

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

Rubber, Fluorocarbon Elastomer, Improved Performance at Low Temperatures

NOTICE

This document has been taken directly from U.S. Military Specification MIL-R-83485, Amendment 3, and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-R-83485, Amendment 3. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Any material relating to qualified product lists has not been adopted by SAE. This material was part of the original military specification and is reprinted here for historic reference only.

1. SCOPE:

1.1 Scope:

This specification covers high temperature, compression set, and fluid resistant fluorocarbon elastomer sheets, strips, molded parts, and extruded shapes for aeronautical and aerospace applications. This material differs from other fluorocarbon elastomers because of its improved low temperature performance of approximately 25°F.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 1998 Society of Automotive Engineers, Inc.
All rights reserved.

Printed in U.S.A.

QUESTIONS REGARDING THIS DOCUMENT:
TO PLACE A DOCUMENT ORDER:
SAE WEB ADDRESS:

(724) 772-7161
(724) 776-4970
<http://www.sae.org>

FAX: (724) 776-0243
FAX: (724) 776-0790

1.2 Classification:

The synthetic rubber shall be of the following types and classes, as specified (see 6.2).

Type I - O-Rings and compression seals

Type II - Molded parts (other than sealing devices), sheets, strips, and extruded shapes

2. APPLICABLE DOCUMENTS:

The following publications, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-P-4861	Packing, Preformed, Rubber, Packing, Packaging of
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-R-83485/1	(USAF) Rubber, Fluorocarbon Elastomer, Improved Performance at Low Temperatures, O-Rings, Sizes and Tolerances
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-289	Visual Inspection Guide for Rubber Sheet Material
MIL-STD-298	Visual Inspection Guide for Rubber Extruded Goods
MIL-STD-407	Visual Inspection Guide for Rubber Molded Items
MIL-STD-413	Visual Inspection Guide for Rubber O-Rings
TT-S-735	Standard Test Fluids; Hydrocarbon
UU-P-268	Paper, Kraft, Untreated Wrapping
PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-636	Box, Fiberboard
PPP-T-45	Tape; Gummed, Paper, Reinforced and Plain, For Sealing and Securing

2.2 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 3021 Reference Fluid for Testing Di-ester (polyol) Resistant Material

AS568 Aerospace Size Standard for O-Rings

2.3 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

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	Evaluating Rubber Property - Retraction at Lower Temperatures (TR Test)
ASTM D 1414	Rubber O-Rings
ASTM D 2240	Rubber Property - Durometer Hardness

3. REQUIREMENTS:

3.1 First article:

When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.3. The approval of the first article sample authorizes the commencement of production, but does not relieve the supplier of responsibility for compliance with all applicable provisions of this specification. The first article sample shall be manufactured in the same facilities to be used for the manufacture of the production items.

3.1.1 Test report: A test report shall be prepared for each type. An updated test report shall be prepared whenever a change is made in the materials, processes, or this specification. Preproduction tests over 3 years old shall not be acceptable.

3.2 Materials:

The cured compound of fluorocarbon elastomer shall be entirely suitable for the intended purpose, and shall be of the same composition as the material used for the preproduction sample.

3.3 Dimensions and tolerances:

3.3.1 Sheets and strips: Unless otherwise specified (see 6.2), the width of the sheet material shall be 36 ± 1 inches, and the tolerances on thickness shall be as shown in table I. The width of strip material, or of shapes cut from sheet, shall be as specified within a tolerance of ± 5 percent. The thickness of strip material, other than shapes cut from sheet, shall be as specified within a tolerance of ± 5 percent, and the length shall be as specified within a tolerance of ± 1 percent.

Table 1
Thickness tolerances for sheet

Nominal thickness (inch)	Tolerance (inch)
0.060 and less	±0.010
Over 0.060 to 0.120, inclusive	±0.016
Over 0.120 to 0.500, inclusive	±0.031
Over 0.500 to 1.000, inclusive	±0.047
Over 1.000	±0.063

3.3.2 Molded parts (excluding O-rings) and extruded shapes (including tubing): Unless otherwise specified (see 6.2), dimensions and tolerances of molded parts (excluding O-rings) and extruded shapes (including tubing) shall be as specified on the drawing or in the contract or order.

