



# RAYCHEM SCL TUBING Specification

Formerly RT-1301

TEC-108-120027

Polyolefin, Selectively Crosslinked, Semi-rigid, Encapsulant Lined, Heat Shrinkable Tubing

SCL is encapsulant-lined, heat-shrinkable tubing that provides moisture resistance, strain relief, and electrical insulation for electrical splices, terminations, breakouts, and mechanical connections.

SCL is constructed as a dual-wall tubing. The outer wall is a semi-rigid, crosslinked polyolefin, while the inner wall is a meltable polyolefin that flows with the application of heat.

Heating SCL shrinks the outer jacket and melts the inner “encapsulant” wall to flow and fill surface irregularities. While still hot, the tubing can be pinched and blocked to form a wire breakout. SCL provides a splash-resistant, moisture-resistant covering suitable for many applications. SCL also performs satisfactorily if briefly exposed to common solvents or chemicals. The installed tubing provides rugged protection against abrasion, vibration, and flexing. A wide range of applications can be accommodated with only a few sizes of SCL tubing.

SCL is UL-recognized at 125°C, 600 V, and meets the requirements of AS23053/4, Class 1.

Continuous operating range: -55°C to 110°C (-67°F to 230°F)

THIS IS A CLASS 1 DOCUMENT WHICH IS NONCONFIDENTIAL.

*The information contained within this document is the property of TE Connectivity. It is supplied in confidence and the commercial security of the contents must be maintained. It must not be used for any purpose other than that for which it is supplied nor may any information contained in it be disclosed to unauthorized persons. It must not be reproduced in whole or in part without obtaining written permission from TE Connectivity (TE).*

While TE has made every reasonable effort to ensure the accuracy of the information in this catalog, TE does not guarantee that it is error-free, nor does TE make any other representation, warranty or guarantee that the information is accurate, correct, reliable or current. TE reserves the right to make any adjustments to the information contained herein at any time without notice. TE expressly disclaims all implied warranties regarding the information contained herein, including, but not limited to, any implied warranties of merchantability or fitness for a particular purpose. The dimensions in this catalog are for reference purposes only and are subject to change without notice. Specifications are subject to change without notice. Consult TE for the latest dimensions and design specifications.

\*Trademark. TE Connectivity, TE connectivity (logo), and TE (logo) are trademarks. Other logos, product and/or company names may be trademarks of their respective owners.



**Table of Contents**

**1. SCOPE ..... 3**

**2. APPLICABLE DOCUMENTS ..... 3**

    2.1. GOVERNMENT-FURNISHED DOCUMENTS..... 3

    2.2. OTHER PUBLICATIONS ..... 3

**3. REQUIREMENTS ..... 4**

    3.1 MATERIALS.....4

    3.2 COLOR.....4

    3.3 PROPERTIES ..... 4

**4. QUALITY ASSURANCE PROVISIONS ..... 4**

    4.1 CLASSIFICATION OF TESTS ..... 4

        4.1.1 Qualification Tests ..... 4

        4.1.2 Acceptance Tests .....4

    4.2 SAMPLING INSTRUCTIONS .....4

        4.2.1 Qualification Test Samples .....4

        4.2.2 Acceptance Test Samples .....5

        4.2.3 Lot Formation ..... 5

    4.3 TEST PROCEDURES ..... 5

        4.3.1 Dimensions .....5

        4.3.2 Longitudinal Change.....5

        4.3.3 Flow of Inner Wall ..... 5

        4.3.4 Tensile Strength and Ultimate Elongation.....6

        4.3.5 Heat Shock .....6

        4.3.6 Heat Resistance.....6

        4.3.7 Dielectric Strength.....6

        4.3.8 Corrosive Effect.....7

        4.3.9 Fluid Resistance.....7

    4.4 REJECTION AND RETEST .....7

**5. PREPARATION FOR DELIVERY .....7**

    5.1 FORM ..... 7

    5.2 PACKAGING ..... 8

    5.3 MARKING ..... 8

**APPENDIX ..... 8**

    TABLE 1 MANDREL DIMENSIONS.....8

    TABLE 2 REQUIREMENTS.....9



## 1. SCOPE

This specification covers the requirements for one type of selectively crosslinked, electrically insulating, encapsulating, extruded tubing whose diameter will reduce to a predetermined size upon the 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 referenced documents applies. The following documents form a part of this specification to the extent specified herein.

