FILS-125 HEAT-SHRINK TUBING SPECIFICATION

108-120029

**Environmental Sealing,
Polyolefin, Flexible, Adhesive-Lined**

**FILS-125 is a clear dual wall tubing designed for environmental sealing and electrical insulation for in-line splices of wires in an automotive environment.
Continuous operating temperature: -30 to 125°C (-22 to 257°F).**

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1. SCOPE

This Specification establishes the quality standard for FILS-125.

The objective of this document is to specify tests that will qualify the performance of FILS-125 for protecting, insulating in-line splices of wires. Due to the variation in size and design of in-line splices, no claim is made with respect to sealing in this specification.

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 135ºC (257ºF).

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)

ASTM D 471	Standard Test Method for Rubber Property²Effect of Liquids
ASTM D 471	Standard Specification for Diesel Fuel
ASTM D 975	Diesel Fuel No. 2
ASTM D 2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical Use
ASTM D 3306	Standard Specification for Glycol Base Engine Coolant for Automobile and Light-Duty Service
ASTM D 570	Standard Test Method for Water Absorption of Plastics

(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. SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J 1128	Low Tension Primary Cable, Standard
SAE J 1703	Motor Vehicle Brake Fluid

(Copies of SAE publications may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096).

2.3. Federal Motor Vehicle Safety Standards

FMVSS302	Flammability of Interior Materials

3. REQUIREMENTS

3.1. DIMENSIONS

The dimensions shall be in accordance with Drawings of FILS-125-4, FILS-125-6, FILS-125-8.

3.2. MATERIALS

The tubing shall consist of two components.

a) The jacket shall be fabricated from a thermally stabilized, modified polyolefin and shall be crosslinked by irradiation.

b) The liner shall be a thermoplastic adhesive 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. COLOUR

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

3.4. PROPERTIES

The tubing shall meet the requirements of Table 2.

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

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Tensile Strength
Ultimate Elongation
Heat Shock
Longitudinal Change

4.2. SAMPLING INSTRUCTIONS

4.2.1. Qualification Test Samples

Qualification test samples shall consist of 15 m (50 feet) of FILS-125-4/1-X and FILS-125-8/2-X

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

4.3.1. Material Properties

Unless otherwise specified, perform tests on specimens which have been recovered by heating for 3 minutes in a 200 ± 5ºC (392 ± 9ºF) oven. Condition the test specimens (and measurement gauges when applicable) for 3 hours at 23 ± 3ºC (73 ± 5ºF). For referee purposes, condition the test specimens at 50 ± 5 percent relative humidity for 3 hours prior to testing. Use mechanical convection type ovens with 8-20 air changes per hour.

4.3.1.1. 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), then re-measure. Prior to and after conditioning, the dimensions of the tubing shall be in accordance with Drawings of FILS-125-4 and FILS-125-8 and the longitudinal change shall be in accordance with Table 2. Calculate the longitudinal change as follows:

$$C = \frac{L1 - L0}{L0} \times 100$$

Where: C = Longitudinal Change [percent]
L_0 = Length Before Conditioning [mm (inches)]
L1 = Length After Conditioning [mm (inches)]

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4.3.1.2. Tensile Strength and Ultimate Elongation

Perform the tests in accordance with ASTM D 2671 using 25 mm (1 inch) bench marks, 50 mm (1 inch) initial jaw separation and jaw separation speed of 50 ± 5 mm (2.0 ± 0.2 inches) per minute.

Calculate the tensile strength based on the wall thickness of the jacket only.

4.3.1.3. Flammability

The test method shall be essentially in accordance with FMVSS302.

Perform the tests on a length of tubing that has been fully recovered at 200°C ± 5°C for 3 minutes in a fan assisted air circulating oven and allowed to cool naturally to room temperature. The length of the test specimen shall be 330mm.*

Apply the flame at the end of the specimen for 15 seconds and remove. When the flame reaches the 1st Datum Mark start the timer. Record the time in seconds for the flame to reach the 2nd Datum Mark.

