



Designation: D 3903 – 00

Standard Specification for Rubber Seals Used in Air-Heat Transport of Solar Energy Systems¹

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1. Scope

1.1 This specification covers the general requirements for the rubber seals used in solar energy systems employing air-heat transport. Examples are duct and damper seals. Particular applications may necessitate other requirements that would take precedence over these requirements when specified.

NOTE 1—Rubber seals for the collector are covered in Specifications D 3667 and D 3771.²

1.2 Design requirement pertains only to permissible deflections of the rubber during thermal expansion or contraction of the seal in use and the tolerances in dimensions of molded and extruded seals.

1.3 This specification does not include requirements pertaining to the fabrication or installation of the seals.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *The following safety hazards caveat pertains only to the test methods portion, Section 10, of this specification: This standard does not purport to address the safety concerns associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

C 661 Test Method for Indentation Hardness of Elastomeric-Type Sealants By Means of a Durometer³

C 717 Terminology of Building Seals and Sealants³

C 719 Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)³

D 395 Test Methods for Rubber Property—Compression Set⁴

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers—Tension⁴

¹ This specification is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.36 on Seals.

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² Annual Book of ASTM Standards, Vol 09.02.

³ Annual Book of ASTM Standards, Vol 04.07.

⁴ Annual Book of ASTM Standards, Vol 09.01.

D 865 Test Method for Rubber—Deterioration by Heating in Air (Test Tube Enclosure)⁴

D 1149 Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber⁴

D 1229 Test Method for Rubber Property—Compression Set at Low Temperatures⁴

D 1349 Practice for Rubber—Standard Temperatures for Testing⁴

D 1415 Test Method for Rubber Property—International Hardness⁴

D 1566 Terminology Relating to Rubber⁴

D 2137 Test Methods for Rubber Property—Brittleness Point of Flexible Polymers and Coated Fabrics⁴

D 2240 Test Method for Rubber Property—Durometer Hardness⁴

D 3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets⁴

D 3183 Practice for Rubber—Preparation of Pieces for Test Purposes From Products⁴

D 3667 Specification for Rubber Seals Used in Flat-Plate Solar Collectors²

D 3771 Specification for Rubber Seals Used in Concentrating Solar Collectors²

G 7 Practice for Atmospheric Environment Exposure Testing of Nonmetallic Materials⁵

G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources⁶

G 155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials⁶

2.2 Other Standards:

RMA Handbook—Rubber Products: Molded, Extruded, Lathe Cut, and Cellular (Third Edition)⁷

3. Terminology

3.1 *Definitions*—Refer to the definitions of terms in Terminology C 717 and Terminology D 1566.

4. Classification

4.1 Types:

⁵ Annual Book of ASTM Standards, Vol 06.01.

⁶ Annual Book of ASTM Standards, Vol 14.04.

⁷ Available from the Rubber Manufacturers Association (RMA), 1901 Pennsylvania Ave. N.W., Washington, DC 20006.

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4.1.1 *Type C*, intended for use in cold climates (below -10°C in winter).

4.1.2 *Type W*, intended for use in warm climates (above -10°C in winter).

4.2 *Grades*—Grade designations represent differing degrees of hardness as follows:

4.2.1 *Grade 2*, hardness of 20 ± 5 .

4.2.2 *Grade 3*, hardness of 30 ± 5 .

4.2.3 *Grade 4*, hardness of 40 ± 5 .

4.2.4 *Grade 5*, hardness of 50 ± 5 .

4.2.5 *Grade 6*, hardness of 60 ± 5 .

4.2.6 *Grade 7*, hardness of 70 ± 5 .

4.2.7 *Grade 8*, hardness of 80 ± 5 .

NOTE 2—The grade to be used in a particular application depends on the design of the seal and must be specified by the designer.

4.3 *Classes*—Seals shall be classified as follows:

4.3.1 *Class PS*, preformed rubber seal.

4.3.2 *Class SC*, sealing compound.

