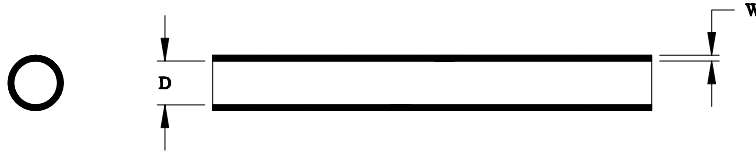


# NETM2000

This specification applies to 150°C heat resistant tubing used for outer cover binder of wire harness and terminal for electrical insulation.

**1. Size and appearance**



**Table 1: Dimensions**

Size	Inside Diameter (D)		Wall Thickness (W)	
	mm.	in.	mm.	in.
6	6±0.5	.236±.02	0.5±.05	.020±.002
8	8±0.5	.315±.02	0.5±.05	.020±.002
10	10±0.5	.394±.02	0.5±.05	.020±.002
12	12±0.5	.472±.02	0.5±.05	.020±.002

**2. Material and processing method**

The tube shall be made of a flame-retardant polyolefin compound. It shall not contain any material harmful for use, and shall be excellent in heat resistance, aging resistance, oil resistance and flexibility.

**3. Color**

Unless otherwise specified tubing color shall be black.

**4. Appearance**

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

**5. Characteristics**

The characteristics of the tube shall be in accordance with table 2 when tested according to the methods specified in section 6.

**Specification Control Drawing**

<b>tyco</b> <i>Electronics</i>	Tyco Electronics Corporation 300 Constitutional Drive Menlo Park, CA 94025 USA		<b>Raychem</b>	Title: <b>NETM2000</b>		
	Tyco Electronics reserves the right to amend this drawing at any time. Users should evaluate the suitability of the product for their application			Document No : <b>NETM2000</b>		
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**Table 2: Properties**

Property	Unit	Requirement	Test Method
Cold Resistance	--	No cracking	JIS Z 8703
Tensile Strength	MPa ( <i>PSI</i> )	15.7 (2277)	JIS Z 8703
Elongation	Percent	150 minimum	
Residual rate after heating followed by test for:			JIS Z 8703
Tensile Strength	MPa ( <i>PSI</i> )	9.8 (1421)	
Elongation	Percent	50 minimum	
Oil resistance followed by test for:			JIS Z 8703
Tensile Strength	Map ( <i>PSI</i> )	9.8 (1421)	
Elongation	Percent	50 minimum	
Flammability	--	15 seconds flaming maximum	JIS Z 8703
Heat characteristic			JIS Z 8703
Deformation after heating	Percent	Thickness decrease 15 or less	
Shrinkage after heating	Percent	Length decrease 10 or less	
Heat Resistance	--	No cracks	JIS Z 8703
Volume Resistivity	M ohm/m	1000 minimum	JIS Z 8703
Voltage Withstand	Volts	1000 for 1 minute	JIS Z 8703
Bridging (Gel rate)	Percent	40 minimum	JIS Z 8703
Wear test at high temperature	--	200 strokes minimum	JIS Z 8703

**6. Test****6.1 Testing conditions****6.1.1 Environment**

The tests shall be performed under ambient temperature and humidity (temperature  $20 \pm 5^\circ$  C, humidity  $65 \pm 20\%$ ) specified in JIS Z 8703. (Standard Atmospheric Conditions for Testing) unless otherwise specified.

**6.2 Test Method****6.2.1 Appearance Test****6.2.2 Dimensions****1. Inside diameter**

Prepare 5 tubes 50mm or longer . Select a smooth gage rod that will fit into one end of the tube without causing the tube to expand. A gage rod that fits snug with no visible air space between the end of the tube and the rod shall be measured and recorded as the tubing inside diameter.

**2.****Thickness**

Cut five tubes and a go-gauge for the inner diameter of the tubes. Insert the go-gauge in each of the tubes and measure the outer diameter using a micrometer specified in JIS B 7502 (Micrometer Calipers for external measurement) or other measuring instrument having an equivalent or superior precision. The outer diameter shall be measured at three points on each of the five tubes (15 total measurements). Half of the difference between the measured outer diameter and the diameter of the go-gauge shall be recognized as the thickness. The test result shall be represented by the average of the 15 measurements.

