



Technical Specification 09-13

Issue 2 2013

High voltage heat-shrinkable material
components for use up to and including 36 kV

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First published, October, 1981; Amendment 1, 1993

Amendments since publication

Issue	Date	Amendment
Issue 2	April, 2013	<p>Major revision of Issue 1 to align with BS EN 60684 and BS EN 62329, where appropriate, and changes in other reference BS and IEC Standards. Converted into the new ENA Technical Specification (TS) template and updated in accordance with Engineering Recommendation G0 Issue 1 2012 <i>Rules for structure, drafting and presentation of ENA engineering documents</i>.</p> <p>This issue includes the following principal technical changes:</p> <p>Clause 1 Scope: Expanded scope to cover other high voltage equipment, where applicable. Changed scope of maximum voltage range from “33,000 V” to “36 kV”.</p> <p>Clause 4.1 Test requirements: Added requirement for tests to be carried out generally in accordance with EN 60684-2 for heat-shrinkable tubing components and BS EN 62329-2 for heat-shrinkable moulded components.</p> <p>Added requirement for composite materials used as cable accessories to be tested in accordance with BS 7888-4.1, HD 629.1 or BS 7888-4.2, HD 629.2, as applicable.</p> <p>Clause 4.3 Identification: Aligned with BS EN 60684-1 and BS EN 62329-1 including new requirements for identification of reels. Deleted requirement for specific size and spacing of markings.</p>

