



UL 157

STANDARD FOR SAFETY

Gaskets and Seals

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UL Standard for Safety for Gaskets and Seals, UL 157

Second Edition, Dated March 8, 1996

Summary of Topics

This revision to UL 157 includes the following changes in requirements:

- ***Clarification of Profile Test Applicability***
- ***Deletion of Drinking Water End-Use Gasket Requirements***
- ***Deletion of Compressibility, Recovery, and Sealability Test in Section 12***
- ***Revision of ASTM References for Ozone Exposure***
- ***Update and Removal of Dates on References to Outside Standards***

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated July 17, 2014.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

The following table lists the future effective dates with the corresponding reference.

Future Effective Dates	References
Effective date to be determined	Table 4.1, Table 4.2, Paragraphs 5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.6, 5.2.7, Table 5.1, 5.4.3, 5.4.7, 6.2.1, 6.4.1, 7.2.1, 7.3.1, 7.4.1, 7.4.2, 8.2.1, 9.2.1, 9.3.1, 9.4.1, Section 12, Paragraphs 13.2.1, 15.2.1, 15.3.1, 15.4.1, 17.2.1, 17.3.2, 18.2.1, 18.3.1, and 18.4.1

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INTRODUCTION

1 Scope

1.1 These requirements cover test procedures and performance criteria for the evaluation of nonmetallic gasket and seal materials such as elastomers, composite gasket material, flexible cellular material, thermoplastics and thermoplastic elastomers for specific end products.

1.2 The general use of these gasket and seal materials is to exclude or hold within an enclosure materials that are liquid, gas, or vapor.

1.3 The materials covered in this standard are incomplete in certain construction features or restricted in performance capabilities, and are intended for use as components in complete equipment.

1.4 This standard covers gaskets and seals as:

- a) Elastomers, thermoplastics and thermoplastic elastomers in the form of solid sheets, flexible cellular sheets, slabs, rolls, or parts, "O" rings, seats, shaft seals, and special forms.
- b) Composite gaskets in the form of sheets, rolls and cut forms of the types described in 3.2.
- c) Coated fabrics in the form of elastomers reinforced with fabrics in sheets or diaphragm form.

1.5 The material composition of these gaskets and seals excludes metals.

1.6 The gaskets and seals are evaluated for various properties to provide profile information – see Table 4.1. They are also evaluated for specific end-use applications – see Table 4.2. Table 4.3 specifies the oven aging required for establishing the maximum temperature for an expected use.

1.7 Deleted March 2, 2015

2 General

2.1 Details

2.1.1 The properties and requirements in this standard may be superseded by the applicable end-product standard.

2.2 Units of measurement

2.2.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

2.3 Undated references

2.3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3 Glossary

3.1 COATED FABRIC – An elastomeric material reinforced with fabric and used as a gasket and diaphragm.

3.2 COMPOSITE GASKET MATERIAL – A material of one of the following types:

Type I – Composite cork consisting of granular cork mixed in a binder other than rubber.

Type II – Plant fiber consisting of different saturated grades of paper.

Type III – Plant fiber and cork particles mixed in a binder other than rubber.

Type IV – Granular cork and rubber compound mixed in a rubber binder.

Type V – Fibers such as Aramide, glass, and carbon mixed in a rubber or other binder.

3.3 COMPRESSION SET – The residual deformation of a material after removal of the compressive stress, expressed as a percentage of the original deflection.

3.4 DIAPHRAGM – A membrane that separates or divides and serves as part of an actuating device.

3.5 ELASTOMER – Rubber or any various polymers that have properties similar to those of rubber, also referred to as solid elastomer in this standard.

3.6 FLEXIBLE CELLULAR MATERIAL – A cellular polymeric material that does not rupture when a 1/4 to 1/2 inch (6.3 to 12.7 mm) thick specimen is bent around a 1 inch (25.4 mm) diameter mandrel at room temperature. A material that contains many cells, open, closed or both, dispersed throughout. Flexible cellular materials are referred to as cellular in this Standard.

3.7 GASKETS AND SEALS – A deformable material clamped or located between two surfaces to prevent the passage of gases, vapors, or liquids consisting of "O" rings, seats, shaft seals, flexible cellular material, sealing materials, facings and special forms.

3.8 OXYGEN ENRICHED – For the purposes of this standard, oxygen enriched refers to atmospheres containing an oxygen content greater than 21 percent oxygen.

3.9 PROPERTY PROFILE – Results of various tests used to describe the physical properties of gaskets and seals.

3.10 RUBBER – A material that is capable of recovering from large deformation quickly and forcibly.

3.11 SEALING MATERIAL – A pourable or extrudable substance, capable of some degree of hardening and bonding to substrates and used as a formed-in-place seal of joints or openings to prevent passage of gases, vapors, or liquids.

3.12 TENSILE SET – The extension remaining after a test specimen has been stretched and allowed to retract. Alternatively referred to as recovery or permanent set.

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3.13 THERMOPLASTIC – A material that is capable of being repeatedly softened by heating and hardened by cooling through a temperature range characteristic of the polymer.

3.14 THERMOPLASTIC ELASTOMER MATERIAL – A material that has the mechanical properties of elastomers and the processing advantages of conventional thermoplastics.

PERFORMANCE

4 General

4.1 Apparatus, test methods, and exposure conditions are specified in Sections 4 – 19.

4.2 The test properties, requirements, apparatus, test methods and exposure conditions to evaluate gasket and seal materials for general and profile information are given in Table 4.1. The test properties, requirements, apparatus, test methods and exposure conditions to evaluate gasket and seal materials for specific end-use applications and profile information are given in Table 4.2. The oven aging required for establishing the maximum temperature for an expected use is given in Table 4.3.

4.3 Samples are to be of sheet or slab material. When this is not practical, the samples are to be of a molded part of sufficient size to conduct all applicable tests. For the Mullens burst test the coated fabric is to be used. Unless otherwise specified in the individual test method, the standard atmospheric conditions surrounding the specimen prior to and during the test is to be $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity.

