IEC 60684-2

Edition 3.0 2011-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Flexible insulating sleeving –
Part 2: Methods of test

Gaines isolantes souples –
Partie 2: Méthodes d'essai

IEC 60684-2:2011

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FOREWORD

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International Standard IEC 60684-2 has been prepared by IEC technical committee 15: Solid electrical insulating materials.

This third edition cancels and replaces the second edition published in 1997, and constitutes a minor revision and technical updating. The main changes from the previous edition are as follows: three additional methods for circumferential extension, voltage proof and thermal shock and alignment with North American methods.

The text of this standard is based on the following documents:

FDIS	Report on voting
15/634/FDIS	15/644/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 60684 series, under the general title *Flexible insulating sleeving*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This International Standard is one of a series which deals with flexible insulating sleeving. The series consists of three parts:

Part 1: Definitions and general requirements (IEC 60684-1)

Part 2: Methods of test (IEC 60684-2)

Part 3: Specifications for individual types of sleeving (IEC 60684-3)

FLEXIBLE INSULATING SLEEVING –

Part 2: Methods of test

1 General

1.1 Scope

This part of IEC 60684 gives methods of test for flexible insulating sleeving, including heat-shrinkable sleeving, intended primarily for insulating electrical conductors and connections of electrical apparatus, although they may be used for other purposes.

The tests specified are designed to control the quality of the sleeving but it is recognized that they do not completely establish the suitability of sleeving for impregnation or encapsulation processes or for other specialized applications. Where necessary, the test methods in this part will need to be supplemented by appropriate impregnation or compatibility tests to suit the individual circumstances.

1.2 Normative references

The following referenced documents 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.

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60093:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials*

IEC 60212:2010, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60216 (all parts), *Electrical insulating materials – Thermal endurance properties*

IEC 60216-4-1:2006, *Electrical insulating materials – Thermal endurance properties – Part 4-1: Ageing ovens – Single-chamber ovens*

IEC 60216-4-2:2000, *Electrical insulating materials – Thermal endurance properties – Part 4-2: Ageing ovens – Precision ovens for use up to 300 °C*

IEC 60243-1:1998, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60250:1969, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths*

IEC 60426:2007, *Electrical insulating materials – Determination of electrolytic corrosion caused by insulating materials – Test methods*

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

IEC 60589:1977, *Methods of test for the determination of ionic impurities in electrical insulating materials by extraction with liquids*

IEC 60684-3 (all parts), *Flexible insulating sleeving – Part 3: Specifications for individual types of sleeving*

IEC 60695-6-30:1996, *Fire hazard testing – Part 6: Guidance and test methods on the assessment of obscuration hazards of vision caused by smoke opacity from electrotechnical products involved in fires – Section 30: Small scale static method – Determination of smoke opacity – Description of the apparatus*

IEC/TS 60695-11-21, *Fire hazard testing - Part 11-21: Test flames - 500 W vertical flame test method for tubular polymeric materials*

IEC 60754-1:1994, *Tests on gases evolved during combustion of materials from cables – Part 1: Determination of the amount of halogen acid gas*

IEC 60754-2:1991, *Test on gases evolved during combustion of electric cables – Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*
Amendment 1 (1997)

ISO 5-1:2009, *Photography and graphic technology – Density measurements – Part 1: Geometry and functional notation*

ISO 5-2:2009, *Photography and graphic technology – Density measurements – Part 2: Geometric conditions for transmittance density*

ISO 5-3:2009, *Photography and graphic technology – Density measurements – Part 3: Spectral conditions*

ISO 5-4:2009, *Photography and graphic technology – Density measurements – Part 4: Geometric conditions for reflection density*

ISO 37:2005, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

ISO 62:2008, *Plastics – Determination of water absorption*

ISO 105-A02, *Textiles – Tests for colour fastness – Part A02: Grey scale for assessing change in colour*

ISO 105-B01, *Textiles – Tests for colour fastness – Part B01: Colour fastness to light: Daylight*

ISO 182-1:1990, *Plastics – Determination of the tendency of compounds and products based on vinyl chloride homopolymers and copolymers to evolve hydrogen chloride and any other acidic products at elevated temperature – Part 1: Congo red method*

