

THERMOFIT™ FLUOROPOLYMER MOLDED COMPONENTS
Modified Fluoropolymer, Radiation Crosslinked,
Flexible, Abrasion Resistant, Flame Retarded, Heat Shrinkable

1. SCOPE

This specification covers the requirements for one type of flexible, electrical insulating molded component whose expanded dimensions will reduce to a predetermined size upon the application of heat in excess of 220°C (428°F). The molded components are suitable for use in wire harness systems requiring high fluid resistance and resistance to the effects of nuclear, biological and chemical agent exposure and decontamination as defined herein and in RT-700.

2. APPLICABLE DOCUMENTS

This specification takes precedence over documents referenced herein. Unless otherwise specified, the latest issue of referenced documents applies. The following documents form a part of this specification to the extent specified herein.

2.1 GOVERNMENT-FURNISHED DOCUMENTS

Military

MIL-L-2104	Lubricating Oil, Internal Combustion Engine, Heavy Duty
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP-8
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-A-8243	Anti-Icing and Deicing - Defrosting Fluids
MIL-D-12468	Decontaminating Agent, STB
MIL-C-43616	Cleaning Compounds, Aircraft Surface
MIL-D-50030	Decontaminating Agent, DS-2

Federal

O-S-1926	Sodium Chloride, Technical
VV-F-800	Fuel Oil, Diesel, Grade DF-2

2.2 OTHER PUBLICATIONS

American Society for Testing and Materials (ASTM)

ASTM D 149	Standard Methods of Tests for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies
ASTM D 257	Standard Methods of Test for D-C Resistance or Conductance of Insulating Materials
ASTM D 412	Standard Method of Tests for Rubber Properties in Tension
ASTM D 570	Standard Methods of Test for Water Absorption of Plastics
ASTM D 635	Standard Methods of Test for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 792	Standard Methods of Test for Specific Gravity and Density of Plastics by Displacement
ASTM D 910	Standard Specification for Aviation Gasolines
ASTM D 2671	Standard Methods of Testing Heat Shrinkable Tubing for Electrical Use

ISO 846 Determination of behaviour under the action of fungi and bacteria - Evaluation by visual examination or measurement of change in mass or physical properties.

(Copies of ASTM Publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

Raychem Corporation

RT-700 Harness System Chemical Agent Exposure & Decontamination

3. REQUIREMENTS

3.1 MATERIAL

The molded components shall be fabricated from a crosslinked, thermally stabilized, flame-retarded, modified fluoropolymer material. They shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, cracks and inclusions.

3.2 COLOR

The molded components shall be black.

3.3 PROPERTIES

The molded components and the material from which they are fabricated shall meet the requirements of Table 1.

3.4 SYSTEMS PERFORMANCE

The performance of harness systems fabricated with this material shall satisfy the requirements of Systems Specification RT-700.

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS

4.1.1 Qualification Tests

Qualification tests are those performed on molded slabs and components submitted for qualification as satisfactory products and shall consist of all tests listed in this specification.

4.1.2 Acceptance Tests

Acceptance tests are those performed on molded slabs and components submitted for acceptance under contract. Acceptance tests shall consist of the following:

Visual
Dimensional Recovery
Tensile Strength
Ultimate Elongation
Heat Shock
Flammability

4.2 SAMPLING INSTRUCTIONS

4.2.1 Qualification Test Samples

Qualification test samples shall consist of twelve molded slabs, 6 x 6 x 0.075 ± 0.010 inches (152 x 152 x 1.9 ± .25 mm) and the number of molded components specified. The molded slabs shall be fabricated from the same lot of material and shall be subjected to the same degree of crosslinking as the molded components.

4.2.2 Acceptance Test Samples

Acceptance test samples shall consist of specimens cut from a molded slab 6 x 6 x 0.075 ± 0.010 inches (152 x 152 x 1.9 ± .25 mm), and molded components selected at random. The molded slab shall be fabricated from the same lot of material and shall be subjected to the same degree of crosslinking as the molded components. A lot of components shall consist of all molded components from the same lot of material, from the same production run, and offered for inspection at the same time.

4.3 TEST PROCEDURES

4.3.1 Dimensions and Dimensional Recovery

Measure samples of molded components, as supplied, for dimensions in accordance with ASTM D 2671. Then condition the samples for 10 minutes in a 250 ± 3°C (482 ± 5°F) oven, or equivalent, cool to room temperature and remeasure.