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Table 4.1
Tests for property profile information

Table 4.1 revised, effective date to be determined

Property ^a	Requirements ^b	Apparatus, Test Methods and Exposure Conditions
Minimum tensile strength		Section 5
Composite Gaskets ^c		
Type I	100 psi (689 kPa)	
Type II	800 psi (5515 kPa)	
Type III	200 psi (1379 kPa)	
Type IV	200 psi	
Type V	800 psi	
All other materials ^d	See note e	
Minimum elongation – All materials ^f	See note e	Section 5
Minimum tensile strength after air oven – Table 4.3		Section 6
All materials ^d	60 percent of original	
Minimum elongation after air oven – Table 4.3		
All materials ^{d,f}	60 percent of original	
Maximum compression set ^f		Section 7
Elastomer ^d	See note e	
Cellular	See note e	
Other materials	See note e	
Maximum tensile set ^f		Section 8
Elastomer ^d	25 percent	
Other materials	No requirement	
Maximum hardness change ^{g, f}		Section 9
Elastomer ^d	10 units	
Thermoplastic	10 units	
Thermoplastic elastomer	10 units	
Other materials	No requirement	
Low temperature ^h – All materials ^f	No cracking	Section 10
Minimum adhesion ⁱ		Section 13
As received	1 pound/inch (179 g/cm) of width	
After conditioning	50 percent of original	
Mullens burst test – Coated fabrics only	See note e	Section 18

^a Properties required vary with the specific end-product standard.

^b These requirements may be superseded by requirements in the applicable end-product Standard.

^c Tensile strength test conducted in transverse and longitudinal directions.

^d Including elastomer portion only of coated fabrics.

^e As given in end-product standard.

^f Not required for composite gaskets.

^g Type A durometer; aged in accordance with Table 4.3.

^h Minus 40 ±2°C (minus 40 ±3.6°F) or 54±2°C (minus 65 ±3.6°F). Other temperatures may be requested.

ⁱ Applicable when adhesive properties are relied upon for securing the gasket in place during its intended use.

Table 4.2
Test considerations for end use applications

Table 4.2 revised, effective date to be determined

End-use applications	Test media, time, temperature	Properties required ^e	Requirements ^f	Apparatus, test methods and exposure conditions
Extinguishing agents ^a	Requested extinguishing agents (liquid and vapor); 30 days; 23 ±2°C (73 ±3.6°F)	Tensile strength and elongation	60 percent of original ^g	Section 14
Gasoline	ASTM Fuels A and C ^b ; 70 h; 23 ±2°C (73 ±3.6°F)	Tensile strength, elongation, volume change and extraction	60 percent of original minus 1 to plus 40 percent ^h , 10 percent	Section 11
Gasoline-alcohol	ASTM Fuels A and C ^b , Fuel C/Methanol, and/or ASTM Fuel C/Ethanol ^c ; 70 h 23 ±2°C (73 ±3.6°F)			
Naphtha or kerosene	ASTM Fuel A ^b ; 70 h; 23 ±2°C (73 ±3.6°F)	Tensile strength, elongation and volume change	60 percent of original minus 1 to plus 25 percent	Section 11
Kerosene ^d	Kerosene (Type K1 deodorized); 70 h; 23 ±2°C (73 ±3.6°F)			
MPS Gas	Liquid MPS Gas (Methylacetylene propadiene stabilized); 70 h, 23 ±2°C, (73 ±3.6°F)	Tensile strength, elongation, volume change, and extraction	60 percent of original minus 1 to plus 25 percent, 10 percent	Section 11
Diesel fuel, fuel oil or lubricating oil	IRM Oil No. 903 ^b ; 70 h; 23 ±2°C (73 ±3.6°F)	Tensile strength, elongation and volume change	60 percent of original minus 1 to plus 25 percent	Section 11
Heated fuel oil	No. 6 Fuel Oil ⁱ ; 28 days; 121 ±1°C (250 ±1.8°F)	Tensile strength, elongation and volume change	60 percent of original minus 1 to plus 25 percent	Section 11
Anhydrous ammonia	Liquid anhydrous ammonia; 70 h ^j	Tensile strength, elongation, volume change and extraction	60 percent of original minus 1 to plus 25 percent, 10 percent	Section 11
Liquefied petroleum gas (LP Gas)	IRM Oil No. 903 ^b , and n-Hexane 70 h; 23 ±2°C (73 ±3.6°F)	Tensile strength, elongation, volume change, and extraction (n-Hexane only)	60 percent of original minus 1 to plus 25 percent, 10 percent	Section 11
Manufactured gas or natural gas				
Dry cleaning agents	Tetrachloroethylene; 70 h; 70 ±1°C (158 ±1.8°F)	Tensile strength, elongation and volume change	50 percent of original minus 25 to plus 90 percent	Section 16
Laundry detergents	Laundry detergent and laundry detergent/bleach; 168 h; boiling solutions	Tensile strength and elongation	50 percent of original	Section 16
Dish washing detergents	Dish washing detergent; 168 h; boiling solution	Tensile strength and elongation	50 percent of original	Section 16
Atmospheric ozone	100 mPa ozone; 70 h; 40 ±1°C (104 ±1.8°F)	Visual examination	No cracking	Section 15
Generated ozone	12,500 MPa; 70 h; 40 ±1°C (104 ±1.8°F)	Visual examination	No cracking	Section 15
Refrigerants	Requested refrigerants agents (liquid); 30 days at 70 ±2°C (158 ±3.6°F)	Tensile strength and elongation	60 percent of original	Section 19
	IRM Oil No. 903 ^b ; 70 h; 23 ±2°C (73 ±3.6°F)	Volume change	minus 1 to plus 25 percent	Section 11

