

Rubber: Fluorocarbon Elastomer (FKM)
70 to 80 Hardness, Low Temperature Sealing Tg -40 °F (-40 °C)
For Elastomeric Seals in Aircraft Engine Oil, Fuel and Hydraulics Systems

RATIONALE

Specification covers a grade of fluoroelastomer capable of meeting a glass transition (Tg) value of -40 °F (-40 °C).

1. SCOPE

1.1 Form

This specification covers high temperature, compression set and fluid resistant fluorocarbon elastomer material to be used in the form of O-rings, compression seals, O-ring cord, and molded-in-place gaskets for aeronautical and aerospace applications.

1.2 Application

These products have resistance to a variety of gas turbine engine oils, including high thermal stability (HTS) oils, fuels, and hydraulic fluids, but usage is not limited to such applications. Each application should be considered separately. This fluorocarbon (FKM) has a service temperature range of -60 to +400 °F (-51 to +204 °C) in air.

1.3 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards, which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2817 Packaging and Identification, Preformed Packings

AS568 Aerospace Size Standard for O-Rings
AIR851 O-Ring Tension Testing Calculations

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 297 Rubber Products - Chemical Analysis
ASTM D 395 Rubber Property - Compression Set
ASTM D 471 Rubber Property - Effects of Liquids
ASTM D 573 Rubber - Deterioration in an Air Oven
ASTM D 1329 Rubber Property - Retraction at Lower Temperatures (TR Test)
ASTM D 1414 Rubber O-Rings
ASTM D 1418 Standard Practice for Rubber and Rubber Latexes - Nomenclature
ASTM D 2240 Rubber Property - Durometer Hardness

2.3 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 3601-3 Fluid Power Systems O-rings Part 3: Quality acceptance criteria

2.4 PRI Publications

Available from Performance Research Institute, 161 Thorn Hill Road, Warrendale, PA 15086-7257, Tel: 724-772-1616, www.pri-network.org.

PD2000 Procedures for an Industry Qualified Product Management Process

3. TECHNICAL REQUIREMENTS

3.1 Material

The product shall be prepared from ingredients as shall be necessary to achieve the requirements detailed in this standard. The composition is not defined by this standard. The basic ingredient shall be based on 100% virgin fluorocarbon (FKM) elastomer meeting ASTM D 1418 Type 3. No reprocessed or non-fluorocarbon polymer is acceptable.

3.2 Properties

The product shall conform to the requirements shown in Table 1. Whenever possible, tests shall be performed on the product supplied and in accordance with ASTM D 1414. O-ring sizes that are suitable for testing are shown in Table 3. For all other sizes tests shall be conducted on AS568 size -214 O-rings of identical batch and state of cure as the end item. Calculations of tensile strength and elongation may be made in accordance with AIR851.

TABLE 1 - PROPERTIES

	Property	Requirements	Test Method
3.2.1	Hardness, Durometer "A" or Equivalent	75 ± 5	ASTM D 2240
3.2.2	Tensile Strength, min	1300 psi (8.96 Mpa)	ASTM D 1414
3.2.3	Elongation, min	120%	ASTM D 1414
3.2.4	Specific Gravity	Qualification Value ± 0.02	ASTM D 297, hydrostatic method
3.2.5	Low-Temperature Resistance	-37 (-38.3)	ASTM D 1329 (use test slab as specimen)
3.2.6	Temperature Retraction, (TR ₁₀), °F (°C) max		
3.2.6	Low-Temperature Resistance Glass Transition (Tg) Mid-Point, max °F (°C)	-40 (-40)	ASTM D 3418
3.2.7	Aromatic Fuel Resistance		ASTM D 471 ASTM Reference Fuel B 73 °F ± 5 (23 °C ± 2) 70 hours ± 0.5
3.2.7.1	Hardness Change, Durometer "A" or Equivalent	-10	
3.2.7.2	Tensile Strength Change, max	-35%	
3.2.7.3	Elongation Change, max	-20%	
3.2.7.4	Volume Change, max	1 to +10%	
3.2.8	Turbine Engine Oil Resistance		ASTM D 471 (Note 1) SAE 3085 (Reference Oil 300) 392 °F ± 5 (200 °C ± 2) 70 hours ± 0.5
3.2.8.1	Hardness Change, Durometer "A" or Equivalent	-10	
3.2.8.2	Tensile Strength Change, max	-30%	
3.2.8.3	Elongation Change, max	-20%	
3.2.8.4	Volume Change, max	0 to +10%	
3.2.8.5	Compression Set, max	25%	ASTM D 395 Method B SAE 3085 (Reference Oil 300) 392 °F ± 5 (200 °C ± 2) 70 hours ± 0.5
3.2.8.6	Long Term Compression Set, max	55%	ASTM D 395 Method B SAE 3085 (Reference Oil 300) 392 °F ± 5 (200 °C ± 2) 336 hours ± 0.5
3.2.9	Hydraulic Fluid Resistance		ASTM D 471 (Note 1) MIL-PFR-83282 275 °F ± 5 (135 °C ± 2) 70 hours ± 0.5
3.2.9.1	Hardness Change, Durometer "A" or Equivalent	-7	
3.2.9.2	Tensile Strength Change, max	-25%	
3.2.9.3	Elongation Change, max	-15%	
3.2.9.4	Volume Change, max	+6%	
3.2.9.5	Compression Set, max	20%	ASTM D 395 Method B MIL-PFR-83282 275 °F ± 5 (135 °C ± 2) 70 hours ± 0.5
3.2.9.6	Long Term Compression Set, max	35%	ASTM D 395 Method B MIL-PFR-83282 275 °F ± 5 (135 °C ± 2) 336 hours ± 0.5

