Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 7269

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Revised

RINGS, SEALING, SILICONE RUBBER
Low Outgassing, Space and Vacuum Service
45 - 55

1. SCOPE:

1.1 Form: This specification covers a special, low-outgassing silicone rubber compound in the form of molded rings.

1.2 Application: Sealing rings specifically formulated, formed, and postcured for use in interplanetary space and other hard vacuums from -73° to +150° C (-100° to +302° F), with a minimum of condensable outgassing products. While within the earth's atmosphere, the silicone rubber compound is resistant to deterioration by ozone, smog, and weathering. Standard sizes are as shown in AS 568.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS), Aerospace Standards (AS), and Aerospace Information Reports (AIR) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2817 - Packaging and Identification, Preformed Packings

2.1.2 Aerospace Standards:

AS 568 - Aerospace Size Standard for O-Rings
AS 871 - Manufacturing and Inspection Standards for Preformed Packings (O-Rings)

2.1.3 Aerospace Information Report:

AIR 851 - O-Ring Tension Testing Calculations

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM D15 - Compound and Sample Preparation for Physical Testing of Rubber Products
ASTM D624 - Tear Resistance of Vulcanized Rubber
ASTM D1329 - Evaluating Low-Temperature Characteristics of Rubber and Rubber-Like Materials by a Temperature-Retraction Procedure (TR Test)
ASTM D1414 - Testing Rubber O-Rings

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120, except as noted in 2.3.2.

2.3.1 Military Standards:

MIL-STD-413 - Visual Inspection Guide for Rubber O-Rings

2.3.2 National Aeronautics and Space Administration (NASA) Publications:

2.3.2.1 NASA Johnson Space Center Publication: Available from Lyndon B. Johnson Space Center, Houston, Texas 77058.

SP-R-0022 - Vacuum Stability Requirements of Polymeric Material for Spacecraft Application

2.3.2.2 NASA Goddard Space Flight Center (GSFC) Publication: Available from Goddard Space Flight Center, Greenbelt, Maryland 20771.

GSFC X-735-69-471 - Micro-Volatile Condensable Materials System for Polymer Outgassing Studies

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be a compound based on methyl-phenyl-vinyl silicone rubber selected, formulated, cured, postcured, and otherwise processed to outgas a minimal amount of condensable material in hard vacuum (below 1×10^{-6} torr) when heated to any temperature up to 150° C (302° F) and to meet the requirements of this specification.

3.2 Properties: The product shall conform to the following requirements; tests shall be performed on the product supplied, except for the tests of 3.2.1.4 and 3.2.5, and in accordance with ASTM D1414 except as specified in 4.5, insofar as practicable:

3.2.1 As Received:

3.2.1.1	Hardness, Durometer "A" or equiv.	50 ± 5
3.2.1.2	Tensile Strength, min	900 psi (6.21 MPa)
3.2.1.3	Elongation, min	400%
3.2.1.4	Tear Resistance, min	100 lb per in. (17.5 kN/m)
3.2.1.5	Corrosion	None
3.2.1.6	Specific Gravity	Qualification value ± 0.03

3.2.2 Dry Heat Resistance: Temperature: 225° C ± 2 (437° F ± 3.6)

3.2.2.1	Hardness Change, Durometer "A" or equiv.	-10 to +10	Time: 70 hr ± 0.5
3.2.2.2	Tensile Strength Change, max	-20%	
3.2.2.3	Elongation Change, max	-35%	

3.2.3 Compression Set:		Temperature:	175° C ± 2 (347° F ± 3.6)
3.2.3.1 Percent of Original Deflection, max		Time:	22 hr ± 0.3
Ring Cross Section Diameter			
0.066 to 0.110 in. (1.68 to 2.79 mm), incl	25		
Over 0.110 in. (2.79 mm)	20		
3.2.4 Low-Temperature Resistance:			
Temperature Retraction, TR_{10} point, max	-73° C (-99.4° F)		
3.2.5 Outgassing Hard Vacuum:			
3.2.5.1 Total Mass Loss, max	1%		GSFC X-735-69-471 or JSC SP-R-0022 (See 8.2)
3.2.5.2 Collected Volatile Condensable Material, max	0.1%		GSFC X-735-69-471 or JSC SP-R-0022
3.2.5.3 Visible Condensable Material	None		4.5.4

3.3 Quality: The product shall be uniform in quality and condition, clean, smooth, as free from foreign material as commercially practicable, and free from internal imperfections detrimental to performance of parts. Surface imperfections shall, unless otherwise specified, be no greater than permitted by MIL-STD-413 for minor defects.