Table 4.2 Continued on Next Page

Table 4.2 Continued

End-use applications	Test media, time, temperature	Properties required ^e	Requirements ^f	Apparatus, test methods and exposure conditions
Oxygen enriched atmospheres	Oxygen pressure aging; 14 days; 80 ±1°C (176 ±1.8°F) and 300 ±15 psig (2068 ±103 kPa)	Tensile strength and elongation	60 percent of original	Section 17
^a Exposure tests are not required for dry chemical and water extinguishing agents. ^b Reference fuels and oils as described in, Standard Test Method for Rubber Property – Effect of Liquids ASTM D471. ^c Maximum 15 percent reagent grade by volume. Other blends may be requested and are subject to additional end-use product requirements. ^d For unvented kerosene-fired room heaters. ^e Properties required may vary with end-product standards. Properties applied to the elastomer portion of coated fabrics. Properties for composite gasket – transverse and longitudinal tensile strength without elongation. ^f These requirements may be superseded by requirements in the applicable end-product standard. ^g For carbon dioxide extinguishing agents there shall also be no blistering. ^h Minus 1 to plus 25 percent for ASTM Fuel A. ⁱ Reference fuel as described in the Standard Specification for Fuel Oils, ASTM D396. ^j Conducted at outdoor ambient temperature. ^k Hexane having an n-hexane content of at least 95%.				

Table 4.3
Oven aging

Table 4.3 revised June 30, 1999

Maximum service temperature		Oven time and temperature	
°C	(°F)	°C	(°F)
60	(140)	70 hours at 100	(212) ^a
75	(167)	168 hours at 100	(212) ^b
80	(176)	168 hours at 113	(235)
90	(194)	168 hours at 121	(250)
105	(221)	168 hours at 136	(277)
115	(239)	1440 hours at 123 or 360 hours at 143	(253) (289)
125	(257)	1440 hours at 133 or 360 hours at 153	(271) (307)
135	(275)	1440 hours at 143 or 360 hours at 163	(289) (325)
145	(293)	1440 hours at 153 or 360 hours at 173	(307) (343)
150	(302)	1440 hours at 158 or 360 hours at 178	(316) (352)
155	(311)	1440 hours at 164 or 360 hours at 184	(327) (363)
165	(329)	1440 hours at 174 or 360 hours at 194	(345) (381)
175	(347)	1440 hours at 184 or 360 hours at 204	(363) (399)
185	(365)	1440 hours at 194 or 360 hours at 214	(381) (417)
195	(383)	1440 hours at 204 or 360 hours at 224	(399) (435)
200	(392)	1440 hours at 210 or 360 hours at 230	(410) (446)
210	(410)	1440 hours at 220 or 360 hours at 240	(428) (464)
220	(428)	1440 hours at 230 or 360 hours at 250	(446) (482)
230	(446)	1440 hours at 240 or 360 hours at 260	(464) (500)
240	(464)	1440 hours at 250 or 360 hours at 270	(482) (518)
250	(482)	1440 hours at 260 or 360 hours at 280	(500) (536)
^a Replaces the 96 hour oxygen bomb aging at 70°C (158°F). ^b Replaces the 168 hour oxygen bomb aging at 80°C (176°F) and the 20 hour air bomb aging at 127°C (261°F).			

5 Tensile Strength and Ultimate Elongation Test

5.1 General

5.1.1 The tensile strength and ultimate elongation tests are to be conducted on all materials except that elongation tests need not be conducted for composite gasket materials.

5.2 Apparatus

5.2.1 The buffing or skiving equipment is to be as specified in the Standard Practice for Rubber—Preparation of Pieces for Test Purposes from Products, ASTM D3183.

5.2.1 revised, effective date to be determined

5.2.2 Dies A, C or D are to be as specified in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412.

5.2.2 revised, effective date to be determined

5.2.3 A micrometer or equivalent is to be used for measuring dumbbell specimens as specified in Method A, Standard Practice for Rubber – Measurement of Dimensions, ASTM D3767.

5.2.3 revised, effective date to be determined

5.2.4 A micrometer or equivalent is to be used for measuring flexible cellular material as specified in the Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber, ASTM D1056.

5.2.4 revised, effective date to be determined

5.2.5 A micrometer or equivalent is to be used for measuring “O” rings as specified in Method C, Standard Methods of Testing Rubber O-Rings, ASTM D1414.

5.2.5 revised, effective date to be determined

5.2.6 A bench marker, if required, is to be as specified in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412.

5.2.6 revised, effective date to be determined

5.2.7 Tensile test equipment is to be as specified in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412.

5.2.7 revised, effective date to be determined

5.2.8 An extensometer, scale, or other device is to be capable of indicating the elongation with an accuracy of 0.1 inch (2.5 mm).

5.3 Specimens

5.3.1 Tensile strength and elongation test specimens are to be as specified in Table 5.1.

Table 5.1
Test specimens

Table 5.1 revised, effective date to be determined

Material	Specimen type	Specimen preparation	Specimen measurement
Parts, slabs and sheet material	Dumbbell	Buff or skive in accordance with ASTM D3183 ^b . Die cut in accordance with ASTM D412 using Die C or D except Die A is to be used for composite gasket materials. ^a	Measure in accordance with ASTM D3767 Method A ^c
	Straight	No preparation required	Same as above ^d
"O" Rings and samples having circular cross-sections	Segment	Cut from Sample ^e	Measure in accordance with ASTM D1414 ^f
Tubular material	Tube diameter < 0.150 inch (3.81 mm) ^g	Insert closely fitting mandrel at each end during measurement	Measure in accordance with ASTM D1414 ^h
Flexible cellular material	Dumbbell	Die cut using ASTM D412 Die A ⁱ	Measure using ASTM D1056 dial micrometer or equivalent
	Straight	No preparation required	Same as above ^j

^a Composite Gaskets are to be die cut from sheets having a thickness of up to 1/4 inch (6.4 mm) single-ply or laminated.

^b Standard sheets may not require buffing or skiving. Die D is to be used only when a specimen is too narrow to use Die C.

^c The minimum of three measurements is to be used as the thickness of the specimen.

