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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J18

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Superseding J18 DEC2000

Sponge and Expanded Cellular Rubber Products[1]

1. Scope

1.1 The SAE Committee on Automotive Rubber Specifications has concluded, that in light of the fact that SAE J18 is a mirror image of ASTM D 1056 (Vol. 8.01), SAE J18 will be eliminated in the year 2005.

1.2 This SAE Recommended Practice covers flexible cellular rubber products known as sponge rubber and expanded rubber, but does not apply to latex foam rubber or ebonite cellular rubber. The base material for an open/closed cellular product may be made of synthetic, natural, reclaimed rubber, or a mixture, and may contain other polymers or chemicals, or both, which may be modified by organic or inorganic additives. These elastomeric materials have properties similar to those of vulcanized rubber, namely (a) the ability to be converted from a thermoplastic to a thermosetting state by crosslinking (vulcanization) and or (b) substantial recovery of their original shapes when strained or elongated, or both.

1.3 Extruded or molded shapes of sizes too small for cutting standard test specimens are difficult to classify or test by these methods and will usually require special testing procedures.

1.4 In case of conflict between the provisions of this general specification and those of detailed specifications or test methods for a particular product, the latter shall take precedence. Reference to the test methods in this document should specifically state the particular test or tests desired.

1.5 The values stated in SI units are to be regarded as the standard. English units are included for reference only.

1.6 The following safety hazards caveat pertains only to the test methods portions of this document: *This document 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 document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use*.

NOTE—ASTM D 1056-98 and ISO 6916-1 are similar to this document.

1. This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.22 on Flexible Cellular Materials.

   Current edition approved May 10 and June 10, 1997 and April 10, 1998. Published May 1998. Originally published as D 1056-49 T. Last previous edition D 1056-98.

2. *References*

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein.

2.1.1 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 395—Test Methods for Rubber Property—Compression Set[2]
ASTM D 471—Test Method for Rubber Property—Effect of Liquids[2]
ASTM D 573—Test Method for Rubber—Deterioration in an Air Oven[2]
ASTM D 575—Test Methods for Rubber Properties in Compression[2]
ASTM D 832—Practice for Rubber Conditioning for Low-Temperature Testing[2]
ASTM D 1056—Specification for Flexible Cellular Materials—Sponge or Expanded Rubber[3]
ASTMD1171—Test Method for Rubber Deterioration—Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)[2]
ASTMD3182—Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets[2]
ASTM D 3183—Practice for Rubber—Preparation of Pieces for Test Purposes from Products[2]

2.1.2 ISO PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 6916-1—Flexible Cellular Polymeric Materials; Sponge and Expanded Cellular Rubber Products—Specification Part 1 Sheet

3. *Definitions*—Definitions of Terms Specific to this Document.

3.1 Cellular Material—A generic term for materials containing many cells (either open, closed, or both) dispersed throughout the mass.

3.2 Closed Cell—A product whose cells are totally enclosed by its walls and hence not interconnecting with other cells.

3.3 Expanded Rubber—Cellular rubber having closed cells made from a solid rubber compound.

3.4 Flexible Cellular Material—A flexible cellular organic polymeric material will not rupture within 60 s when a specimen 200 x 25 x 25 mm (8 x 1 x 1 in) is bent around a 25 mm (1 in) diameter mandrel at a uniform rate of one lap/5 s in the form of a helix at a temperature between 18 and 29 °C (65 and 85 °F).

3.5 Open Cell—A product whose cells are not totally enclosed by its walls and open to the surface, either directly or by interconnecting with other cells.

3.6 Rubber—A material that is capable of recovering from large deformations quickly and forcibly, and can be, or already is, modified to a state in which it is essentially insoluble (but can swell) in boiling solvent, such as benzene, methyl ethyl ketone, and ethanol-toluene azeotrope.

3.6.1 DISCUSSION—A rubber in its modified state, free of diluents, retracts within 1 min to less than 1.5 times its original length after being stretched at room temperature, 20 to 27 °C (68 °F ± 81 °F) to twice its length and held for 1 min before release.

2. Annual book of ASTM Standards, Vol 09.01.
3. Annual Book of ASTM Standards, Vol 08.01.

3.7 Skin—The textured outer surface on the material formed during manufacture by contact with molds, cover plate, air, or other curing medium.

3.7.1 DISCUSSION—Normally, this skin is formed by contact with the mold or cover plates during manufacture. Molded open-cell (sponge) parts usually have a skin on all surfaces, except when cut to length from longer strips. Parts made by cutting from open-cell (sponge) sheets usually have skin on two faces and open cells at the cut edges. Closed-cell (expanded) rubber sheets are frequently split from thicker pieces and consequently do not have the skin faces. On some products, it is desirable to add a solid rubber skin coating. The use to which the cellular rubber product is to be put determines the thickness of added skin required. Products subject to abrasion or open-cell (sponge) rubber that must withstand absorption of water or transmission of gases will ordinarily require an applied skin coating. Closed-cell (expanded) rubber does not usually require an added skin for these reasons.

3.8 Sponge Rubber—Cellular rubber consisting predominantly of open cells made from a solid rubber compound.

4. Classification (Types, Classes, Grades, and Suffix Letters)

4.1 Types—These specifications cover two types of cellular rubber designated by the prefix numbers 1 and 2.

4.1.1 TYPE 1—Open cell rubber.

4.1.2 TYPE 2—Closed cell rubber.

4.2 Classes—Both types are divided into four classes designated by the letters A, B, C, and D added to the number prefix.

4.2.1 CLASS A—Cellular rubber made from synthetic rubber, natural rubber, reclaimed rubber, or rubber-like materials, alone or in combination where specific resistance to the action of petroleum base oils is not required.

4.2.2 CLASS B—Cellular rubber made from synthetic rubber or rubber-like materials alone or in combination, having specific requirements for oil resistance with low mass change.

4.2.3 CLASS C—Cellular rubber made from synthetic rubber or rubber-like materials alone or in combination, having specific requirements for oil resistance with medium mass change.

4.2.4 CLASS D—Cellular rubbers made from synthetic rubber or rubber-like materials alone or in combination having specific requirements for extreme temperature resistance ranging from –75 to 175 °C (–103 to 347°F); but specific resistance to the action of petroleum-base oils is not required.

NOTE—ASTM Oil No. 3 is no longer available (as of December 1993). It has been replaced by IRM 903[4], which does not necessarily produce the same degree of swelling as ASTM #3 Oil. Comparison of the effect of IRM 903 versus ASTM Oil No. 3, on most elastomers tested, produces a close correlation.

4. Available from R. E. Carroll, P. O. Box 139, Trenton, NJ 08801

4.3 Grades—Each type and class has been divided into a number of different grades. Each grade is based on a specific range of firmness as expressed by compression-deflection (see Section 17). Grades are designated by digit, the softer grades being identified with the lower numbers and the higher grades being identified with the higher numbers.

