



SPECIFICATION 108-120010

Formerly Raychem RW-2052 HTAT TUBING

HTAT is a semi-flexible, electrically insulating, adhesive-lined heat shrinkable flame retarded tubing.

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1. SCOPE

This specification establishes the quality standard for HTAT tubing. HTAT is a semi-flexible, electrically insulating, adhesive-lined heat shrinkable flame retarded tubing available in a 4:1 expansion ratio format.

Continuous operating temperature -55 °C to + 125°C

2. REVISION HISTORY

As RW-2052

Revision number	Change request	Date	Incorporated By
0	Formerly RK 6192 Rev 2		
1	CRF T 1020 CR98-DM-0031	27 th August 1997 17 th February 1998	C.Woosnam L.Abrams
2	Via DMTec	5 th October 2012	C.Diss
3	Via DMTec	27 th February 2014	C.Diss

As TEC-108-120010

A	Via PDM link	January 2018	C.Diss
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As 108-120010

A	Via PDM link	February 2019	M. Bakare
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3.

RELATED 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.

ASTM D882	Standard Test Methods for Tensile Properties of Thin Plastic Sheeting
ASTM D2671	Standard Test Methods for Heat Shrinkable Tubing for Electrical Use
IEC 60212	Standard Conditions for Use Prior to and During Testing of Solid Electrical Insulating Materials
IEC 60243-1	Methods of Test for Electric Strength of Solid Insulating Materials part1 Tests at Power Frequencies
ISO 37	Rubber, vulcanized or thermoplastic – Determination of Tensile Stress-Strain Properties
ISO 62	Determination of Water Absorption
ISO 188	Rubber, vulcanized -Accelerated Ageing or Heat Resistance Tests
ISO 1183	Methods for determining the density and relative density of non-cellular plastics
ISO 1817	Rubber, vulcanized – Determination of the effect of liquids



4. **REQUIREMENTS**

4.1 **COMPOSITION, APPEARANCE AND COLOUR**

The tubing shall be fabricated from thermally stabilized, modified polyolefin jacket and polyolefin based hot melt adhesive and shall be crosslinked by irradiation. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks, and contaminants. The jacket shall be black. The liner shall be amber.

4.2 **PROPERTIES**

The tubing shall meet the requirements of Table 1.

5. **QUALITY ASSURANCE PROVISIONS**

5.1 **CLASSIFICATION OF TESTS**

Tests shall be carried out on a sample taken at random from each batch of finished tubing. A batch of tubing is defined as that quantity of tubing extruded at any one time. Testing frequency shall be Qualification, 10th batch or Production routine as detailed below:

5.1.1 **Qualification Tests (frequency in accordance with the Design Authority)**

Qualification tests are those performed on tubing submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification.

5.1.2 **Production routine tests (Every Batch)**

Visual examination
Dimensions
Longitudinal change

5.1.3 **10th Batch Testing (Every 10th batch)**

Tensile Strength
Ultimate elongation
Specific gravity
Crimp performance



6.0 TEST METHODS

6.1 Preparation of Test Specimens

Unless otherwise specified, tests shall be carried out on specimens of tubing recovered by conditioning in a fan assisted air circulating oven at $200 \pm 5^{\circ}\text{C}$ for 6 ± 1 minutes and allowed to cool in air to ambient temperature. No pre-conditioning period is required prior to testing. Unless otherwise specified, all tests shall be made under standard ambient conditions according to IEC 60212. In cases of dispute the tests shall be carried out at a temperature of $23 \pm 2^{\circ}\text{C}$ and at $50 \pm 5\%$ relative humidity.

6.2 Dimensional and Longitudinal Change

The test method shall be as specified in ASTM D2671.
The length and inside diameter of three 150mm long specimens of expanded tubing shall be measured. The specimen shall be recovered in a fan assisted air circulating oven and the length and inside diameter of each shall be measured. The longitudinal change shall be expressed as a percentage of the original length. The minimum and maximum recovered wall thickness shall be determined.

6.3 Tensile Strength and Ultimate Elongation

The test method shall be as specified in ISO 37
For tubing of recovered bore greater than 4mm, five tubular specimens five type 2 dumb-bell specimens shall be tested. For tubing of recovered bore less than or equal to 4mm, five tubular specimen 125mm long shall be tested. Initial jaw separation shall be 50mm and rate of jaw separation shall be $50 \pm 5\text{mm per minute}$.
The test shall be carried out at a temperature of $23 \pm 2^{\circ}\text{C}$.
Calculation of tensile strength shall be based on the cross sectional area of the jacket only.

6.4 Secant Modulus at 2% Strain

The test method shall be as specified in Method A of ASTM D882. The test is to be carried out on recovered tubing.
For tubing of recovered bore greater than 6mm, five strip specimens 150mm long shall be tested. For tubing of recovered bore less than or equal to 6mm, five tubular specimens 150mm long shall be tested. Initial jaw separation shall be 100mm and rate of jaw separation $10 \pm 1\text{mm per minute}$.
The test shall be carried out at a temperature of $23 \pm 2^{\circ}\text{C}$.



