RAYCHEM FB2 TUBING Specification

108-120041

Raychem FB2
Polyolefin, Flexible, Heat-Shrinkable

FB2 is a single wall, flexible, zero halogen flame-retardant, general purpose, polyolefin tubing. It is designed to provide mechanical, thermal, and flame-resistance performance. The flexibility allows it to conform to irregular shapes. Product is UL224 rated to 105°C.

Continuous operating temperature -30°C to 105°C *(-22°F to 221°F).*

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1. SCOPE

This specification covers the requirements for electrical insulating, extruded tubing diameter that will reduce to a predetermined size upon the application of heat in excess of 110°C *(230°F)*.

1.1. FORM

The tubing shall be flame retarded and shall be black.

2. APPLICABLE DOCUMENTS

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

2.1. AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

ASTM D2671 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 or via the ASTM website at http://www.astm.org).

2.2. INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60695-2-12-2010 Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials

(Order at https://global.ihs.com/standards.cfm?publisher=IEC&rid=Z56&mid=IEC or call: Americas: +1 800 854 7179 | Asia Pacific: +852 2368 5733 | Europe, Middle East, Africa: +44 1344 328039)

2.3. OTHER DOCUMENTS

FB2 SCD	RAYCHEM FB2 Tubing SCD
UL224	UL224 Extruded Insulating Tubing (https://standardscatalog.ul.com/standards/en/standard_224_6)

3. REQUIREMENTS

3.1. MATERIALS

The tubing shall be fabricated from thermally stabilized, modified polyolefin and shall be crosslinked by irradiation. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks, and inclusions.

3.2. PROPERTIES

The tubing shall meet all the requirements in Table 2.

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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 be:

Dimensions
Longitudinal Change
Tensile Strength
Ultimate Elongation

Statistical process control data may be used to demonstrate conformance for dimensions.

4.2. SAMPLING INSTRUCTIONS

4.2.1. Qualification Test Samples

Qualification test samples shall consist of 21 m (*70 feet)* of 3.0 mm tubing tested to all items in Table 2. Three meters (10 ft) in the size range of 6.0 to 12.0 mm of tubing to be tested for flammability only. Six meters of 30.0 mm tubing for dimensions only.

4.2.2. Acceptance Test Samples

Acceptance test samples shall consist of not less than 5 m *(16 feet*) of tubing selected at random from each compound batch or the first sleeving production lot of the batch compound. Physical property tests performed at this time qualify subsequent sleeving lots produced from the same compound batch.

4.2.3. Lot Formation

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

Dimensions can be found in FB2 SCD or the specific drawing for the numbered size. Condition test specimens and measurement gauges at 23 ± 3°C *(73 ± 5°F)* and ambient relative humidity prior to all testing, whether before or after heat shrinking. Unless otherwise specified, perform tests on specimens which have been fully recovered by conditioning for 3 minutes in a 200 ± 5°C *(392 ± 9°F)* oven. Use mechanical convection

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type ovens in which air passes the specimens at a velocity of 30 to 60 m *(100 to 200 feet)* per minute.

4.3.1. Dimensions and Longitudinal Change

Measure three 150 mm *(6-inch)* specimens of tubing, as supplied, for length ± 1 mm *(± 1/32 inch)*, and inside diameter in accordance with ASTM D 2671. Condition the specimens for 3 minutes in a 200 ± 5°C *(392 ± 9°F)* oven, cool to 23 ± 3°C *(73 ± 5°F)* and then remeasure. Prior to and after conditioning, the dimensions of the tubing shall be in accordance with the FB2 SCD and the longitudinal change shall be in accordance with Table 2.