4.3.1 GRADE 0—For Types 1 and 2 cellular rubber, a compression-deflection range from 0 to 15 kPa (0 to 2 psi).

4.3.2 GRADE 1—For Types 1 and 2 cellular rubber, a compression-deflection range from 15 to 35 kPa (2 to 5 psi).

4.3.3 GRADE 2—For Types 1 and 2 cellular rubber, a compression-deflection range from 35 to 65 kPa (5 to 9 psi).

4.3.4 GRADE 3—For Types 1 and 2 cellular rubber, a compression-deflection range from 65 to 90 kPa (9 to 13 psi).

4.3.5 GRADE 4—For Types 1 and 2 cellular rubber, a compression-deflection range from 90 to 120 kPa (13 to 17psi).

4.3.6 GRADE 5—For Types 1 and 2 cellular rubber, a compression-deflection range from 120 to 170 kPa (17 to 25psi).

5. Materials and Manufacture

5.1 Sponge Rubber—Sponge rubber is made by incorporating into the compound a blowing agent, such as sodium bicarbonate, that gives off a gas which expands the mass during the vulcanization process. Sponge rubber is manufactured in sheet, strip, molded, or special shapes. Unless otherwise specified, sheet and strip sponge rubber shall have a natural skin on both the top and bottom surfaces. Fabric surface impressions are ordinarily not objectionable. The coarseness of the impressions shall be agreed upon by the parties concerned.

5.2 Expanded Rubber—Closed-cell rubbers are made by incorporating gas-forming ingredients in the rubber compound, or by subjecting the compound to high-pressure gas such as nitrogen. Expanded rubber is manufactured in sheet, strip, molded, tube, cord, and profile shapes by molding or extruding. Unless otherwise specified, the presence of skin on the top or bottom surfaces of sheet and strip expanded rubber shall be optional. Extruded shapes have skin on all surfaces except cut ends.

6. Physical Properties

6.1 The various grades of cellular rubber shall conform to the physical property requirements listed in Tables 1 and 2, together with any additional requirements indicated by suffix letters in the grade designations as described in Section 4 and Table 3.

7. Tolerances on Dimensions

7.1 Tolerances on dimensions of cellular rubber products shall be as specified in Table 4.

8. Color

8.1 Unless otherwise specified, the color of cellular rubber shall be black.

TABLE 1A—PHYSICAL REQUIREMENTS OF CELLULAR RUBBERS, TYPE 1, OPEN-CELL SPONGE—BASIC REQUIREMENTS

Grade Number	Compression Deflection, 25% Deflection (Limits), kPa (psi)[1]	Compression Deflection after Oven Aging, % Change from Original 168 h at 70 °C (158 °F)	Compression Deflection after Oven Aging, % Change from Original 22 h at 150 °C (302 °F)	Oil-Aged 22 h at 70 °C (158 °F), Change in Volume in IRM 903 (Limits), %	Compression Set, 50% Deflection, max %, 22 h at 70 °C (158 °F)	Compression Set, 50% Deflection, max %, 22 h at 100 °C (212 °F)	Low-Temperature Flex, 5 h at –55 °C (–67 °F)
Class A, Non-Oil Resistant							
1A0	less than 15 (2)	±20[2]	—	—	15	—	—
1A1	15 to 35 (2 to 5)	±20	—	—	15	—	—
1A2	35 to 65 (5 to 9)	±20	—	—	15	—	—
1A3	65 to 90 (9 to 13)	±20	—	—	15	—	—
1A4	90 to 120 (13 to 17)	±20	—	—	15	—	—
1A5	120 to 170 (17 to 25)	±20	—	—	15	—	—
Class B, Oil-Resistant, Low Mass Change[3]							
1B0	less than 15 (2)	±20[2]	—	–25 to 10	40	—	—
1B1	15 to 35 (2 to 5)	±20	—	–25 to 10	40	—	—
1B2	35 to 65 (5 to 9)	±20	—	–25 to 10	40	—	—
1B3	65 to 90 (9 to 13)	±20	—	–25 to 10	40	—	—
1B4	90 to 120 (13 to 17)	±20	—	–25 to 10	40	—	—
1B5	120 to 170 (17 to 25)	±20	—	–25 to 10	40	—	—
Class C, Oil-Resistant, Medium Swell[3]							
1C0	less than 15 (2)	±20[2]	—	+ 10 to 60	50	—	—
1C1	15 to 35 (2 to 5)	±20	—	+ 10 to 60	50	—	—
1C2	35 to 65 (5 to 9)	±20	—	+ 10 to 60	50	—	—
1C3	65 to 90 (9 to 13)	±20	—	+ 10 to 60	50	—	—
1C4	90 to 120 (13 to 17)	±20	—	+ 10 to 60	50	—	—
1C5	120 to 170 (17 to 25)	±20	—	+ 10 to 60	50	—	—
Class D, High-Temperature-Resistant							
1D0	less than 15 (2)	—	±5	—	—	—	pass
1D1	15 to 35 (2 to 5)	—	±5	—	—	50	pass
1D2	35 to 65 (5 to 9)	—	±5	—	—	30	pass
1D3	65 to 90 (9 to 13)	—	±5	—	—	30	pass
1D4	90 to 120 (13 to 17)	—	±5	—	—	30	pass
1D5	120 to 170 (17 to 25)	—	±5	—	—	30	pass

1. Compression deflection ranges modified to agree with ASTM D 1056-98.
2. If this grade after aging still falls within the compression-deflection requirement of <15 kPa (2 psi), it shall be considered acceptable even though the change from the original is greater than ±20%.
3. Terminology was changed in 1997 from low swell to low mass change to better reflect the data obtained.

