

**Thermofit[®] NSM Molded Components
Flame Retarded, Heat-Shrinkable**

1. SCOPE

This specification covers the requirements for one type of electrically insulating molded component whose dimensions will reduce to a predetermined size upon the application of heat in excess of $160 \pm 3^{\circ}\text{C}$ ($320 \pm 5^{\circ}\text{F}$). These molded components are suitable for use in wire harness systems requiring 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

Federal

PC-437	Cleaning Compound, High Pressure (Steam) Cleaner
VV-F-800	Fuel Oil Diesel
O-S-1926	Sodium Chloride, Technical

Military

MIL-L-2104	Lubricating Oil, Internal Combustion Engine, Tactical Service
MIL-G-3056	Gasoline, Automotive, Combat
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-A-8243	Anti-Icing and Deicing-Defrosting Fluid
MIL-D-12468	Decontaminating Agent, STB
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base
MIL-H-46170	Hydraulic Fluid Rust Inhibited, Fire-Resistant Synthetic Hydrocarbon Base
MIL-D-50030	Decontaminating Agent, DS-2

Drawings

10873919	Electrolyte
----------	-------------

2.2 OTHER PUBLICATIONS

American Society for Testing and Materials (ASTM)

ASTM D 149	Standard Methods of Test for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at commercial Power Frequencies
ASTM D 257	Test Methods for D-C Resistance or Conductance of Insulating Materials
ASTM D 412	Standard Methods of Test 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 882	Test Methods for Tensile Properties of Thin Plastic Sheeting
ASTM D 1002	Standard Test Method for Strength Properties of Adhesive in Shear By Tension Loading
ASTM D 2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use
ASTM G 21	Recommended Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

(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
RT-1012	Thermofit [®] S-1264, Adhesive, Epoxy, Flexible
RT-1333	Thermofit [®] DCNS Tubing and Molded Components

3. REQUIREMENTS

3.1 MATERIAL

The molded components shall be fabricated from a crosslinked, thermally stabilized, flame-retarded, modified fluoropolymer composition. 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:

Dimensions
Dimensional Recovery
Color
Tensile Strength
Ultimate Elongation
Heat Shock
Initial Flammability

4.2 SAMPLING INSTRUCTIONS

4.2.1 Qualification Test Samples

Qualification test samples shall consist of six molded slabs, 6 x 6 x 0.075 ± 0.010 inches (150 x 150 x 1.9 ± .25 mm), and the number of molded components required. 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 (150 x 150 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

Samples of molded components, as supplied, shall be measured for dimensions in accordance with ASTM D 2671. The samples then shall be conditioned for 10 minutes in a 200 ± 5°C (392 ± 9°F) oven, or equivalent, cooled to room temperature, and remeasured.

4.3.2 Elastic Memory

A 6 x 1/8 inch (150 x 3.2 mm) specimen cut from a molded slab shall be marked with two parallel gauge lines, 1 inch (25.4 mm) apart in the central portion of the specimen. The distance between gauge lines shall be recorded as the original length. A 2-inch (50 mm) portion of the specimen including both gauge lines then shall be heated for 1 minute in a 175 ± 3°C (347 ± 5°F) oven, or equivalent, removed from the oven, and stretched within 10 seconds, until the gauge lines are 4 inches (100 mm) apart. The extended specimen shall be cooled to room temperature and released from tension. After 24 hours at room temperature, the distance between the gauge lines shall be measured and recorded as the extended length. The portion of the specimen including both gauge lines then shall be reheated for 1 minute in a 175 ± 3°C (347 ± 5°F) oven, or equivalent, cooled to room temperature and the distance between gauge lines then shall be measured and recorded as the retracted length. Expansion and retraction shall be calculated 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

Three specimens cut from a molded slab using Die D of ASTM D 412 shall be tested for tensile strength and ultimate elongation in accordance with ASTM D 412. A 1-inch (25-mm) bench mark, 2-inch (50-mm) initial jaw separation, and a jaw separation speed of 2 ± 0.2 inches (50 ± 5 mm) per minute shall be used.

4.3.4 Secant Modulus

Three die-cut strips, 6 x 1/4 inch (150 x 6.3 mm), cut from a slab, shall be tested in accordance with ASTM D 882, using Method A at 2% strain. A 5-inch (125-mm) jaw separation and a jaw separation speed of 0.5 inches (12.5 mm) per minute shall be used.

4.3.5 Low Temperature Flexibility

Three 6 x 1/4 inch (150 x 6.3 mm) specimens cut from a slab shall be conditioned, along with a 1-inch (25 mm) mandrel, in a cold chamber at $-57 \pm 3^{\circ}\text{C}$ ($-70 \pm 5^{\circ}\text{F}$) for 4 hours. After completion of the conditioning, and while still in the cold chamber, each specimen shall be bent around the mandrel through not less than 360 degrees within 10 ± 2 seconds. The specimens then shall be visually examined for cracks.