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### 6.2.3 Cold Resistance Test

Cut a tube of adequate length and a flexible bar which has a diameter approximately equal to the inner diameter of the tube. Insert the bar into the tube. Place the assembly in a cold chamber at  $-40 \pm 3$  °C for 30 minutes. Remove the assembly from the cold chamber and wrap it 180° over a mandrel specified in Table 3. For tubing that has an inside diameter of 5mm or less wrap the tubing 6 turns around the mandrel in approximately 6 seconds. Examine the tubes for evidence of cracks.

Table 3

Tubing Inner Diameter (mm)	6 to 10	11 to 15
Mandrel Diameter (mm)	200	300

### 6.2.4 Tensile Strength and Elongation

#### 1. Normal Temperature

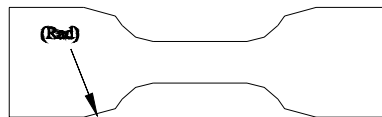
##### a. Inside Diameter 8mm or less

Cut five tubes approximately 150 mm long. Mark the center of each piece with 50mm bench marks. Mount the test piece into a tensile testing machine specified in JIS B 7721 (Tensile Testing Machines). Separation speed shall be approximately 200mm/min. Measure the load and the elongation between the bench marks when the test piece is torn apart. Average the test results for the 5 test pieces for both tensile strength and elongation. Any test pieces that break outside the bench marks shall be excluded and another test piece prepared for the test. Temperature during testing shall be recorded.

##### b. Inside Diameter greater than 8mm

Cut five tubes approximately 150 mm long. Slit each sample parallel to its longitudinal axis and flatten so that it can be cut into a No. 4 dumbbell specified in JIS K 6301 (Physical Testing Methods for Vulcanized Rubber) as shown in Figure 1 below. Mark the center of each piece with 20mm bench marks. Mount the test piece into a tensile testing machine specified in JIS B 7721 (Tensile Testing Machines). Separation speed shall be approximately 200mm/min. Measure the load and the elongation between the bench marks when the test piece is torn apart. Average the test results for the 5 test pieces for both tensile strength and elongation. Any test pieces that break outside the bench marks shall be excluded and another test piece prepared for the test. Temperature during testing shall be recorded.

Figure 1



#### 2. Residual Rate After Heating

Heat a 150mm long tube to a temperature of  $180 \pm 5$  °C for 200 hours. Remove from heat and cool to room temperature. Measure the tensile strength and elongation of the tube as described in 6.2.4 1.

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### 6.2.5 Oil Resistance Test

Cut three tubes each approximately 150 mm long. Mix equal amounts of oil in which No. 1 lubrication oil of 1-3 types specified in JIS K2215 and the oil specified in JIS K 2209 or equivalent are blended (See item 7). The mixed oil shall be heated to 50 +/- 3°C prior to testing. Soak the test pieces in the oil mixture for 20 hours. Remove the test pieces from the oil mixture and lightly wipe the excess oil from the surface. Measure the tensile strength and elongation of the tube as described in 6.2.4 1.

### 6.2.6 Flame Resistance Test

Cut a tube approximately 150 mm long. Insert a noncombustible rod into it and bend it approximately 30° at a point 50mm from one of its ends. Hang it vertically by fixing the other end so that it can be suspended over a flame of a spirit lamp or gas burner at a point approximately 20 mm from its bottom end. When the test piece begins to burn remove it from the flame and record the length of time the piece burns. During the test provide a windshield to prevent the flame from being blown by a draft or breeze causing it to flicker.

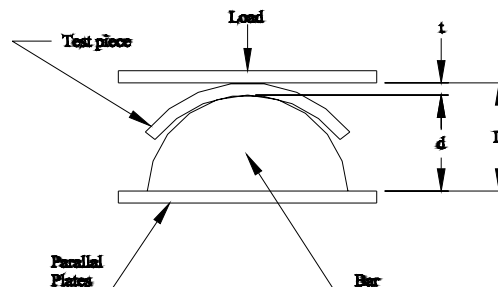
### 6.2.7 Heat Characteristic

#### 1. Deformation After Heating

Prepare an arc-shaped test piece 30mm long and measure its thickness. Heat the test piece to 120 +/- 3°C for 30 minutes using a heat deformation tester specified in JIS C 3005 (Testing Methods for Rubber or Plastic Insulated Wires and Cables) item 23. Put the test piece between the parallel plates of a measuring device shown in Figure 2 and apply a load of 3.92N (400gf) to the test piece. Condition the assembly at 105 +/- 3°C for 30 minutes, remove from heat and cool to room temperature. Remeasure the thickness. The residual rate shall be calculated using the formula below.