TABLE 1B—PHYSICAL REQUIREMENTS OF CELLULAR RUBBERS, TYPE 1, OPEN-CELL SPONGE—REQUIREMENTS ADDED BY SUFFIX LETTERS

Grade Number	Compression Deflection, 25% Deflection (Limits), kPa (psi)[1]	A4 Compression Deflection after Oven Aging, % Change From Original, 22 h at 175 °C (347 °F)	B1 Compression Set, 50% Deflection max %, 22 h at 70 °C (158 °F)	F1 Low-Temperature Flex 5 h at –40 °C (–40 °F)	F2 Low-Temperature Flex 5 h at –55 °C (–67 °F)	F3 Low-Temperature Flex 5 h at –75 °C (–103 °F)
Class A, Non-Oil Resistant						
1A0	less than 15 (2)	—	—	pass	pass	—
1A1	15 to 35 (2 to 5)	—	—	pass	pass	—
1A2	35 to 65 (5 to 9)	—	—	pass	pass	—
1A3	65 to 90 (9 to 13)	—	—	pass	pass	—
1A4	90 to 120 (13 to 17)	—	—	pass	pass	—
1A5	120 to 170 (17 to 35)	—	—	pass	pass	—
Class B, Oil-Resistant, Low Mass Change[2]						
1B0	less than 15 (2)	—	—	pass	—	—
1B1	15 to 35 (2 to 5)	—	—	pass	—	—
1B2	35 to 65 (5 to 9)	—	—	pass	—	—
1B3	65 to 90 (9 to 13)	—	—	pass	—	—
1B4	90 to 120 (13 to 17)	—	—	pass	—	—
1B5	120 to 170 (17 to 35)	—	—	pass	—	—
Class C, Oil-Resistant, Medium Mass Change[2]						
1C0	less than 15 (2)	—	25	pass	—	—
1C1	15 to 35 (2 to 5)	—	25	pass	—	—
1C2	35 to 65 (5 to 9)	—	25	pass	—	—
1C3	65 to 90 (9 to 13)	—	25	pass	—	—
1C4	90 to 120 (13 to 17)	—	25	pass	—	—
1C5	120 to 170 (17 to 35)	—	25	pass	—	—
Class D, High-Temperature-Resistant						
1D0	less than 15 (2)	±25	—	pass	—	pass
1D1	15 to 35 (2 to 5)	±25	—	pass	—	pass
1D2	35 to 65 (5 to 9)	±25	—	pass	—	pass
1D3	65 to 90 (9 to 13)	±25	—	pass	—	pass
1D4	90 to 120 (13 to 17)	±25	—	pass	—	pass
1D5	120 to 170 (17 to 35)	±25	—	pass	—	pass

1. Compression deflection ranges modified to agree with ASTM D 1056-98.
2. Terminology was changed in 1997 from low swell to low mass change to better reflect the data obtained.

TABLE 2A—PHYSICAL REQUIREMENTS OF CELLULAR RUBBERS, TYPE 2, CLOSED-CELL EXPANDED—BASIC REQUIREMENTS

Grade Number	Compression Deflection 25% Deflection (Limits) kPa (psi)[1]	Oven-Aged, % Change from Original Compression Deflection Values (Limits), 168 h at 70 °C (158 °F)	Oven-Aged, % Change from Original Compression Deflection Values (Limits), 22 h at 150 °C (302 °F)	Water Absorption, max weight % Density over 160 kg/m^3 (10 lb/ft^3)	Water Absorption, max weight % Density of 160 kg/m^3 (10 lb/ft^3) or less	Fluid Immersion, 7 Days at 23 °C (73.4 °F), max weight %[2] Density over 160 kg/m^3 (10 lb/ft^3)	Fluid Immersion, 7 Days at 23 °C (73.4 °F), max weight %[2] Density 160 kg/m^3 (10 lb/ft^3) or less
Class A, Non-Oil Resistant							
2A0	Less than 15 (2)	±30	—	5	10	—	—
2A1	15 to 35 (2 to 5)	±30	—	5	10	—	—
2A2	35 to 65 (5 to 9)	±30	—	5	10	—	—
2A3	65 to 90 (9 to 13)	±30	—	5	10	—	—
2A4	90 to 120 (13 to 17)	±30	—	5	10	—	—
2A5	120 to 170 (17 to 25)	±30	—	5	10	—	—
Class B, Oil Resistant, Fuel-Resistant, Low Mass Change[3]							
2B0	Less than 15 (2)	±30	—	5	10	50	100
2B1	15 to 35 (2 to 5)	±30	—	5	10	50	100
2B2	35 to 65 (5 to 9)	±30	—	5	10	50	100
2B3	65 to 90 (9 to 13)	±30	—	5	10	50	100
2B4	90 to 120 (13 to 17)	±30	—	5	10	50	100
2B5	120 to 170 (17 to 25)	±30	—	5	10	50	100
Class C, Fuel-Resistant, Medium Mass Change[3]							
2C0	Less than 15 (2)	±30	—	5	10	150	250
2C1	15 to 35 (2 to 5)	±30	—	5	10	150	250
2C2	35 to 65 (5 to 9)	±30	—	5	10	150	250
2C3	65 to 90 (9 to 13)	±30	—	5	10	150	250
2C4	90 to 120 (13 to 17)	±30	—	5	10	150	250
2C5	120 to 170 (17 to 25)	±30	—	5	10	150	250
Class D, High-Temperature-Resistant							
2D0	Less than 15 (2)	—	±5	5	10	—	—
2D1	15 to 35 (2 to 5)	—	±5	5	10	—	—
2D2	35 to 65 (5 to 9)	—	±5	5	10	—	—
2D3	65 to 90 (9 to 13)	—	±5	5	10	—	—
2D4	90 to 120 (13 to 17)	—	±5	5	10	—	—
2D5	120 to 170 (17 to 25)	—	±5	5	10	—	—

1. Compression deflection ranges modified to agree with ASTM D 1056-98.
2. This test (see Section 19) of weight change in Reference Fuel B is used in place of the usual oil-resistance test of volume change of IRM 903 oil for the following reason: Oil or solvent immersion of flexible closed cellular materials usually causes loss of gas, by diffusion through the softened cell walls, that results in some shrinkage of the test sample. This shrinkage counteracts the swell that would normally occur, therefore invalidating test data based on volume change. Reference Fuel B is used because it produces a wider and more consistent differentiation among the A, B, and C classes than does IRM 903 oil.
3. Standard oil resistance test methods give inconsistent results on closed cellular materials. This test gives a general indicati on of oil resistance but more reliable information should be obtained by testing in actual or simulated service conditions.

   The values of 150% maximum Class C and 50% maximum Class B apply to cellular materials having densities of more than 160 kg/m^3 (10 lb/ft^3). For cellular materials with densities of 160 kg/m^3 or less, the values of maximum mass change allowed are 250% for Class C and 100% for Class B.
   Terminology was changed in 1997 from low swell to low mass change to better reflect the data obtained.