TABLE 1 - PROPERTIES (CONTINUED)

Property		Requirements	Test Method
3.2.10	Dry Heat Resistance		ASTM D 573 518 °F ± 5 (270 °C ± 2) 70 hours ± 0.5
3.2.10.1	Hardness Change, Durometer "A" or Equivalent	-10 to +5	
3.2.10.2	Tensile Strength Change, max	-45%	
3.2.10.3	Elongation Change, max	-10%	
3.2.10.4	Weight Loss, max	10%	4.6.1
3.2.10.5	Compression Set, % of Original Deflection, max	20%	ASTM D 395 Method B 392 °F ± 5 (200 °C ± 2) 22 hours ± 0.5
3.2.10.6	Long Term Compression Set, max	55%	ASTM D 395, Method B 392 °F ± 5 (200 °C ± 2) 336 hours ± 0.5

Note 1: Do not dip specimens in acetone; blot dry residual oil from specimen.

3.3 Quality

Seals, as received by purchaser, shall be uniform in quality and condition, smooth, as free from foreign material as commercially practicable, and free from internal imperfections detrimental to usage of the seals. Surface imperfections shall be no greater than permitted by ISO 3601-3 grade CS for minor defects.

3.4 Dimensions and Tolerances

Dimensions and tolerances shall be as specified in the parts standard, drawing or purchase document. If not specified, O-rings standard sizes and tolerances shall be specified in AS568.

3.5 Toxicological Formulations

The material shall have no adverse effects on the health of personnel when used for its intended purpose in accordance with manufacturer's instructions and with appropriate handling procedures.

3.6 Qualification

Products sold to this specification shall be listed on the Performance Review Institute (PRI) Qualified Products List (QPL). The qualified products list shall be in accordance with PD2000 (See 8.2).

3.6.1 Qualification shall be reapproved every three years in accordance with PD2000 and the instructions from the PRI. Testing shall be in accordance with 4.2.2.2.

4. QUALITY ASSURANCE

4.1 Responsibility for Inspection

The manufacturer of the product shall be responsible for performance of all required tests. Purchaser reserves the right to sample and perform any testing deemed necessary to ensure that the product conforms to the AMS requirements.

4.1.1 Manufacturer

Shall be on the current PRI Qualified Manufacturer's List (QML).

4.2 Classification of Tests

4.2.1 Acceptance Tests

Each lot of product shall conform to Table 2.

TABLE 2 - INITIAL ACCEPTANCE TESTS

Requirement	Paragraph
Hardness	3.2.1
Tensile Strength	3.2.2
Elongation	3.2.3
Specific Gravity	3.2.4
Compression Set	3.2.10.5
Quality	3.3
Sizes and Tolerances	3.4

4.2.1.1 Lot

A quantity of one size of product processed and packaged as one production entity from a batch.

4.2.1.2 Batch

A quantity of compound run through a mill or mixer at one time.

4.2.1.3 Random Sampling

The method shall be specified in the parts standard, drawing or purchase document. If not specified, product shall be taken at random from each lot to perform all the required acceptance tests. The number of test iterations for each requirement shall be specified in the applicable test procedure.