$$\text{Residual rate(\%)} = \frac{\text{Thickness before heating} - \text{Thickness after heating}}{\text{Thickness before heating}} \times 100$$

Figure 2



#### 2. Shrinkage After Heating

Cut 3 tubes approximately 300mm long as the test pieces. Put two benchmarks 200mm apart in center of the test piece. Heat the test pieces to 120 +/- 3°C for one hour, remove from heat and cool to room temperature. Measure the length between the two marks using a pair of calipers specified in JIS B 7507 (Venir Calipers) or other measuring instrument of equal or superior precision. Calculate the decrease rate by the formula below. The test result shall be represented by an average of the decrease rate of the three test pieces.

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$$\text{Decrease rate(\%)} = \frac{\text{Length before} - \text{Length after}}{\text{Length before heating}} \times 100$$

**6.2.8 Heat Resistance**

Cut a tube approximately 300mm long as the test piece. After heating the test piece at 200 +/- 30°C for 30 minutes, remove from heat and let it cool for 30 minutes or more at room temperature. Wrap the test piece at least 3 turns around a mandrel that has a diameter approximately equal to the outer diameter of the test piece. Examine the condition of the test piece.

**6.2.9 Volume Resistivity**

Cut a tube of 250mm long as test piece. Select a well-polished metal bar which closely fits inside of the tube. Insert the metal bar into the tube to serve as the inside electrode. Wrap metal foil tightly around a 200mm wide section of the tube to serve as the outside electrode. Apply voltage of 500V DC to the electrodes. Then measure the value of the resistance using a highly sensitive absolute ohmmeter. The test result shall be calculated as follows.

$$* = 1.257 \times R / \ln(d+2t/d)$$

- \* : volume resistivity (Q m)
- R : measured volume resistance in ohms(Q)
- d : diameter if inner electrode(mm)
- t : thickness of test piece(mm)

**6.2.10 Voltage Withstand Test**

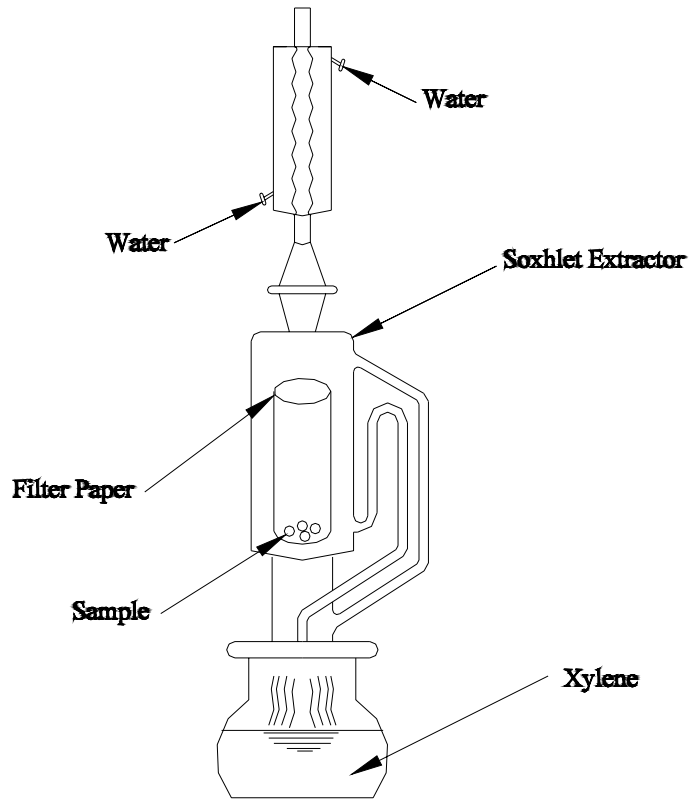
Cut a tubing specimen of adequate length and slit the specimen along one edge parallel to its longitudinal axis. Place the test specimen between two electrodes as specified in JIS C 2110 Figure 5, item 7.1. The pressure applied to the specimen shall be approximately 4.9N (500gf). Increase the test voltage applied to the test specimen to 1000V at 50 or 60 Hz. The test specimen must withstand the test voltage for one minute.

**6.2.11 Bridging**

Cut a sample of tubing approximately 0.5g, weigh it and subject it to extraction for 18 hours using xylene with a Soxhlet extractor. Remove the sample and dry it at 100° C for 3 hours in a dryer. Remove sample from dryer and cool to room temperature. Reweigh the sample. Calculate the weight difference as a percentage of the original weight.