ISO 182-2:1990, *Plastics – Determination of the tendency of compounds and products based on vinyl chloride homopolymers and copolymers to evolve hydrogen chloride and any other acidic products at elevated temperature – Part 2: pH method*

ISO 974:2000, *Plastics – Determination of the brittleness temperature by impact*

ISO 1431-1:2004, *Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain test*

ISO 13943: 2008, *Fire safety – Vocabulary*

ISO 4589-2:1996, *Plastics – Determination of burning behaviour by oxygen index – Part 2: Ambient-temperature test*

ISO 4589-3:1996, *Plastics – Determination of burning behaviour by oxygen index – Part 3: Elevated-temperature test*

2 Test conditions

2.1 Unless otherwise specified, all tests shall be made under standard ambient conditions according to IEC 60212; i.e., at a temperature between 15 °C and 35 °C and at ambient relative humidity.

In cases of dispute, the tests shall be carried out at a temperature of 23 °C ± 2 K and at (50 ± 5) % relative humidity.

2.2 When heating at elevated temperature is specified for a test procedure, the specimen shall be maintained for the prescribed period in a uniformly heated oven complying with IEC 60216-4-1.

2.3 Where a test at low temperature is specified, the specification sheets of IEC 60684-3 may require it to be carried out at *–t* °C or lower. In such cases the operator may carry out the test at the specified temperature or any lower temperature which is convenient. If, however, at a temperature below that specified the specimen fails to meet the requirements, the test shall be repeated at the specified temperature, subject to a tolerance of ± 3 K as specified in IEC 60212. If the specimen then passes, it shall be considered to have met the requirements.

3 Measurements of bore, wall thickness and concentricity

NOTE Within this standard, the terms "bore" and "internal diameter" are interchangeable.

3.1 Bore

3.1.1 Number of test specimens

Three specimens shall be tested.

3.1.2 General method

Plug or taper gauges of appropriate diameter shall be used to establish that the bore lies between the maximum and minimum specified values. The gauge shall enter the bore without causing expansion of the sleeving. A lubricant in powder form will assist when some types of sleeving are being measured. For small bore sizes a micrometer microscope may be used and measurements shall be made to the nearest 0,05 mm.

3.1.3 Relaxed bore of expandable braided sleeving

Select a 250 mm long steel mandrel of the same diameter as the specified minimum relaxed bore of the sleeving.

Insert the mandrel completely into the sleeving so that 50 mm of sleeving projects beyond the mandrel at the cut end.

At the opposite end, wrap wire around the sleeving just beyond the end of the mandrel to prevent the mandrel penetrating further into the sleeving.

Smooth the sleeving firmly onto the mandrel from the secured end towards the cut end and twist the sleeving so that it traps the end of the mandrel. Secure by wrapping with wire.

Mark 200 mm gauge lines centrally on the sleeving using a marking medium which does not degrade the sleeving, e.g., typewriter correction fluid.

Release the cut end and allow sleeving to relax.

Measure the distance between gauge lines in millimetres.

If this measurement is 195 mm or greater, then the sleeving is of the maximum relaxed bore diameter.

If this measurement is less than 195 mm, repeat the determination with progressively larger mandrels until the measurement is equal to or larger than 195 mm.

3.1.4 Expanded bore of expandable braided sleeving

Select a plug gauge of the same diameter as the specified minimum expanded bore.

Grip the sleeving 50 mm below the cut end.

Open the cut end of the sleeving for 10 mm and insert the plug gauge.

Attempt to push the plug gauge further into the undisturbed gripped sleeving.

If the plug gauge enters further without undue force, the sleeving is of the minimum expanded bore.

If the plug gauge does not enter further without undue force, repeat the determination with progressively smaller mandrels.

3.1.5 Result

Report all measured values as the result.

3.2 Wall thickness for textile sleeving

3.2.1 Number of test specimens

Three specimens shall be tested.

