



SPECIFICATION TEC-108-120004

Raychem RK-6772 VERSAFLEX EXPANDABLE BRAIDED SLEEVING (Incorporating Versaflex and Versaflex-FR)

Versaflex and Versaflex FR are expandable braided sleeves consisting of braided polyester monofilaments. The product is intended for use in applications where mechanical protection of a substrate (e.g. a rubber hose or a wire bundle) is required.

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1. SCOPE

This Quality Assurance Specification establishes the quality standard for TE Connectivity Versaflex expandable sleeving products (FR and non-FR) which consist of braided polyester monofilaments. The product is intended for use in applications where mechanical protection of a substrate (e.g. a rubber hose or a wire bundle) is required.

2. REVISION HISTORY

Issue	Change Request	Date	Incorporated by
1	Original issue via PDM Link	12 th of March 2018	M. Bakare
2	Corrected diameters in Appendix	14 th of March 2018	M. Bakare
3	Corrected tracers in Composition and typos	21 st of September 2018	M. Bakare

3. RELATED STANDARDS & ISSUES

ISO 2062:2009	Textiles – Yarns from packages – Determination of single-end breaking force and elongation at break using constant rate of extension (CRN) testers
ISO 6722-1:2011	Road vehicles -- 60 V and 600 V single-core cables -- Part 1: Dimensions, test methods and requirements for copper conductor cables
PSA Peugeot-Citroen D47 1924 (OR:16/01/1998)	Test method for Plastics and Rubbers in Occasional Contact with Automotive Fluids
GMW14327 (issue 3)	Abrasion Protection Textile Sleeves
UL 224	Extruded Insulating Tubing
FMVSS No. 302	Flammability of interior materials

Subsequent amendments to, or revisions of, any of the above publications apply to this standard only when incorporated in it by updating or revision.



4. REQUIREMENTS

4.1 Composition, Appearance and Construction

The sleeving shall consist of braided, polyester monofilament fibres.

The fibre colours for the standard Versaflex product will be black or grey whilst the colour for all sizes of Versaflex-FR product is black with a white tracer. Versaflex and Versaflex-FR products shall be clean and free from fraying or deformation.

Versaflex and Versaflex-FR shall be constructed as specified in Appendix A.

4.2 Tensile Properties

The monofilaments used to construct standard Versaflex and Versaflex-FR shall have the following tensile properties when tested in accordance with ISO 2062:

Product	Monofilament size (mm)*	Recommended minimum breaking force (N)*	Recommended minimum elongation-at-break (%)*
Versaflex (metric)	0.22 ± 0.02	22	20
Versaflex (imperial)	0.25 ± 0.02	25	20
Versaflex-FR	0.25 ± 0.02	25	20

*average of five samples

4.3 Regulatory Compliance

At the time of the contract or order fulfilment, the braided sleeving shall:

- comply with substance restrictions of the Restriction on Hazardous Substances Directive 2011/65/EU in Electrical and Electronic Equipment (RoHS2)
- comply with the End of Life Vehicles Directive 2000/53/EC (ELV)
- comply with MIIT Order 32 - the Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products (also known as China RoHS 2)
- not contain Substances of Very High Concern (SvHC) greater than 0.1 % by weight (1000ppm) as listed in Annex XIV or XVII of the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulation i.e. (EC) No. 1907/2006 (or its applicable amendments) or as otherwise maintained by the European Chemicals Agency (ECHA)
- be free from intentionally added halogens



4.4 Properties

The sleeving shall meet the requirements as specified in Table 1.

5 QUALITY ASSURANCE PROVISIONS

5.1 Classification of Tests

Tests shall be carried out on specimens taken at random from each batch of finished sleeving. A batch of sleeving is defined as that quantity of sleeving braided at any one time. The testing frequency shall be Qualification or Production Routine as detailed below:

5.1.1 Qualification

Qualification tests are those performed on sleeving submitted for qualification as a satisfactory product and shall consist of all tests listed in this specification. This should be carried out every 3 years (or whenever there are significant changes to materials/construction).

5.1.2 Production routine

Production Routine tests consisting of appearance, colour, construction (i.e. number of spindles/carriers and number of yarns), length, flammability and packaging shall be carried out on every batch of product.

6. TEST METHODS

6.1 Preparation of Test Specimens

Unless otherwise specified, all tests shall be carried out at a temperature of $23 \pm 3^\circ\text{C}$ and at $55 \pm 15\%$ relative humidity and on as-supplied specimens of the appropriate dimensions as specified below:

Product	Braid Size	Length
Versaflex (metric)-10-0	10mm	100mm
Versaflex (imperial)-1/4-0	6mm	
Versaflex-FR-3/8-0	10mm	

The sizes given above shall qualify the entire size range.

