Raychem TAK-Sleeve Specification
Adhesive-Lined
Modified PVDF Tubing

108-120020

TAK-Sleeve is a dual wall tubing fabricated from a jacket layer of modified polyvinylidene fluoride and an adhesive layer which is a special high-performance material which exceeds the high and low temperature properties of many other thermoplastic adhesives. It is especially suitable for applications requiring high-temperature performance, outstanding abrasion and cut-through resistance, or superior chemical and solvent properties. Being semi-rigid it will also offer a degree of strain relief.
The adhesive in TAK-Sleeve is tough and flexible and exhibits very low flow in the melt. It bonds well to polymeric materials such as Raychem's polyolefins and neoprene, and to metals such as steel and aluminum.
RoHS and REACH compliant.
Continuous operating temperature -55 to 135°C *(-67 to 275 ºF)*.
Recommended maximum temperature for use as a primary insulator 135°C *(275 ºF)*.

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1. SCOPE

This specification covers the requirements for one type of electrical insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 175°C (347°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-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-T-83133	Turbine Fuel, Aviation, Kerosene Type, JP-8
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base

2.2. OTHER PUBLICATIONS

ISO 846	Plastics – Evaluation of the action of microorganisms.
ISO 6722	Road vehicles -- 60 V and 600 V single-core cables
ASTM D2671	Standard Methods of Testing Heat-Shrinkable Tubing for Electrical use
ASTM D910	Standard Specification for Leaded Aviation Gasolines

(Copies of ASTM publications may be obtained from the American Society of Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103)

AMS1424	De-icing/Anti-Icing Fluid, Aircraft, SAE Type I

3. REQUIREMENTS

3.1. MATERIAL

The tubing shall consist of two components: The jacket shall be fabricated from a modified polyvinylidene fluoride compounded and crosslinked by irradiation. 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, defected, pinholes, seams, cracks or inclusions.

3.2. COLOR

The tubing described herein shall be supplied in a standard unpigmented state, the jacket is transparent to translucent light tan (clear) in color, unless otherwise specified. The adhesive liner is light amber.

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3.3. 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 samples submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification. Qualification of any size within each size range specified below shall qualify all sizes within that size range:

Expanded ID Size Ranges
1/8 through 3/16
Greater than 3/16 (0.188 mm)

4.1.2. Acceptance Tests

Acceptance tests are those performed on tubing submitted for acceptance under contract. Acceptance tests shall consist of the following tests: dimensional recovery, longitudinal change, tensile strength, ultimate elongation, secant modulus and heat shock. 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 15 m *(50 feet)* of tubing of the size specified.

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.

4.3. TEST PROCEDURES

Unless otherwise specified, tests shall be performed on specimens which have been fully recovered by conditioning for 3 minutes in a 200 ± 5°C *(392 ± 9°F)* oven. Prior to all testing, the test specimens (and measurement gauges, when applicable) shall be conditioned for at least 3 hours at 23 ± 3°C *(73 ± 5°F)* and 50 ± 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.

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4.3.1.Dimensions and Longitudinal Change

Three 6-inch *(150-mm)* specimens of tubing, as supplied, shall be measured for length ± 1 mm *(± 1/32 inch)* and inside diameter in accordance with ASTM D 2671. These specimens shall be conditioned for 3 minutes in a 200 ± 5°C *(392 ± 9°F)* oven, removed from the oven and cooled to 23 ± 3°C *(73 ± 5°F)*, and remeasured for length, inside diameter and wall thickness. Longitudinal change shall be calculated as follows:

$$LC = \frac{(L_1 - L_0)}{L_0} \times 100$$

Where: LC = Longitudinal Change [percent]
L_0 = Length Before Conditioning
L_1 = Length After Conditioning

4.3.2.Tensile Strength and Ultimate Elongation

The tensile strength and ultimate elongation of the tubing shall be determined in accordance with ASTM D 2671 using 1 inch (25 mm) bench marks and a 1 inch (25 mm) initial jaw separation. The speed of jaw separation shall be 2 + .2 inches (50 + 5 mm) per minute. Calculate the tensile strength based on the wall thickness of the jacket only.