3.3.3 O-Rings: Dimensions and tolerances of O-Rings shall be in accordance with MIL-R-83485/1 (USAF).

3.4 Physical properties:

The physical properties of the fluorocarbon elastomer rubber shall conform to the values given in Table II.

3.5 Identification of product:

3.5.1 Sheets and strips: Unless otherwise specified (see 6.2), sheet material (including strips cut from sheets) shall be marked to show the specification number, type, the manufacturer, the manufacturer's designation (compound number), and the cure date by quarter and year; for example, 3Q76), thus:

MIL-R-83485, Type II
Compound No.
Cure date
XYZ Co.

The identification shall recur constantly, from one end of the sheet to the other, in rows spaced approximately 5 inches apart; shall be clear, legible, and not less than 3/8 inch high; and shall be applied by suitable means using marking fluid that is not deleterious to the fluorocarbon elastomer. The marking shall not be obliterated by normal handling. The color of the marking shall be white, or a contrasting color if the product is white or very light.

3.5.2 Molded parts and extruded shapes (including tubing): Where the size of the product permits, the identification shall be marked as indicated in 3.5.1. When identification marking of the product is impracticable, the unit package shall show the compound number and manufacturer in addition to those markings specified in 5.3. Temporary marking of O-rings for the manufacturer's identification shall be permitted at the time of manufacture but shall in no way affect the properties or function of the O-rings.

Table II
Physical Properties

Original	Type I (O-Rings and Compression Seals)	Type II (Molded parts [other than sealing devices] sheets, strips, and extruded shapes)
Specific gravity	As Determined	As Determined
Hardness points	75±5	75±5
Tensile strength, psi, min.	1600	1600
Elongation,%, min.	120	120
Temperature Retraction, 10% (TR-10), °F, max.	-20	-20
After air aging 70 hours at 75° + 5°F Compression set, % of original deflection, max.	25	25
After aging 70 hours at 75°F in TT-S-735, Type III		
Hardness change, points	±5	+5, -10
Tensile strength decrease,% max.	30	20
Elongation decrease,% max.	20	20
Volume change, %, max.	1 to 10	1 to 10
After air aging 70 hours at 528° ± 5°F		
Hardness change, points	±5	±5
Tensile strength, decrease,% max.	35	35
Elongation decrease, %, max.	10	10
Weight loss,% max.	12	12
After air aging 166 hours at 347° ± 5°F		
Compression set,% of original deflection, max.	25	20
After air aging 22 hours at 392° ± 5°F		
Compression set,% of original deflection, max.	20	15
After aging 70 hours at 347° ± 5°F in Stauffer Blend 7700		
Hardness change, points	+0, -15	+0, -15
Tensile strength decrease,% max.	35	30
Elongation decrease,% max.	20	20
Volume change,%	1 to 20	1 to 20
Compression set,% of original deflection, max.	10	15

3.6 Workmanship:

The product shall be uniform in quality and condition, clean, and free from foreign materials and from defects detrimental to fabrication, appearance, or performance of parts.

4. QUALITY ASSURANCE PROVISIONS:

4.1. Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specifications where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance: All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in specifications shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspections, as part of manufacturing operations, is an acceptance practice to ascertain, conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of tests:

The inspection and testing of the synthetic rubber shall be classified as follows:

- a. Preproduction inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 Preproduction Inspection:

4.3.1 Samples: Test samples for type I materials shall be Size -214 O-rings conforming to MIL-R-83485/1 (USAF) tolerances. Hardness shall be determined on specimens of sufficient dimensions to comply with ASTM D 2240. Samples for type II material shall be obtained from 6 inches by 6 inches by 0.075 platen sheets.