3.4 Sizes and Tolerances: Shall be as specified on the drawing. Standard size O-rings as shown in AS 568 may be described by a part number composed of this specification number followed by a dash and three digits indicating the desired AS 568 size. Inspection for conformance to dimensional requirements shall be made in accordance with AS 871, unless otherwise agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of rings shall supply all samples and shall be responsible for performing all required tests except for outgassing in hard vacuum (3.2.5). The outgassing in hard vacuum qualification tests shall be the responsibility of the purchaser. Results of tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the rings conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to the following requirements are classified as acceptance or routine control tests and shall be performed on each lot of rings. A lot of rings shall be all rings of the same size from the same batch of compound processed in one continuous run and submitted for the vendor's inspection at one time. A batch shall be the quantity of compound run through a mill or mixer at one time.

Test	Paragraph Reference
Hardness as-received	3.2.1.1
Tensile strength as-received	3.2.1.2
Elongation as-received	3.2.1.3
Specific gravity	3.2.1.6
Compression set	3.2.3.1

4.2.2 Periodic Control Tests: Tests to determine conformance to the acceptance tests of 4.2.1 plus the following tests are classified as periodic control tests and shall be performed on rings produced from a production batch of compound at intervals not greater than 6 months.

Test	Paragraph Reference
Tear Resistance, Die "B"	3.2.1.4
Corrosion	3.2.1.5
Dry heat resistance	3.2.2
Low temperature resistance	3.2.4

4.2.3 Qualification Tests: Tests to determine conformance to all technical requirements of this specification are classified as qualification tests and may be the basis for approval of the compound and processing (See 4.4.1).

4.3 Sampling: A sufficient number of rings and standard ASTM D15 test sheets shall be taken from each lot or batch to perform each test as follows; all ASTM D15 test sheets shall be made from the same batch of compound as the rings they represent, shall be press-cured to equivalent state-of-cure, and postcured with the rings they represent:

4.3.1 Acceptance Tests:

4.3.1.1 Hardness As-Received and Specific Gravity: Three rings.

4.3.1.2 Tensile Strength and Elongation As-Received: Seven rings.

4.3.1.2.1 If rings smaller than AS 568-010 are ordered, rings of -214 or -218 size shall be provided for determining tensile strength and elongation; such rings shall be from the same batch of compound cured in the same press and under the same conditions as the rings they represent and postcured with those rings.

4.3.1.3 Compression Set: Two rings.

4.3.2 Periodic Control Tests:

4.3.2.1 Tear Resistance: One ASTM D15 test sheet.

4.3.2.2 Corrosion: At least one ring.

4.3.2.3 Dry Heat Resistance: Seven rings.

4.3.2.4 Low Temperature Resistance: One ring.

4.3.3 Qualification Tests: Tests for resistance to outgassing in hard vacuum shall be performed on specimens cut from ASTM D15 test sheets.

4.4 Approval:

4.4.1 Sample rings and test sheets shall be approved by purchaser before rings for production use are supplied. Results of tests on production rings shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall establish for each size of ring the control factors of processing which will produce rings meeting all requirements of this specification. These shall constitute the approved procedures and shall be used for manufacturing production rings. If necessary to make any change in control factors of processing which could affect quality or properties of the rings, vendor shall submit for reapproval a statement of the revised procedures and, when requested, sample rings and test sheets. No production rings incorporating the revised procedures shall be shipped prior to receipt of reapproval.

4.4.2.1 Control factors for producing rings include, but are not limited to, the following:

Base polymer, molecular weight distribution, and pretreatment
Compound ingredients and proportions thereof within established limits
Sequence of mixing compound ingredients
Type of mixing equipment
Method and equipment for preparing preforms
Basic molding procedure (compression, transfer, injection)
Curing time and temperature (must be held within plus two, minus zero, half lives of the decomposition of the peroxide utilized)
Pressure (variations of ± 10% are permissible)
First postcure step for complete removal of curing by-products
Overall postcure steps, times, and temperatures
Finishing methods
Methods of routine inspection
Protection from external contamination

4.4.2.1.1 Any of the above control factors of processing considered proprietary by the vendor may be assigned a code designation. Each variation in such factors shall be assigned a modified code designation.