3.2.2 Procedure

A plug gauge or mandrel shall be inserted so that it enters freely but has a diameter not less than 80 % of the bore. The overall dimension shall then be measured using a micrometer having flat anvils of approximately 6 mm in diameter. In making this measurement, the pressure applied by the micrometer shall be just sufficient to close the sleeving on to the inserted plug gauge or mandrel. The wall thickness shall be calculated by halving the difference between the overall dimension and the plug gauge or mandrel diameter.

3.2.3 Result

Report all measured values for wall thickness as the result.

3.3 Minimum/maximum wall thickness and concentricity for extruded sleeving

3.3.1 Number of test specimens

Three specimens shall be tested.

3.3.2 Wall thickness

This standard does not give mandatory methods for making this measurement. By means of a suitable number of tests, locate the points on the wall corresponding to the minimum and maximum wall thickness. All measurements shall be measured to the nearest 0,01 mm. In cases of dispute a calibrated micrometer microscope shall be used capable of measuring to the nearest 0,001 mm.

NOTE The following methods of measurement have proved suitable: optical profile projector, optical comparator, a suitable micrometer. In the event of a dispute, use one of the optical methods. A microscope micrometer has been found suitable for measuring small bore sizes and for determining the inner and outer wall thicknesses of dual wall sleeving.

3.3.3 Concentricity

Calculate the concentricity of each specimen of the sleeving by use of the following equation:

$$\text{concentricity (\%)} = \frac{\text{minimum wall thickness}}{\text{maximum wall thickness}}\ 100$$

3.3.4 Result

Report all values for minimum and maximum wall thickness and concentricity as the result.

4 Density

4.1 Number of test specimens

At least three specimens shall be tested.

4.2 Procedure

Any method for the determination of the density may be used which can ensure an accuracy of 0,01 g/cm^3.

NOTE Small bore sleeving specimens should be cut longitudinally and opened out to avoid air entrapment during the determination.

4.3 Result

Identify the method selected for the determination and report all measured values for density; the result is the mean unless specified otherwise in the specification sheets of IEC 60684-3.

5 Resistance to splitting after heating

5.1 Number of test specimens

Three specimens shall be tested.

5.2 Form of test specimen

The specimens shall be produced by cutting rings whose cut length equals the wall thickness. Precautions shall be taken to ensure that the cut is clean since imperfections can affect the result.

NOTE Where practical difficulties do not permit a square section ring to be cut, the length may be increased to not more than 2,5 mm.

5.3 Procedure

The specimens shall be tested using a tapered mandrel which has an inclined angle of (15 ± 1)°. The specimens shall be maintained for a period of (168 ± 2) h at a temperature of 70 °C ± 2 K unless another temperature is specified in IEC 60684-3, and then allowed to cool to 23 °C ± 5 K. They shall then be rolled up the mandrel so that they are extended by an amount equal to the percentage of nominal bore specified in IEC 60684-3. The specimens shall be kept in that position and at a temperature of 23 °C ± 5 K for (24 ± 1) h and then examined for splitting.

5.4 Result

Report whether there is any splitting.

6 Heat shock (resistance to heat)

6.1 Number of test specimens

Five specimens shall be tested.

6.2 Form of test specimens

Lengths of approximately 75 mm of sleeving, or specimens in accordance with Clause 19 shall be prepared where tensile strength or elongation at break are to be measured. Where cut pieces of sleeving are used the length shall be measured to the nearest 0,5 mm.

6.3 Procedure

The specimens shall be suspended vertically in an oven conforming to IEC 60216-4-1 or IEC 60216-4-2 for 4 h ± 10 min at the temperature specified in IEC 60684-3.

The specimens shall be removed and allowed to cool to room temperature. They shall then be examined for any signs of dripping or cracking. Measure the length and calculate the percentage change. In addition, when so specified in IEC 60684-3, the specimens shall be tested for tensile strength and/or elongation at break. Also, when so specified in IEC 60684-3, the specimen shall be wound 360 degrees around a mandrel of diameter specified in IEC 60684-3 at a uniform rate and within 2 s to 4 s. The specimens shall then be examined for any signs of cracks. Side cracking of the flattened tubing shall not be cause for rejection.