The minimum time between manufacturing and testing shall be 24 hours unless otherwise specified.

6.2 Visual

The specimens shall be examined with the naked eye for any signs of splitting or damage and its weave shall be well-proportioned.



6.3 Abrasion Resistance

The test method shall be broadly based on the scrape abrasion methodology of GMW14327.

Three specimens of an appropriate sized product as per Clause 4.2 shall each be installed and secured over an appropriately-sized steel mandrels. The scrape abrasion apparatus shall be according to figure 1.

The abrasion probe shall be fixed to the moving probe assembly with the probe designed to abrade in both directions along the longitudinal axis of the test specimen.

The conditions of the test shall be as follows:

- Temperature = (23 ± 3) °C
- Abrasion probe diameter = (0.45 ± 0.01) mm
- Load = (7.00 ± 0.05) N
- Abrasion probe stroke = (50 ± 1) mm
- Frequency = (55 ± 5) cycles/minute (one cycle consists of one reciprocating movement)
- Test duration (number of cycles) = test to failure (see Table 1 for definition of failure)

Determine the number of cycles to failure by taking four readings. After each reading, move the test specimen 100mm and rotate it clockwise 90°, changing the probe after each reading. The minimum recorded value must be equal to or greater than that listed in Table 1.

Note: The abrasion apparatus must be in good condition, running smoothly with the minimum amount of vibration and with a valid calibration label. The middle section of the probe shall be inspected for wear prior to each test.

6.4 Long Term Heat Resistance

The test method shall be broadly based on GMW14327 using a fan-assisted air circulating oven with ventilation of 3 to 10 air changes per hour.

Three specimens each of 300mm length shall be heated for the period of time as specified in Table 1. On removal from the oven, the specimens shall be allowed to stabilise at ambient conditions, examined with the naked eye and tested for abrasion resistance to Clauses 6.3.

6.5 Low Temperature Flexibility

The test method shall be broadly based on GMW14327.

Three 500mm lengths of braided sleeving shall be conditioned as specified in Table 1. After conditioning and whilst still in the cold chamber, each specimen shall be wound 360° at a rate of one turn per 10 seconds around a mandrel whose diameter is four times the nominal sleeve diameter (see Clause 6.1).

The specimens shall then be removed from the cold chamber, allowed to stabilise to room temperature and examined visually.

6.6 Fluid Resistance

The test method shall be broadly based on process A of PSA D47 1924.



Three specimens shall be tested in the appropriate fluid according to the following test cycles:

- Non-volatile fluids
 - i) Sample shall be immersed for 15 seconds at ambient temperature
 - ii) For zinc chloride, dry in a desiccator placed in an oven for 24 hours at 23°C
 - iii) For brake fluid, dry in a desiccator placed in an oven for 24 hours at 23°C
 - iv) For other non-volatile fluids, dry in a desiccator placed in an oven for 24 hours at 150°C
- Volatile fluids
 - i) Immerse in fluid volume at least 15 times that of the specimen in a sealed flask (Figure 2) for 24 hours at 70°C
 - ii) For cooling fluid, heat to 118°C for 24 hours
 - iii) For diesel, heat to 40°C for 24 hours.
- Battery acid
 - i) Expose the specimen to acid vapour only in a sealed flask (Figure 3) at 70°C for 2 hours

At the end of each cycle, allow to dry for 4 hours at ambient temperature (in the case of an immersion test, remove the specimen from the fluid) and visually examine.

6.7 Flame Resistance

Versaflex shall be broadly in accordance with FMVSS No. 302 (report maximum burn rate of five samples).

Versaflex-FR shall meet the VW-1 Flame Test requirements of UL 224.