Calculate the longitudinal change as follows:

$$LC = ((L_1 - L_0) / L_0) \times 100$$

Where: LC = Longitudinal Change [percent]
L_0 = Length Before Conditioning [inches (mm)]
L_1 = Length After Conditioning [inches (mm)]

4.3.2. Tensile Strength and Ultimate Elongation

Determine the tensile strength and ultimate elongation of the tubing in accordance with ASTM D 2671 using 25-mm *(1-inch)* bench marks, a 25-mm *(1-inch)* initial jaw separation or greater if using an extensometer, and jaw separation speed of 500 ± 50 mm (*20 ± 2 inches)* per minute.

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 defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and action taken to correct the defects shall be furnished to Quality.

5. PREPARATION FOR DELIVERY

5.1. FORM

5.1.1. The tubing shall be supplied on spools unless otherwise specified.

5.2. PACKAGING

5.2.1. Packaging shall be in accordance with good commercial practice.

5.3. MARKING

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

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APPENDIX

TABLE 1
MANDREL DIMENSIONS FOR BEND TESTING

Tubing Size	Mandrel Diameter	
	mm.	*in.*
0.5 to 3.2 mm inclusive	7.9 ± 0.05	*5/16* ± 0.002
3.3 to 6.4 mm inclusive	9.5 ± 0.08	*3/8 ± 0.003*
6.5 to 25.4 mm inclusive	11.1 ± 0.10	*7/16 ± 0.004*
25.5 to 50.8 mm inclusive	22.2 ± 0.13	*7/8 ± 0.005*

TABLE 2
REQUIREMENTS

PROPERTY	UNIT	Requirement	TEST METHOD
PHYSICAL Dimensions	mm	In accordance with FB2 SCD	Section 4.3.1 ASTM D 2671
Longitudinal Change	Percent	+0, -15	
Tensile Strength	MPa *(psi)*	10.4 minimum *(1500)*	Section 4.3.2 ASTM D 2671
Ultimate Elongation	Percent	200 minimum	
2% Secant Modulus (Expanded)	MPa *(psi)*	173 maximum *(2.5×10^4)*	ASTM D 2671
Low Temperature Flexibility 1 hour at -30 ± 1°C *(-22 ± 1.8°F)*	---	No cracking	Table 1 ASTM D 2671 Procedure C
Heat Shock 4 hours at 180 ± 1°C *(356 ± 1.8°F)*	---	No dripping, flowing or cracking	Table 1 ASTM D 2671
Heat Resistance 168 hours at 136 ± 1°C *(276.8 ± 1.8°F)* Followed by test for: Tensile Strength Ultimate Elongation Dielectric Strength	 MPa *(psi)* Percent kV/mm *(Volts/mil)*	 7.3 *(1050)* min 100 minimum 19,680 minimum *(500)*	ASTM D 2671
Dielectric Withstand at 2500V Dielectric Breakdown	Seconds Volts	60 minimum 50% minimum of unaged specimen or 2500 V whichever is greater	UL224
Restricted Shrinkage	--	Pass	UL224
ELECTRICAL Dielectric Strength	Volts/mm *(Volts/mil)*	19,680 minimum *(500)*	ASTM D 2671
Volume Resistivity	ohm-cm	1×10^{14} minimum	ASTM D 2671
Dielectric Withstand at 2500 V	Seconds	60 minimum	UL224

Requirements are continued on next page.

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TABLE 2
REQUIREMENTS (continued)

PROPERTY	UNIT	Requirement	TEST METHOD
CHEMICAL Copper Contact Corrosion 168 hours at 136 ± 1°C *(276.8 ± 1.8°F)*	---	No pitting or blackening of copper	ASTM D 2671 Procedure B
Copper Stability 168 hours at 136 ± 1°C *(276.8 ± 1.8°F)* Followed by test for: Ultimate Elongation	--- Percent	No brittleness, glazing, cracking, or severe discoloration of tubing 100 minimum	
Flammability	---	Self-extinguishing within 1 minute, 25% maximum flag burn	UL224 All Tubing
Glow wire test >750 ºC		Te≤Ta+30s (after removal of the glow wire) and no ignition of wrapping tissue	IEC 60695-2-12-2010

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