^d Measure width and thickness.

^e "O" rings 1-1/4 inch (31.8 mm) inside diameter and 0.139 inch (3.5 mm) thick are recommended. When samples have an internal diameter less than 1 inch (25.4 mm), slab or sheet material is to be used for testing. See slab and sheet material.

^f The "O" ring cross-sectional diameters are to be measured at three equally distributed points and the lowest measurement used as the diameter of the specimen.

^g If the diameter is equal to or greater than 0.150 inch, cut lengthwise and test in accordance with slab and sheet material.

^h The average diameter is to be taken at each end. The lowest measurement is to be used as the diameter of the sample. The diameter of the mandrel is to be recorded for calculations, see 5.4.7 (d).

ⁱ Adhesive layer may be removed by skiving or with a suitable solvent.

^j Measure width and thickness. The lowest of three measurements is to be used as the thickness and width of the specimen.

5.4 Method

5.4.1 A set of three specimens is to be used for the tensile strength and elongation tests. See Table 5.1 for specimen preparation.

5.4.2 For elongation, two benchmarks, 1 inch (25 mm) apart, are to be marked on the central portion of each specimen. If an extensometer is used that does not require bench marks, the bench marks may be omitted. The specimens are to be conditioned for a minimum of 1/2 hour under the conditions specified in 4.3.

5.4.3 Tensile strength and ultimate elongation of the specimens of gasket and seal materials is to be determined in accordance with 5.4.4 – 5.4.7 using a power-driven testing machine as specified in the Test Methods for Rubber Properties in Tension, ASTM D412.

5.4.3 revised, effective date to be determined

5.4.4 The rate of travel of the power-actuated grip is to be:

- a) $5 \pm 1/4$ inches (127.0 ± 6.4 mm) per minute for Composite Gasket Material, and
- b) 20 ± 1 inches (508.0 ± 25.4 mm) per minute for all other gaskets and seal materials.

5.4.5 The elongation, if required, is to be measured by means of a scale, extensometer, or other device indicating the elongation with an accuracy of 0.1 inch (2.5 mm).

5.4.6 After conditioning the specimen is to be placed in the grips of the power-driven testing machine so that the bench marks are between and not covered by the grips. The movable grip is to be adjusted to make the specimen taut but not under tension. The grips are to be separated at the rate specified in 5.4.4 until rupture. During separation, the distance between bench marks is to be measured and recorded at the point of rupture to the nearest 0.1 inch (2.5 mm).

5.4.7 Calculations are to be made for each of the specimens and averaged using the following formulas. Specimen measurements for the calculation of the area are to be made before aging and exposure.

- a) Tensile strength, psi equals F/A in which:

F is the maximum observed force in pounds.

A is the cross-sectional area of the unstressed specimen in square inches. See (b) – (e).

- b) Cross-sectional area of die-cut or straight specimen equals $W \times T$ in which:

W is the width of the constricted portion of the die-cut or straight specimen in inches.

T is the minimum thickness of the specimen in inches.

- c) Cross-sectional area of "O" ring specimens and specimens with a circular cross-section equals $0.7854 D^2$ in which:

D is the cross-sectional diameter in inches as measured in accordance with Table 5.1.

- d) Cross-sectional area of tubular specimen equals $0.7854 (D^2 - d^2)$ in which:

D is the outside diameter in inches and d is the internal diameter in inches.

e) Cross-sectional area for irregular shaped specimens equals $W/163.87G$ in which:

W is the grams mass (to the nearest 0.005 g) of a specimen length or lengths totaling 10 inches (254 mm).

G is the specific gravity of the compound. The specific gravity may be determined by means of the following: $G = W1/(W1+W3-W2)$ in which:

W1 is the gram mass on the balance pan of the specimen (to the nearest 0.005 g).

W2 is the gram mass of the fully immersed specimen and its partially immersed suspending wire (to the nearest 0.005 g).

W3 is the gram mass of the partially immersed suspending wire.

Reference may be made to the Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement, ASTM D792.

f) Elongation percent equals $[(L-L_0)/L_0] \times 100$ in which:

L is the measured distance between the bench marks at rupture.

L_0 is the original distance between the bench marks.

5.4.7 revised, effective date to be determined

6 Accelerated Air Oven Aging Test

6.1 General

6.1.1 The accelerated air oven aging is to be conducted on all materials. See Table 4.3 for the appropriate test times and temperatures.

6.2 Apparatus

6.2.1 The oven used for accelerated aging is to be Type IIA as specified in the Standard Specification for Gravity-Convection and Forced-Ventilation Ovens, ASTM E145. Apparatus for the tensile strength and ultimate elongation determinations is to be as specified in 5.2.1 – 5.2.8.

6.2.1 revised, effective date to be determined

6.3 Specimens

6.3.1 The specimens are to be as specified in Table 5.1.

6.4 Method

6.4.1 A set of three specimens is to be prepared as specified for the Tensile Strength and Ultimate Elongation Test, Section 5, except that the 1 inch (25.4 mm) bench marks, if required, are to be placed on the specimens after aging (see 5.4.2). After the accelerated air oven aging the specimens are to be conditioned as specified in 4.3 for not less than 16 hours and not more than 96 hours. The test is to be conducted in accordance with the Standard Test Method for Rubber – Deterioration in an Air Oven, ASTM D573.

6.4.1 revised, effective date to be determined

6.4.2 A set of three specimens of the same lot that have not been subjected to the accelerated aging is to be subjected to the tensile strength and elongation tests and averaged for comparison purposes. See Table 4.1.

7 Compression Set Test

7.1 General

7.1.1 The compression set test is to be conducted on solid elastomer material, the elastomer portion of coated fabrics and both open and closed flexible cellular material.

7.2 Apparatus

7.2.1 The apparatus is to be as specified in the Standard Test Methods for Rubber Property – Compression Set, Method B, ASTM D395 for solid elastomer materials and as specified in the Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber, ASTM D1056, for open and closed flexible cellular material.

