SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 3216G

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Superseding AMS 3216F

Fluorocarbon (FKM) Rubber
High-Temperature - Fluid Resistant
Low Compression Set
70 to 80

1. SCOPE:

1.1 Form:

This specification covers a fluorocarbon (FKM) rubber in the form of sheet, strip, tubing, extrusions, and molded shapes.

1.2 Application:

These products have been used typically in components in contact with air and a wide variety of fuels, synthetic lubricants, and specific hydraulic fluids from -29 to +204 °C (-20 to +400 °F), but usage is not limited to such applications. Each application should be considered individually. This class of fluoroelastomers is not recommended for use in high temperature stabilized, “HTS”, engine oils. Each “HTS” oil should be evaluated separately.

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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

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2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2279	Tolerances, Rubber Products
AMS 2810	Identification and Packaging, Elastomeric Products
AMS 3023	Fluid, Reference, for Testing Polyol Ester (and Diester) Resistant Materials

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM D 297	Rubber Products - Chemical Analysis
ASTM D 395	Rubber Property - Compression Set
ASTM D 412	Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 471	Rubber Property - Effect of Liquids
ASTM D 573	Rubber - Deterioration in an Air Oven
ASTM D 1329	Rubber Property - Retraction at Lower Temperatures (TR Test)
ASTM D 2240	Rubber Property - Durometer Hardness

3. TECHNICAL REQUIREMENTS:

3.1 Material:

Shall be a compound, based on a fluorocarbon (FKM) elastomer, suitably cured to produce a product meeting the requirements of 3.2 and 3.3. A dihydroxy/bisphenol cure system shall be used. Material shall be based on 100% virgin fluorocarbon (FKM) elastomer. No reprocessed or non-fluorocarbon polymer is acceptable.

3.1.1 Color: Shall be black or brown. No other color shall be acceptable.

3.2 Properties:

The product shall conform to the requirements shown in Table 1; tests shall be performed on the product supplied and in accordance with ASTM Test Methods, insofar as practicable.

TABLE 1 - Properties

	Property	Requirement	Test Method
3.2.1	Hardness, Durometer “A” or equivalent	75 ± 5	ASTM D 2240
3.2.2	Tensile Strength, min	1600 psi (11.02 MPa)	ASTM D 412
3.2.3	Elongation, min	125%	ASTM D 412
3.2.4	Specific Gravity	Preproduction Value ±0.02	ASTM D 297 (Hydrostatic Method)
3.2.5	Aromatic Fuel Resistance		ASTM D 471 ASTM Ref. Fuel B 23 °C ± 2 (73 °F ± 5) 70 hours ± 0.5
3.2.5.1	Hardness Change, Durometer “A” or equivalent	-5 to +5	
3.2.5.2	Tensile Strength Change, max	-20%	
3.2.5.3	Elongation Change, max	-20%	
3.2.5.4	Volume Change	0 to +5%	
3.2.6	Synthetic Lubricant Resistance		ASTM D 471 (Note A) AMS 3023 200 °C ± 3 (392 °F ± 5) 70 hours ± 0.5
3.2.6.1	Hardness Change, Durometer “A” or equivalent	-15 to 0	
3.2.6.2	Tensile Strength Change, max (based on area before immersion)	-35%	
3.2.6.3	Elongation Change, max	-20%	
3.2.6.4	Volume Change	+1 to +25%	

TABLE 1 – Properties (Continued)

3.2.6.5	Compression Set, Percent of Original Deflection, max	20	ASTM D 395 Method B
3.2.7	Dry Heat Resistance		ASTM D 573 270 °C ± 3 (518 °F ± 5) 70 hours ± 0.5
3.2.7.1	Hardness Change, Durometer "A" or equivalent	-5 to +10	
3.2.7.2	Tensile Strength Change, max	-35%	
3.2.7.3	Elongation Change, max	-15%	
3.2.7.4	Weight Loss, max	10%	4.6.1
3.2.8	Compression Set: Percent of Original Deflection, max	15	ASTM D 395 Method B 200 °C ± 3 (392 °F ± 5) 22 hours ± 0.5
3.2.9	Long-Term Compression Set: Percent of Original Deflection, max	45	200 °C ± 3 (392 °F ± 5) 336 hours ± 0.5
3.2.10	Low-Temperature Resistance Temperature Retraction, TR_{10}, Point, max	-15 °C (+5 °F)	ASTM D 1329

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

3.3 Properties After Humidity Aging on Brown Material Only:

The properties shown in Table 2 shall be determined on brown specimens that have been aged for 28 days ± 2 hours at 25 °C ± 2 (77 °F ± 5) and 95% ± 3 relative humidity.