TABLE 2B—PHYSICAL REQUIREMENTS OF CELLULAR RUBBERS, TYPE 2, CLOSED-CELL EXPANDED—REQUIREMENTS ADDED BY SUFFIX LETTERS

Grade Number	Compression Deflection 25% Deflection (Limits) kPa (psi)	Compression Set, max %, Under Constant Deflection of 50% Suffix B1 22 h at 100 °C (212 °F)	Compression Set, max %, Under Constant Deflection of 50% Suffix B2[1] 22 h at 23 °C (73.4 °F) 24 h recovery	Compression Set, max %, Under Constant Deflection of 50% Suffix B3 22 h at 23 °C (73.4 °F) 24 h recovery	Low-Temperature Flex, Suffix F1 5 h @ −40 °C (−40 °F)	Low-Temperature Flex, Suffix F2 5 h at −55 °C (−67 °F)
Class A, Non-Oil Resistant						
2A0	Less than 15 (2)	—	25	35	pass	—
2A1	15 to 35 (2 to 5)	—	25	35	pass	—
2A2	35 to 65 (5 to 9)	—	25	35	pass	—
2A3	65 to 90 (9 to 13)	—	25	35	pass	—
2A4	90 to 120 (13 to 17)	—	25	35	pass	—
2A5	120 to 170 (17 to 25)	—	25	35	pass	—
Class B, Oil Resistant, Fuel-Resistant, Low Mass Change[2]						
2B0	Less than 15 (2)	—	25	35	pass	—
2B1	15 to 35 (2 to 5)	—	25	35	pass	—
2B2	35 to 65 (5 to 9)	—	25	35	pass	—
2B3	65 to 90 (9 to 13)	—	25	35	pass	—
2B4	90 to 120 (13 to 17)	—	25	35	pass	—
2B5	120 to 170 (17 to 25)	—	25	35	pass	—
Class C, Fuel-Resistant, Medium Mass Change[2]						
2C0	Less than 15 (2)	—	25	35	pass	—
2C1	15 to 35 (2 to 5)	—	25	35	pass	—
2C2	35 to 65 (5 to 9)	—	25	35	pass	—
2C3	65 to 90 (9 to 13)	—	25	35	pass	—
2C4	90 to 120 (13 to 17)	—	25	35	pass	—
2C5	120 to 170 (17 to 25)	—	25	35	pass	—
Class D, High-Temperature-Resistant						
2D0	Less than 15 (2)	80	—	—	—	pass
2D1	15 to 35 (2 to 5)	80	—	—	—	pass
2D2	35 to 65 (5 to 9)	80	—	—	—	pass
2D3	65 to 90 (9 to 13)	80	—	—	—	pass
2D4	90 to 120 (13 to 17)	80	—	—	—	pass
2D5	120 to 170 (17 to 25)	80	—	—	—	pass

1. Previous versions of SAE J18 inadvertently listed the suffix as "B," instead of "B2."
2. Standard oil resistance test methods give inconsistent results on closed cellular materials. This test gives a general indication of oil resistance but more reliable information should be obtained by testing in actual or simulated service conditions.
   The values of 150% maximum Class C and 50% maximum Class B apply to cellular materials having densities of more than 160 kg/m^3 (10 lb/ft^3). For cellular materials with densities of 160 kg/m^3 or less, the values of maximum mass change allowed are 250% for Class C and 100% for Class B.
   Terminology was changed in 1997 from low swell to low mass change to better reflect the data obtained.

TABLE 3—SAE/ASTM TEST METHODS

NOTE—Example: Grade 1A1C1F1 denotes soft sponge rubber containing natural, reclaimed, synthetic, or blends of these rubbers with a compression deflection value of 14 to 35 kPa (2 to 5 psi), having no specific solvent or oil resistance and requiring in addition to the basic tests a weather resistance test run in accordance with Test Method D 1171, Ozone Chamber Exposure, Method A, and a low-temperature test at –40 °C (–40 °F). Examples of specification conversions are given in Figure 1.

Basic Requirements and Suffix Number Requirement or Suffix Letter	Basic Requirements	Suffix Number 1	Suffix Number 2	Suffix Number 3	Suffix Number 4
Compression Deflection	SAE J18, Section 17				
Heat Resistance	SAE J18, Sections 16 and 20, change in compression deflection after aging 7 days at 70 °C (158 °F)				
Oil Resistance (1B and 1C rubber only)	SAE J18, Section 18, 22 h at 70 °C (158 °F)				
Compression Set (1A, 1B, and 1C rubber only)	SAE J18, Section 22, 22h at 70 °C (158 °F) 50% deflection, 30-min recovery at 23 °C ± 2 °C (73.4 °F ± 3.6 °F)				
Compression Set (1D and 2D rubber only)	SAE J18, Section 22, 22h at 100 °C (212 °F), 50% deflection, 30-min recovery at 23 °C ± 2 °C (73.4 °F ± 3.6 °F)				
Water Absorption (2A, 2B, 2C, and 2D rubber only)	SAE J18, Sections 21				
Suffix A, Heat Resistance		SAE J18, Sections 17 and 20, change in compression deflection after aging 22 h at 100 °C ± 1 °C (212 °F ± 1.8 °F)	J18, Sections 17 and 20, change in compression deflection after aging 22 h at 125 °C ± 1 °C (257 °F ± 1.8 °F)	J18, Sections 17 and 20, change in compression deflection after aging 22 h at 150 °C ± 1 °C (302 °F ± 1.8 °F, ±5%)	J18, Sections 17 and 20, change in compression deflection after aging 22 h at 175 °C ± 1 °C (347 °F ± 1.8 °F)
Suffix B, Compression Set (1C, 2A, 2B, and 2C)		SAE J18, Section 22, 22 h at 70 °C (158 °F), 50% deflection, 30-min recovery at 23 °C ± 2 °C (73.4 °F ± 3.6°F), 25% max	J18, Section 22, 22 h at 23 °C ± 2 °C (73.4 °F ± 3.6 °F), 50% deflection, 24-h recovery at 23 °C ± 2°C (73.4 °F ± 3.6°F), 25% max	J18, Section 22, 22 h at 23 °C ± 2 °C (73.4 °F ± 3.6 °F), 50% deflection, 24-h recovery at 23 °C ± 2°C (73.4 °F ± 3.6 °F)	
Suffix C, Ozone or Weather Resistance		ASTM D 1171[1] ozone exposure Method A	ASTM D 1171[1], outdoor exposure	ASTM D 1171[1], ozone exposure, Method B	
Suffix D, Load Deflection[2]					
Suffix E, Fluid Resistance		SAE J18[3] Section 19, 150% max	SAE J18[3], Section 19, 50% max		
Suffix F, Low-Temperature Resistance		SAE J18, Section 23 to 60, 5 h at –40 °C (–40 °F)	SAE J18, Section 23 to 60, 5 h at –55 °C (–67 °F)	SAE J18, Section 23 to 60, 5 h at –75 °C (–103 °F)	
Suffix G, Tear Resistance[2]					
Suffix J, Abrasion Resistance[2]					
Suffix K, Adhesion Capability[2]					
Suffix L, Water Absorption[2]					
Suffix M, Flammability Resistance[2]					
Suffix N, Impact Resistance[2]					
Suffix P, Staining Resistance[2]					
Suffix R, Resilience[2]					
Suffix W, density[2]					
Suffix Z, Special Requirements[2]					

1. Ratings to be arranged between the purchaser and the supplier.
2. Test method and values to be arranged between the purchaser and the supplier.
3. Table 2 for materials having densities of 160 kg/m^3 (10 lb/ft^3) or less.

