cellular rubber materials, for which the minimum nominal thickness

[1] This test method is under the jurisdiction of ASTM Committee F03 on Gaskets and is the direct responsibility of Subcommittee F03.20 on Mechanical Test Methods.

Current edition approved Jan. 1, 2015. Published February 2015. Originally approved in 1951. Redesignated F36 in 1963. Last previous edition approved in 2009 as F36 – 99 (2009). DOI: 10.1520/F0036-15.

[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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Contact ASTM for a list of recommended suppliers.

[5] Use of thicker specimens may result in lower compressibility and higher recovery versus standard.

TABLE 1 Conditioning and Test Loads for Gasket Materials

Procedure[A]	Type of Gasket Material	F104 Identification First Two Numerals of Six-Digit Number	Conditioning Procedure[B]	Penetrator Diameter, mm (in.)	Pre-Load N (lbf)	Major Load, N (lbf)	Total Load (Sum of Major Load and Pre-Load)	
							N (lbf)	MPa (psi)
A	Compressed asbestos sheet; asbestos beater sheet; flexible graphite	F11, F12, F51, F52	1 h at 100 ± 2°C (212± 3.6°F). Cool in desiccator over a suitable desiccant at 21 to 30°C (70 to 85°F)	6.4 (0.252)	22.2 (5)	1090 (245)	1112 (250)	34.5 (5000)
H	Asbestos paper and millboard	F13	4 h at 100 ± 2°C (212± 3.6°F). Cool as in Procedure A	6.4 (0.252)	4.4 (1)	218 (49)	222 (50)	6.89 (1000)
F	Cork composition Cork and cellular rubber	F21, F23	at least 46 h at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity	28.7 (1.129)	4.4 (1)	440 (99)	445 (100)	0.69 (100)
B	Cork and rubber	F22	at least 46 h at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity	12.8 (0.504)	4.4 (1)	351 (79)	356 (80)	2.76 (400)
G	Treated and untreated papers from cellulose or other organic fibers	F31, F32, F33, F34	4 h at 21 to 30°C (70 to 85°F) over a suitable desiccant followed immediately by at least 20 h at 21 to 30°C and 50 to 55 % relative humidity	6.4 (0.252)	4.4 (1)	218 (49)	222 (50)	6.89 (1000)
J	Compressed nonasbestos sheet; non-asbestos beater sheet	F71, F72	1 h at 100 ± 2°C (212 ± 3.6°F). Cool in desiccator over a suitable desiccant at 21 to 30°C (70 to 85°F)	6.4 (0.252)	22.2 (5)	1090 (245)	1112 (250)	34.5 (5000)
K	Non-asbestos paper and millboard	F73	4 h at 100 ± 2°C (212 ± 3.6°F). Cool as in Procedure J.	6.4 (0.252)	4.4 (1)	218 (49)	222 (50)	6.89 (1000)
L	Fluorocarbon polymer[C] (Sheet, Form-in-Place Gaskets)	F41, F42, F45	1 h at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity	6.4 (0.252)	22.2 (5)	534 (120)	556 (125)	17.25 (2500)
M	Fluorocarbon polymer[C] (Sheet, Form-in-Place Gaskets)	F41, F42, F45	1 h at 21 to 30°C (70 to 85°F) and 50 to 55 % relative humidity	6.4 (0.252)	22.2 (5)	1090 (245)	1112 (250)	34.5 (5000)

[A] Procedures C, D, and E were deleted from Test Method F36 to ensure compliance with conditioning procedures in Sections 6 and 7 of Specification D1170, which appear as part of Classification F104.
[B] Anhydrous calcium chloride and silica gel have been determined to be suitable desiccants.
[C] Please refer to 6.1 for specific information regarding Fluorocarbon polymer, Type 4, materials.

shall be 3.2 mm (⅛ in.). If applied to specimens outside of the test thicknesses, the results shall be regarded merely as indicative. For specification purposes, agreement on compressibility and recovery figures shall be reached between producer and consumer for those materials whose thickness in a single ply or multiple plies does not fall within the tolerances of the two nominal thicknesses specified. The tolerances for the test thicknesses are listed in Classification F104, Table 3. The specimen shall contain no joint or separation within the minimum test area.

4.2 The test specimen for Procedure L, as described in Table 1, shall be at least two in. long and wider than the penetrator used for the test. It shall consist of a single ply and contain no joint or separation. No thickness tolerances are given for gaskets covered by this procedure. Test results shall be regarded merely as indicative.

5. Conditioning of Specimens

5.1 Specimens shall be conditioned as specified for the particular type of material. Conditioning procedures for various types of gasket materials are as shown in Table 1, unless otherwise specified.

5.2 If a mechanical means of maintaining 50 to 55 % relative humidity is not available, a tray containing a saturated solution of reagent grade magnesium nitrate ($Mg(NO_3)_2 \cdot 6H_2O$) shall be placed in the chamber to provide the required relative humidity. In all cases where testing is conducted outside the area of specified humidity, specimens shall be removed from the chamber one at a time as needed.

6. Temperature of Test

6.1 The test shall be conducted with both specimen and apparatus at a temperature of 21 to 30°C (70 to 85°F).[6]

7. Procedure

7.1 Determine the amount of deflection of the penetrator at each of the loads used in the test with no specimens present. Add the absolute value of this penetrator deflection to the thickness under total load *M* in 9.1 to obtain a corrected reading. The values are machine constants which may vary for different instrument designs.

