

THERMOFIT® ES1000 TUBING
Polyolefin, Semi-Rigid, Adhesive-Lined

1. SCOPE

This specification covers the requirements for a dual wall, electrically insulating, extruded tubing, whose diameter will reduce to a predetermined size upon application of heat in excess of 135° C (275° F).

2. APPLICABLE DOCUMENTS

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

2.1 AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

D 2671 Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use

(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 DIMENSIONS

The dimensions shall be in accordance with Table 2.

3.2 MATERIALS

The tubing shall consist of two components.

- a) The jacket shall be fabricated from a thermally stabilized, modified semi-rigid polyolefin, and shall be crosslinked by irradiation.
- b) The liner shall be a thermoplastic adhesive sealant which melts and flows at the shrink temperature of the jacket.

The tubing shall be essentially free from flaws, defects, pinholes, bubbles, seams, cracks and inclusions.

3.3 COLOR

Unless otherwise specified, the jacket shall be clear; the adhesive liner shall be amber.

3.4 PROPERTIES

The tubing shall meet the requirements of Table 3.

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS

4.1.1 Qualification Tests

Qualification tests are those performed on tubing submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification.

4.1.2 Acceptance Tests

Acceptance tests are those performed on tubing submitted for acceptance under contract. Acceptance tests shall consist of

Dimensions
Tensile Strength
Ultimate Elongation
Heat Shock
Longitudinal Change

Acceptance tests shall be performed on each lot of tubing or on a skip-lot basis per a statistically justified control plan determined by Thermofit.

4.2 SAMPLING INSTRUCTIONS

4.2.1 Qualification Test Samples

Qualification test samples shall consist of 50 feet (15 m) of tubing of each size.

Qualification of ES1000-1 qualifies ES1000-1 and ES1000-2
Qualification of ES1000-3 qualifies ES1000-3 and ES1000-4

4.2.2 Acceptance Test Samples

Acceptance test samples shall consist of not less than 16 feet (5 m) of tubing selected at random from each lot. A lot shall consist of all tubing of the same size from the same production run, and offered for inspection at the same time.

4.3 TEST PROCEDURES

4.3.1 Material Properties

Unless otherwise specified, perform tests on specimens which have been recovered by conditioning for 3 minutes in a $175 \pm 3^\circ\text{C}$ ($347 \pm 5^\circ\text{F}$) oven. Condition the test specimens (and measurement gauges, when applicable) for 3 hours at $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) and 50 ± 5 percent relative humidity for 3 hours prior to all testing. Use mechanical convection type ovens in which air passes the specimens at a velocity of 100 to 200 feet (30 to 60 m) per minute.

4.3.1.1 Dimensions and Longitudinal Change

Measure three 6-inch (150 mm) specimens of tubing as supplied, for length $\pm 1/32$ inch (± 1 mm), and inside diameter in accordance with ASTM D 2671. Condition the specimens for 3 minutes in a $200 \pm 5^\circ\text{C}$ ($392 \pm 9^\circ\text{F}$) oven, cool to $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$), and then remeasure. Prior to and after conditioning, the dimensions of the tubing shall be in accordance with Table 1 and the longitudinal change shall be in accordance with Table 3. Calculate the longitudinal change as follows:

$$C = \frac{L_1 - L_0}{L_0} \times 100$$

Where: C = Longitudinal Change [percent]
 L₀ = Length Before Conditioning [inches (mm)]
 L₁ = Length After Conditioning [inches (mm)]

4.3.1.2 Tensile Strength and Ultimate Elongation

Perform the tests in accordance with ASTM D 2671, using 1-inch (25-mm) bench marks, 1-inch (25-mm) initial jaw separation and jaw separation speed of 2 ± 0.2 inches (50 ± 5 mm) per minute. Calculate the tensile strength based on the wall thickness of the jacket only.

4.3.1.3 Heat Aging

Three samples shall be conditioned for 168 hours in an air circulating oven at $175 \pm 3^\circ\text{C}$. After conditioning, the specimens shall be cooled to room temperature and bent through 180° over a mandrel selected in accordance to Table 1. Any side cracking caused by flattening of the specimen on the mandrel shall be disregarded.

Table 1: Mandrel Sizes

Tube Size "I.D", inches	Mandrel, O.D. inches
$.047 \leq \text{ID} \leq .250$.313
$.250 \leq \text{ID} \leq .500$.375
$.500 \leq \text{ID} \leq 2.0$.437

4.4 REJECTION AND RETEST

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

5. PREPARATION FOR DELIVERY

5.1 FORM

The tubing shall be supplied in lengths in accordance with the applicable drawings.

5.2 PACKAGING

Packaging shall be in accordance with good commercial practice.

5.3 MARKING

Each container of tubing shall be permanently and legibly marked with the size, quantity, manufacturer's identification, part number, and lot number.

TABLE 2
Tubing Dimensions

Part Number	As Supplied		As Recovered							
	Minimum Expanded I.D. Including Core		Maximum Recovered I.D. Including Core		Minimum Recovered Jacket Wall		Minimum Recovered Adhesive Wall		Minimum Recovered Total Wall	
	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.
ES1000-1	0.225	5.72	0.050	1.27	0.025	0.64	0.022	0.56	0.047	1.20
ES1000-2	0.293	7.44	0.065	1.65	0.030	0.76	0.030	0.76	0.060	1.52
ES1000-3	0.427	10.85	0.095	2.41	0.035	0.89	0.040	1.02	0.075	1.91
ES1000-4	0.700	17.78	0.175	4.45	0.041	1.04	0.054	1.37	0.095	2.41

TABLE 3
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Material Properties			
Dimensions	inches (mm)	In accordance with Table 2	ASTM D 2671 Section 4.3.1.1
Longitudinal Change	percent	0 to -10	
Tensile Strength	psi (MPa)	1500 (10.3) minimum	ASTM D 2671
Ultimate Elongation	percent	200 minimum	Section 4.3.1.2
Low Temperature Flexibility -40° C	-	No Cracking	ASTM D 2671
Heat Shock 4 hours at 225° C (437° F)	--	No cracking of outer jacket	ASTM D 2671
Heat Aging 168 hrs at 175° C	--	No Cracking	ASTM D 3032 Section 4.3.1.3
Dielectric Strength, (jacket only)*	Volts/mil	350 minimum	ASTM D 149
Volume Resistivity	ohm-cm	1.0×10^{12} minimum	ASTM D 2671
Water Absorption	%	1.0 maximum	ASTM D 570 Procedure A

*Calculate based on wall thickness of jacket only.