



Designation: D3667 – 05

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 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.

NOTE 1—Practices [G151](#) and [G155](#) are performance-based practices that replace Practice [G26](#) cited in previous versions of D3667. Practice [G26](#) described very specific designs for devices used for xenon arc exposure. The apparatus described in Practice [G26](#) is covered by the practices that replace it.

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

2. Referenced Documents

2.1 ASTM Standards:²

- [C661](#) Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
- [C717](#) Terminology of Building Seals and Sealants

¹ This specification is under the jurisdiction of ASTM Committee [D11](#) on Rubber 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.

[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 Temperatures 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 Atmospheric Environmental Exposure Testing of Nonmetallic Materials

[G26](#) Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials³

[G151](#) Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

[G155](#) Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2 Other Standards:⁴

[RMA Handbook](#) —Rubber Products: Molded, Extruded, Lathe Cut, and Cellular

³ Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from the Rubber Manufacturers Association (RMA), 1400 K St., NW, Suite 900, Washington, DC 20005.

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 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:

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 3—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.

5.1.1 Resistance to solar radiation can be determined by either desert outdoor exposure in accordance with Practice [G7](#), or laboratory exposure to a xenon arc in accordance with Practices [G151](#) and [G155](#). Desert outdoor exposure using unbacked specimens at an angle of 45° shall be for at least six months including at least one month preceding and following the summer solstice. Laboratory exposure shall use window glass filters and the exposure device shall be programmed for continuous light only. The irradiance level shall be set at 0.35 W/(m².nm) at 340 nm at the control point. For the equivalent irradiance setting specifications for broad band measurements of 300–400 nm and 300–800 nm, consult the manufacturer of the apparatus. The uninsulated black panel temperature shall be set at 70°C at the control point. In devices that control chamber air temperature, it shall be set at 47°C. The relative humidity shall be set at 30 % at the control point. Exposure duration shall be for at least 1000 h, but of sufficient length to produce a statistically significant change in the property of interest in a product known to give poor performance so that the test is able to identify an unacceptable material. After exposure, slight surface chalking and dulling are permitted. Brittleness, cracking, loss of elongation, tackiness, or other deterioration affecting serviceability shall not be permitted.

NOTE 4—For the allowed operational fluctuations of the specified set points for irradiance, temperature, and relative humidity, refer to Table A3.1 in [G151](#). If the actual operating conditions do not comply with the maximum allowable fluctuations in Table A3.1 after the equipment has stabilized, discontinue the test and correct the cause of the problem before continuing.

6. Requirements

6.1 Class PS material shall conform to the requirements given in [Table 1](#).

TABLE 1 Requirements for Class PS Material Used to Seal Flat-Plate Solar Collectors

Property	Grade						ASTM Test Method
	3	4	5	6	7	8	
Ultimate elongation, min, %	350	300	250	200	150	100	D412
Compression set, max, %:							
after 70 h at 150°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 (for 166 h at 150°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
Tensile strength change, max, %	20	20	20	20	20	20	D412
Volatiles lost, max, %	1	1	1	1	1	1	See 9.3
Volatiles condensable, max, %	0.1	0.1	0.1	0.1	0.1	0.1	See 9.4
Resistance to ozone:							D1149
100 mPa, ^D for 166 h at 40°C				No cracking			
Resistance for low temperature:							D2137
Type C only, max, °C	-40	-40	-40	-40	-40	-40	

^A Method B.

^B Set 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.

^C The test temperature of 150°C is used to test seals for cover plates. A seal in contact with an absorber plate should be tested at a standard test temperature listed in Practice [D1349](#) next above the maximum temperature of the absorber plate in service (which generally occurs under stagnation conditions and maximum radiation flux) but not less than 150°C. The higher test temperatures are: 175, 200, 225, and 250.

^D 100 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 [D1149](#).