4.3.3.Low Temperature Flexibility

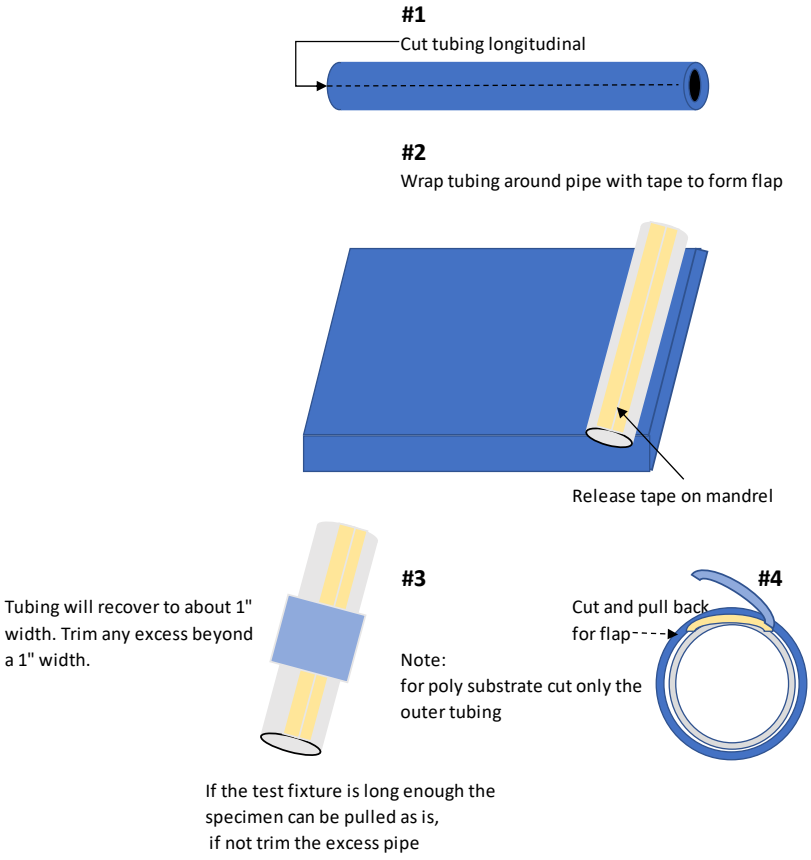
For tubing of expanded diameter 1/4 inch (6 mm) or greater, three strip specimens 1/4 inch (6 mm) wide and 12 inches (300 mm) long shall be cut from the expanded tubing. For tubing of expanded diameter less than 1/4 inch (6 mm) three tubular specimens, 12 inches (300 mm) long, shall be cut from the expanded tubing. The specimens shall be recovered in accordance with Section 4.3 and conditioned with appropriate mandrels for 4 hours at -55 ± 2°C (-67 ± 4°F). The mandrel diameter shall be 10 times the specimen thickness, ± 10%. For tubular specimens, the specimens thickness shall be equivalent to the outside diameter. While at the specified temperature, and without removing the specimens from the cold chamber, the specimens shall be wrapped for 360 degrees around the mandrel in approximately 2 seconds. Any side cracking, caused by flattening of the specimens on the mandrel, shall be disregarded.

4.3.4.Peel Strength

The test shall be carried out using expanded TAK-Sleeve-No.2 if available. Five cylindrical rolling drum adhesion test mandrels 63mm *(2.5 in)* long by 25mm *(1 in)* diameter and of surface material as specified shall be cleaned, degreased and lightly abraded using P400 *(325-grit)* sand paper. Apply a piece of tape axially across the mandrel, this will allow for a flap after the tube is recovered onto the mandrel.
Specimens of TAC-Sleeve-No.2 approximately 163mm *(6.5 in)* long shall be cut and slit longitudinally forming a 163 mm *(6.5 in)* long by 63mm *(2.5 in)* wide strip with adhesive on one side. Wrap the resultant strip, adhesive layer in contact with

