



Designation: D3667 – 16 (Reapproved 2022)

Standard Specification for Rubber Seals Used in Flat-Plate Solar Collectors¹

This standard is issued under the fixed designation D3667; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope

1.1 This specification covers the general requirements for materials used in rubber seals of flat-plate solar collectors, except vertically mounted passive collectors. Particular applications may necessitate other requirements that would take precedence over these requirements when specified.

1.2 The 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 standard. No other units of measurement are included in this standard.

1.5 The following safety hazards caveat pertains only to Section 9, Test Methods, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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

2. Referenced Documents

2.1 ASTM Standards:²

¹ This specification is under the jurisdiction of ASTM Committee D11 on Rubber and Rubber-like Materials and is the direct responsibility of Subcommittee D11.37 on Coated Fabrics, Rubber Threads and Seals.

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

- C661 Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
- C717 Terminology of Building Seals and Sealants
- C719 Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
- D395 Test Methods for Rubber Property—Compression Set
- D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
- D865 Test Method for Rubber—Deterioration by Heating in Air (Test Tube Enclosure)
- D1149 Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment
- D1229 Test Method for Rubber Property—Compression Set at Low Temperatures
- D1349 Practice for Rubber—Standard Conditions for Testing
- D1415 Test Method for Rubber Property—International Hardness
- D1566 Terminology Relating to Rubber
- D2137 Test Methods for Rubber Property—Brittleness Point of Flexible Polymers and Coated Fabrics
- D2240 Test Method for Rubber Property—Durometer Hardness
- D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets
- D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products
- G7 Practice for Natural Weathering of Materials
- G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
- G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

2.2 Other Standards:³

- RMA Handbook —Rubber Products: Molded, Extruded, Lathe Cut, and Cellular

³ Available from Rubber Manufacturers Association (RMA), 1400 K St., NW, Suite 900, Washington, DC 20005, <http://www.rma.org>.

3. Terminology

3.1 *Definitions*—Refer to the definitions of terms in Terminology **C717** and Terminology **D1566**.

4. Classification

4.1 Types:

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:

4.2.1 Grade designations represent differing degrees of hardness as follows:

4.2.1.1 *Grade 2*, hardness of 20 ± 5 .

4.2.1.2 *Grade 3*, hardness of 30 ± 5 .

4.2.1.3 *Grade 4*, hardness of 40 ± 5 .

4.2.1.4 *Grade 5*, hardness of 50 ± 5 .

4.2.1.5 *Grade 6*, hardness of 60 ± 5 .

4.2.1.6 *Grade 7*, hardness of 70 ± 5 .

4.2.1.7 *Grade 8*, hardness of 80 ± 5 .

NOTE 1—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:

4.3.1 Seals shall be classified as follows:

4.3.1.1 Class PS, preformed rubber seal.

4.3.1.2 Class SC, sealing compound.

NOTE 2—Class SC material should not be used in designs where the seal is under mechanical stress.

5. Materials and Manufacture

5.1 Seals shall be rubber vulcanizates conforming to the requirements in Section 6 and resistant to deterioration by solar radiation.

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

5.2.1 Desert outdoor exposure, in accordance with recommended Practice **G7** using the exposure rack at an angle of 45° for unbacked exposure of the specimens. Desert outdoor exposure shall be for at least six months including at least one month preceding and following the summer solstice.

5.2.2 Xenon arc laboratory exposure, in accordance with recommended Practice **G151** and **G155** using daylight filters and operating conditions as described below:

5.2.2.1 The irradiance level shall be maintained at 0.55 ± 0.02 W/(m²·nm) at 340 nm at the control point. For equivalent broad band irradiance levels and tolerances at 300 to 400 nm and 300 to 800 nm, consult the manufacturer of the apparatus.

5.2.2.2 The default exposure cycle shall be 102 min light only followed by 18 min light plus either water spray on the front surface or immersion in water. The spray water can be fresh or recirculated from a holding tank. The temperature of the spray water is uncontrolled and for fresh water typically ranges between 16 and 26°C. Recirculated spray water can be at a higher temperature. Immersion water is generally in a holding tank for recirculation. The uncontrolled temperature of the recirculated immersion water during operation of the weathering device typically ranges between 45 and 55°C.

NOTE 3—Water spray and immersion in water are different kinds of moisture exposures and may produce different results.

5.2.2.3 The uninsulated black panel temperature (BPT) shall be maintained at 63 ± 2.5 °C at the control point during the dry period of exposure to light. For the equivalent insulated black panel temperature (black standard temperature (BST)), consult the manufacturer of the apparatus.

5.2.2.4 Relative humidity shall be maintained at 60 ± 10 % at the control point during the dry period of exposure to light in xenon arc apparatus that uses water spray for wetting.

5.2.2.5 The chamber air temperature shall be maintained at 48 ± 2 °C at the control point in equipment that uses water spray for wetting and provides for adjustment of the chamber air temperature.

5.2.2.6 The exposure duration shall be by agreement between the parties concerned. The exposure time shall be at least 1000 h, but long enough to produce a substantial change in the property of interest in the least stable formulation of the type of material being evaluated.

NOTE 4—The specified set point is the target condition for the control sensor as programmed by the user. When a Standard calls for a particular set point, the user programs the exact number. The tolerances (maximum allowed operational fluctuations) specified with the set point do not imply that the user is allowed to program a set point higher or lower than the exact set point specified. The operational fluctuations specified are the maximum deviations allowable from the set point at the control sensor during equilibrium conditions. The machine variables determine the operational fluctuations. If under equilibrium conditions they exceed those allowed, stop the test and correct the problem before continuing.

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

6. Requirements

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

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

7. Dimensions

7.1 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 5—If the thermal coefficient of linear expansion for the rubber is not known, a value of 0.0003/K may be assumed for design purposes.

7.2 The tolerances in dimensions shall conform to the following designations in the RMA Handbook:

7.2.1 Molded Seals:

7.2.1.1 Commercial Dimensions—RMA A3-F3-T.032.

7.2.1.2 Critical Dimensions—RMA A2-F3-T.032.

7.2.2 Extruded Seals:

7.2.2.1 Commercial Dimensions—RMA A2-F3.

8. Workmanship, Finish, and Appearance

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