4.3.2 Tests: Preproduction tests shall consist of all the tests specified in 4.6.

4.3.3 Identification of samples: When specified (see 6.2), and as soon as practicable after the award of contract or order, preproduction samples shall be separately packaged and forwarded to the laboratory designated by the contracting officer. Samples shall be plainly identified by securely attached durable tags, marked with the following information:

- a. Samples for preproduction inspection
- b. MIL-R-
- c. Document title, i.e., Rubber, Fluorocarbon, etc.
- d. Manufacturer's part number
- e. Name of manufacturer

4.4 Quality conformance inspection:

4.4.1 Sampling for inspection: Sampling for quality conformance inspection shall be in accordance with MIL-STD-105, except where otherwise indicated herein. Quality conformance tests are required for all production lots of material.

4.4.1.1 Lot: A lot shall consist of all material of the same identity cured in the same production run, from the same batch, and submitted at the same time for inspection.

4.4.1.2 Batch: A batch shall be the quantity of material compounded on a mill or mixer at one time.

4.4.2 Quality conformance test samples: With the exception of o-rings, the end item, or specimens cut from the end item, shall be used as the sample, whenever possible. If these items are unsuitable for use as test samples, tests shall be performed on samples of identical composition and state of cure as that of the end item. Quality conformance tests on o-rings shall always be conducted on Size -214 rings which have been molded at the same time as the production batch.

4.4.3 Inspection of materials and components: The supplier is responsible for insuring that materials and components used were manufactured, tested, and inspected in accordance with referenced subsidiary specifications and standards to the extent specified, or if none, in accordance with this specification (see 4.1). In the event of conflict, this specification shall govern. Inspection records shall be kept complete and available to the procuring activity at all times.

4.4.4 Inspection of the end item: Examination of the end item shall be in accordance with the classification of defects, inspection levels, and acceptable quality levels (AQL's) set forth herein. The lot size, for the purpose of determining the sample size in accordance with MIL-STD-105, shall be expressed in units of O-rings, molded parts, or yards of sheets, strips, or extruded shapes, as applicable for examinations as specified in 4.4.4.1, 4.4.4.2, and 4.4.4.3. If the end item is less than 1 yard, the sample unit shall be the end item.

4.4.4.1 Examination for defects in appearance and workmanship:

4.4.4.1.1 Molded parts including O-rings: The sample unit shall be one molded part and the examination shall be in accordance with MIL-STD-413 for O-rings and MIL-STD-407 for other molded products. The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be 1.5.

4.4.4.1.2 Sheets, strips, and extruded shapes: The sample unit shall be 1 linear yard, except if the end item is less than 1 linear yard, the sample unit shall be the end item. The examination shall be in accordance with MIL-STD-289 and MIL-STD-298, as applicable. Defects in marking such as "incomplete, not legibly identified", or not as specified in 5.1, shall be considered minor. The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be 2.5.

4.4.4.2 Examination for dimensional defects:

4.4.4.2.1 Molded parts including O-rings: The sample unit shall be one molded part. Dimensions shall be in accordance with the applicable size in MIL-R-83485/1(USAF). The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be 1.5.

4.4.4.2.2 Sheets, strips, and extruded shapes: The sample unit shall be 1 linear yard, except if the end item is less than 1 linear yard, the sample unit shall be the end item. The dimensions shall be within the tolerances specified in 3.3.1. Dimensions for extruded shapes shall be as specified on the drawing or in the contract or order. The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be 1.5.

4.4.4.3 Examination for defects in preparation for delivery: An examination shall be made to determine that the packaging, packing, and markings comply with section 5. The sample unit for this examination shall be one shipping container fully packed, selected just prior to the closing operation. Shipping containers fully prepared for delivery shall be examined for closure defects.

<u>Examine</u>	<u>Defect</u>
Packaging (O-rings, molded parts, and extruded shapes)	Not the level specified. Not packaged as specified or required. Packaging material, closures not as specified. Unit items not individually wrapped when specified.
(Sheets)	Not interleaved; separator sheets do not fully cover the full area of contact between the sheets.
(Strips)	Stacked over 10 inches high. Not in rolls; not wound on suitable cores. Rolls not wrapped or sealed as specified.
Packing	Total length per roll varies by more than the indicated tolerances (5.1.1.2.2). Not level specified; not in accordance with contract requirements. Container not as specified, closures not accomplished by specified or required methods or materials.
Packing	Any nonconforming component, component missing, damaged or otherwise defective, affecting serviceability. Inadequate application of components, such as incomplete closure of case liners, containing flaps loose or inadequate strapping, bulged or distorted containers.
Count	Less than specified or indicated quantity, linear footage, or units, as applicable.
Weight	Gross weight exceeds specified requirements.
Markings	Interior or exterior markings, as applicable, omitted, illegible, incorrect, incomplete, or not in accordance with contract requirements. Date of cure, storage instruction missing.