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the mandrel, around the mandrel twice so that the mandrel is centered. Fasten the end with heat resistant tape.
If TAK-Sleeve No. 2 is not available use TAK-Sleeve-1/2, and unitize to a width of 25 mm for the peel force.
Recovered on to the mandrels by conditioning in a fan assisted air circulating oven at 200 ± 5°C *(392 ± 9°F)* for 3 minutes. After conditioning, the specimens shall be removed from the oven and allowed to cool naturally to room temperature. The result should be that the tubing is about 25 mm *(1 in.)* wide on the 63 mm *(2.5 in.)* long mandrel. If the fixture is not long enough to accommodate the 63 mm *(2.5in.)* mandrel, the surplus length of the mandrel can be trimmed.



The specimens shall be slit axially along one edge of the tape applied to the mandrel before the tubing was wrapped onto it and recovered. Peel the tubing from the mandrels in a suitable tensile testing machine such that the tubing peels off at a rate of 50 ± *5mm (2 ± 0.2in)* length per minute as the mandrel rotates. See Figure below. The test shall be carried out at a temperature of 23 ± 3°C *(73 ± 5°F)*. The mean peel-off force for each specimen shall be recorded, and the mean of the five recorded measurements reported as the Inner Wall Adhesion.

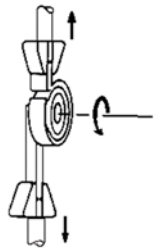
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For the reported peel force unitize to 25 mm using the following formula:

$$PF = F \times \frac{25}{W}$$

Where: PF = Reported Peel Force
F = Measured Peel Force
W = Actual width of Peel specimen

Peel Specimen in Tensile Tester Setup



4.3.5. Heat Shock

Three 6-inch *(150-mm)* specimens of tubing shall be conditioned for 4 hours in a 250 ± 5°C *(482 ± 9°F)* oven. After this conditioning, the specimens shall be removed from the oven, cooled to 23 ± 3°C *(73 ± 5°F)*, wrapped 180 degrees around a mandrel selected in accordance with Table 1, and then visually examined for evidence of dripping, flowing or cracking. Any side cracking caused by flattening of the specimen on the mandrel shall not constitute failure.

4.3.6. Heat Resistance

Three 12-inch *(300-mm)* specimens of tubing shall be conditioned for 168 hours in a 158 ± 5°C *(316 ± 9°F)* oven. After conditioning, the specimens shall be removed from the oven, cooled to 23 ± 3°C *(73 ± 5°F)* and tested for ultimate elongation in accordance with Section 4.3.2.

4.3.7. Corrosive Effect

4.3.7.1. Copper Mirror Corrosion

The tubing shall be tested for copper mirror corrosion in accordance with ASTM D 2671, Procedure A, for 168 hours at 175 ± 3°C *(347 ± 5°F)*. Evidence of corrosion shall be the removal of copper from a mirror, leaving an area of transparency greater than 5 percent of its total area.

4.3.7.2. Corrosion in Contact with Copper

The tubing shall be tested for corrosion in contact with copper in accordance with ASTM D 2671, Procedure B, for 16 hours at 175 ± 3°C *(347 ± 5°F)*. Examine the copper for evidence of pitting or blackening.

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4.3.8. Flammability

The test method shall be essentially in accordance with ISO6722.
Recover five 500 mm *(20 inch)* lengths of tubing with adhesive over mandrels with a diameter just slightly larger than the fully recovered ID indicated in the TAK-Sleeve SCD. Suspend the specimen in a draft free environment in the configuration shown in Figure 1. Using a Bunsen burner with a 100 mm *(4 inch)* tube, adjust the burner to achieve a flame with an inner blue cone of approximately 50 mm *(2 inches)* and overall flame height of 100 mm *(4 inches)* and a temperature of 950 ± 50°C *(1,742 ± 90°F)*. For reference the gas flow rate for natural gas is approximately 0.4 slpm.
The time of exposure of the test flame to the specimen is one application of 15 seconds if the fully recovered ID is 1.78 mm *(0.070 in)* or less or 30 seconds for a fully recovered ID greater than 1.78 mm *(0.070 in)*,
Record the time for each specimen to self-extinguish after removal of the flame. The result is the average burning time for all five specimens.