4.3.6 Heat Shock

Three 6 x 1/4 inch (150 x 6.3 mm) specimens cut from a molded slab shall be conditioned 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 (30 to 60 m) per minute past the specimens. After conditioning, the specimens shall be removed from the oven and cooled to room temperature. The specimens then shall be visually examined for evidence of dripping, flowing or cracking.

4.3.7 Heat Resistance

4.3.7.1 Procedure A

Three specimens, prepared and measured in accordance with 4.3.3, shall be conditioned for 168 hours in a $250 \pm 5^{\circ}\text{C}$ ($482 \pm 9^{\circ}\text{F}$) mechanical convection oven in which air passes the specimens at a velocity of 100 to 200 feet (30 to 60 m) per minute. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and tested for tensile strength and ultimate elongation in accordance with 4.3.3.

4.3.7.2 Procedure B

Three specimens, prepared and measured in accordance with 4.3.3, shall be conditioned for 2000 hours in a $150 \pm 3^{\circ}\text{C}$ ($302 \pm 5^{\circ}\text{F}$) mechanical convection oven in which air passes the specimens at a velocity of 100 to 200 feet (30 to 60 m) per minute. After conditioning, the specimens shall be removed from the oven, cooled to room temperature, and tested for tensile strength and ultimate elongation in accordance with 4.3.3.

4.3.8 Corrosive Effect

Three 1 x 1/4 inch (25 x 6.3 mm) specimens cut from a molded slab shall be tested for corrosive effect in accordance with ASTM D 2671, Procedure A. The specimens shall be conditioned for 16 hours at $175 \pm 3^{\circ}\text{C}$ ($347 \pm 5^{\circ}\text{F}$).

4.3.9 Fluid Resistance

Three specimens, 1 x 2 x .075 inch (25 x 50 x 1.9 mm) cut from molded slabs and weighed, and three tensile and elongation specimens, prepared and measured in accordance with 4.3.3, shall be prepared for each of the fluids listed in Table 1. Three specimens of each configuration shall be immersed in each of the fluids for the time and temperatures specified in Table 1. The volume of the fluid shall not be less than 20 times that of the specimens. After immersion, all the specimens shall be lightly wiped and air dried for 30 to 60 minutes at room temperature. The three specimens intended for the tensile and elongation tests shall then be tested in accordance with 4.3.3. The other three specimens shall be weighed and the weight change calculated as a percentage.

4.3.10 Flammability After Fluid Immersion

Three specimens, 6 x 1/2 inch (*125 x 12.9 mm*) cut from a molded slab shall be immersed in each of the fluids,

MIL-G-3056	Gasoline, Automotive, Combat
VV-F-800 DF-2	Fuel Oil, Diesel
MIL-T-5624	Turbine Fuel, Aviation, JP-4

for 24 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$). The specimens shall be removed from the fluids, allowed to drain for 5 minutes at room temperature and tested for flammability in accordance with ASTM D 635.

4.3.11 Adhesive Compatibility in Shear

4.3.11.1 Sample Preparation

Prepare 3 x 1 x 0.35 inch (*76.2 x 25.4 x .9 mm*) molded strips from materials specified in Table 1 by abrading 0.5 inch (*12.7 mm*) of one end with No. 320 emery cloth and wiping with a tissue wet with 1,1,1 trichloroethane. Apply S-1264 adhesive to the abraded surface.

The assembly and test procedures are similar to those described in ASTM D 1002.

4.3.11.2 Assembly of Test Specimen

Overlap the abraded surface of one strip on top of the coated section of a coated strip to form the combination specified in Table 1. Place the assembly in a press at 25 - 50 psi (*172 - 345 kPa*) and cure for 1 hour at $85 \pm 3^{\circ}\text{C}$ ($185 \pm 5^{\circ}\text{F}$) followed by postcure 72 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$).

4.3.11.3 Procedure

Test the adhesive bond in shear in accordance with ASTM D 1002 at a jaw separation speed of $2 \pm .02$ inches (*50 \pm 5mm*) per minute. Record the load at failure and express all failing loads in pounds per square inch (*kilopascals*). Report the average of five specimens.

4.3.12 Radiation Resistance

Three specimens cut from a molded slab, using Die D of ASTM D 412 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 4.3.3.

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 then 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

If not specified, packaging of molded components shall be in accordance with good commercial practice. The exterior shipping container shall be not less than 125 pound test fiberboard.