The sample size shall be in accordance with inspection level II of MIL-STD-105 and the AQL related to percent defective shall be in 2.5.

4.4.5 Quality conformance tests: The following tests shall be conducted on each lot of material (see 4.4.2):

<u>Original</u>	<u>Air aged 22 hours @ 392° ± 5°F</u>
Tensile strength	Compression set
Elongation	
Hardness	
Specific gravity	

If the items are unsuitable for use as test samples, tests shall be performed on samples of identical composition and state of course as the item.

4.4.5.1 Rejection criteria: A lot shall be rejected upon the failure of any sample to meet the test requirements specified herein. A lot that has been rejected may be reworked to correct the deficiencies and resubmitted for acceptance.

4.5 Test conditions:

4.5.1 Control fluid: The control fluid used to conduct the oil aging in this specification shall be in accordance with AMS 3021. It consists of a MIL-L-7808 standard production base fluid plus 0.5 percent phenothiazine. New fluid shall be used for each aging test.

4.5.2 Atmospheric conditions: All fluid cooling, conditioning, and physical property determinations of rubber shall be conducted in an atmosphere of 50 ± 15 percent relative humidity and at a temperature of 75° ± 5°F.

4.6 Test methods:

4.6.1 Physical properties: Unless otherwise specified herein, physical properties shall be determined in accordance with ASTM test methods for rubber products as follows:

<u>Property</u>	<u>ASTM Method</u>
Hardness	D 2240
Tensile strength and elongation	
Type I	D 1414
Type II	D 412, (Use die C for oil aging)
Volume	D 471
Specific gravity	D 297, hydrostatic method
Temperature Retraction (TR-10)	
Type I	D 1414
Type II	D 1329

4.6.2 Air aging at 528°F: Air aging shall be conducted in accordance with ASTM D 573, except that the rubber shall be aged for 70 hours at 528°F + 5°F. Tensile strength, elongation, and hardness changes shall be determined as specified in 4.6.1.

4.6.2.1 Weight loss: The weight loss test shall be conducted on samples air-aged in accordance with 4.6.3. Test specimens shall be conditioned for 24 hours 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 follows:

$$\frac{w_1 - w_2}{w_1} \times 100$$

where w_1 = weight of sample before air-aging

w_2 = weight of sample after air-aging

4.6.3 Oil aging: Oil aging of specimens shall be conducted in clean 38 millimeters (mm) OD by 300 mm pyrex glass test tubes fitted with 2-hole cork stoppers. Each stopper shall be fitted with 2 lengths of 8 mm pyrex glass tubing (chimneys), one 3 inch in length, the other 5 inches in length. The 3-inch chimney shall extend through and 1/2 inch above the top of the stopper. The 5-inch chimney shall extend through and 3-1/2 inches above the top of the stopper. An aluminum block heater shall be used for aging the specimens. Use of an oil bath is permissible, but is not desired. For each test, 140 milliliters (ml) of oil shall be used. The test shall be inserted into the aluminum block or oil bath in such manner that the fluid level in the test tubes shall be approximately 1-5/8 inches above the heating unit of the aluminum block or surface of the oil bath. The distance shall not be measured from the top of the aluminum block or covering of the oil bath. The specimens shall be suspended in the oil by soft iron or nichrome wire hangers as follows:

- a. Type I: Three specimens shall be suspended horizontally in the fluid, one each at depths of 1-1/2 inches, 3-1/2 inches, and 5-1/2 inches below the surface of the fluid. Hardness specimens shall be placed in a separate chimney stoppered tube keeping approximately the same rubber-to-oil ratio.
- b. Tube II: Four dumbbells cut with a die "C", conforming to ASTM D412, shall be tested. There shall be only two specimens aged in a single test tube. The specimens shall be suspended vertically in the fluid, one each at depths of 1 inch and 2 inches below the surface of the fluid. The measurement of specimen depth in the fluid shall be made between the top edge of the specimen and the fluid level. Care shall be taken to prevent contact of specimens with each other or the wall of the test tube.