		<p>Clause 4.4 Packaging and labelling: New title. Requirements aligned with Clauses 10 and 11 of BS EN 60684-1 for tubing and Clauses 10 and 11 of BS EN 62329-1 for moulded components including:</p> <ul style="list-style-type: none">• Allowance of manufacturer's/supplier's name or mark.• Labelling of packages and tubing supplied in reels.• Protection during transport, handling and storage.• Provision of safety data sheets, if requested by purchaser. <p>Clause 4 General: The following new clauses added to generally align with requirements in EN 60684-2 for heat-shrinkable tubing components and BS EN 62329-2 for heat-shrinkable moulded components:</p> <ul style="list-style-type: none">• Clause 4.6 Dimensions.• Clause 4.7 Colour and transparency.• Clause 4.8 Material composition. <p>Clause 5.1 Tubing components: Added new requirements for "External insulating tubing".</p> <p>Clause 5.2 Moulded components: Added new requirements for "External insulating tubing".</p> <p>Clause 6.1 Test 1 — Corrosion resistance: Test requirements aligned with Clause 32 of EN 60684-2. Added notes regarding different oven temperature/time period and adhesion as cause for rejection in Clause 32 of EN 60684-2.</p> <p>Clause 6.2 Test 2 — Density: Test requirements aligned with Clause 4 of EN 60684-2 for tubing and Clause 6 of BS EN 62329-2 for moulded components.</p> <p>Clause 6.3 Test 3 – Dimensions and longitudinal change:</p> <ul style="list-style-type: none">• Revision of test requirements to align with Clause 3 of EN 60684-2 for tubing and Clause 5 of BS EN 62329-2 for moulded components.• Added requirement to measure internal diameter (bore) and concentricity in the expanded and recovered condition.• Error of determination changed from 0.025 mm to 0.01 mm.• Text relating to determination of longitudinal shrinkage deleted and replaced by cross reference to Clause 9 of EN 60684-2.• Text relating to concentricity deleted and replaced by cross reference to Clause 3.3.3 of EN 60684-2. <p>Clause 6.4 Test 4 — Electric strength: Reference to IEC 243 requirements deleted. Test requirements aligned with Clause 21 of EN 60684-2 for tubing and Clause 12 of BS EN 62329-2 for moulded shapes (generally in accordance with BS EN 60243-1). Number of specimens changed to five.</p> <p>Clause 6.5 Test 5 — Flame retardance: Reference to BS 4066 deleted. Test requirements aligned with Clause 26 of EN 60684-2 for tubing and Clause 16 of BS EN 62329-2 for moulded components. Requirement for the method of test to be determined for particular types of grades of tubing and moulded shapes.</p>
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	<p>Clause 6.6 Test 6 – Fungus resistance: Amended to be an optional test.</p> <p>Clause 6.7 Test 7 — Heat shock: Test requirements aligned with Clause 6 of EN 60684-2 for tubing and Clause 7 of BS EN 62329-2 for moulded components. Temperature and time period for recovering test specimens aligned with BS EN 60684-3 and Table B.1 (for tubing) and BS EN 62329-3 or Table B.2 (for moulded components), whichever is more onerous.</p> <p>Clause 6.8 Test 8 — Low temperature flexibility:</p> <ul style="list-style-type: none">• Test requirements aligned with Clause 14 of EN 60684-2 for tubing and Clause 8 of BS EN 62329-2 for moulded components.• Changed temperature and time period for recovering test specimens to align with BS EN 60684-3 or Table B.1 (for tubing) and BS EN 62329-3 or Table B.2 (for moulded components), whichever is more onerous.• Separation time changed from 2s to not more than 2 s.• No. of specimens reduced from five to three in accordance with BS EN 62329-2. <p>Clause 6.9 Test 9 — Relative permittivity: Reference to ASTM D150 requirements deleted. Test requirements aligned with Clause 24 of EN 60684-2 for tubing and Clause 14 of BS EN 62329-2 for moulded components. “thermal” changed to “heat”. Clarified tests do not apply to conductive materials.</p> <p>Clause 6.10 Test 10 — Secant modulus at 2% elongation: Test requirements aligned with Clause 19.4 of EN 60684-2 for tubing and Clause 11 of BS EN 62329-2 for moulded components.</p> <p>Clause 6.11 Test 11 — Resistance to selected fluids: Complete revision of test requirements to align with Clause 36 of EN 60684-2 for tubing and Clause 20 of BS EN 62329-2 for moulded components. References changed to Table B.4.</p> <p>Clause 6.12 Test 12 – Tensile strength and elongation at break: Revision of test requirements to align with Clause 19 of EN 60684-2 for tubing and Clause 10 of BS EN 62329-2 for moulded shapes. Deleted prescriptive test requirements that are covered in the normative Standards.</p> <p>Clause 6.13 Test 13 — Heat ageing: Test requirements aligned with Clause 39 of EN 60684-2 for tubing and Clause 23 of BS EN 62329-2 for moulded shapes. Changed temperature and time period for recovering test specimens to align with BS EN 60684-3 or Table B.1 (for tubing) and BS EN 62329-3 or Table B.2 (for moulded shapes), whichever is more onerous. Added requirement to determine electric strength.</p> <p>Clause 6.14 Test 14 — Tracking resistance: Reference to ASTM D2303 requirements deleted. Test requirements aligned with Clause 25 of EN 60684-2 for tubing and Clause 15 of BS EN 62329-2 for moulded components. No. of specimens reduced from five to three in accordance with BS EN Standards.</p> <p>Clause 6.15 Test 15 – Visual examination: Reference to BS 6746C changed to IEC 60304. Specific dimensions for coating deleted and replaced by functional requirement for an effective seal.</p> <p>Clause 6.16 Test 16 – Volume resistivity: Test requirements aligned with Clause 23 of EN 60684-2 for tubing and Clause 15 of BS EN 62329-2 for moulded components. Replaced reference to BS 2782, Method 202A with Test 13.</p>
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	<p>Changed temperature and time period for recovering test specimens to align with BS EN 60684-3 and Table B.1 (for tubing) and BS EN 62329-3 and Table B.2 (for moulded components), as applicable.</p> <p>Clause 6.17: Test 17 — Water absorption: Test requirements aligned with Clause 40 of EN 60684-2 and Clause 24 of BS EN 62329-2 (generally in accordance with Method 1 of ISO 62). Tolerance of measurement changed from 0.1 per cent to 0.1 mg. Amended formula to align with BS EN Standards for water absorption. Option to carry out water vapour transmission tests in accordance with Test 18 if specified by the purchaser.</p> <p>Clause 6.19 Test 19 Weather resistance: Added new Clause 6.19.1 with general requirements. Test requirements aligned with ENA TS 09-11. Test requirements for tubing and moulded parts harmonised. Tolerances for atmospheric concentrations changed from “pphm” to “ppmv”. Added cross-reference to ISO 4892-3: 2006 as regards apparatus and recommended practice.</p> <p>Clause 7.6 Test F — Peel strength: Test requirements aligned with Clause 57 of EN 60684-2. Added “mean” before “average”. Reworded “Fifteen specimens...” to “Sufficient specimens...”. Cooling temperature tolerance changed from +3 °C to +2 °C. Added requirements when testing the adhesive bond between an aluminium substrate and heat-shrinkable material.</p> <p>Clause 6.11 Test 11 — Resistance to selected fluids: Deleted reference to “Twenty-one specimens” and replaced with “Sufficient specimens”.</p> <p>Annex B: Type approval and quality assurance.</p> <p>Table B.1 and Table B.2 amendments:-</p> <ul style="list-style-type: none">• Amended type approval requirement for Test 3 Dimensions to conform to BS EN 60684-3.• Amended wall thickness concentricity from 0.6 to 60%.• Amended low temperature flexibility test to be at -40 °C.• Amended type approval requirements for Test 5 Flame Retardance.• Values of tensile strength converted to MPa. <p>Table B.3 amendments:-</p> <ul style="list-style-type: none">• Aligned selected fluids with those in ENA TS 09-11.• Values of internal pressure sealing ability converted to MPa.• Added warning note regarding use of creosote. <p>Added table note “Unless specified otherwise by purchaser”.</p> <p>Annex D: Addition of test method for determination of water vapour transmission.</p> <p>Details of all other technical, general and editorial amendments are included in the associated Document Amendment Summary for this Issue (available on request from the Operations Directorate of ENA).</p>
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Foreword