7 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

Test	Test Method	Test Requirements
Visual		As per Clauses 4.1 and 6.2
Tensile properties		As per Clause 4.2
Abrasion Resistance <ul style="list-style-type: none"> - Versaflex (metric) - Versaflex (imperial) - Versaflex-FR 	Clause 6.3	<ul style="list-style-type: none"> - $\geq 1,800$ cycles - $\geq 1,800$ cycles - $\geq 2,000$ cycles
Long Term Heat Resistance (504 hrs +0 hrs/-2 hrs at 150 °C ± 3 °C) <ul style="list-style-type: none"> - Versaflex (metric) - Versaflex (imperial) - Versaflex-FR 	Clause 6.4	No cracking or damage <ul style="list-style-type: none"> - $\geq 1,600$ cycles - $\geq 1,600$ cycles - $\geq 1,600$ cycles
Low Temperature Flexibility (24h at -50 °C)	Clause 6.5	No cracking or damage
Fluid Resistance for: <ul style="list-style-type: none"> • Non-volatile fluids <ul style="list-style-type: none"> ○ Mechanical transmission oil (SAE 80 W-BHT) ○ Engine oil (SAE 15W-30) ○ Automatic transmission oil (DEXRON II D or DEXRON III) ○ Brake fluid (DOT Types 3, 4, 5) ○ Power-assisted steering oil (DEXRON II D) ○ Zinc chloride 	Clause 6.6	No splitting, swelling or dissolution

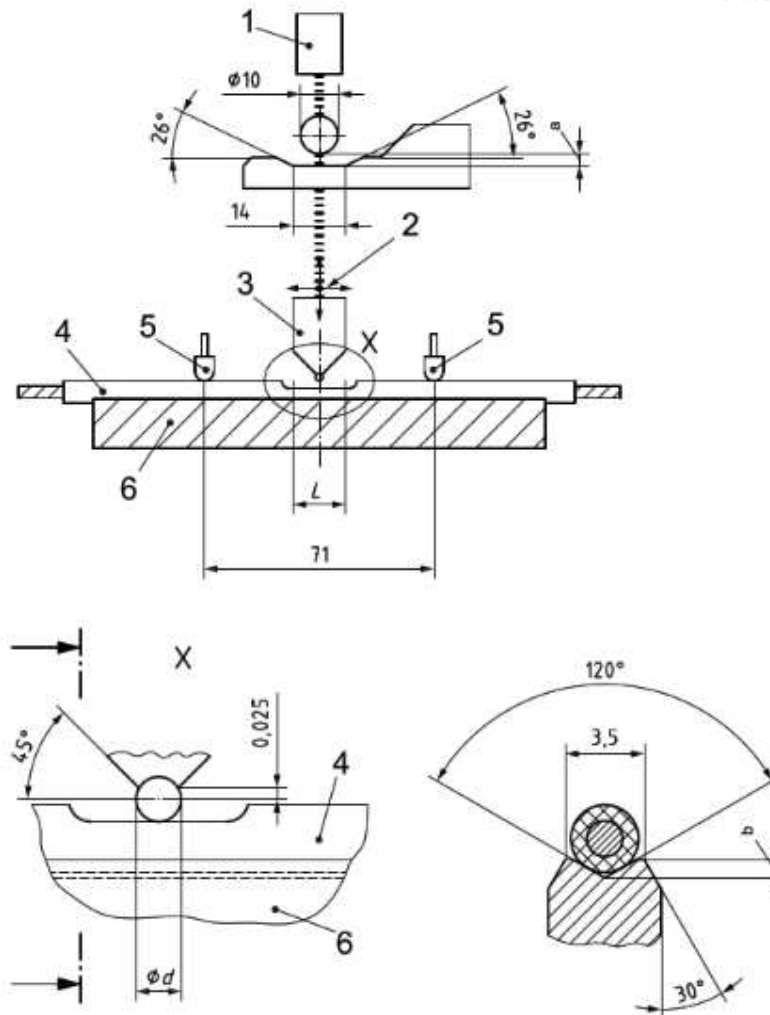


<ul style="list-style-type: none"> • Volatile fluids <ul style="list-style-type: none"> ○ Cooling fluid (Type D in 50/50 mix with distilled water) ○ Diesel (90% ISO 1817:2015 Oil No. 3 + 10% p-xylene) • Battery acid (35% H_2SO_4 solution, w/w) 		No splitting, swelling or dissolution No splitting, swelling or dissolution
Flame Resistance <ul style="list-style-type: none"> • UL -224, VW-1 • FMVSS No. 302 	Clause 6.7	Pass ≤ 102 mm/minute (flame propagation rate)