7.2.1 revised, effective date to be determined

7.3 Specimens

7.3.1 Three specimens are to be prepared for each test. The specimens are to be Type 1 or plied discs cut from sheet material as specified in:

- a) Standard Test Methods for Rubber Property – Compression Set, ASTM D395, for solid elastomer materials, and
- b) Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber, ASTM D1056, for open and closed flexible cellular material.

7.3.1 revised, effective date to be determined

7.4 Method

7.4.1 For solid elastomer material the test is to be as specified in Method B of the Standard Test Methods for Rubber Property – Compression Set, ASTM D395. The deflection is to be 25 percent and the test time and temperature are to be $22 \pm 1/2$ hours at $70 \pm 1^\circ\text{C}$ ($158 \pm 1.8^\circ\text{F}$). The recovery period is to be 30 minutes at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$).

7.4.1 revised, effective date to be determined

7.4.2 For open and closed cell material the test is to be as specified in the Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber, ASTM D1056. The deflection is to be 50 percent. The test time is to be $22 \pm 1/2$ hours.

a) For open cell materials the temperature is to be $70 \pm 1^\circ\text{C}$ ($158 \pm 1.8^\circ\text{F}$). The recovery period is to be 30 minutes at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$).

b) For closed cell materials the temperature is to be $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$). The recovery period is to be 24 hours at $23 \pm 2^\circ\text{C}$.

7.4.2 revised, effective date to be determined

7.4.3 The average percent compression set is to be calculated as follows:

$$\text{Compression set, \%} = \frac{(t_0 - t_1)}{t_0 - t_s} \times 100$$

where:

t_0 = Original thickness,

t_1 = Thickness of specimen after specified recovery period, and

t_s = Thickness of spacing bar used.

8 Tensile Set Test

8.1 General

8.1.1 The tensile set test is to be conducted on solid elastomer material and the elastomer portion of coated fabrics. See Table 4.1 for the appropriate requirement.

8.2 Apparatus

8.2.1 The apparatus is to be as specified in Method A of the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412.

8.2.1 revised, effective date to be determined

8.3 Specimens

8.3.1 A dumbbell or straight specimen, or a sample part such as an "O" ring segment or tubular segment is to be used.

8.4 Method

8.4.1 The specimen is to be conditioned at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) for 1/2 hour and then marked with a 1 inch (25.4 mm) bench marker. The specimen is to be placed in the grips of the testing machine and adjusted symmetrically. The grips are to separate at a rate of 20 ± 2 inches (508 $\pm$ 50.8 mm) per minute until an elongation of 100 percent is attained. The specimen is to be held at this elongation for 2 minutes and then released. The specimen is to be placed on thermal insulating material at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) for 2 minutes and the distance between the bench marks measured to the nearest 0.01 inch (0.25 mm). The tensile set is to be calculated, in percent, as follows:

$$\text{Tensile set} = 100(L_r - L_o) / L_o$$

where:

L_r = measured distance between the bench marks after the recovery period, and

L_o = original 1 inch (25.4 mm) distance between the bench marks.

9 Hardness Test

9.1 General

9.1.1 The hardness test is to be conducted on solid elastomer, the elastomer portion of coated fabrics and thermoplastic material. See Table 4.1 for the requirement.

9.2 Apparatus

9.2.1 The apparatus is to be as specified in the Standard Test Method for Rubber Property – Durometer Hardness, ASTM D2240, and the Standard Test Method for Rubber – Deterioration in an Air Oven, ASTM D573.

9.2.1 revised, effective date to be determined

9.3 Specimens

9.3.1 The specimens are to be as specified in the Standard Test Method for Rubber Property – Durometer Hardness, ASTM D2240. Three specimens are to be used for each test.

9.3.1 revised, effective date to be determined

9.4 Method

9.4.1 The test is to be as specified in the Standard Test Method for Rubber Property – Durometer Hardness, ASTM D2240, and is to be conducted on the same specimens before and after aging in accordance with Table 4.3. The conditioning for the as-received measurements is to be at least 1/2 hour at $23 \pm 2^\circ\text{C}$ ($73 \pm 3.6^\circ\text{F}$). The conditioning for the aged measurements is to be not less than 16 hours and not more than 96 hours at $23 \pm 2^\circ\text{C}$. The hardness is the average of the three specimens.

9.4.1 revised, effective date to be determined

10 Low Temperature Test

10.1 General

10.1.1 The low temperature test is to be conducted on solid elastomer material, thermoplastic, coated fabric material, and both open and closed flexible cellular material.

10.2 Apparatus

10.2.1 The apparatus is to include a cold chest capable of maintaining temperatures of minus $40 \pm 2^\circ\text{C}$ (minus $40 \pm 3.6^\circ\text{F}$) and minus $54 \pm 2^\circ\text{C}$ (minus $65 \pm 3.6^\circ\text{F}$) and a metal mandrel having a 0.25 inch (6.4 mm) diameter.

10.3 Specimens

10.3.1 The specimens are to be 5 inches (127 mm) long, 0.25 to 0.50 inches (6.4 to 12.7 mm) wide, and 0.125 to 0.150 inches (3.2 to 3.8 mm) thick. Specimens of "O" ring segments are to be of solid elastomer material, having an inside diameter of 1-1/4 inches (31.8 mm), and a cross-sectional thickness of 0.139 inch (3.5 mm). Three specimens are to be used for each test.

10.4 Method

10.4.1 The specimens or "O" ring segments and mandrel are to be subjected to $24 \pm 1/2$ hours at minus $40 \pm 2^\circ\text{C}$ (minus $40 \pm 3.6^\circ\text{F}$) or minus $54 \pm 2^\circ\text{C}$ (minus $65 \pm 3.6^\circ\text{F}$), or any other temperatures as requested by the manufacturer, depending on the intended use. While at the test temperature, each specimen or "O" ring is to be bent within 5 seconds around the 0.25 inch (6.4 mm) mandrel to form a "U" bend. To minimize heat transfer to the specimen or "O" ring segment, gloves are to be worn. Each specimen or "O" ring segment is to be examined for evidence of cracking.