TABLE 4—TOLERANCES ON DIMENSIONS OF CELLULAR RUBBER PRODUCTS FOR GENERAL APPLICATIONS

Form	Thickness Dimension, mm (in)	Thickness Tolerance, ±, mm (in)	Length and Width Dimension, mm (in)	Length and Width Tolerance, ±, mm (in)
Sponge Rubber				
Sheet and strip	3.2 (0.125) and under	0.4 (0.016)	152 (6) and under	1.6 (0.063)
	Over 3.2 (0.125) to 12.7 (0.50), incl	0.8 (0.032)	Over 152 (6) to 457 (18) incl	3.2 (0.125)
	Over 12.7 (0.50)	1.2 (0.047)	Over 457 (18)	0.5%
Molded or special shapes	6.4 (0.250) and under	0.8 (0.032)	6.4 (0.250) and under	0.8 (0.032)
	Over 6.4 (0.250) to 76.2 (3), incl	1.6 (0.063)	Over 6.4 (0.250) to 76 (3) incl	1.6 (0.063)
			Over 76 (3) to 457 (18) incl	3.2 (0.125)
			Over 457 (18)	0.5%
Expanded Rubber				
Sheet and strip	3.2 (0.125) and under	1.6 (0.063)	152 (6) and under	6.4 (0.250)
	3.2 (0.125) to 12.7 (0.50), incl	1.6 (0.063)	152 (6) and under	6.4 (0.250)
	Over 12.7 (0.50)	2.4 (0.094)	Over 152 (6) to 305 (12) incl	9.6 (0.375)
			Over 305 (12)	3%
Molded or special shapes	3.2 (0.125) to 12.7 (0.50) incl	1.6 (0.063)	152 (6) and under	6.4 (0.250)
	Over 12.7 (0.50) to 38.1 (1.50) incl	2.4 (0.094)	Over 152 (6) to 305 (12) incl	9.6 (0.375)
	Over 38.1 (1.50) to 76.2 (3) incl	3.2 (0.125)	Over 305 (12)	3%

9. Workmanship, Finish, and Appearance—Cellular rubbers furnished under this document shall be manufactured from synthetic rubber, natural rubber, or rubber-like materials together with added compounding ingredients of such nature and quality that the finished product complies with the specification requirements. In permitting choice in use of those materials by the producer, it is not intended to imply that the different rubber materials are equivalent in respect to all physical properties. Any special characteristics other than those prescribed in this document that may be desired for specific applications, shall be specified in the product specifications, as they may influence the choice of the type of rubber material or other ingredients used. All materials and workmanship shall be in accordance with good commercial practice, and the resulting cellular rubber shall be free from defects affecting serviceability.

10. Test Methods

10.1 Unless specifically stated otherwise, all tests shall be made in accordance with the methods specified in Sections 13 through 24 and Table 3.

11. Inspection and Rejection

11.1 All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified. The manufacturer shall afford the inspector all reasonable facilities for tests and inspection.

11.2 The purchaser may make the tests and inspection to govern acceptance or rejection of the material at his own laboratory or elsewhere. Such tests and inspection shall be made no later than 15 days after receipt of the material.

11.3 All samples for testing, provided as specified in Section 14, shall be visually inspected to determine compliance with the material, workmanship, and color requirements.

11.4 Any material that fails in one or more of the test requirements may be retested. For this purpose, two additional tests shall be made for the requirement in which failure occurred. Failure of either of the retests shall be cause for final rejection.

11.5 Rejected material shall be disposed of as directed by the manufacturer.

12. Packaging and Package Marking—The material shall be properly and adequately packaged. Each package or container shall be legibly marked with the name of the material, name, or trademark of the manufacturer, and any required purchaser's designations.

13. General Test Methods

13.1 Scope—Except as otherwise specified in these methods, the following ASTM test methods and the various test methods in Table 3, applicable in general to vulcanized rubber, shall be complied with as required and are hereby made a part of these methods:

13.1.1 GENERAL PHYSICAL TEST REQUIREMENTS—ASTM D 3182 and D 3183.

13.1.2 AGING TEST—ASTM D 573, with modifications as described in Sections 16 and 20.

13.1.3 COMPRESSION SET, SUFFIX B—Method described in Section 22.

13.1.4 FLUID IMMERSION, SUFFIX E—ASTM D 471 and Sections 18 and 19.

13.1.5 LOW-TEMPERATURE TEST, SUFFIXES F1, F2, AND F3—Method described in Section 23. Suitable low-temperature cabinets and conditioning procedures are described in ASTM D 832.

13.1.6 In case of conflict between provisions of the test methods referenced in 13.1.1 through 13.1.5 and the procedures specifically described herein for cellular rubbers, the latter shall take precedence.

14. Sampling

14.1 When possible, the completed manufactured product shall be used for the tests specified. Representative samples of the lot being examined shall be selected at random as required.

14.2 When it is necessary or advisable to obtain test specimens from the article, as in those cases where the entire sample is not required or adaptable for testing, the method of cutting and the exact position from which specimens are to be taken shall be specified. The apparent density and the state of cure may vary in different parts of the finished product, especially if the article is of complicated shape or of varying thickness, and these factors affect the physical properties of the specimens. Also, the apparent density is affected by the number of cut surfaces as opposed to the number of skin-covered surfaces on the test specimen.

14.3 When the finished product does not lend itself to testing or to the taking of test specimens because of complicated shape, small size, metal or fabric inserts, solid covers, adhesion to metal, or other reasons, standard test slabs shall be prepared. When differences due to the difficulty in obtaining suitable test specimens from the finished part arise, the manufacturer and purchaser may agree on acceptable deviations. This can be done by comparing results of standard test specimens and those obtained on actual parts.

15. Test Specimens and Slabs

15.1 Test Specimens—Standard test specimens shall be disks 28.00 mm ± 0.50 mm (1.10 in ± 0.02 in) in diameter, which yields a 645.70 mm^2 (1 in^2) specimen. The specimens may be cut with a revolving die[5] using a soap solution as a lubricant. If a lubricant is used, the specimens shall be thoroughly dried before proceeding with the testing. In some cases, it may be necessary to freeze the cellular rubber to obtain parallel cut edges. Samples shall not be compression die cut because this process distorts the sample, which will affect the final properties. When cut from standard test slabs, they shall be cut from the center area as shown in Figure 1. The thickness shall be measured as described in 15.3.2. As stated under the test methods, the minimum thickness of test specimens is 6.00 mm (0.24 in). Plied-up samples may be used as indicated in the test methods for compression set and compression deflection (see Note in 17.3.2).