4.2.1.4 Sample

Shall be end product whenever possible. Suitable test size for O-rings shall be determined by Table 3. When impossible to test the end product, AS568 size -214 O-rings with the same state of cure as the production part shall be tested.

TABLE 3 - SUITABLE TEST SIZES

Spool Size	Cross-section	O-ring Size
1/8 inch	0.070	-011 to -014
1/4 inch	0.070	-015 to -021
	0.103	-113 to -213
	0.139	-211 to -213
1/2 inch	0.070	-022 to -050
	0.103	-120 to -163
	0.139	-214 to -258

4.2.1.5 Report

The supplier of the product shall prepare an acceptance test report. This report shall include: AMS number, manufacturer's identification and product designation, batch/lot number, date of manufacture, and the results of all acceptance tests.

4.2.2 Qualification Tests

All technical requirements shall be performed prior to the initial shipment of the product to a purchaser, when a change in ingredients and/or processing requires reapproval, when purchaser deems confirmatory testing to be required, and for reapproval of qualification per 3.6.1.

4.2.2.1 Sample

Shall be from a production batch/lot; AS568 size -214 O-rings shall be used for all testing.

4.2.2.2 Testing

Shall be in accordance with PD2000. Verification tests shall consist of tests listed in Table 2 plus long term compression set (3.2.8.6 and 3.2.9.6). Testing for qualification reapproval shall be all technical requirements (no verification tests are required).

4.2.2.3 Report

The supplier of the product shall make a qualification test report available. This report shall include AMS number, manufacturer's identification and product designation, batch/lot number, date of manufacture, and the results of all qualification tests.

4.3 Inspection

4.3.1 End of Manufacturing Process Inspection

Each individual seal shall be inspected according to ISO 3601-3 Class CS under 1X magnification. The entire seal surface shall be manually or electronically inspected.

4.3.2 Final Inspection

The sample size shall be as indicated in Table 4. Inspection shall be according to ISO 3601-3 Class CS under 2X magnification. The entire seal surface shall be manually or electronically inspected.

TABLE 4 - FINAL INSPECTION SAMPLE SIZE

Lot Size	Sample Size
2 to 8	Entire Lot
9 to 90	8
91 to 150	12
151 to 280	19
281 to 500	21
501 to 1200	27
1201 to 3200	35
3201 to 10 000	38
10 001 to 35 000	46
35 001 to 150 000	56
150 001 and over	65

4.4 Test Methods

4.4.1 Weight Loss Tests

The weight loss test shall be conducted on samples air-aged at $518^{\circ}\text{F} \pm 5$ ($270^{\circ}\text{C} \pm 2$). Test specimens shall be conditioned for 24 hours ± 0.5 in a desiccator before and after air aging. The specimens shall be weighed immediately after the desiccation period before and after aging. The percentage weight loss shall be calculated as shown in Equation 1.

$$\text{Percentage Weight Loss} = \frac{W_1 - W_2}{W_1} * 100 \quad (\text{Eq. 1})$$

where:

W_1 = Weight of sample before air-aging

W_2 = Weight of sample after air-aging

4.5 Approval

4.5.1 Manufacturer shall use ingredients, manufacturing procedures, processes, and methods of inspection on production product which are essentially the same as those used on the qualification sample. If any change in ingredients, in type of equipment for processing, or in manufacturing procedures is necessary, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing and, when requested, sample product. Production product made by the revised procedure shall not be shipped prior to receipt of re-approval.

4.5.2 Manufacturer shall establish, for each size of seal, parameters for the process control factors which will produce seals meeting the technical requirements of this specification. These shall constitute the approved procedures and shall be used for manufacturing production of seals. If necessary to make any change in parameters for the process control factors, manufacturer shall submit for re-approval a statement of the proposed changes in ingredients and/or processing. When requested, sample seals shall be submitted in accordance with the provisions of 4.1. Seals manufactured using a revised procedure shall not be shipped prior to re-approval of qualification in writing.

4.5.2.1 Control factors for producing seals include, but are not limited to, the following:

Compound ingredients and proportions thereof within established limits

Sequence of mixing compound ingredients

Type of mixing equipment

Method and equipment for preparing performs

Basic molding procedure (compression, transfer, injection)

Cure time, cure temperature, and cure pressure; variations of $\pm 10\%$ are permissible

Postcure time and postcure temperature; variations of $\pm 10\%$ are permissible

Finishing methods

Methods of inspection