*Tubing not installed on a mandrel for this test

Calculate the Horizontal Burn Rate as follows:

$$V = 254 \times 60/t$$

Where V= Horizontal Burning Rate
t = Duration of the combustion, in seconds, to burn 254mm

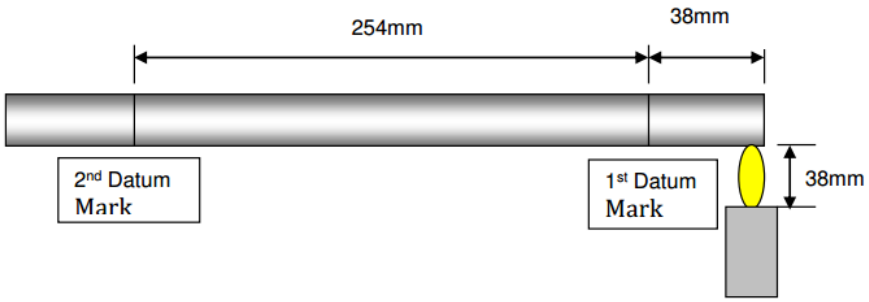

Figure 1 Flammability testing set-up

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4.3.2. Splice Performance Properties

4.3.2.1. Specimen Preparation

Where crosslinked polyolefin wire is specified for specimen preparation, use wire conforming to ISO 6722. Test three specimens of each size property.

4.3.2.1.1. FILS-125-4/1-X

Construct a 2-wire to 2-wire in-line splice in any suitable manner (crimped, soldered or welded). Splice two (2) 0.50mm^2 wires to two (2) 0.50mm^2 wires, using wires approximately 30 cm (12 inches) long. The splice area shall have a length of approximately 12.5 mm (0.5 inch) of exposed conductor. Install a 50 mm (2 inch) length of FILS-125-4/1-X centrally over the splice in an air circulating oven at 150 ± 3ºC (302 ± 5ºF) for 5 minutes, then cool to room temperature.

4.3.2.1.2. FILS-125-8/2-X

Construct a 2 wire to 4 wire inline splice in any suitable manner (crimped, soldered or welded). Splice four (4) 0.75mm^2 wires to four (4) 0.75mm^2 wires plus one (1) 1.25 mm^2 wire, using wires approximately 30 cm (12 inches) long. The splice area shall have a length of approximately 12.5 mm (0.5 inch) of exposed conductor. Install a 65 mm (2.5 inch) length of FILS-125-8/2-X centrally over the splice in an air circulating oven at 150 ± 3ºC (302 ± 5ºF) for 5 minutes, then cool to room temperature.

4.3.2.2. Current Leakage

Test three specimens each with TXL wire.

Immerse the center section of all specimens in a 23 ± 3ºC (73 ± 5ºF) water bath containing 5 percent sodium chloride by weight. The ends of the specimens should be a minimum of 50.8 mm (2 inches) above the water line.

Measure the leakage current between the conductors in the specimens and the water bath after 24 hours of immersion. The applied voltage for the measurement shall be 50 volts dc. After environmental exposure (sections 4.3.2.3 through 4.3.2.8) the immersion period shall be 4 hours.

4.3.2.3. Flex Test (Room Temperature)

While at room temperature, wrap 3 specimens made with TXL wire around 50.8 mm (2 inch) mandrels, using the following procedure. Attach

one end of the specimen to the mandrel and the other end to a weight (see Table 1). Rotate the mandrel sufficiently to cause the splice area to wrap around the mandrel, and the wires on the opposite side of the splice to contact the mandrel. Rotate the mandrel in the opposite direction until the splice is again wrapped around the mandrel. This shall be one cycle. Test each sample for five cycles. Measure the current leakage in accordance with section 4.3.2.2.

4.3.2.4. Thermal Shock

Suspend vertically 3 specimens made with TXL wire in a circulating air oven for 30 minutes at 130 ± 5ºC (266 ± 9ºF). Remove the specimens from the oven and within 2 minutes immerse them in a 5 percent sodium chloride solution by weight at 5 ± 5ºC (41 ± 9ºF). Remove them from the bath within 30 minutes. This shall be one cycle. Test the samples for 5 cycles and measure the current leakage in accordance with section 4.3.2.2.

4.3.2.5. Low Temperature Flexibility

Condition 3 specimens in a cold chamber for 4 hours at -30 ± 3°C (-22 ± 5ºF). While at this temperature, wrap the specimens around a 10 cm (4 inch) mandrel. Attach one end of the specimen to the mandrel and the other end to a weight (see Table 1). Rotate the mandrel sufficiently to cause the splice area to wrap around the mandrel, and the wires on the opposite side of the splice to contact the mandrel. Then rotate the mandrel in the opposite direction until the splice is again wrapped around the mandrel. This shall be one cycle. Test each specimen for five cycles. Upon completion of the fifth cycle, test the specimens for dielectric withstand.