### 2.1. GOVERNMENT-FURNISHED DOCUMENTS

#### Military

MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordinance
MIL-T-83133	Turbine Fuel, Aviation, Grades JP-8

### 2.2. OTHER PUBLICATIONS

#### American Society for Testing and Materials (ASTM)

D 2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use
D 149	Standard Methods of Test for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies.
D 257	Standard Methods of Test for D-C Resistance or Conductance of Insulating Materials.
D 412	Standard Test Methods for Rubber Properties in Tension.
D 570	Standard Method of Test for Water Absorption of Plastics.
D 638	Standard Method of Test for Tensile Properties of Plastics.
D 746	Standard Method of Test for Brittleness Temperature of Plastics and Elastomers by Impact.
D 792	Standard Methods of Test for Specific Gravity and Density of Plastics by Displacement.
D 876	Standard Methods of Testing nonrigid Vinyl Chloride Polymer Tubing.
G 21	Standard 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 or via the ASTM website at <http://www.astm.org>.)

#### International Organization for Standardization (ISO)

ISO 846 Plastics – Evaluation of the action of Microorganisms

(Copies of ISO publications may be obtained from the International Organization for Standardization, 1, rue de Varembe, CH-1211 Geneva 20, Switzerland or via the ISO website at <http://www.iso.ch/iso/en/ISOOnline.frontpage>)



### 3. REQUIREMENTS

#### 3.1. MATERIALS

The tubing shall be fabricated from thermally stabilized, modified polyolefin and shall be selectively crosslinked by irradiation so that:

- a. The inner wall of the tubing is capable of melting, flowing, and adhering to itself upon the application of heat in excess of 135°C (275°F).
- b. The outer wall of the tubing is non-melting and possesses elastic memory which causes it to reduce its diameter to a predetermined size upon the application of heat in excess of 135°C (275°F).

#### 3.2. COLOR

Unless otherwise specified, the tubing shall be black.

#### 3.3. 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 the following: dimensions, longitudinal change, tensile strength, ultimate elongation, flow of inner wall and heat shock.

#### 4.2. SAMPLING INSTRUCTIONS

##### 4.2.1. Qualification Test Samples

Qualification test samples shall consist of 15 m (50 feet) of tubing. Qualification of any size within each size range specified below shall qualify all sizes within that size range.

Range of Sizes  
1/8 through 1/4  
1/2 through 1



#### 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 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

Unless otherwise specified, tests shall be performed on recovered specimens. Prior to all testing, the test specimens (and measurement gauges, when applicable) shall be conditioned for 3 hours at  $23 \pm 3$  °C ( $73 \pm 5$  °F) and  $50 \pm 5$  percent relative humidity. All ovens shall be of the mechanical convection type 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

Three 150 mm (6-inch) specimens of tubing shall be measured for inside diameter in accordance with ASTM D 876. The specimens then shall be placed on mandrels and conditioned for 10 minutes in a  $200 \pm 3$  °C ( $392 \pm 5$  °F) oven. The diameter of the mandrels shall equal the maximum inside diameter of the recovered tubing as specified in SCL SCD, plus 0.000, minus 0.050 mm (0.002 in) or 2 percent, whichever is greater. After conditioning, the specimens, while still on the mandrels, shall be removed from the oven, cooled for at least 30 seconds in water at less than 35 °C (95 °F), and inspected for wall thickness in accordance with ASTM D 876. If air space is visible between the specimen and the mandrel, the specimen shall be removed from the mandrel, measured for inside diameter and inspected for wall thickness in accordance with ASTM D 876.

#### 4.3.2. Longitudinal Change

Three 150 mm (6-inch) specimens of tubing shall be measured for length to an accuracy of  $\pm 0.8$  mm (1/32 inch). The specimens then shall be conditioned on aluminium foil for 3 minutes in a  $200 \pm 3$  °C ( $392 \pm 5$  °F) oven. After conditioning, the specimens shall be removed from the oven, cooled to  $23 \pm 3$  °C ( $73 \pm 5$  °F), and remeasured. The longitudinal change shall be calculated 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)]

#### 4.3.3. Flow of Inner Wall

Three 6-inch specimens of tubing shall be conditioned on aluminium foil for 3 minutes in a  $200 \pm 3$  °C ( $392 \pm 5$  °F) oven. After conditioning, the specimens shall be removed from the oven and, within 5 seconds, approximately 1/4 inch of one end of each specimen shall be lightly pressed together using a pair of needle-nose pliers. The pressure shall be sufficient to completely close the