11 Immersion Test

11.1 General

11.1.1 The immersion test is to be conducted on solid elastomer material, the elastomer portion of coated fabrics, composite material, thermoplastic, and both open and closed flexible cellular material. See Table 4.2 for appropriate tests and requirements.

11.2 Apparatus

11.2.1 Apparatus for tensile strength and ultimate elongation determinations is to be as specified in 5.2.1 – 5.2.8.

11.2.2 Apparatus for the volume change test is to consist of an analytical balance with a bridge for the support of a vessel of distilled water, a small diameter wire hook, alcohol, and a metal die or other equipment for cutting 1 by 1 inch (25.4 by 25.4 mm) specimens. For open flexible cellular material and other absorbing materials, a scale in 1/100 inch (0.25 mm) divisions and a micrometer as specified in 5.2.4 are to be provided.

11.3 Specimens

11.3.1 The tensile strength and elongation test specimens are to be prepared as specified in Table 5.1.

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11.3.2 Volume change and extraction test specimens may be obtained from parts such as an "O" ring or cut from smooth and uniform slab or sheet material. In order to provide for smooth and uniform material, the sample may be buffed or skived as specified in Table 5.1. Cutting with a die or other equipment specified in 11.2.2 is to be followed for slab or sheet material.

11.4 Method

11.4.1 Tensile Strength and Elongation Tests

11.4.1.1 A set of three specimens is to be prepared as specified for Tensile Strength and Ultimate Elongation Test, Section 5, except the 1 inch (25.4 mm) bench marks, if required, are to be placed on the specimens after the immersion period (see 5.4.2). The specimens are to be immersed so that they do not touch each other or the sides of the container. The specimens are to be immersed in the applicable test liquids tabulated in Table 4.2 for $70 \pm 1/2$ hours at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) unless otherwise specified.

11.4.1.2 At the end of the immersion period, the specimens are to be removed from the test liquid, cooled if tested above 23°C by use of test liquid at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) for 1/2 hour, blotted dry with a soft cloth or filter paper, the 1 inch (25.4 mm) bench marks applied if required, and subjected to the tensile strength and elongation tests described in 5.4.1 – 5.4.7. A set of three specimens is to be subjected to the tensile strength and elongation test that have not been subjected to the accelerated aging for comparison purposes. See Table 4.1.

11.4.2 Volume Change Test

11.4.2.1 Specimens specified in 11.3.2 are to be used for the volume change test. The volume of each specimen is to be determined by weighing each specimen to the nearest 0.1 mg, first in air and then in water. Each specimen is to be rinsed in alcohol and then in water before weighing in water. For open flexible cellular material, and other absorbing materials, the length, width, and thickness is to be determined with the scale and micrometer specified in 11.2.2. The specimens are to be immersed in the applicable test liquids indicated in Table 4.2 for $70 \pm 1/2$ hours at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) unless otherwise specified.

11.4.2.2 At the end of the immersion period, the specimens are to be removed one at a time from the test liquid, and again weighed, first in air and then in water. Each specimen is to be rinsed in alcohol and then in water before weighing in water. The weight in air is to be taken within 30 seconds after the specimen is removed from the test liquid, and the weight in water is to be taken within 60 seconds after the specimen is removed from the test liquid. For open flexible cellular material and other flexible materials the length, width, and thickness measurements are to be determined within 60 seconds. The percent volume change is to be calculated for each of the three specimens and averaged.

- a) The percent change in volume by the displacement method is:

$$\Delta V\% = \frac{[(M3 - M4) - (M1 - M2)] \times 100}{M1 - M2}$$

in which:

M1 is the weight of the specimen in air on hook, and if used, the ballast, in water, before the immersion test,

M2 is the weight of the specimen, and, if used, the ballast, in water on hook before the immersion test,

M3 is the weight of the specimen in air on hook, and, if used, the ballast in water, after the immersion test, and

M4 is the weight of the specimen, and, if used, the ballast, in water on hook after the immersion test.

b) The percent change in volume by the measurement method for open flexible cellular material and other flexible materials is:

$$\Delta V\% = \frac{(L \times W \times T) - (l \times w \times t)}{l \times w \times t} \times 100$$

in which:

L, W, and T are the length, width, and thickness after the immersion; and

l, w, and t are the length, width, and thickness before the immersion.

11.4.2.3 The set of three specimens used for the volume change may be used for the extraction test. Prior to the volume change test the weight of each specimen is to be determined with an analytical balance. Following the volume change test the specimens are to be dried in air for $70 \pm 1/2$ hours at $23 \pm 2^\circ\text{C}$ ($73 \pm 3.6^\circ\text{F}$) and the weight of each specimen determined again. The percent change in weight is to be calculated for each of the three specimens and averaged.

$$\text{Percent change in weight} = \frac{(M_b - M_a) \times 100}{M_b}$$

in which:

M_a is the weight of the specimen after the extraction test.

M_b is the weight of the specimen before the extraction test.

12 Compressibility, Recovery and Sealability

Section 12 deleted, effective date to be determined

13 Adhesion Test

13.1 General

13.1.1 The adhesion test is to be conducted on gasket material provided with pressure-sensitive adhesives that is relied upon for securing the gasket in place during its intended use. This test is also to be conducted on formed-in-place gasket material that is relied upon for securing the gasket in place during its intended use. See Table 4.1 for requirements.

13.2 Apparatus

13.2.1 The test apparatus is to consist of:

- a) Tensile test equipment as specified in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412;
- b) Type IIA oven as specified in the Standard Specification for Gravity-Convection and Forced-Ventilation Ovens, ASTM E145;
- c) A 4.5 ± 0.1 pound (2040 ± 45 g) roller as specified in the Standard Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications, ASTM D1000;
- d) A cold chest capable of maintaining temperatures of $\text{minus } 10 \pm 2^{\circ}\text{C}$ ($14 \pm 3.6^{\circ}\text{F}$);
- e) A humidity cabinet capable of maintaining a temperature of $32 \pm 2^{\circ}\text{C}$ ($89.6 \pm 3.6^{\circ}\text{F}$) and a relative humidity of 87 ± 5 percent; and
- f) A short length of 10 pound (44.5 N) test line and a metal spring clip.

