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Specification	**RT-1308**
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Thermofit® Polyolefin Molded Components for use in Outer Space Flame-Retarded, Heat-Shrinkable

1. SCOPE

This specification covers the requirements for one type of semi-rigid, electrically insulating molded component whose dimensions will reduce to a predetermined size upon the application of heat in excess of 121°C *(250°F)*. These components have low outgassing characteristics and are suitable for use in outer space.

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-G-5572	Gasoline, Aviation, Grades 80/87, 100/130, 115/145
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5

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	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 Tests for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 747	Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
ASTM D 792	Standard Methods of Test for Specific Gravity and Density of Plastics by Displacement
ASTM D 2240	Standard Method of Tests for Rubber Property-Durometer Hardness
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.)

3. REQUIREMENTS

3.1 MATERIAL

The molded components shall be fabricated from a crosslinked, thermally stabilized, flame-retarded, modified polyolefin 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, unless otherwise specified.

3.3 PROPERTIES

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

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
Tensile Strength
Ultimate Elongation
Heat Shock
Hardness

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 *(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 $\pm$ 0.010 in. *(152 x 152 x 1.9 $\pm$ .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 Dimensional Recovery

Measure samples of molded components, as supplied, for dimensions in accordance with ASTM D 2671. Condition the samples for 10 minutes in a 175 ± 2°C *(347 ± 4°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 gage lines 1 inch *(25.4 mm)* apart in the central portion of the specimen. Record the distance between gage lines as the original length. Heat the specimen, including both gage lines, for 1 minute in a 150 ± 2°C *(302 ± 4°F)* oven, remove from the oven, and stretch within 10 seconds, until the gage lines are 3 inches *(76 mm)* apart. Cool the extended specimen to room temperature and release from tension. After 24 hours at room temperature, measure the distance between the gage lines and record as the extended length. Reheat the portion of the specimen, including both gage lines, for 1 minute in a 150 ± 2°C *(302 ± 4°F)* oven, or equivalent, and measure the distance between gage lines and record 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

Cut five specimens from a molded slab using Die D of ASTM D 412 and test 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 slab along with a 1-1/8 inch *(28.6 mm)* diameter mandrel, in a cold chamber at -55 ± 2°C *(-67 ± 4°F)* for 4 hours. After completion of the conditioning, and while still in the cold chamber, wrap each specimen around the mandrel through not less than 360 degrees within 10 ± 2 seconds. Visually examine the specimens 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 225 ± 5°C *(437 ± 9°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, 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. Visually examine the specimens for evidence of dripping, flowing or cracking.

4.3.6 Heat Aging

Condition five specimens, prepared and measured in accordance with 4.3.3, for 24 hours in a 135 ± 3°C *(275 ± 5°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, 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 slab, for corrosive effect in accordance with ASTM D 2671, Procedure A. Condition the specimens for 16 hours at 175 ± 3°C *(347 ± 5°F)*.

4.3.8 Fluid Resistance

Completely immerse three specimens prepared and measured in accordance with 4.3.3, in each of the fluids listed in Table 1 for 24 hours at 23 ± 3°C *(73 ± 5°F)*. The volume of the fluid shall be not less that 20 times that of the specimens. After conditioning, lightly wipe and air-dry the specimens 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 Vacuum Outgassing

Recover three 0.5 ± .05 gram specimens for 3 minutes at 200°C *(392°F)* and test for percent total mass loss and percent volatile condensible materials. The conditions for testing are: exposure time, 24 hours; sample temperature, 125 ± 3°C *(257 ± 5°F)*; condensing surface temperature, 23 ± 3°C *(73± 5°F)*; and pressure, not greater than 1×10^{-5} torr. The vacuum shall be provided by a diffusion pump, liquid nitrogen trap vacuum system. The apparatus shall consist of a glass sample chamber, refluxing liquid heat source and a polished stainless steel plate in close contact with a copper cold finger cooled internally by circulating water. The axis of the exit of the sample chamber shall be perpendicular to and approximately 15-mm from the cooled condensing plate. A micro balance shall be used for weighing. Weigh the specimen before and after conditioning and calculate percent total mass loss. Weigh the condensing plate before and after to calculate percent volatile condensible material.

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. PACKAGING AND ITEM IDENTIFICATION

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 with the manufacturer's name or symbol and the manufacturer's part number, when appropriate.

TABLE 1
Requirements

PROPERTY	UNIT	REQUIREMENTS	TEST METHOD
PHYSICAL			
Dimensions	Inches *(mm)*	In accordance with applicable specification control drawing	Section 4.3.1 ASTM D 2671
Dimensional Recovery	Inches *(mm)*	In accordance with applicable specification control drawing	
Elastic Memory	Percent	175 minimum expansion 93 minimum retraction	Section 4.3.2
Tensile Strength	psi *(MPa)*	1500 minimum *(10.3)*	Section 4.3.3
Ultimate Elongation	Percent	250 minimum	ASTM D 412
Stiffness	psi *(MPa)*	20,000 maximum *(138)*	ASTM D 747
Specific Gravity	---	1.41 maximum	ASTM D 792
Hardness	Shore D	50 ± 10	ASTM D 2240
Low Temperature Flexibility 4 hours at -55°C *(-67°F)*	---	No cracking	Section 4.3.4
Heat Shock 4 hours at 225°C *(437°F)*	---	No dripping, flowing o cracking.	Section 4.3.5
Heat Aging 24 hours at 135°C *(275°F)* Followed by tests for:	---	---	Section 4.3.6
Tensile Strength	psi *(MPa)*	500 minimum *(10.3)*	Section 4.3.3
Ultimate Elongation	Percent	250 minimum	
Outgassing 24 hours at 125°C *(257°F)*			Section 4.3.9
Total Mass Loss	Percent	1.0 maximum	
Volatile Condensable Material	Percent	0.1 maximum	
ELECTRICAL			
Dielectric Strength	Volts/mil *(kV/mm)*	200 minimum *(7.9)*	ASTM D 149
Volume Resistivity	ohm-cm	10^{14} minimum	ASTM D 257
CHEMICAL			
Corrosive Effect 16 hours at 175°C *(347°F)*	---	Noncorrosive	Section 4.3.7 ASTM D 2671 Procedure A
Flammability			ASTM D 635
Average Time of Burning	Seconds	150 maximum	
Average Extent of Burning	Inches *(mm)*	1 maximum *(25)*	
Fungus Resistance	---	Rating of 1 or less	ASTM G 21
Water Absorption 24 hours at 23°C *(73°F)*	Percent	0.5 maximum	ASTM D 570
Fluid Resistance 24 hours at 23°C *(73°F)* in: JP-4 Fuel (MIL-T-5624) Skydrol* 500 Hydraulic Fluid (MIL-H-5606) Aviation Gasoline (100/130) (MIL-G-5572) Water Followed by tests for:	---	---	Section 4.3.8
Tensile Strength	psi *(MPa)*	1200 minimum *(8.3)*	Section 4.3.3
Ultimate Elongation	Percent	200 minimum	

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