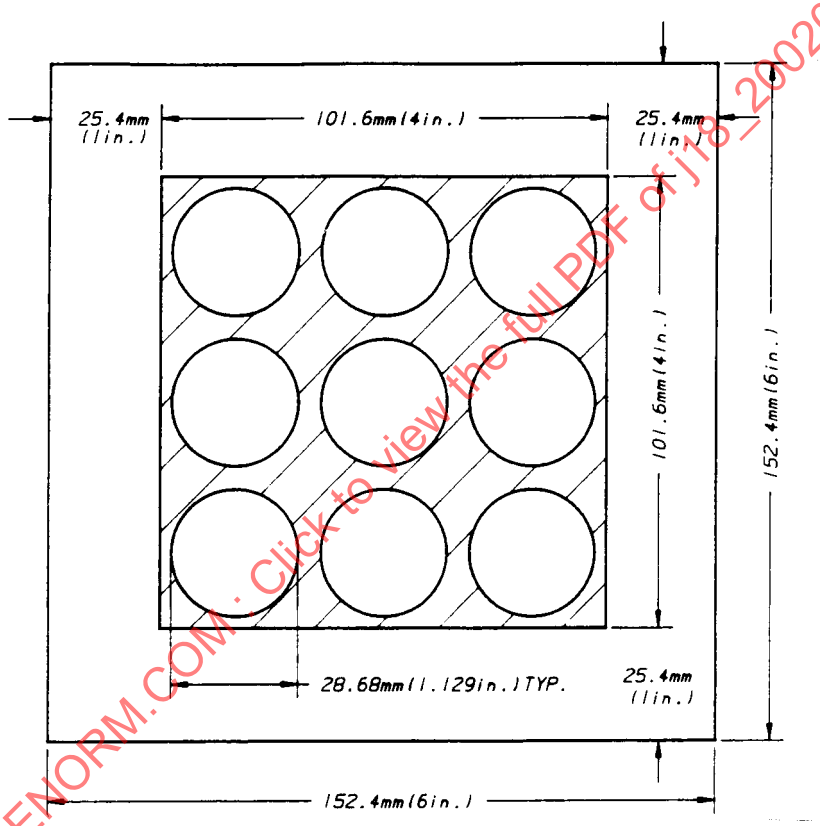

FIGURE 1—LOCATION FROM WHICH STANDARD TEST SPECIMENS ARE TO BE CUT WHEN TESTING STANDARD TEST SLABS OR COMMERCIAL FLAT SHEETS

5. A satisfactory die and its method of application are described in Section 4 of ASTM D 575.

15.2 Test Slabs—Standard test slabs of all types of cellular rubber shall be pieces 150 mm ± 5 mm (nominally 6in) square and 12.5 mm ± 0.5 mm (nominally 0.5 in) in thickness made from the same compound and having the same apparent density and state of cure as the product they represent. In all cases, the surface skin shall be left intact on both top and bottom faces of the test slab. Standard test slabs shall be prepared either by cutting them from flat sheets of the specified thickness or as described in 15.2.1 or 15.2.2.

15.2.1 When specially prepared standard test slabs of sponge rubber are required, they shall be made using the frame shown in Figure 2 together with top and bottom plates each approximately 12.50 mm (0.50 in) in thickness. The frame and plates shall be made of aluminum or steel. The stock shall be in sheet form, cut into squares slightly smaller than the frame cavities. The thickness of the square sheets shall be such as to give the required apparent density when the material is blown during cure to fill the molding cavities. The squares of stock shall be dusted with talc and the excess brushed off to avoid pitting. They shall then be placed in the frame, and fabric sheeting shall be applied on the top and bottom between the frame and the plates to allow venting of gases produced during the cure. This fabric shall be a commercial sheeting with a mass of approximately 135 g/m^2 (4 oz/yd^2), having approximately 2.75 ends/mm (70 ends/in) and 2.36 picks/mm (60 picks/in). The specimens shall be vulcanized in a platen press under conditions of time and temperature chosen to produce the same state of cure in the standard slabs as in the finished products they represent.

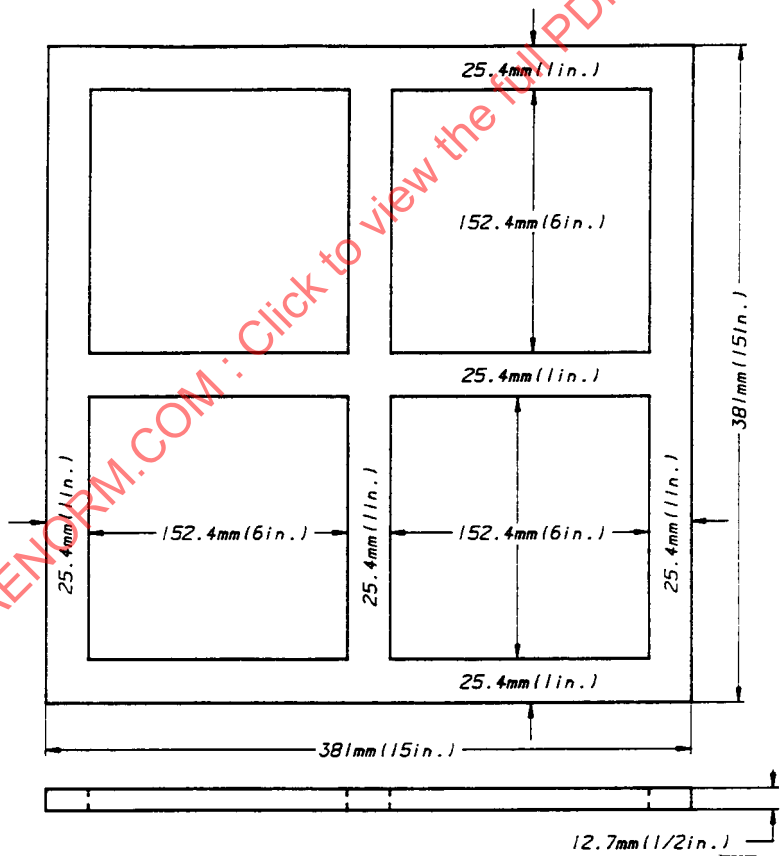

FIGURE 2—FOUR-CAVITY FRAME FOR STANDARD TEST SLABS OF CELLULAR RUBBERS

15.2.2 Where specially prepared standard test slabs of expanded rubber are required, they shall be made using the same process that was used for the product to be represented by the test slab. The specimens shall be prepared to have approximately the same density, and shall be vulcanized under conditions of time and temperature chosen to produce the same state of cure in the standard slabs, as in the finished products they represent.

15.3 Measurements of Test Specimens

15.3.1 The length and width shall be measured to 0.5 mm (0.02 in). Care shall be taken not to distort the cellular rubber.

15.3.2 Thicknesses up to and including 25.0 mm (1 in) shall be measured using a dial-type gage[6] having a maximum stem and foot mass of 25 g and a foot 30.0 mm (1.25 in) in diameter. Thicknesses over 25 mm (1 in) shall be measured using a sliding caliper gage. When a sliding caliper gage is employed, the gage setting shall be made with the gage out of contact with the cellular rubber. The sample shall be passed through the previously set gage and the proper setting shall be the one in which the measuring faces of the gage contact the surfaces of the article without compressing it.

15.3.3 The steel scale or tape used to measure length or width shall be graduated to 1 mm (0.031 in). The dial gage for measuring thickness shall be graduated to 0.02 mm (0.001 in). The calipers used for measuring thickness shall be graduated to 0.1 mm (0.005 in).