4.5 Test Methods:

4.5.1 Tensile Strength and Elongation: For rings smaller than can be tested using 1/2 in. (12.7 mm) diameter spools, use successively smaller spools having diameters half the diameter of the next larger size, 1/4 in. (6.4 mm), 1/8 in. (3.2 mm), 1/16 in. (1.6 mm), as required. Spool mounts shall be rotated 180 deg (3.14 rad) relative to each other to allow closing to the computed zero elongation for small o-rings. The spool center-to-center distance for zero elongation of the ring can be computed from the following formula from AIR 851: $d = (\pi D - \pi S)/2$. Calculations of tensile strength and elongation may be made in accordance with AIR 851.

4.5.2 Tear Resistance: Shall be determined in accordance with ASTM D624 on specimens cut from a standard sheet, using Die B.

4.5.3 Low-Temperature Resistance: May be determined in accordance with ASTM D1329, using 1-in. (25.4-mm) long T-50 specimens cut from a standard test sheet in lieu of testing rings. In all cases, specimens shall be stretched to 300% elongation and cooled to below -100° C (-148° F) in a bath of denatured alcohol chilled with liquid nitrogen.

4.5.4 Visible Condensable Material: Shall be determined in a test tube conforming to Fig. 1. The specimen shall be 6 sq in. (39 cm^2) of surface area cut from a standard test sheet or 4 - 5 g of ring. The test tube shall be connected to a high-vacuum system and pumped to a pressure lower than 3×10^{-6} torr. The temperature of the specimen shall be raised gradually, by radiant heat, so as not to raise the system pressure above 5×10^{-6} torr. The specimen temperature shall be sensed by a thermocouple contacting the specimen. The temperature shall be raised to 144° - 150° C or 291° - 302° F and the specimen maintained at that temperature and under that vacuum for not less than four days. The temperature of the room where the equipment is operated shall be maintained at 22° - 27° C or 72° - 80° F to limit variations in the condensing surface temperature. The tube above the heated region shall be carefully examined visually (normal or corrected to normal) for condensation, using optimum lighting and viewing angles. The appearance of fog, droplets, or film on the unheated portion of the test tube at any time during the test shall be cause for rejection. Any subjective, possible condensation which may be controversial between observers shall be resolved in favor of acceptability of the specimen.

4.6 Reports:

4.6.1 The vendor of rings shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the acceptance test requirements of this specification. This report shall include the purchase order number, material specification number, vendor's compound number, batch number, part number, and quantity.

4.6.2 In addition to the reports of 4.6.1, the vendor shall furnish at six-month intervals, the results of tests to determine conformance to the periodic control test requirements. This report shall be included with, or shall form a part of, the report of results of acceptance tests on the first lot of parts shipped following determination of conformance to the periodic control test requirements.

4.7 Resampling and Retesting: If the mean of seven specimens used in the tensile strength and elongation tests, as received or dry-heat-aged, fails to meet the specified requirements, disposition of the rings may be based on the mean of all data after testing four additional rings. Questionable compression set data shall be rerun in duplicate, averaging all results. Other tests shall be rerun and results pooled. Failure of the median or average, as applicable in the test method, of pooled values for any test to meet the specified requirements shall be cause for rejection of the rings represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Marking: Rings shall be packaged and identified as follows:

5.1.1 Individual rings shall be packaged and identified in accordance with AMS 2817. In addition, the package shall be marked: "SPECIAL LOW-OUTGASSING SILICONE O-RINGS FOR SPACE AND VACUUM SERVICE."

5.1.2 Ring packages shall be packed in cartons in such a manner that the rings, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to contamination or any normal hazard. Each carton shall be marked to give the following information:

AMS 7269
PART NUMBER _____
PURCHASE ORDER NUMBER _____
QUANTITY _____
COMPOUND NUMBER _____
BATCH NUMBER _____
MANUFACTURER'S IDENTIFICATION _____
DATE OF SHIPMENT _____
"SPECIAL LOW-OUTGASSING SILICONE
O-RINGS FOR SPACE AND VACUUM SERVICE"

5.1.3 Cartons shall be prepared for shipment in accordance with commercial practice to assure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES:

8.1 Intended Use: Seals conforming to this specification are intended for use in electrical connectors, components, assemblies, and vehicle segments on the external configuration of spacecraft, where no condensation can be tolerated on critical surfaces (windows, optics, thermal control coatings, etc) when such critical surfaces may be as cold as 23° C (73.4° F) and the seal may be as hot as 150° C (302° F). Seals for man-inhabited areas of spacecraft may require additional testing and approval.