6.5 Specific Gravity

The test shall be carried out in accordance with Method A of ISO 1183

6.6 Inner Wall Adhesion

The test shall be carried out on size 48/13 HTAT. Five cylindrical Aluminium rolling drum adhesion test mandrels 25mm long x 25mm diameter shall be abraded with 320 grit emery paper and the degreased with IMS. Specimens of size 48/13 HTAT approximately 50mm long shall be recovered onto the mandrels by conditioning in a fan assisted air circulating oven set at $160 \pm 3^{\circ}\text{C}$ for 20 minutes. After conditioning the specimens shall be removed from the oven and allowed to cool naturally to room temperature. Surplus lengths of the the HTAT tubing shall be trimmed level with the ends of the madrels. The specimens shall be slit axially and peeled from mandrels in a suitable tensile testing machine such that the tubing peels off at a rate of $50 \pm 5\text{mm}$ per minute as the mandrel rotates. See figure 1.

The test shall be carried out at a temperature of $23 \pm 2^{\circ}\text{C}$. 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.

6.7 Heat Shock

The test shall be as specified in ASTM D2671.

The specimens shall be conditioned in a fan assisted air circulating oven as specified in Table 2.

6.8 Heat Ageing

The test method shall be as specified in ISO 188.

For tubing of recovered bore greater than 6mm, five strip specimens 75mm x 6mm shall be tested. For tubing of recovered bore less than or equal to 6mm, five tubular specimens 75mm long shall be tested. The specimens shall be conditioned in a fan assisted air circulating oven as specified in Table 2.

6.9 Low Temperature Flexibility

The test method shall be as specified in Procedure C of ASTM D2671.

The tubing shall be tested in the “as supplied” state.

Mandrel diameter shall be $20 \times$ specimen thickness $\pm 10\%$.

The specimens and mandrels shall be conditioned as specified in Table 2.

**6.10 Flammability**

The test method shall be as specified in Procedure B of ASTM D2671.
The test shall be carried out on size HTAT 16/4.

6.11 Electric Strength

The test method shall be as specified in IEC 60243-1 (short term test).

6.12 Copper Mirror Corrosion

The test method shall be as specified in ASTM D2671.
The specimens shall be conditioned as specified in Table 2.

6.13 Water Absorption

The test method shall be as specified in Method 1 of ISO 62.
For tubing of recovered bore greater than 8mm, three disc specimens of diameter 25 ± 1 mm shall be cut from the tubing. For tubing of recovered bore less than or equal to 8mm, three tubular specimens 50mm long shall be cut from the tubing.

6.14 Fluid Resistance

The test method shall be as specified in ISO 1817.
Five tensile test specimens prepared as in Clause 6.3 shall be completely immersed in each of the fluids for the times and temperatures specified in Table 2. The volume of the fluid shall not be less than 20 times that of the specimen. After immersion lightly wipe the specimens and allow to air dry at $23 \pm 2^\circ\text{C}$ for $1\text{h} \pm 15$ mins. The Tensile Strength and Ultimate Elongation of each specimen shall be tested in accordance with clause 6.3. The test shall be repeated on the remaining specified fluids.
Five rolling drum adhesion strength specimens prepared in accordance with Clause 6.6 shall be immersed in each of the fluids for the times and temperatures specified in Table 1. After immersion, lightly wipe the specimens and allow to air dry at $23 \pm 2^\circ\text{C}$ for $1\text{h} \pm 15$ mins.
The adhesion of each specimen shall be tested according to Clause 6.6.
The test shall be repeated on the remaining specified fluids.



6.15 **Crimp Performance**

A 5mm long crimp area is made at each end of a pre-heated 75mm length of recovered HTAT, by squeezing together, for approximately 30 seconds. The specimen shall be allowed to cool naturally to room temperature for at least 1 hour, then placed in a fan assisted air circulating oven at the temperature and time specified in Table 2. After conditioning remove from the oven and examine visually.

6.16 **Boiling water Resistance**

A 5mm long crimp area is made at each end of a pre-heated 75mm length of recovered HTAT, by squeezing together, for approximately 30 seconds. The specimen shall be allowed to cool naturally to room temperature for at least 1 hour, then placed in boiling water for one hour, removed and allowed to cool naturally to room temperature then visually examined and slit longitudinally to assess if any water has ingressed.

6.17 **Dynamic Shear Strength**

Only tubing sizes 16/4 and above can be tested.
Five 100mm long rods of material as specified having an outside diameter approximately 25% above the recovered diameter of the sleeving to be tested, shall have at least 25mm from one end abraded with 320 grit emery paper and degreased with IMS. A 100 mm length of HTAT shall then be recovered on to the rod by conditioning in a fan assisted air circulating oven set at $160 \pm 3^{\circ}\text{C}$ for 20 minutes, so that a 12-14mm joint is made over the abraded area.
The specimens shall be allowed to cool naturally to room temperature, and tested using a suitable tensile testing machine. Initial jaw separation shall be 100mm. Rate of jaw separation shall be 50mm / minute. The Dynamic Shear Strength shall be reported as the average value of the five breaking loads.