4.6.3.1 The oil-aging time and temperature shall be 70 hours at 347° ± 5°F. After aging and prior to the physical property determinations, the specimens shall be removed from the hot fluid and cooled 30 minutes in fresh fluid. Tensile strength, elongation, hardness, and volume change shall then be determined as specified in 4.6.1.

- 4.6.4 Fuel aging: Specimens shall be immersed in test fluid conforming to TT-S-735, type III, for 70 hours at $75^{\circ} \pm 5^{\circ}\text{F}$. The ratio of fluid to rubber shall be approximately 40 ml per gram. Aging shall be conducted in a glass container. An airtight seal shall be maintained for the duration of the test. One sample at a time shall be removed from the fluid, immediately blotted dry, and tested. The tensile strength, elongation, hardness and volume change tests shall be conducted in accordance with 4.6.1.
- 4.6.5 Compression set: Except where otherwise specified herein, compression set shall be determined in accordance with ASTM D 395, method B. Specimens for type I materials shall be two O-rings. Two circular plied-up buttons with dimensions of 1.129 0.010 inches diameter and approximately 0.5 inch thick shall be used for type II material.
- 4.6.5.1 Air aged: Compression set shall be determined on specimens air aged for 70 hours at $75^{\circ}\text{F} \pm 5^{\circ}\text{F}$, on specimens air aged for 166 hours at $347^{\circ}\text{F} \pm 5^{\circ}\text{F}$ and on specimens air aged 22 hours at $392^{\circ}\text{F} \pm 5^{\circ}\text{F}$. A single set of specimens shall be used for the 75°F and 392°F tests and two sets shall be used for the 347°F tests. The test procedure shall be in accordance with ASTM D 395 for the 75°F and 392°F specimens and one set of the 347°F specimens. The second set of 347°F specimens shall cool for 18 hours prior to removal from the test fixture. The usual 30 minute waiting period before taking the final thickness measurement shall be used.
- 4.6.5.2 Oil aged: Compression set shall be determined on two sets of specimens aged 70 hours at $347^{\circ}\text{F} \pm 5^{\circ}\text{F}$ immersed in fluid conforming to AMS 3021. The compression set plates for testing type I material shall be approximately 0.375 inch by 2 inches by 4 inches. There shall be six 1/4-inch bolt holes; one on each corner and one located in the middle of each 4-inch edge and on the center line of the corner holes. There shall also be 1/4-inch holes through the middle of each half of the plates to allow fluid to be in contact with the inside diameter of the O-rings. The compression set plates for type I compression seals other than O-rings and type II material shall be in accordance with ASTM D 395. The original thickness of the specimens shall be measured and the test fixtures shall be assembled using two test specimens. The specimens shall be compressed 25 percent. The test fixture shall be placed in a 1-liter stainless steel beaker and 800 milliliters of fluid conforming to AMS 3021 shall be added to the beaker. The beaker shall be fitted with a suitable vented stainless steel cap. The cap shall be sealed with an O-ring conforming to type I, class 1 of this specification (size -240 ARP 568 has been used). The beaker shall be placed in a suitable oven at $347^{\circ}\text{F} \pm 5^{\circ}\text{F}$ with vent open. After the fluid has reached the test temperature (approximately 2 hours) the vent shall be closed and the beaker left in the oven for a total aging time of 70 hours. At the end of the aging time, the set of specimens shall be removed from the compression plates immediately and allowed to cool on paper towels for 30 minutes. Excess fluid shall be blotted from the specimens with paper towels and the final thickness determined. The other set of specimens shall be allowed to cool in the fluid for 18 hours. The specimens shall be removed from the compression set plates and allowed to rest on paper towels for 30 minutes. The excess fluid shall be blotted from the specimens and the final thickness measurement made.