This Technical Specification (TS) is published by the Energy Networks Association (ENA) and comes into effect from date of publication. It has been prepared under the authority of the ENA Engineering Policy and Standards Manager and has been approved for publication by the ENA Electricity Networks and Futures Group (ENFG). The approved abbreviated title of this engineering document is “ENA TS 09-13”.

This document cancels and replaces ENA TS 09-13 Issue 1.

The purpose of this Specification is to specify the properties and test requirements of a range of heat-shrinkable components and sealants for use above 1 kV up to and including 36 kV on high voltage distribution systems. Heat-shrinkable components are supplied in an expanded state and are installed by being heated to an appropriate temperature to activate the heat-shrink mechanism. Recovery ('shrinking') takes place on to a substrate having dimensions within a specified application range.

Issue 1 of the Specification was prepared essentially as a performance Specification in order that a range of heat-shrinkable components and sealants could be used, provided that relevant test requirements could be met and long term performance could be shown to be satisfactory. Subsequently, BS EN 60684 and BS EN 62329 have been published, which specify requirements and methods for test for heat-shrinkable components used for electrical purposes.

This revision incorporates relevant requirements from BS EN 60684-1, BS EN 60684-3 and EN 60684-2:2011, for heat-shrinkable tubing, and BS EN 62329, for heat-shrinkable moulded components, where these requirements are compatible with the original performance requirements.

NOTE: In this document the terms 'extruded' and 'tubing' are interchangeable.

The intention is generally to align requirements in ENA TS 09-13 with relevant Standards without any significant reduction in performance required in the previous issue.

In this Specification the term 'heat-shrinkable' is applied to extruded or moulded polymeric materials which are cross-linked, either by irradiation or by chemical means, such that when their temperature is raised beyond the normal base polymer crystalline melting point, they do not melt but merely become rubbery. In this state, if the material is then mechanically expanded and held in this position until the temperature falls below the crystalline melting point, it remains in the expanded state. Subsequent heating in an unconstrained state will then result in the material recovering or 'shrinking' to its original extruded or moulded size and shape.

Test requirements for heat-shrinkable components and sealants forming part of complete products (i.e. cable joints and terminations) are not included in this Specification. Complete joints incorporating screens and insulation are subject to other test requirements for cable accessories (see 2).

Users are recommended to consult the manufacturers/suppliers about heat-shrinkable materials not included in this Specification as the development of new materials, composite materials and new techniques is a continuing process and new materials brought into use may not be adequately covered by the current issue of this specification.

In the context of this document the term “tubing” and “sleeving” are interchangeable and have the same meaning.

Annex C of this Technical Specification includes “Self Certification Conformance Declaration” sheets to enable manufacturers/suppliers to declare conformance or otherwise, clause by clause, with relevant parts of this Specification.

Where the term “shall” is used in this document it expresses a requirement. The term “may” is used to express permission.

NOTE: Commentary, explanation and general informative material is presented in smaller type, and does not constitute a normative element.

1 Scope

This Specification specifies the properties and test requirements for heat-shrinkable components and sealants suitable for use on both effectively earthed and non-effectively earthed electrical systems above 1 kV up to and including 36 kV.