15.3.4 Results reported shall be the average of a minimum of three measurements. If the results vary between the specimens more than 10%, two additional specimens should be taken into the average.

16. Accelerated Aging Tests

16.1 Test Specimen

16.1.1 The test specimen used in any of the aging tests shall be of the size and shape as specified by the appropriate called-out test method.

17. Compression-Deflection Tests

17.1 Scope

17.1.1 This test method consists of measuring the force necessary to produce a 25% deflection on a test specimen.

17.2 Apparatus

17.2.1 Any compression machine that meets the following requirements will be satisfactory. The machine shall be capable of compressing the specimen at a rate of 12.5 to 50 mm/min (0.5 to 2 in/min) gently without impact. The machine may be motor- or hand-driven. It shall be equipped with a gage to measure the deflection caused by the increase in load. The rate of compression of the specimen is specified rather than the rate of the compressing platform of the machine. This is an important consideration when scales are used, since sponges of various compression-deflection characteristics will require different times to compress 25% due to the travel of the scale platform under varying loads.

17.2.2 The deflection shall be read on a dial gage graduated in 0.02 mm (0.001 in). No gage is necessary if the machine automatically compresses the specimen 25%.

6. Supporting data are available from ASTM Headquarters. Request RR: D20-1198.

17.3 Test Specimens

17.3.1 Standard test specimens can be used for this test.

17.3.2 Test specimen size may vary provided the indenter foot of the apparatus used is larger than the sample. Test specimens may be cylindrical or square. They shall be cut so that opposite edges are parallel, either from the finished product in a manner agreed upon between the parties concerned or, as shown in Figure 2, from standard test slabs or from flat sheets. The thickness of the test specimens may vary, but shall be measured and stated in the report. The minimum thickness shall be 6.0 mm (0.25 in). Thin samples may be plied-up to obtain this thickness, or a standard test slab may be used if agreed upon between the manufacturer and the purchaser.

NOTE— In sponge rubbers, using the same compound, thin sections under 6 mm (0.25 in) do not blow in the same manner as those over 6 mm (0.25 in). The thinner sections are usually higher in compression deflection and density. However, in closed-cell (expanded) rubbers where thin sheets are split from thicker sheets there is usually very little difference between the thin sheet and thicker sheets.

17.4 Procedure—Cellular rubber less than 6 mm (0.250 in) in thickness shall be tested by plying up the proper number of plies to obtain a thickness as near 12.5 mm (0.50 in) as possible. Compress the standard test specimen between the parallel metal plates of the machine until the thickness has been reduced 25%, and take the reading of the load immediately. Repeat the test with the same specimen until the load readings do not change more than 5%. The top and bottom plates shall be at least 38 mm (1.5 in) in diameter.

17.5 Report

17.5.1 The unit load required for the last reading, expressed in kilopascals (or pounds per square inch), shall be reported as the result of the compression-deflection test.

17.6 Precision and Bias

17.6.1 See Section 25.

18. Oil-Immersion Test, Open-Cell Sponge (see Table 1)

18.1 Scope

18.1.1 This test method determines the fluid resistance (oil) of a sample (open cell sponge) by means of measuring volume change after a specified immersion time/temperature.

18.2 Test Specimens

18.2.1 Standard test specimens approximately 12.5 mm (0.50 in) in thickness shall be used for this test. The diameter and thickness shall be measured before and after immersion in the specified petroleum-base oil for 22 h at 70°C (158 °F) and the percent change in volume calculated. Three specimens shall be run on each test and the average of the three values reported.

18.3 Procedure

18.3.1 Follow the procedure of ASTM D 471, using petroleum base oil IRM 903.

19. Fluid Immersion Test, Closed Cell (Expanded) (See Footnote 2, Table 2)

19.1 Scope

19.1.1 This test method determines the fluid resistance (fuel) of a sample (closed cell foam) by means of measuring weight change after a specified immersion time/temperature.

19.2 Apparatus

19.2.1 Equipment required are an analytical balance, screens, ASTM Reference Fuel B, paper towels, and 250-cm^3 (8-oz) containers (minimum size).

19.3 Test Specimens

19.3.1 The test specimens shall be 25 by 50 by 6 mm (nominally 1 by 2 by 0.250 in). It is preferable that the specimens be cut with clean, square edges.

19.4 Procedure

19.4.1 Weigh the specimens to the nearest 0.01 g. Place a noncorrosive screen having 2-mm openings (10-mesh) on the bottom of the container. Alternatively place specimens of one material and screens into the cans. Use one can per material. Fill the cans with ASTM Reference Fuel B and seal with their lids. Store the cans for 7 days at a temperature of 23 °C ± 2 °C (73.4 °F ± 4 °F). Remove one specimen at a time from the test fluid. Without squeezing the specimen, place it on top of one sheet of paper towel and immediately place a second paper towel on top of it. Blot lightly without squeezing, then remove the top paper towel. Immediately determine the mass of the specimen to the nearest 0.01 g.

19.5 Calculation

19.5.1 Calculate the percent change in mass as shown in Equation 1.

$$W = [(A-B)/B] \times 100 \qquad \text{(Eq. 1)}$$

where:

W = change in mass, %
A = final mass of specimen, and
B = initial mass of specimen

19.6 Report

19.6.1 The report should include fluid type, time and temperature of test, data from three specimens, and the average of the three.

19.7 Requirements

19.7.1 See Tables 1 and 2.

19.8 Precision and Bias

19.8.1 See Section 25.

20. Test for Compression-Deflection Change After Oven Aging

20.1 Scope

20.1.1 This test method determines the heat aging properties of a sample by measuring the change in compression deflection after a specified time/temperature.

20.2 Test Specimen

20.2.1 SAMPLE BEFORE OVEN AGING—A representative sample, approximately 12.5 mm (0.5 in) thick and a minimum area of 161 cm^2 (25 in^2).

20.2.2 SPECIMEN SIZE FOR TEST METHOD—Standard specimen size (in accordance with Section 15) shall be a disk 28.00 mm ± 0.50 mm (1.10 in ± 0.02 in) diameter and approximately 12.5 mm (0.5 in) thick. For thin materials, the disks shall be stacked to approximately 12.5 mm (0.5 in) in height.

20.3 Apparatus

20.3.1 The air-oven aging test as described in ASTM D 573 shall be used for cellular rubber, except that the sample and test specimen size shall be as described in Section 19.3. See 17.2 for compression deflection apparatus.

20.4 Procedure

20.4.1 Cut three standard test specimens out of a larger test sample and place the remaining part of the sample in an oven for 168 h ± 1 h oven aging. Allow to cool for at least 2 h but not more than 24 h and then cut three standard test specimens that are at least 1 in from any edge or cut surface. Determine compression deflection (see 17.4). Determine percent change in compression deflection.