4.3.9. Fluid Resistance

Six 6-inch *(150-mm)* specimens of tubing, prepared and measured in accordance with ASTM D 2671, shall be completely immersed in each of the fluids listed in Table 2 for 24 ± 2 hours at 23 ± 3°C *(73 ± 5°F)*. The volume of the fluid shall be not less than 20 times that of the specimens. After immersion, the specimens shall be lightly wiped and air dried for 30 to 60 minutes at room temperature. Three specimens then shall be tested for dielectric strength and the other three for tensile strength.

4.4. REJECTION AND RETEST

Failure of a 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 the rejection and the action taken to correct the defect shall be furnished to the inspector.

5. PREPARATION FOR DELIVERY

5.1. FORM

The tubing shall be supplied in lengths of 1200 +25, -0 mm *(48 +1, -0 inches)* 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 product designation, size, quantity, manufacturer's identification and lot number.

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APPENDIX

FIGURE 1

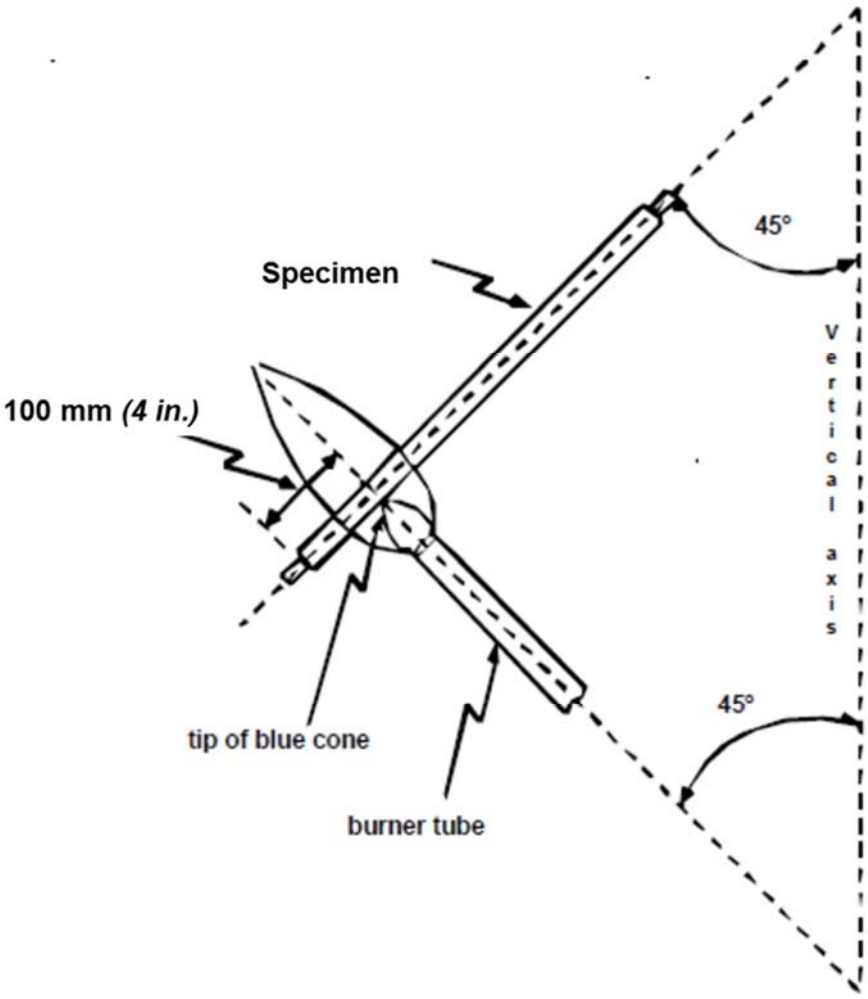


TABLE 1
Mandrel Dimensions

Tubing Expanded ID Size	Mandrel Diameter	
mm *(inches)*	mm.	*in*
1.16 *(0.046)* through 4.79 *(0.188)*	7.9	*5/16*
4.80 *(0.189)* through 50.8 *(1.000)*	19.1	*3/4*