The scope of this document applies primarily to heat-shrinkable components and sealants used as cable accessories to provide one or more of the following functions:

- Electrical insulation.
- Electrical stress control.
- Electrical conductivity.
- Resistance to electrical tracking and erosion.
- Resistance to the effects of weathering.
- Mechanical and environmental protection.

However, the requirements and test methods may be applied to applications in other high voltage equipment, where applicable.

Certain performance characteristics required for specific applications may not be covered by this specification. Prominent among these is the behaviour of components in fire conditions. NOTE: Requirements such as fire performance are specific to the product application, location etc and are therefore better dealt with in specifications directly relevant to the application.

2 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 6622:2007, *Electric cables. Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV. Requirements and test methods*

BS 6480, *Specification for impregnated paper-insulated lead or lead alloy sheathed electric cables of rated voltages up to and including 33 000V*

BS 7870, *LV and MV polymeric insulated cables for use by distribution and generation utilities*

BS 7888-4.1:2006+A1:2008, HD 629.1 S2:2006+A1:2008, *Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36(42) kV. Cables with extruded insulation*

BS 7888-4.2:2006+A1:2008, HD 629.2 S2:2006+A1:2008, *Test requirements on accessories for use on power cables of rated voltage from 3,6/6(7,2) kV up to 20,8/36(42) kV. Cables with impregnated paper insulation*

BS EN 60243-1:1998, IEC 60243-1:1998, *Methods of test for electric strength of solid insulating materials. Tests at power frequencies*

BS EN 60587:2007, *Electrical insulating materials used under severe ambient conditions. Test methods for evaluating resistance to tracking and erosion*

BS EN 60684-1:2003, *Flexible insulating sleeving. Definitions and general requirements*

BS EN 60684-3 (specific parts), *Flexible insulating sleeving. Specifications for individual types of sleeving*

BS EN 62329-1:2006, *Heat shrinkable moulded shapes. Definitions and general requirements*

BS EN 62329-2:2006, *Heat shrinkable moulded shapes. Methods of test*

BS EN 62329-3-101:2010 (specific parts), *Heat-shrinkable moulded shapes. Specification requirements for shape dimensions, material requirements and compatibility performance*

BS EN ISO 4892-3:2006, *Plastics. Methods of exposure to laboratory light sources. Fluorescent UV lamps*

EN 60684-2:2011, *Flexible insulating sleeving – Part 2: Methods of test*¹⁾

CENELEC HD 620, *Distribution cables with extruded insulation for rated voltages from 3,6/6 (7,2) kV to 20,8/36 (42) kV*

CENELEC HD 621, *Medium voltage impregnated paper insulated distribution cables*

IEC 60304:1982, *Standard colours for insulation for low-frequency cables and wires*

Other publications

[N1] ENA TS 09-12, *Impregnated paper insulated corrugated aluminium sheathed 6 350/11 000 V cable*

[N2] ENA TS 09-17, *Single core cables for use in substations having extruded insulation and rated voltages of 6 350/11 000 volts, and 19 000/33 000 volts*

[N3] ENA TS 09-20, *Single core cable having cross linked polyethylene insulation and lead sheath for rated voltage 19 000/33 000 volts ($U_m=36\ 000$ volts)*

¹⁾ At the time of publication, current work was in hand to revise BS EN 60684-2 in line with EN 60684-2:2011. On this basis, reference has been made to the latest publication EN 60683-2:2011. It is expected that the revision of BS EN 60684-2, when published, will be identical to EN 60683-2:2011.

[N4] ENA TS 09-21, *Cross-linked polymeric insulated triplex cables for a rated voltage of 6350/11 000 volts ($U_m=12\ 000V$)*

[N5] ENA ER P17 (all parts), *Current ratings for distribution cables*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

accessory

essential component of a cable system other than the cable itself, which is required for it to function

NOTE: Particular examples are joints and terminations.

3.2

air-circulating oven

electrically-heated automatic temperature-controlled oven, in which the air is circulated internally by mechanical means

3.3

anti-track

resistant to the formation of surface conducting paths by surface electrical activity

3.4

batch

quantity of material or components processed at one time

3.5

concentricity

ratio of minimum to maximum wall thickness expressed in per cent

3.6

erosion

loss of material due to surface electrical activity

3.7

expanded

as supplied state, which can be recovered

3.8

fully-recovered

final state after heat-shrinking without constraint

3.9

glove

heat-shrinkable component for sealing the crotch of a cable

3.10

moulded plaque

sample of material moulded in sheet form for preparation of test pieces