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Figure 3



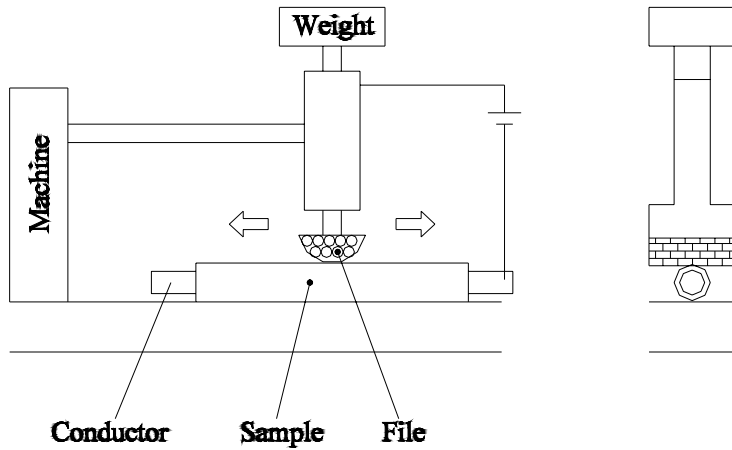
Soxhlet extractor

### 6.2.12 Wear Test at High Temperature

Insert a support mandrel into the tube and place the test assembly into the testing machine (Figure 4). Use JIS B 4703 flat round type middle range file with a 4.4N (450g) weight. Place file in contact with the test specimen. Set file to travel 20 to 50mm length of travel in 1-2 seconds. Perform test at 140° C. The result is calculated as the average of five samples.

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Figure 4



7. **Supplemental description of the reference standards**
1. The tension tester specified in JIS B 7721 is a tester equipped with a device to pull the test piece gradually and clamps to hold the test piece and a device to indicate and record the tensile load.
  2. The kerosene specified in JIS K 2203 is a mineral oil of adequate quality for lamp lights, heaters, cookers, petroleum engines or as a solvent or a cleaner. It shall not contain any water or deposit, and shall satisfy the specification listed in Table 4.

Table 4

Type	Reaction	Ignition Point °C	Distilled Property 95% (Distillate temp., °C)	Sulfur %	Smoke Point	Copper Corrosion	Color (Safe Bolt)
No.1	Neutral	40 or more	270 or less	0.015 or less	23 or more	1 or less	+25 or over
No.2	Neutral	40 or more	300 or less	0.50 or less	-	-	-

3. The No. 1 lubricating oils of types 1-3 specified in JIS K 2215 (Internal Combustion Engine Oils) are refined mineral oils having adequate quality as a lubricating oil for gasoline engines and diesel engines or the equivalent containing some additives. They shall not contain any water or deposits and must satisfy the requirement cited in Tables 5, 6 and 7 respectively.

**Table 5: Type 1**

Properties No.1	Unit	Requirement	Test Method
Color (ASTM) Neutral	--	4 or less	JIS K 2215
Reaction	--	Neutral	JIS K 2215
Ignition Point (°C)	--	170 or less	JIS K 2215
Kinematic Viscosity (P) at -18°C	--	25.0 or less	JIS K 2215
Residual carbon (mass%)	--	0.3 or less	JIS K 2215
Fluid Point (°C)	--	-25 or less	JIS K 2215
Copper Corrosion (100°C/3 hours)	--	1 or less	JIS K 2215

**Table 6: Type 2**

Properties No.2	Unit	Requirement	Test Method
Ignition Point (°C)	--	170 or more	JIS K 2215
Kinematic Viscosity (P) at -18°C	--	25.0 or less	JIS K 2215
Viscosity Index	--	75 or more	JIS K 2215
Fluid Point (°C)	--	-25 or less	JIS K 2215
Oxidation Stability (165.5°C/24 h)	--	Viscosity Ratio	JIS K 2215
		Increase of total acid value (mg KOH/g)	
		3.0 or less	
		3.0 or less	

**Table 7: Type 3**

Properties No.3	Unit	Requirement	Test Method
Ignition Point (°C)	--	170 or more	170 or more
Kinematic Viscosity (P) at -18°C	--	25.0 or less	25.0 or less
Viscosity Index	--	85 or more	85 or more
Fluid Point (°C)	--	-25 or less	-25 or less
Engine Test	--	Accepted	Accepted