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TABLE 2
Requirements

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
PHYSICAL Dimensions	mm *(Inches)*	In accordance with TAK-SLEVE SCD	Section 4.3.1
Longitudinal Change	Percent	+0, -10 maximum	ASTM D 2671
Tensile Strength	MPa *(psi)*	34.5 minimum *(5000)*	Section 4.3.2
Ultimate Elongation	Percent	150 minimum	ASTM D 2671
Secant Modulus (expanded)	MPa *(psi)*	690 minimum *(1 x 10^5)*	ASTM D 2671
Specific Gravity		1.8 maximum	ASTM D 2671
Low Temperature Flexibility 4 hours at -55 ± 2°C *(-67 ± 4°F)*	---	No cracking	Section 4.3.3
Peel Strength To Copper To Aluminum To Crosslinked Poly (RNF-100)	N/25mm *(Lbf/in)*	 89 minimum *(20)* 44 minimum *(10)* 44 minimum *(10)*	Section 4.3.4
Heat Shock 4 hours 250 ± 5°C *(482 ± 9°F)*	---	No dripping, flowing, or cracking	Section 4.3.5
Heat Resistance 168 hours at 158 ± 5°C *(317 ± 9°F)* Followed by test for:	---	---	Section 4.3.6
Ultimate Elongation	Percent	100 minimum	
ELECTRICAL Dielectric Strength (Jacket Only) Sizes 3/64 through 1/2 Sizes 3/4 through 2	 Volts/mm *(Volts/mil)*	 31,500 minimum *(800)* 23,600 minimum *(600)*	ASTM D 2671
Volume Resistivity	ohm-cm	1 x 10^{13} minimum	ASTM D 2671
CHEMICAL Corrosive Effect Copper Mirror 16 hours at 175 ± 3°C *(347 ± 5°F)*	---	Non-Corrosive	Section 4.3.7.1 ASTM D 2671 Procedure A
Copper Contact 168 hours at 175 ± 3°C *(347 ± 5°F)*	---	No pitting or blackening of copper	Section 4.3.7.2 ASTM D 2671 Procedure B
Flammability Average Time of Burning	Seconds	70 maximum	Section 4.3.8. ISO 6722

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TABLE 2
Requirements
(continued)

PROPERTY	UNIT	REQUIREMENT	TEST METHOD
CHEMICAL (continued) Fungus Resistance Followed by tests for: Tensile Strength Ultimate Elongation Dielectric Strength Sizes 3/64 through 1/2 Sizes 3/4 through 2	 MPa (psi) Percent Volts/mm (Volts/mil)	 34.5 minimum (5000) 150 minimum 31,500 minimum (800) 23,600 minimum (600)	 ISO 846 Method B Section 4.3.2 ASTM D 2671 ASTM D 2671
Water Absorption 24 hours at 23 ± 3°C (73 ± 5°F)	Percent	0.5 maximum	ASTM D 2671
Fluid Resistance 24 hours at 23 ± 3°C *(73 ± 5°F)* JP-8 Fuel (MIL-T-83133) Skydrol* 500 Hydraulic Fluid (MIL-H-5606) Aviation Gasoline 100/130 (ASTM D910) Salt Water (5% salt) Anti-icing Fluid (AMS1424) Lubricating Oil (MIL-L-7808) Followed by tests for:	---	---	Section 4.3.9
Dielectric Strength Sizes 3/64 through 1/2 Sizes 3/4 through 2	Volts/mm *(Volts/mil)*	27,600 minimum *(700)* 19,700 minimum *(500)*	ASTM D 2671
Tensile Strength	MPa *(psi)*	34.5 minimum *(5000)*	Section 4.3.2 ASTM D 2671

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