Figure 1: Abrasion rig

Dimensions in millimetres

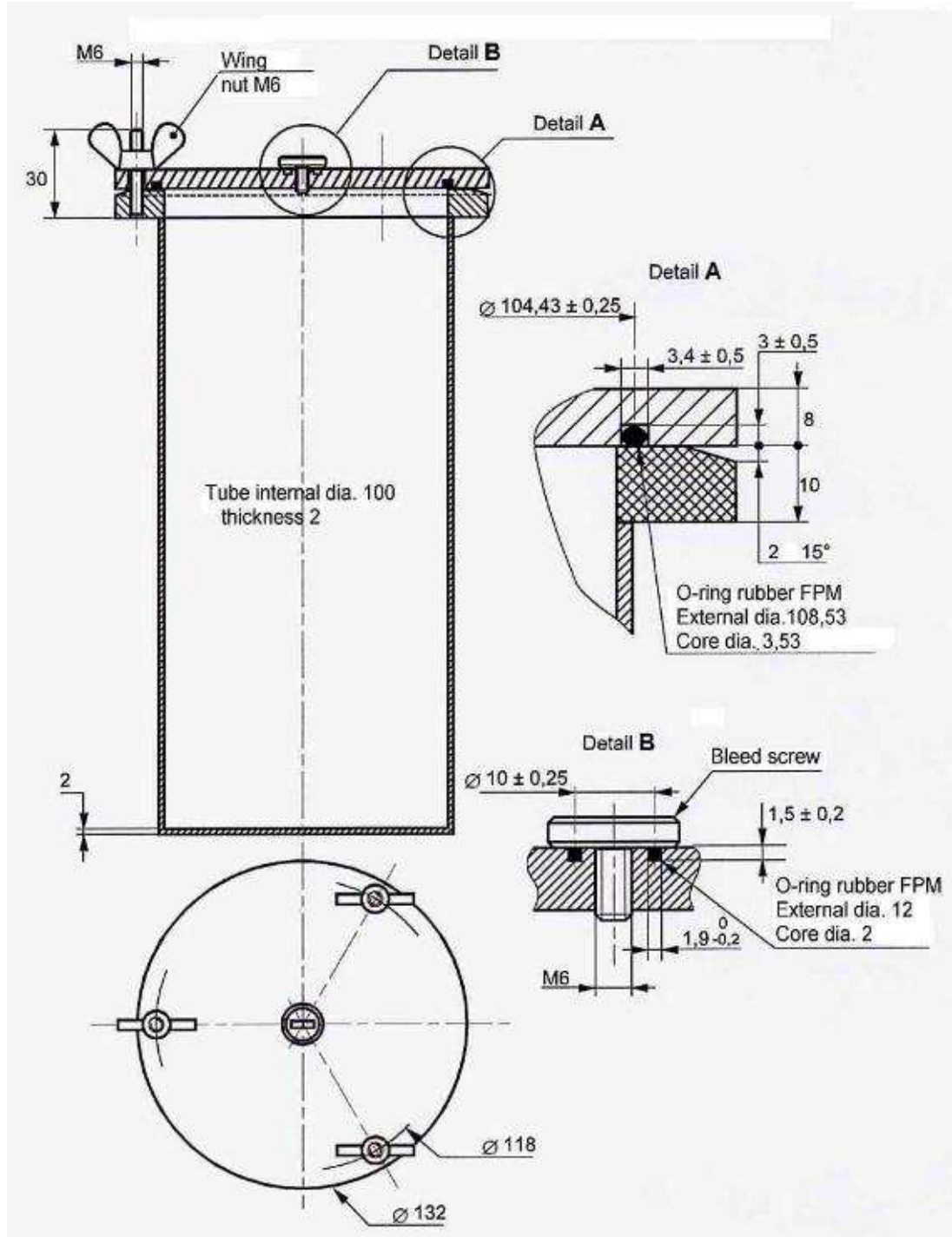


Key

- 1 mass
- 2 travel
- 3 needle holder
- 4 test sample
- 5 clamp
- 6 test sample holder
- L abrasion length, $(15,5 \pm 1)$ mm
- d needle diameter, $(0,45 \pm 0,01)$ mm
- a Clearance during abrasion.
- b Groove depth
 0,4 mm, Conductor size $\leq 0,35$ mm²
 0,8 mm, Conductor size $> 0,35$ mm²