20.5 Calculation

20.5.1 Express the results as a percentage of the change in compression deflection, calculated as shown in Equation 2.

$$P = [(A - O)/O] \times 100 \qquad \text{(Eq. 2)}$$

where:

P = Change in compression deflection, %
O = Original compression deflection, and
A = Final compression deflection after oven aging

20.6 Report

20.6.1 Report the following information:

20.6.1.1 Time and temperature of test

20.6.1.2 Original and final compression deflection data

20.6.1.3 Percent change for three specimens

20.6.1.4 Percent change, average of three specimens

20.7 Requirements

20.7.1 See Tables 1 and 2.

20.8 Precision and Bias

20.8.1 See Section 25.

21. Water Absorption Test

21.1 Scope

21.1.1 This test method determines the water absorption properties of a closed cell foam by measuring the change in weight (mass) after a specified immersion period. This test method is indirectly a measure of the sample's cell structure/closed cell content. The water absorption test (see Footnote 1 of Table 2) is applicable to expanded rubber (closed-cell type). It should not be used on sponge rubber (open-cell type) unless they are completely encased in an added skin.

21.2 Test Specimens

21.2.1 Test specimens approximately 12.5 mm (0.050 in) in thickness and 2500 mm^2 (4 in^2) in area shall be used for this test. Round specimens are preferable.

21.3 Procedure

21.3.1 Submerge specimens in distilled water at room temperature, 18 to 35 °C (65 to 95 °F) 50 mm (2 in) below the surface of the water, and reduce the pressure above the water to 17 kPa (2.5 psi absolute) for 3 min. Release the vacuum, and allow the specimen to remain submerged for 3 min at atmospheric pressure. Remove the specimen, blot dry, and calculate the percent change in mass.

21.4 Calculation

21.4.1 Calculate the percent change in mass as shown in Equation 3.

$$W = [(A - B)/B] \times 100 \qquad \text{(Eq. 3)}$$

where:

W = Change in mass, %
A = Final mass of specimen
B = Initial mass of specimen

21.5 Report

21.5.1 Report the following information:

21.5.1.1 Original and final weights of three specimens

21.5.1.2 Percent change in weight for each

21.5.1.3 Average percent change for the three specimens

21.6 Requirements

21.6.1 See Table 2.

21.7 Precision and Bias

21.7.1 See Section 25.

22. Test for Compression Set Under Constant Deflection (Calculations Based on Amount of Deflection) Suffix B (1, 2, 3)

22.1 Scope

22.1.1 This test method determines the recovery properties of a sample when subjected to a constant deflection for a specified time/temperature/deflection by measuring its gage before and after the test period.

22.2 Test Specimens

22.2.1 Standard test specimens shall be used for this test. They shall be cut so that opposite edges are parallel, either from the finished product in a manner agreed upon by the parties concerned, or, as shown in Figure 1, from standard test slabs or from commercial flat sheets. The thickness of the test specimens may vary, but shall be measured and stated in the report. The minimum thickness for open-cell sponge rubber shall be 6mm (0.250 in). These samples of open-cell sponge rubber may be plied up to obtain this thickness. The minimum thickness for closed-cell expanded rubber shall be 12.5 mm (0.50 in). Thin samples of closed-cell expanded rubber shall not be plied up to obtain this thickness. A standard test specimen may be used for either open-cell sponge or closed expanded material, if agreed upon by the manufacturer and the purchaser.

22.3 Procedure

22.3.1 The apparatus and procedure shall be the same as that prescribed in Method B of ASTM D 395, except as follows: For open-cell (sponge) rubber, compress test specimens to 50% of their original thicknesses. Release the load at the end of 22 h and measure the thickness after a 30 min rest at room temperature. For closed-cell (expanded) rubber, compress the test specimens to 50% of their original thicknesses. Release the load at the end of 22 h and measure the thickness after 24 h at room temperature. In both cases (open-cell sponge and closed-cell expanded rubber), measure the thickness as described in 15.3.2. The temperature of the test for open-cell (sponge) rubber shall be 70 °C ± 2 °C (158 °F ± 4 °F), except for Class 1D rubbers. The temperature of the test for closed-cell (expanded) rubber shall be 23 °C ± 2 °C (73.4 °F ± 4 °F), except for Class 2D rubber. For Class 1D and 2D rubber, the temperature of the test shall be 100 °C ± 1 °C (212 °F ± 2 °F). The time of the test shall be as specified. Chromium-plated metal plates are not required. Aluminum plates or any stiff plates that are clean and smooth, and that will not deflect measurably under the load necessary for deflection of the specimen, may be used.

22.4 Calculation

22.4.1 Calculate the percentage compression set as shown in Equation 4:

$$\text{Compression set, \%} = [(t_0 - t_1)/(t_0 - t_s)] \times 100 \qquad \text{(Eq. 4)}$$

where:

t_0 = Original thickness
t_1 = Thickness of specimen after specified recovery period
t_s = Thickness of space bar used

22.5 Report

22.5.1 Report the following information:

22.5.1.1 Duration and temperature of oven exposure

22.5.1.2 Original and final thickness for three specimens

22.5.1.3 Percent set for each specimen

22.5.1.4 Average percent set for the specimens

22.6 Requirements

22.6.1 See Tables 1 and 2.

22.7 Precision and Bias

22.7.1 See Section 25.

23. Low-Temperature Flex Test

Suffix F1, –40 °C ± 1 °C (–40 °F ± 2 °F)
Suffix F2, –55 °C ± 1 °C (–67 °F ± 2 °F)
Suffix F3, –75 °C ± 1 °C (–103 °F ± 2 °F)

23.1 Scope

23.1.1 This test is to determine the brittleness of cellular rubber at low temperatures.

23.2 Apparatus

23.2.1 A low-temperature chamber capable of –75 °C (–103 °F) that can be accurately controlled for low temperatures. If the box is cooled by dry ice, the specimen should not make direct contact with gaseous CO_2. This chamber must be large enough to permit the bending of the test piece while it is still in the box.

23.2.2 Mandrel diameter shall be approximately 4 times the sample thickness.

23.3 Test Specimens

23.3.1 The test specimens shall be 50 mm ± 10 mm (2 in ± 0.5 in) wide by 140 mm ± 10 mm (6 in ± 0.5 in) long by 3mm (0.125 in) to 12.5 mm (0.50 in) thick.

23.4 Procedure

23.4.1 Place three test specimens and mandrel in a low-temperature chamber for 5 h ± 0.25 h at –40 °C (–40 °F), –55°C (–67 °F), or –75 °C (–103 °F) as specified by the suffix letter and number.

23.4.2 At the end of the test period, open the cold box and bend the specimen 180 degrees around the mandrel taking no longer than 2 to 3 s to perform the bend. If there are multiple samples, bend and record results as soon as possible to maintain temperature to within ±5 °C of set temperature.