TABLE 2 - Humidity Aged Properties

	Property	Requirement	Test Method
3.3.1	Tensile Strength, min	1600 psi (11.02 MPa)	
3.3.2	Elongation, min	125%	
3.3.3	Tensile Strength Change, max[1]	-15%	
3.3.4	Elongation Change, max[1]	-15%	
3.3.5	Synthetic Lubricant Resistance		ASTM D 471 (Note A) AMS 3023 200 °C ± 3 (392 °F ± 5) 70 hours ± 0.5
3.3.5.1	Tensile Strength Change, max[2]	-35%	
3.3.5.2	Elongation Change, max[2]	-20%	
3.3.5.3	Compression Set, Percent of Original Deflection, max	15	
3.3.6	Dry Heat Resistance After Humidity Age		ASTM D 573 270 °C ± 3 (518 °F ± 5) 70 hours ± 0.5
3.3.6.1	Tensile Strength Change, max	-35%	
3.3.6.2	Elongation Change, max	-25%	
3.3.7	Compression Set, Percent of Original Deflection, max	15	ASTM 395 Method B 200 °C ± 3 (392 °F ± 5) 22 hours ± 0.5

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

(1) Shall be based on the original tensile strength and elongation found when tested to the requirements of Table 1.

(2) Shall be based on the tensile strength and elongation found after aging 28 days ± 2 hours at 250 °C ± 2 (77 °F ± 5) and 95% ± 3 relative humidity.

3.4 Quality:

Products, as received by purchaser, shall be uniform in quality and condition, smooth, as free from foreign materials as commercially practicable, and free from internal imperfections detrimental to usage of the product.

3.5 Sizes and Tolerances:

Shall conform to all applicable requirements of AMS 2279.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

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

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Requirements shown in Table 3 are acceptance tests and shall be performed on each lot.

TABLE 3 - Acceptance Requirements

Requirement	Paragraph
Hardness	3.2.1
Tensile Strength	3.2.2
Elongation	3.2.3
Density	3.2.4
Compression Set	3.2.8
Quality	3.4

4.2.2 Preproduction Tests: All technical requirements shall be performed prior to or on the initial shipment of the product to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.2.2.1, and when purchaser deems confirmatory testing to be required.

4.2.2.1 Manufacturer shall use ingredients, manufacturing procedures, processes, and methods of inspection on production product which are essentially the same as those used on the approval sample. If necessary to make any change in ingredients, in type of equipment for processing, or in manufacturing procedures, 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 reapproval.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 Acceptance Tests: Sufficient product shall be taken at random from each lot to perform all the required tests. The number of determinations for each requirement shall be as specified in the applicable test procedure except as otherwise specified in 4.3.1.4 or, if not specified therein, not less than three.

4.3.1.1 If specimens cannot be prepared from the product, ASTM test specimens prepared from the same batch and state of cure shall be used. When the product supplied is an extrusion of such shape that suitable test specimens cannot be cut from the product, a separate flat strip test sample from the same production lot shall be supplied upon request. This strip shall be prepared from tubing 1.000 inch ± 0.063 (25.40 mm ± 1.60) in OD by 0.075 inch ± 0.008 (1.90 mm ± 0.20) in wall thickness, mechanically slit and flattened into a strip while being extruded, and cured in the same manner as production product. When the product is a molded shape from which test specimens cannot be cut, a slab 6 inches (152 mm) square by 0.075 inch ± 0.008 (1.90 mm ± 0.20) thick molded from the same batch of compound shall be supplied upon request.

4.3.1.2 A lot shall be all product produced from the same batch of compound processed in one continuous run and presented for manufacturers inspection at one time.

4.3.1.3 A batch shall be the quantity of compound run through a mill or mixer at one time.

4.3.1.4 Final Inspection Sampling Plan: A statistical sampling plan acceptable to the purchaser may be used in lieu of sampling as in 4.3.1. Sample size for visual and dimensional requirements shall be as shown in Table 4; sample unit shall be one molded part and acceptance based on zero defects.

TABLE 4 - Visual and Dimensional Inspection

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

4.3.2 Preproduction Tests: Acceptable to purchaser or as stated in the contract.

4.4 Approval:

4.4.1 Manufacturer shall establish for each product, parameters for the process control factors which will produce products meeting the technical requirements of this specification. These shall constitute the approved procedures and shall be used for manufacturing production of products. If necessary to make any changes in the parameters for process control factors, manufacturer shall submit for reapproval a statement of the proposed changes in ingredients and/or processing. Products manufactured using a revised procedure shall not be shipped prior to reapproval in writing. Manufacturer shall use ingredients, manufacturing procedures, processes, and methods of inspection in production which are essentially the same as those used on the approved sample.

4.4.1.1 Control factors for production 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 preforms
Basic molding procedure (compression, transfer, injection)
Curing time and pressure; variations of ±10% are permissible
Finishing methods
Methods of inspection.

4.4.1.2 Any of the above process control factors for which parameters are considered proprietary by the manufacturer may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.5 Test Methods:

Shall be as follows:

4.5.1 Weight Loss Tests: The weight loss test shall be conducted on samples air-aged at 270 °C ± 3 (518 °F ± 5). 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.

$$\text{Weight Loss} = \frac{W_1 - W_2}{W_1} \times 100 \qquad \text{(Eq. 1)}$$

where:

W_1 = weight of sample before air-aging
W_2 = weight of sample after air-aging