6.18 **Dynamic Shear strength at Elevated Temperature**

Five HTAT to Aluminium test specimens shall be prepared as in Clause 6.17. The Dynamic Shear Strength of each specimen shall be determined as in Clause 6.17 except that the test shall be performed at the temperature specified in Table 2.

7.0 **Packaging**

Packaging shall be in accordance with good commercial practice. Each package shall bear an identification label showing material quantity, description, size, colour and batch number. Additional information shall be supplied as specified in the contract or order



TABLE 1
Requirements

PROPERTY	TEST METHOD	REQUIREMENT
Visual examination		As per Clause 4.1
Dimensions	ASTM D2671	As per Clause 6.2
Longitudinal Change	ASTM D2671	0 to -20%
Tensile Strength	ISO 37	9.0 MPa minimum
Ultimate Elongation	ISO 37	300% minimum
Secant Modulus @ 2% strain (recovered)	ASTM D882	125 MPa maximum
Specific Gravity	ISO 1183	1.25 maximum
Inner Wall Adhesion - HTAT to Aluminium	Clause 6.6	80 N/25mm minimum
Heat Shock 4h \pm 15m at 225 \pm 5°C	ASTM D2671	No dripping, cracking or flowing of outer wall
Heat Ageing (168 \pm 2h at 150 \pm 3°C)	ISO 188	No dripping, cracking or flowing of outer wall
Low Temperature Flexibility (4h \pm 15m at -55 \pm 2°C)	ASTM D2671	No cracking
Flammability	ASTM D2671	Duration of burning 60s maximum, No burning or charring of indicator
Electric strength	IEC 60243-1	12 MV/m minimum



TABLE 2
Tubing Dimensions

Size	Minimum Inside Diameter mm	Maximum Inside Diameter after recovery mm	Total wall thickness after recovery mm	Inner Meltable Wall thickness after recovery (Nominal) mm
4/1	4.0	1.0	1.00 ± 0.30	0.40
8/2	8.0	2.0	1.00 ± 0.30	0.50
12/3	12.0	3.0	1.40 ± 0.30	0.60
16/4	16.0	4.0	1.80 ± 0.40	0.75
24/6	24.0	6.0	2.25 ± 0.55	0.80
32/8	32.0	8.0	2.55 ± 0.55	1.00
48/13	48.0	13.0	2.55 ± 0.55	1.00

Tubing of special expanded or recovered dimensions may be supplied as specified in the contract or order.

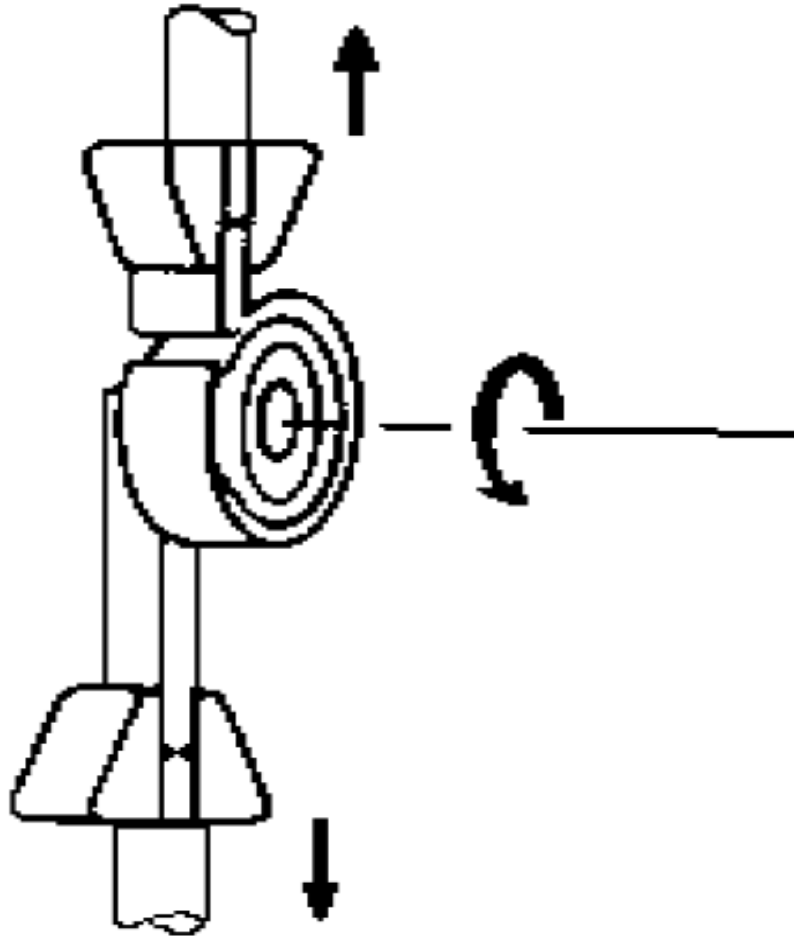


FIGURE 1 Peel test specimen in Tensile Tester