4.3.2 Elastic Memory

Mark a 6 x 1/8-inch (152 x 3.2-mm) specimen cut from a molded slab with two parallel gauge lines 1 inch (25 mm) apart in the central portion of the specimen. Record the distance between gauge lines as the original length. Heat a 2-inch (51-mm) portion of the specimen including both gauge lines for 3 minutes in a 250 ± 3°C (482 ± 5°F) oven, or equivalent, remove from the oven and stretch within 10 seconds, until the gauge lines are 4 inches (102 mm) apart. Cool the extended specimen to room temperature and release from tension. After 24 hours at room temperature, measure the distance between the gauge lines and record as the extended length. Reheat the portion of the specimen including both gauge lines for 3 minutes in a 250 ± 3°C (482 ± 5°F) oven, or equivalent, and measure the distance between gauge lines; record this distance as the retracted length.

Calculate expansion and retraction as follows:

$$E = \frac{L_e - L_o}{L_o} \times 100$$

$$R = \frac{L_e - L_r}{L_e - L_o} \times 100$$

Where: E = Expansion (percent)
 R = Retraction (percent)
 L_o = Original Length [inches (mm)]
 L_e = Extended Length [inches (mm)]
 L_r = Retracted Length [inches (mm)]

4.3.3 Tensile Strength and Ultimate Elongation

Test three specimens cut from a molded slab using Die D of ASTM D 412 for tensile strength and ultimate elongation in accordance with ASTM D 412.

4.3.4 Low Temperature Flexibility

Condition three 6 x 1/4-inch (*152 x 6.3-mm*) specimens cut from a molded slab, along with a 1.125-inch (28.6 mm) mandrel, in a cold chamber at $-65 \pm 2^{\circ}\text{C}$ ($-85 \pm 4^{\circ}\text{F}$) for 4 hours. After completion of the conditioning, and while the specimens are still in the cold chamber, bend each specimen around the mandrel through not less than 360 degrees within 10 ± 2 seconds. Examine the specimens visually for cracks.

4.3.5 Heat Shock

Condition three 6 x 1/4-inch (*152 x 6.3-mm*) specimens cut from a molded slab for 4 hours in a $300 \pm 5^{\circ}\text{C}$ ($572 \pm 9^{\circ}\text{F}$) mechanical convection oven with an air velocity of from 100 to 200 feet per minute past the specimens. After conditioning, remove the specimens from the oven, cool to room temperature, and bend through 360 degrees over a 3/8-inch (*9.5-mm*) diameter mandrel. Examine the specimens visually for evidence of dripping, flowing or cracking.

4.3.6 Heat Resistance

Condition three specimens, prepared and measured in accordance with 4.3.3 for 336 hours in a $250 \pm 3^{\circ}\text{C}$ ($482 \pm 5^{\circ}\text{F}$) mechanical convection oven with an air velocity of 100 to 200 feet per minute past the specimens. After conditioning, remove the specimens from the oven, cool to room temperature, and test for tensile strength and ultimate elongation in accordance with 4.3.3.

4.3.7 Corrosive Effect

Test three 1 x 1/4-inch (*25.4 x 6.3-mm*) specimens cut from a molded component for corrosive effect in accordance with ASTM D 2671, Procedure A. Condition the specimens for 16 hours at $200 \pm 3^{\circ}\text{C}$ ($392 \pm 5^{\circ}\text{F}$).

4.3.8 Fluid Resistance

Immerse three specimens prepared and measured in accordance with 4.3.3 completely in the test fluids listed in Table 1 for 24 hours at the specified temperatures. Use a volume of fluid not less than 20 times that of the specimens. After conditioning, lightly wipe the specimens and then air-dry for 30 to 60 minutes at room temperature. Test the specimens for tensile strength and ultimate elongation in accordance with 4.3.3.

4.3.9 Radiation Resistance

Three specimens prepared in accordance with Section 4.3.2 shall be subjected to gamma radiation for a total dosage of 10 Mrad at a rate of less than 0.5 Mrad per hour. The specimens shall be measured for tensile strength and ultimate elongation in accordance with Section 4.3.2.

4.4 REJECTION AND RETEST

Failure of any sample to comply with any one of the requirements of this specification shall be cause for rejection of the lot represented. Material which has been rejected may be replaced or reworked to correct the defect and resubmitted for acceptance. Before resubmitting, full particulars concerning the rejection and the action taken to correct the defect shall be furnished to the inspector.

5. PREPARATION FOR DELIVERY**5.1 PACKAGING**

Packaging of molded components shall be in accordance with good commercial practice. The shipping container shall be not less than 125 pound test fiberboard.