13.2.1 revised, effective date to be determined

13.3 Specimens

13.3.1 Gasket material specimens are to be provided in strips 5 inches (127.0 mm) in length by 1 inch (25.4 mm) or less in width from rolls or sheets with pressure-sensitive adhesive in place. Five panels of each surface to be tested (for example metal, plastic, painted surface, and the like) are to be provided. Each panel is to be 6 by 4 inches (152 by 102 mm). In place of the above, the strips may be premounted on the panels as in the manner specified in 13.4.1 and 13.4.2.

13.4 Method

13.4.1 Each panel is to be cleaned with a solvent such as alcohol for metals and glass, or soapy water for painted surfaces and plastics. Panels cleaned with soapy water are to be rinsed with deionized or distilled water. Each panel is to be allowed to air dry for at least 24 hours.

13.4.2 After drying, three 5 inch (127 mm) strips of gasket material are to be applied to each panel, and rolled one at a time with the roller specified in 13.2.1(c). The roller, without additional pressure, is to be rolled the length of each strip once in each direction within 6 seconds.

13.4.3 The prepared panels are to be conditioned for at least 24 hours at a temperature of $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and then subjected to the following:

- a) One panel is to be placed in an air oven for $70 \pm 1/2$ hours at $87 \pm 1^{\circ}\text{C}$ ($188.6 \pm 1.8^{\circ}\text{F}$) unless otherwise specified by the end-product application,
- b) One panel is to be placed in a humidity cabinet for $70 \pm 1/2$ hours at $32 \pm 2^{\circ}\text{C}$ ($89.6 \pm 3.6^{\circ}\text{F}$) and 87 ± 5 percent relative humidity,
- c) One panel is to be immersed in distilled or deionized water for $70 \pm 1/2$ hours at $23 \pm 2^{\circ}\text{C}$,
- d) One panel is to be placed in a cold chest for $70 \pm 1/2$ hours at minus $10 \pm 2^{\circ}\text{C}$ ($14 \pm 3.6^{\circ}\text{F}$) unless otherwise specified by the end-product application, and
- e) One panel is to be used for measurement of the adhesion in the as-received condition and averaged for comparison purposes to the conditioned specimens given in (a) – (d).

13.4.4 Each panel is to be conditioned at $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) and 50 ± 5 percent relative humidity prior to the adhesion test. The test panel subjected to the air oven specified in 13.4.3(a) is to be conditioned for $24 \pm 1/2$ hours prior to the adhesion test. The test panels subjected to the humidity, water immersion, and low temperature specified in 13.4.3 (b) – (d) are to be conditioned for 1/2 hour prior to the adhesion test. The as-received panel is to be conditioned a minimum of 1/2 hour prior to the adhesion test.

13.4.5 After the conditioning specified in 13.4.3 and 13.4.4, a test line is to be secured to the upper grip of the testing machine and the metal spring clip is to be secured to its free end. One end of each strip is to be peeled back approximately 1/2 inch (12.7 mm). This raised end is to be secured by the metal clip and the test panel positioned directly under the top grip in such a way that the test line is at a 90 degree angle to the panel. The panel is to be firmly held to the test table while the crosshead is in motion. The angle of pull is to be 90 ± 5 degrees to the panel. The grip is to be moved at a rate of 0.5 inches (12.7 mm) per minute until a 1-1/2 inch (38 mm) length of gasket has been pulled from the panel. This is to be repeated for each of the three strips on the panel.

13.4.6 The average load obtained, excluding the first 1/2 inch (12.7 mm) of pull, is to be recorded for each strip. The force in pounds per inch (N/mm) of width is to be calculated using the average of the three recorded results.

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14 Extinguishing Agent Exposure Test

14.1 General

14.1.1 The extinguishing agent exposure test is to be conducted on solid elastomer, the elastomer portion of coated fabric, and thermoplastic elastomer material. The specific extinguishing agent liquid and vapor is to be in accordance with the end-use application requirements. See Table 4.2 for the appropriate requirements.

14.2 Apparatus

14.2.1 The extinguishing agent, except carbon dioxide exposure test apparatus is to consist of a pressure vessel of sufficient strength and safety factor to adequately withstand the test pressure of 300 psig (2068 kPa), a means of transferring the extinguishing agent, except carbon dioxide to the test vessel, and a compressed gas cylinder of extra dry nitrogen with a regulator for pressurizing the vessel to 300 psig (2068 kPa). For the extinguishing agent carbon dioxide, the test may be conducted using a carbon dioxide extinguisher and the test is to be done at the vapor pressure of carbon dioxide.

14.3 Specimens

14.3.1 Tensile strength and elongation specimens are as specified in Table 5.1.

14.4 Method

14.4.1 Twelve specimens are to be mounted in the test vessel to a height that would subject six specimens to the specific extinguishing agent liquid and six specimens to the specific extinguishing agent vapor. The extinguishing agent is transferred to the vessel to a level so that the six lower specimens are in the extinguishing agent liquid and the six upper specimens are in the vapor. The vessel is to be maintained at $23 \pm 2^{\circ}\text{C}$ ($73 \pm 3.6^{\circ}\text{F}$) and 300 ± 10 psig (2068 ± 69 kPa) for 30 days. Following the exposure, the pressure is to be relieved slowly and uniformly for at least 5 minutes, and the specimens are to be removed and allowed to condition according to 4.3 for 72 ± 5 hours.