## SCL Specification



opening and shall be applied for 20 to 40 seconds. The specimens then shall be removed from the pliers, cooled to  $23 \pm 3 \text{ }^{\circ}\text{C}$  ( $73 \pm 5 \text{ }^{\circ}\text{F}$ ), and maintained at that temperature for 10 minutes. The specimens then shall be replaced in the  $200 \pm 3 \text{ }^{\circ}\text{C}$  ( $392 \pm 5 \text{ }^{\circ}\text{F}$ ) oven for 5 minutes. After conditioning, the specimens shall be removed from the oven, cooled to  $23 \pm 3 \text{ }^{\circ}\text{C}$  ( $73 \pm 5 \text{ }^{\circ}\text{F}$ ) and examined for openings in the pressed or sealed area.

#### 4.3.4. Tensile Strength and Ultimate Elongation

Three specimens shall be tested for tensile strength and ultimate elongation in accordance with ASTM D 638 using cross head speed of 50 mm/min (*2 in/min*), 25.4 mm (*1 inch*) bench marks and an initial jaw separation of 50.8 mm (*2 inches*). For sizes with the recovered ID is less than or equal to 6.4 mm (*0.25 inch*), the specimens shall be full sections of tubing. For sizes larger than the recovered ID of 6.4 mm (*0.25 inch*), the specimens shall be cut from tubing using die D of ASTM D 412. The die D specimens shall be obtained by cutting the tubing wall along its entire length, flattening the piece, and applying the die with its long dimensions parallel to the longitudinal axis of the tubing.

#### 4.3.5. Heat Shock

Three 150 mm (*6-inch*) specimens of tubing shall be conditioned on aluminium foil for 4 hours in a  $250 \pm 3^{\circ}\text{C}$  ( $482 \pm 5^{\circ}\text{F}$ ) oven. After conditioning, the specimens shall be removed from the oven, cooled to  $23 \pm 3^{\circ}\text{C}$  ( $73 \pm 5^{\circ}\text{F}$ ) and visually examined for evidence of dripping, flowing, or cracking of the outer wall.

#### 4.3.6. Heat Resistance

Three 150 mm (*6-inch*) specimens of tubing shall be conditioned on aluminium foil for 168 hours in a  $175 \pm 2 \text{ }^{\circ}\text{C}$  ( $347 \pm 4 \text{ }^{\circ}\text{F}$ ) oven. After conditioning, the specimens shall be removed from the oven, cooled to  $23 \pm 3^{\circ}\text{C}$  ( $73 \pm 5^{\circ}\text{F}$ ), and bent through  $180^{\circ}$  over a mandrel selected in accordance with Table 2. The specimens then shall be visibly examined for evidence of dripping, flowing or cracking of the outer wall. Any side cracking caused by flattening of the specimen on the mandrel shall not constitute failure.

#### 4.3.7. Dielectric Strength

The dielectric strength of the tubing shall be measured, under oil, in accordance with ASTM D 149. Five 6-inch specimens of tubing shall be recovered over a metal mandrel by conditioning for 10 minutes in a  $200 \pm 3 \text{ }^{\circ}\text{C}$  ( $392 \pm 5 \text{ }^{\circ}\text{F}$ ) oven. The mandrel diameter shall be slightly larger than the recovered inside diameter of the tubing being tested. The metal mandrel shall serve as one electrode and a 1-inch-wide strip of lead foil wrapped around the outside of the tubing as the other electrode. Thickness measurements for calculating dielectric strength shall be made adjacent to the point of breakdown.



#### 4.3.8. Corrosive Effect

##### 4.3.8.1. Copper Mirror Corrosion

Three specimens shall be tested in accordance with ASTM D 2671, Procedure A. The tubing shall be conditioned for 10 minutes in a  $200 \pm 3$  °C ( $392 \pm 5$  °F) oven. For sizes smaller than 3/8, the specimens shall be 1-inch sections of recovered tubing. For sizes 3/8 and larger, the specimens shall be 25.4 x 6.35 mm (1 X 1/4-inch) strips cut longitudinally from recovered tubing. The specimens shall be conditioned for 16 hours at  $121 \pm 2$  °C ( $250 \pm 4$  °F). Evidence of corrosion shall be the removal of copper from the mirror leaving an area of transparency greater than 5 percent of its total area.