5.2 MARKING

Each molded component shall be distinctly identified on the part and/or package with the manufacturing name or symbol, the manufacturer's part number, lot number, date of manufacture, and use before date.

TABLE 1
Requirement

PROPERTY	UNIT	REQUIREMENTS	TEST METHOD
PHYSICAL Dimensions	inches (<i>mm</i>)	In accordance with applicable specification control drawing	Section 4.3.1 ASTM D 2671
Dimensional Recovery	inches (<i>mm</i>)	In accordance with applicable specification control drawing	
Elastic Memory	percent	200 minimum expansion 90 minimum retraction	Section 4.3.2
Tensile Strength	psi (<i>MPa</i>)	3500 minimum (<i>24.1</i>)	Section 4.3.3
Ultimate Elongation	percent	200 minimum	ASTM D 2671
Specific Gravity	---	2.0 maximum	ASTM D 792
Low Temperature Flexibility 4 hours at $-65 \pm 2^{\circ}\text{C}$ ($-85 \pm 4^{\circ}\text{F}$)	---	No cracking	Section 4.3.4
Heat Shock 4 hours at 300°C (572°F)	---	No dripping, flowing or cracking	Section 4.3.5
Heat Resistance 336 hours at 250°C (482°F) Followed by tests for:	---	---	Section 4.3.6
Tensile Strength	psi (<i>MPa</i>)	2000 minimum (<i>13.8</i>)	Section 4.3.3
Elongation	percent	150 minimum	ASTM D 2671
ELECTRICAL			
Dielectric Strength	volts/mil	200 minimum	ASTM D 149
Volume Resistivity	ohm-cm	10^{11} minimum	ASTM D 257
CHEMICAL			
Corrosive Effect 16 hours at $200 \pm 3^{\circ}\text{C}$ ($392 \pm 5^{\circ}\text{F}$)	---	Noncorrosive	Section 4.3.7 ASTM D 2671 Procedure A
Flammability			ASTM D 635
Average Time of Burning	seconds	15 maximum	
Average Extent of Burning	inches (<i>mm</i>)	0.5 maximum (<i>12.5</i>)	
Fungus Resistance Followed by tests for			ISO 846, Method B, 56 day exposure
Tensile Strength	psi(<i>MPa</i>)	3500 minimum	
Elongation	percent	200 minimum	
Dielectric Strength	volts/mil	200 minimum	
Water Absorption 24 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$)	percent	0.5 maximum	ASTM D 570

TABLE 1
Requirement
(continued)

PROPERTY	UNIT	REQUIREMENTS	TEST METHOD
CHEMICAL (continued)			
Fluid Resistance	---	---	Section 4.3.8
24 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$) in: Gasoline, Aviation Grade 100 (ASTM D 910) Coolanol* 25			
Followed by tests for:			
Tensile Strength	psi (MPa)	3000 minimum (20.7)	Section 4.3.3
Ultimate Elongation	percent	150 minimum	ASTM D 2671
24 hours at $50 \pm 3^{\circ}\text{C}$ ($122 \pm 5^{\circ}\text{F}$) in: JP-5 (MIL-T-5624) Deicing Fluid (MIL-A-8243) Cleaning Compound (MIL-C-43616) 5% Salt Solution (O-S-1926) Fuel Oil, Diesel (VV-F-800, DF-2)			
Followed by tests for:			
Tensile Strength	psi (MPa)	3000 minimum (20.7)	Section 4.3.3
Ultimate Elongation	percent	150 minimum	ASTM D 2671
24 hours at $75 \pm 3^{\circ}\text{C}$ ($167 \pm 5^{\circ}\text{F}$) in: Hydraulic Fluid (MIL-H-5606) Skydrol* 500 Lubricating Oil (MIL-L-2104) Lubricating Oil (MIL-L-7808)			
Followed by tests for:			
Tensile Strength	psi (MPa)	3000 minimum (20.7)	Section 4.3.3
Ultimate Elongation	percent	150 minimum	ASTM D 2671
Fluid Resistance	---	---	Section 4.3.8
5 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$) MIL-D-50030 Decontaminating Agent, DS-2 MIL-D-12468 Decontaminating Agent STB			
Tensile Strength	psi (MPa)	3500 minimum (24.1)	Section 4.3.3
Ultimate Elongation	Percent	150 minimum	ASTM D 2671
NUCLEAR			Section 4.3.9
Radiation Resistance			
Followed by tests for:			
Tensile Strength	psi (MPa)	3500 minimum (24.1)	
Ultimate Elongation	percent	150 minimum	

*Trademark, Monsanto Company