Dielectric Withstand
Immerse the center section of all specimens in a 23 ± 3ºC (73 ± 5ºF) water bath containing 5 percent sodium chloride by weight. The ends of the specimens should be a minimum of 50.8 mm (2 inches) above the water line. The specimens shall remain immersed in the bath for two hours prior to testing. Raise the voltage on the immersed specimens to 1,000 volts ac and hold for 1 minute, then inspect for insulation rupture.

4.3.2.6. Accelerated Heat Aging

Suspend the specimens vertically for 168 hours in a circulating air oven.

TXL wire Heat age at 130 ± 5ºC (266 ± 9ºF)

Remove the specimens from the oven and within 2 minutes, immerse in a 5 percent sodium chloride solution by weight at room temperature. Measure current leakage in accordance with section 4.3.2.2.

4.3.2.7. Long Term Heat Aging

Ten specimens shall be prepared as described in section 4.3.2.1.

Suspend the specimens vertically in a fan assisted air circulating oven and conditioned at 125 ± 3°C for 1,200 hours. After conditioning, the specimens shall be allowed to cool naturally to room temperature and visually examined for signs of outer jacket cracking. Visual discoloration of the FILS-125 jacket material or adhesive does not constitute failure.

Measure the current leakage in accordance with section 4.3.2.2.

4.3.2.8. Fluid Immersion

a) Immerse 3 specimens of each wire type for 1 hour at 100 ± 3ºC (212 ± 5ºF) in each of the following fluids:

Oil, IRM 903 (ASTM D 471)
Automatic Transmission Fluid (Dexron III/Mercon)
Engine Coolant, Type III (ASTM D 3306)

b) Immerse 3 specimens of each wire type for 30 minutes at 23 ± 3ºC (73 ± 5ºF) in each of the following fluids:

Diesel Fuel, Grade No. 2 (ASTM D 975)
Screen Wash
Fuel C, ASTM D 471

c) Immerse 3 specimens of each wire type for 10 seconds in each of the following fluids at intervals of 30 minutes for 16 hours at 23 ± 3ºC (73 ± 5ºF) to simulate a splash environment:

Engine Cleaner, GUNK*
Brake Fluid, SAE J 1703

Allow the specimens to drain between immersions.

*Trademark of the Radiator Specialty Co., Charlotte, NC

Visually inspect all fluid immersion specimens for splice insulation integrity. Immediately measure current leakage in accordance with section 4.3.2.2.

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

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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 cut pieces, unless otherwise specified.

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.

APPENDIX

TABLE 1
Weights for Flex Test Procedure
(Section 4.3.2.3)

Size	Weight
4/1	2.27 kg (5 pounds)
8/2	4.54 kg (10 pounds)

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TABLE 2
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
Material Properties			
Dimensions	mm (inches)	In accordance with Drawings of FILS-125	ASTM D 2671 Section 4.3.1.1
Longitudinal Change	%	+0, -10	
Tensile Strength	MPa (psi)	10 (1,450) min.	ASTM D 2671 Section 4.3.1.2
Ultimate Elongation	%	250 min.	
2% Secant Modulus* (expanded)	MPa (psi)	172 (25,000) max.	ASTM D 2671
Heat Shock 4 hours at 225 ± 3ºC (437 ± 5ºF)	--	No dripping, flowing or cracking of outer jacket	ASTM D 2671
Volume Resistivity	Ohm.cm	1.0×10^{12} min.	ASTM D 2671
Dielectric Strength	KV/mm	16 min.	ASTM D 2671
Flammability	mm/min	100 max.	Section 4.3.1.3
Water Absorption	%	0.50	ASTM D 570
Splice Performance Properties			
Current Leakage (original sample)	10^{-6}A	0.25 max.	Section 4.3.2.2
Flex Test (Room Temperature)	--	--	Section 4.3.2.3
Current Leakage	10^{-6}A	0.25 max.	Section 4.3.2.2
Thermal Shock	--	--	Section 4.3.2.4
Current Leakage	10^{-6}A	0.25 max.	Section 4.3.2.2
Low Temperature Flexibility	--	--	Section 4.3.2.5
Dielectric Withstand 1 minute at 1,000 volts	--	No breakdown	Section 4.3.2.5
Accelerated Heat Aging	--		Section 4.3.2.6
Current Leakage	10^{-6}A	0.25 max.	Section 4.3.2.2
Long Term Heat Aging	--	No cracking of tubing jacket after 1,200 hours at 125°C	Section 4.3.2.7
Current Leakage	10^{-6}A	0.25 max.	Section 4.3.2.2
Fluid Immersion	--	--	Section 4.3.2.8
Current Leakage	10^{-6}A	0.25 max.	Section 4.3.2.2

*Calculate based on wall thickness of jacket only.

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