5.2 MARKING

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

TABLE 1
Requirements

PROPERTY	UNIT	REQUIREMENT	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	275 minimum expansion 90 minimum retraction	Section 4.3.2
Tensile Strength	psi (<i>MPa</i>)	4000 minimum (<i>27.5</i>)	Section 4.3.3
Ultimate Elongation	Percent	300 minimum	ASTM D 412
Secant Modulus	psi (<i>MPa</i>)	100,000 maximum (<i>689</i>)	Section 4.3.4 ASTM D 882
Specific Gravity	--	1.85 maximum	ASTM D 792
Low Temperature Flexibility 4 hours at $-57 \pm 3^{\circ}\text{C}$ ($-70 \pm 5^{\circ}\text{F}$)	--	No cracking	Section 4.3.5
Heat Shock 4 hours at $300 \pm 5^{\circ}\text{C}$ ($572 \pm 9^{\circ}\text{F}$)	--	No dripping, flowing or cracking	Section 4.3.6
Heat Resistance 168 hours at $250 \pm 5^{\circ}\text{C}$ ($482 \pm 9^{\circ}\text{F}$) Followed by tests for: Tensile Strength Ultimate Elongation	-- psi (<i>MPa</i>) Percent	-- 3500 minimum (<i>24.1</i>) 250 minimum	Section 4.3.7.1 Section 4.3.3 Section 4.3.3
2000 hours at $150 \pm 3^{\circ}\text{C}$ ($302 \pm 5^{\circ}\text{F}$) Followed by tests for: Tensile Strength Ultimate Elongation	-- psi (<i>MPa</i>) Percent	-- 3500 minimum (<i>24.1</i>) 250 minimum	Section 4.3.7.2 Section 4.3.3 Section 4.3.3
ELECTRICAL Dielectric Strength	Volts/mil (<i>kV/mm</i>)	300 minimum (<i>11.9</i>)	ASTM D 149
Volume Resistivity	ohm-cm	10^{13} minimum	ASTM D 257
CHEMICAL Corrosive Effect 16 hours at $175 \pm 3^{\circ}\text{C}$ ($347 \pm 5^{\circ}\text{F}$)	--	Noncorrosive	Section 4.3.8 ASTM D 2671 Procedure A

TABLE 1
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
CHEMICAL (continued)			
Flammability			
Initial			
Average Time of Burning	Seconds	15 maximum	ASTM D 635
Average Extent of Burning	Inches (<i>mm</i>)	1 maximum (25)	
After Fluid Immersion			Section 4.3.10
24 hours at 23 ± 3°C (73 ± 5°F)			
Gasoline, Automotive, Combat			
MIL-G-3056			
Fuel Oil, Diesel VV-F-800 DF-2			
Turbine Fuel, Aviation, JP-4			
MIL-T-5624			
Average Time of Burning	Seconds	30 maximum	ASTM D 635
Average Extent of burning	Inches (<i>mm</i>)	1 maximum (25)	
Fungus Resistance	--	Rating of 1 or less	ASTM G 21
Water Absorption	Percent	0.5 maximum	ASTM D 570
24 hours at 23 ± 3°C (73 ± 5°F)			
Fluid Resistance	--	--	Section 4.3.9
24 hours at 23 ± 3°C (73 ± 5°F)			
Gasoline, Automotive, Combat			
MIL-G-3056			
24 hours at 50 ± 3°C (122 ± 5°F)			
Fuel Oil Diesel VV-F-800 DF-2			
Turbine Fuel, Aviation, JP-4			
MIL-T-5624			
Electrolyte 10873919			
5% Salt Solution O-S-1926			
Anti-Icing & Defrosting Fluid			
MIL-A-8243			
Lube Oil, Aircraft, Synthetic			
MIL-L-23699			
Lube Oil MIL-L-2104			
Lube Oil, Aircraft, Synthetic			
MIL-L-7808			
24 hours at 100 ± 3°C (212 ± 5°F)			
Hydraulic Fluid, Synthetic			
MIL-H-46170			
4 hours at 50 ± 3°C (122 ± 5°F)			
Cleaning Compound PC-437			

TABLE 1
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
CHEMICAL (continued) Fluid Resistance (continued) 5 hours at $23 \pm 3^{\circ}\text{C}$ ($73 \pm 5^{\circ}\text{F}$) Decontaminating Agent, DS-2 MIL-D-50030 Decontaminating Agent STB MIL-D-12468	--	---	Section 4.3.9
Followed by tests for:			
Tensile Strength	psi (<i>MPa</i>)	3000 minimum (<i>20.7</i>)	Section 4.3.3
Ultimate Elongation	Percent	250 minimum	Section 4.3.3
Weight Increase	Percent	3 maximum	Section 4.3.9
Adhesive Compatibility Lap Shear Strength NSM to S-1264 to DCNS	psi (<i>kPa</i>)	100 minimum (<i>689</i>)	Section 4.3.11
NUCLEAR Radiation Resistance followed by tests for:			Section 4.3.12
Tensile Strength	psi (<i>MPa</i>)	4000 (<i>27.6</i>)	Section 4.3.3
Ultimate Elongation	Percent	250	