14.4.2 For the carbon dioxide extinguishing agent, the test is to be conducted in the same manner as 14.4.1 except a carbon dioxide extinguisher may be used and the test is to be done at the vapor pressure of carbon dioxide. Following the exposure, the pressure is to be relieved over the time required to discharge the extinguisher. The tensile strength and elongation tests are to be conducted in accordance with 5.4.1 – 5.4.7.

14.4.3 A set of six specimens that have not been subjected to the extinguishing agent exposure is to be subjected to the tensile strength and elongation tests for comparison purposes. See Table 4.1. For carbon dioxide exposure the specimens are also to be examined for blistering.

15 Ozone Exposure Test

15.1 General

15.1.1 The ozone test is to be conducted on solid elastomer material, the elastomer portion of coated fabrics, thermoplastic, and both open and closed flexible cellular material. See Table 4.2 for the requirement.

15.2 Apparatus

15.2.1 The ozone test chamber and specimen holder are to be as specified in the Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment, ASTM D1149.

15.2.1 revised, effective date to be determined

15.3 Specimens

15.3.1 The test specimens are to be as specified in the Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment, ASTM D1149.

15.3.1 revised, effective date to be determined

15.4 Method

15.4.1 Three specimens are to be mounted in the specimen holder in a looped position as specified in Method B, Procedure B2 of the Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment, ASTM D1149. The mounted specimens are to be subjected to an ozone partial pressure of 90 – 110 MPa for 70 hours and a temperature of $40 \pm 2^{\circ}\text{C}$ ($104 \pm 3.6^{\circ}\text{F}$) for applications covering atmospheric ozone and an ozone partial pressure of 10,000 – 15,000 MPa for 70 hours and a temperature of $40 \pm 2^{\circ}\text{C}$ ($104 \pm 3.6^{\circ}\text{F}$) for applications covering generated ozone. After the test exposure, the specimens are to be removed and examined for cracking in the looped portion of the specimens, with a hand seven-power magnifying glass.

15.4.1 revised, effective date to be determined

16 Detergent/Cleaner Exposure Test

16.1 General

16.1.1 The detergent/cleaner exposure test is to be conducted on solid elastomer, the elastomeric portion of coated fabrics, thermoplastic elastomer, or thermoplastic materials. See Table 4.2 for the appropriate requirements.

16.2 Apparatus

16.2.1 The apparatus for the detergent/cleaner exposure test is as follows:

- a) Equipment to heat the solutions,
- b) A condenser to reflux the solution vapor, and
- c) A flask to accommodate the solution and the specimens.

16.2.2 Equipment for the tensile strength and elongation testing is as specified in 5.2.1 – 5.2.7 and equipment for the volume change test is as specified in 11.2.2.

16.3 Specimens

16.3.1 Tensile strength and elongation specimens are as specified in Table 5.1. Volume change specimens are as specified in 11.3.2.

16.4 Method

16.4.1 Determine the volume for the volume change specimens, if applicable, for test solution 16.4.2 (d) by weighing each specimen first in air and then in water, as described in 11.4.2.1.

16.4.2 The tensile strength and elongation specimens are tested in the specific solutions that are in accordance with the end-product application as follows:

- a) Twenty-five grams of commercial laundry detergent per 1000 milliliters of boiling water;
- b) Twenty-five grams of commercial laundry detergent and 50 milliliters of commercial bleach containing 5.25 percent sodium hypochlorite per 1000 milliliters of boiling water;
- c) Twenty-five grams of commercial dish washing detergent per 1000 milliliters of boiling water; or
- d) Tetrachloroethylene at 70°C (159°F).

16.4.3 The flasks with the applicable solution are to be heated with generous use of boiling chips. The specimens are then suspended in the solution and the condenser is fitted into the neck of the flask. The specimens in 16.4.2 (a)– (c) are to reflux with the solution at a rate of 10 to 50 drops per minute. All specimens (a) – (d) are to be subjected to those conditions for 168 hours, then cooled by use of the test liquid at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) for 1/2 hour.

16.4.4 The tensile strength and elongation is conducted as specified in 11.4.1.2. The volume change is conducted as specified in 11.4.2.1.

17 Accelerated Oxygen Pressure Aging Test

17.1 General

17.1.1 The accelerated oxygen aging is to be conducted on materials that are exposed to oxygen enriched atmospheres. See Table 4.2 for the test time and temperature.

17.2 Apparatus

17.2.1 The apparatus outlined in the Standard Test Method for Rubber – Deterioration by Heat and Oxygen, ASTM D572, is to be used for this test.

17.2.1 revised, effective date to be determined

17.3 Specimens

17.3.1 The specimens are to be as specified in Table 5.1.

17.3.2 A set of three specimens is to be prepared as specified for the Tensile Strength and Ultimate Elongation Test, Section 5, except that the 1 inch (25 mm) bench marks, if required, are to be placed on the specimens after aging. See 5.4.2. The test is to be conducted in accordance with the Standard Test Method for Rubber – Deterioration by Heat and Oxygen, ASTM D572, except the conditions are to be 14 days at $80 \pm 1^\circ\text{C}$ ($176 \pm 1.8^\circ\text{F}$) and 300 ± 15 psig (2068 ± 103 kPa). After the accelerated oxygen pressure aging the specimens are to be conditioned as specified in 4.3 for not less than 16 hours and not more than 96 hours. The specimens are then to be subjected to the tensile strength and elongation tests described in 5.4.1 – 5.4.7.

17.3.2 revised, effective date to be determined

17.3.3 A set of three specimens that have not been subjected to the accelerated oxygen pressure aging is to be subjected to the tensile strength and elongation tests and averaged for comparison purposes. See Table 4.2.

18 Bursting Strength Test

18.1 General

18.1.1 The as received bursting strength is to be conducted on fabric reinforced elastomer material used as diaphragms, bladders and gasket material. See Table 4.1.

18.2 Apparatus

18.2.1 The apparatus is to be similar to that outlined in the Standard Test Methods for Coated Fabrics, ASTM D751, Procedure A – Pressure Application by Mullen Type Hydrostatic Tester.

18.2.1 revised, effective date to be determined