##### 4.3.8.2. Corrosion in Contact with Copper

Three 6-inch specimens of tubing which have been conditioned for 10 minutes in a  $200 \pm 3$  °C ( $392 \pm 5$  °F) oven shall be tested in accordance with ASTM D 2671, Procedure B. The specimens shall be conditioned for 16 hours at  $121 \pm 2$  °C ( $250 \pm 4$  °F).

#### 4.3.9. Fluid Resistance

Six specimens shall be immersed in each of the fluids listed in Table 3 for 24 hours at  $23 \pm 3$  °C ( $73 \pm 5$  °F). Three of the specimens in each fluid shall be prepared in accordance with 4.3.7 and three shall be prepared and measured in accordance with 4.3.4. The volume of the fluid shall be not less than 20 times that of the specimens. After conditioning, the specimens shall be removed from the fluids, lightly wiped and air dried for 30 to 60 minutes at  $23 \pm 3$  °C ( $73 \pm 5$  °F). Three specimens from each fluid then shall be tested for dielectric strength in accordance with 4.3.7 and the other three for tensile strength in accordance with 4.3.4.

#### 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 the inspector.

### 5. PREPARATION FOR DELIVERY

#### 5.1. FORM

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

# SCL Specification



## 5.2. PACKAGING

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

## 5.3. MARKING

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

## APPENDIX

**TABLE 1**  
**MANDREL DIMENSIONS**

Tubing Size		Mandrel Diameter	
mm	in	mm	in
3.17 through 12.69	1/8 through 1/4	11.1	7/16
12.7 through 25.39	1/2 through 3/4	12.7	1/2
25.4	1	14.2	9/16



**TABLE 2**  
**REQUIREMENTS**

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
<b>PHYSICAL</b>			Section 4.3.1
Dimensions	mm ( <i>inches</i> )	In accordance with SCL SCD	ASTM D 876
Longitudinal Change	Percent	+1,-10	Section 4.3.2
Flow of Inner Wall	---	No openings upon reheating	Section 4.3.3
Tensile Strength	MPa ( <i>psi</i> )	10.3 minimum ( <i>1500</i> )	Section 4.3.4
Ultimate Elongation	Percent	200 minimum	ASTM D 638
Low Temperature Brittleness at -55 °C ( <i>-67 F</i> )	---	No failure	ASTM D 746, Procedure B
Heat Shock 4 hours at 250 °C ( <i>482 °F</i> )	---	No dripping, flowing, or cracking of the outer wall	Section 4.3.5
Heat Resistance 168 hours at 175 °C ( <i>347 °F</i> )	---	No dripping, flowing or cracking of the outer wall	Section 4.3.6
<b>ELECTRICAL</b>			Section 4.3.7
Dielectric Strength	Volts/mm ( <i>Volts/mil</i> )	19,860 ( <i>500</i> ) minimum	ASTM D 149
Volume Resistivity	ohm-cm	10 <sup>15</sup> minimum	ASTM D 257
<b>CHEMICAL</b>			Section 4.3.8 and ASTM D 2671
Corrosive Effect 16 hours at 121 °C ( <i>250 F</i> )	---	Noncorrosive	
Fungus Resistance (Note 1) Followed by tests for: Tensile Strength	MPa ( <i>psi</i> )	10.3 ( <i>1500</i> ) minimum	ISO 846 Method B
Ultimate Elongation	percent	200 minimum	Section 4.3.4
Dielectric Strength	Volts/mm ( <i>volts/mil</i> )	19,860 ( <i>500</i> ) minimum	ASTM D 638 Section 4.3.7 ASTM D 149
	---	Rating - 0	Or ASTM G 21
Water Absorption 24 hours at 23 °C ( <i>73 °F</i> )	Percent	0.5 maximum	ASTM D 570
Fluid Resistance 24 hours at 23 °C ( <i>73 °F</i> ) in: JP-8 Fuel (MIL-T-5624) Skydrol* 500 Hydraulic Fluid (MIL-H-5606) Aviation Gasoline (100/130) Water			Section 4.3.9
Followed by test for: Dielectric Strength	Volts/mm ( <i>Volts/mil</i> )	15,750 ( <i>400</i> ) minimum	Section 4.3.7
Tensile Strength	MPa ( <i>psi</i> )	6.9 ( <i>1000</i> ) minimum	Section 4.3.4

Note 1: For Fungus Resistance use expanded tube size from 4.74 mm (*0.187 inch*) up to 25.3 mm (*0.999 inch*).