Figure 2: Example of sealed flask for volatile fluids

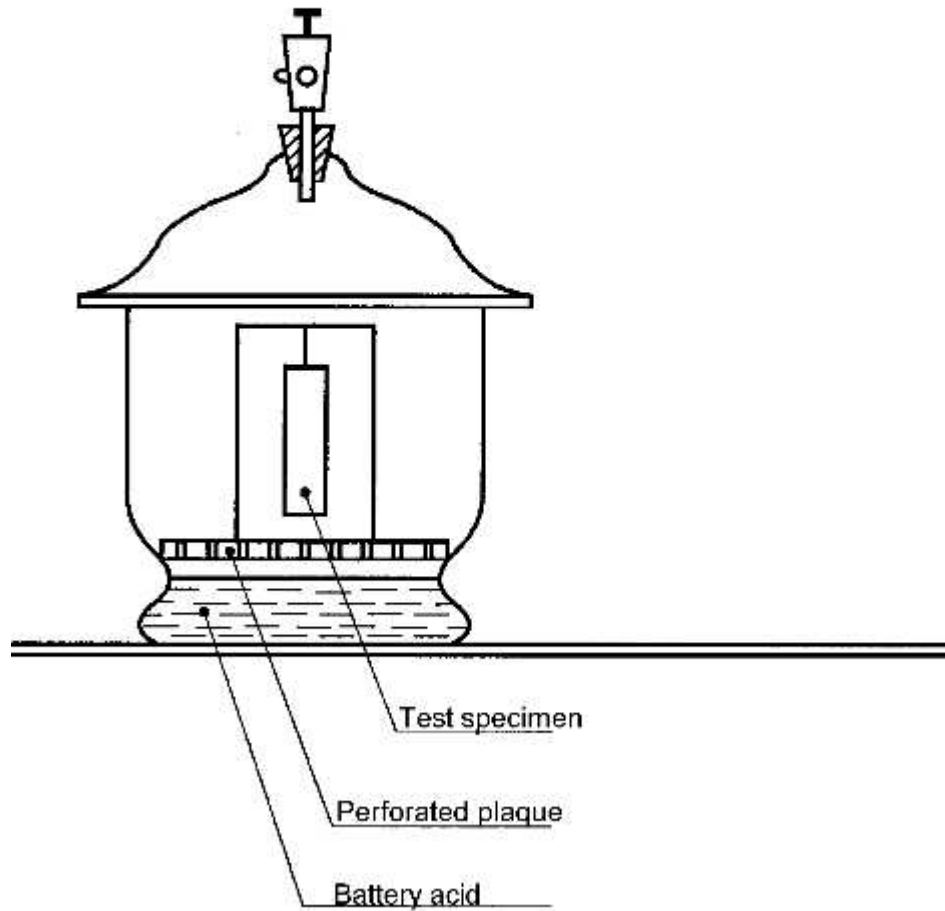


Dimensions are in millimetres



Figure 3: Example of sealed flask for battery acid test

OVEN





Appendix A: Construction matrices

Versaflex (metric)				
Nominal size	Expandable Range* (mm)	Monofilament Diameter (mm)	Monofilaments per carrier	Number of Carriers
3	1 - 5	0.22 ± 0.02	3	20
4	2 - 7	0.22 ± 0.02	3	24
5	3 - 9	0.22 ± 0.02	3	28
6	4 - 12	0.22 ± 0.02	3	32
8	5 - 12	0.22 ± 0.02	3	40
10	7 - 15	0.22 ± 0.02	3	48
12	8 - 17	0.22 ± 0.02	3	56
15	10 - 20	0.22 ± 0.02	3	64
20	14 - 26	0.22 ± 0.02	3	72
25	18 - 34	0.22 ± 0.02	3	96
30	20 - 40	0.22 ± 0.02	3	120
40	30 - 50	0.22 ± 0.02	4	120
50	40 - 60	0.22 ± 0.02	5	120

Versaflex (imperial)				
Nominal size	Expandable Range* (mm)	Monofilament Diameter (mm)	Monofilaments per carrier	Number of Carriers
1/8	2 - 6	0.25 ± 0.02	3	16
1/4	3 - 10	0.25 ± 0.02	3	24
3/8	5 - 16	0.25 ± 0.02	3	40
1/2	6 - 19	0.25 ± 0.02	3	48
3/4	13 - 32	0.25 ± 0.02	3	64
1 1/4	19 - 45	0.25 ± 0.02	3	96
1 3/4	32 - 70	0.25 ± 0.02	4	120
2	38 - 76	0.25 ± 0.02	5	120

Versaflex/Versaflex-FR



Versaflex-FR				
Nominal size	Expandable Range* (mm)	Monofilament Diameter (mm)	Monofilaments per carrier	Number of Carriers
1/8	2 - 6	0.25 ± 0.02	3	16
1/4	3 - 10	0.25 ± 0.02	3	24
3/8	5 - 16	0.25 ± 0.02	3	40
1/2	6 - 19	0.25 ± 0.02	3	48
3/4	13 - 32	0.25 ± 0.02	3	64
1 1/4	19 - 45	0.25 ± 0.02	3	96
1 3/4	32 - 70	0.25 ± 0.02	4	120
2	38 - 76	0.25 ± 0.02	5	120

* Expandable range is for reference only

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