7.2 Center the test specimen upon the anvil and apply the preload and maintain for a period of 15 s, and record the

[6] For Fluorocarbon polymer, Type 4, materials the user should avoid the outer limits of the test range to ensure repeatable results. Practice D3297 states a preferred range of 22 to 25°C (72 to 77°F) for testing of Type 4 materials to avoid the "transition zone" just below the allowable test range of 21 to 30°C (70 to 85°F).

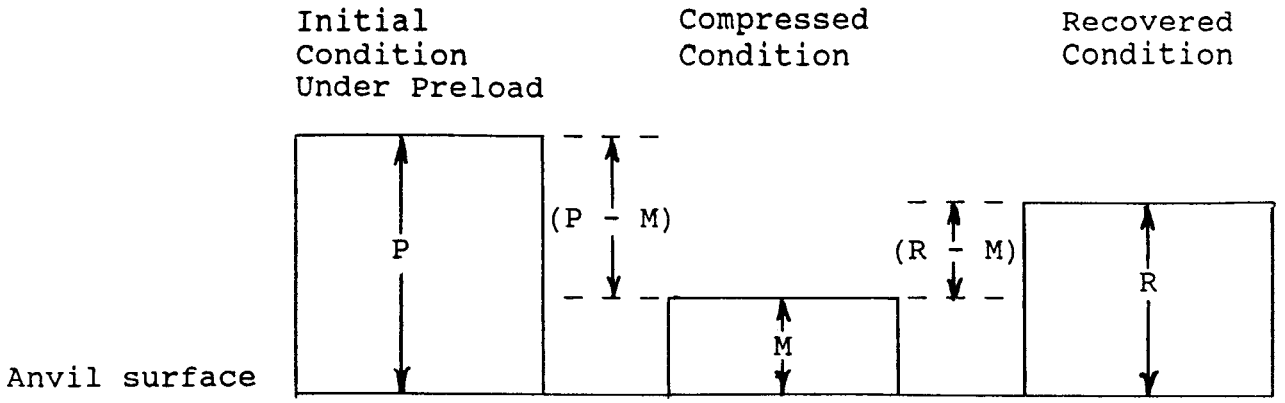

FIG. 1 Representation of Specimen Thickness

preloaded thickness of the specimen. Immediately apply the major load in a slow uniform manner so that the total load is attained within 10 s. Guide the penetrator in its descent so that the surface remains parallel to the surface of the anvil. Maintain the total load for a period of 60 s, and record the thickness of the specimen. Immediately remove the major load, and after a period of 60 s record the thickness of the specimen under the original preload. This is the recovered thickness.

8. Number of Tests

8.1 A minimum of three tests shall be run on separate specimens taken from the same sample and the results averaged.

9. Calculation

9.1 The compressibility and recovery shall be calculated as follows:

$$\text{Compressibility, \%} = [(P - M)/P] \times 100 \quad (1)$$

$$\text{Recovery, \%} = [(R - M)/(P - M)] \times 100 \quad (2)$$

where:

P = thickness under preload, mm (in.),
M = thickness under total load, mm (in.), and
R = recovered thickness, mm (in.).

9.2 When desired, the resiliency shall be calculated as follows:

$$\text{Resiliency, \%} = [(R - M)/M] \times 100 \quad (3)$$

9.2.1 The aforementioned values are illustrated in Fig. 1.

10. Report

10.1 Report the following information:

10.1.1 Identification and classification number of material tested,

10.1.2 Nominal thickness of material tested,

10.1.3 Letter designation of test procedure,

10.1.4 Number of tests performed,

10.1.5 Temperature of specimens and apparatus, and

10.1.6 Compressibility and recovery results for each specimen tested and average for the sample.

11. Precision and Bias[7]

11.1 This precision and bias statement was developed using Practice E691. (See Table 2.)

11.2 In Column 3 are the coefficients of variation for the physical properties listed in Column 2. In Column 4 are the maximum differences (ranges) that should be considered acceptable for two results that are considered to be from nominally identical specimens. These are expressed as a percent of the mean value. The precision data are based on tests conducted on Type 1, Type 2, and Type 3 gasket material specimens. Eleven laboratories participated in the round robin on Type 1 and Type 3 gasket material. Nine laboratories participated in the round robin on the Type 2 gasket material. There was one operator at each of the laboratories testing five specimens.

NOTE 1—The critical differences were calculated using $t = 1.960$ which is based on infinite degrees of freedom.

NOTE 2—$m = 3$ was used in the calculations of the repeatability and reproducibility values because this specification requires a minimum of three tests to be run.

12. Keywords

12.1 compressibility; gasket; material; recovery ; resiliency

[7] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:F03-1005.

TABLE 2 Interlaboratory Test Program

	Physical Property	Coefficient of Variation (percent of mean) (S %) max			Acceptable Range of Two Results[A] (percent of mean) (D2S %) max		
		Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
Repeatability (single operator)	% Compressibility	3.7	2.3	2.2	6.0	3.6	3.6
	% Recovery	4.6	1.1	2.6	7.3	1.8	4.2
Reproducibility (Multilaboratory)	% Compressibility	6.6	7.8	7.9	19.2	21.9	22.1
	% Recovery	7.2	0.9	10.7	21.2	3.0	30.0

[A] A result is an average of three determinations.