NOTE 3—Class SC material should not be used in designs where the seal is under mechanical stress.

5. Ordering Information

5.1 Orders for material under this specification shall include the following information:

5.1.1 Type,

5.1.2 Grade,

5.1.3 Class,

5.1.4 Shape and dimensions,

5.1.5 Quantity,

5.1.6 ASTM designation and year of issue,

5.1.7 Other requirements.

6. Materials and Manufacture

6.1 Resistance to solar radiation can be determined by one of the following:

(a) Desert outdoor exposure, in accordance with recommended Practice G 7. Desert outdoor exposure shall be for at least six months including at least one month preceding and following the summer solstice.

(b) Xenon arc laboratory exposure, in accordance with recommended Practice G 151 and G 155 with Daylight Filters. The xenon arc shall be set to operate at a minimum irradiance level of .35. Laboratory exposure shall be for at least 1000 h with a chamber air (not black panel) temperature of $70 \pm 2^{\circ}\text{C}$.

6.2 After exposure, slight surface chalking and dulling are permitted. Brittleness, cracking, loss of elongation, tackiness, or other deterioration affecting serviceability shall not be permitted.

7. Requirements

7.1 Class PS material shall conform to the requirements given in Table 1.

7.2 Class SC material shall conform to the requirements given in Table 2.

8. Dimensions

8.1 The design of the seal shall not permit the rubber to deflect more than 25 % in any direction during thermal expansion and contraction of the solar collector.

NOTE 4—If the thermal coefficient of linear expansion for the rubber is not known, a value of $0.0003/\text{K}$ may be assumed for design purposes.

8.2 The tolerances in dimensions of molded seals shall conform to the following designations in the RMA Handbook:

8.2.1 *Molded Seals*:

8.2.1.1 *Commercial Dimensions*—RMA -F3-T.032.

8.2.1.2 *Critical Dimensions*—RMA -F3-T.032.

8.2.2 *Extended Seals*:

8.2.2.1 *Commercial Dimensions*—RMA -F3.

9. Workmanship, Finish, and Appearance

9.1 Class PS seals shall be free of blisters, checks, cracks, and other imperfections that can affect their ability to make or maintain a tight seal.

9.2 Class SC material shall be uniform in composition and be free of defects that may affect serviceability.

10. Test Methods

10.1 *Class PS Material*—Prepare the specimens as prescribed in Recommended Practice D 3183 and test the material

TABLE 1 Requirements for Class PS Material Used to Seal Air-Heat Transport Systems

Property	Grade						ASTM Method
	3	4	5	6	7	8	
Ultimate elongation, min, %	350	300	250	200	150	100	D412
Compression set, max, %:							
after 70 h at 125°C	30	30	30	30	30	30	D395 ^A
after 166 h at -10°C	60	60	60	60	60	60	D1229 ^B
Resistance to heating (166 h at 125°C): ^C							D865
Hardness change, max	10	10	10	10	10	10	D1415 or D2240
Ultimate elongation change, max, %	30	30	30	30	30	30	D412
Volatiles lost, max, %	2	2	2	2	2	2	see 10.3
Resistance to ozone, 100 mPa, ^D for 166 h at 40°C			no cracking				D1149
Resistance to low temperature,							D2137
Type C only, max, $^{\circ}\text{C}$	-40	-40	-40	-40	-40	-40	

^AMethod B.

^BSet to be measured at 10 s after release. Lubricated plates or polytetrafluoroethylene film is recommended if the rubber adheres to the metal compression plates during test.

^CThe test temperature of 125°C should cover most applications in air ducts of solar energy systems. A seal in an air-heat transport system operating at temperatures above 100°C should be tested at a standard test temperature listed in Practice D 1349 at least 25°C above the maximum temperature in service. The higher test temperatures are: 150, 175, 200, 225, and 250°C .

^D100 mPa of ozone partial pressure is equivalent to 100 pphm at standard atmospheric pressure (100 kPa). See new terminology on ozone content expressions described in Test Method D 1149.