

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Insulating materials – Industrial rigid round laminated tubes and rods based on thermosetting resins for electrical purposes – Part 2: Methods of test

Matériaux isolants – Tubes et barres industriels rigides, ronds, stratifiés, à base de résines thermodurcissables, à usages électriques – Partie 2: Méthodes d'essai



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Partie 2: Méthodes d'essai**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INSULATING MATERIALS –
INDUSTRIAL RIGID ROUND LAMINATED TUBES
AND RODS BASED ON THERMOSETTING RESINS
FOR ELECTRICAL PURPOSES –****Part 2: Methods of test**

FOREWORD

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International Standard IEC 61212-2 has been prepared by IEC technical committee 15: Standards on specifications for electrical insulating materials.

This second edition cancels and replaces the first edition published in 1995 and constitutes a technical revision.

The main changes from the previous edition are as follows: added application use and safety statements. Reformatted document to bring it up to current IEC document format. Test method references updated.

This bilingual version, published in 2009-06, corresponds to the English version.

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

FDIS	Report on voting
15/273/FDIS	15/306/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.

The French version of this standard has not been voted upon.

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn;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
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INTRODUCTION

This part of IEC 61212 is one of a series which deals with industrial, rigid, round, laminated tubes and rods based on thermosetting resins for electrical purposes. The materials are similar to those described in IEC 62011-1 but of different cross-section.

This series, under the general heading *Insulating materials – Industrial rigid round laminated tubes and rods based on thermosetting resins for electrical purposes*, consists of three parts:

Part 1: Definitions, designations and general requirements (IEC 61212-1)

Part 2: Methods of test (IEC 61212-2)

Part 3: Specifications for individual materials (IEC 61212-3)

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INSULATING MATERIALS – INDUSTRIAL RIGID ROUND LAMINATED TUBES AND RODS BASED ON THERMOSETTING RESINS FOR ELECTRICAL PURPOSES –

Part 2: Methods of test

1 Scope

This part of IEC 61212 describes methods of test for the materials defined in IEC 61212-1.

Materials which conform to this specification meet established levels of performance. However, the selection of a material by a user for a specific application should be based on the actual requirements necessary for adequate performance in that application and not based on this specification alone.

Safety warning:

It is the responsibility of the user of the methods contained or referred to in this document to ensure that they are used in a safe manner.

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2 Normative references (standards.iteh.ai)

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 60167:1964, *Methods of test for the determination of the insulation resistance of solid insulating materials*

IEC 60212:1971, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60216-1:2001, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2:2005, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

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 60296:2003, *Fluids for electrotechnical applications – Unused mineral oils for transformers and switchgear*

IEC 60695-11-10:1999, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*
Amendment 1 (2003)¹

IEC 61212-1, *Insulating materials – Industrial rigid round laminated tubes and rods based on thermosetting resins for electrical purposes – Part 1: General requirements*

IEC 61212-3 (all sheets), *Insulating materials – Industrial rigid round laminated tubes and rods based on thermosetting resins for electrical purposes – Part 3: Specifications for individual materials*

ISO 62:1999, *Plastics – Determination of water absorption*

ISO 178:2001, *Plastics – Determination of flexural properties*

ISO 604:2002, *Plastics – Determination of compressive properties*

ISO 1183-1:2004, *Plastics – Methods for determining the density and relative density of non-cellular plastics – Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 3611:1978, *Micrometer callipers for external measurement*

ISO 3599:1976, *Vernier callipers reading to 0,1 and 0,05 mm*

ISO 6906:1984, *Vernier callipers reading to 0,02 mm*

3 Conditioning of specimens [IEC 61212-2:2006](#)

[https://standards.iteh.ai/catalog/standards/sist/24c26f44-ed12-4cb7-9a75-](https://standards.iteh.ai/catalog/standards/sist/24c26f44-ed12-4cb7-9a75-61cc155e4c73/iec-61212-2-2006)

Unless otherwise specified, test specimens shall be conditioned immediately prior to testing for at least 24 h in standard atmosphere B according to IEC 60212 at a temperature of 23 °C ± 2 K and a relative humidity of (50 ± 5) %.

Unless otherwise specified, each specimen shall be tested in the conditioning atmosphere or the tests shall commence within 3 min of removal of each specimen from the conditioning atmosphere.

Where testing at an elevated temperature is required in a specification sheet of IEC 61212-3, test specimens shall be conditioned for 1 h at the elevated temperature immediately before testing.

4 Dimensions

4.1 General

All dimensions shall be measured in the “as received” condition.

4.2 External diameter

4.2.1 Test apparatus

The external diameter of the tubes and rods shall be determined using one of the apparatus listed below:

¹ There exists a consolidated version 1.1 (2003) that includes IEC 60695-11-10 (1999) and its Amendment 1 (2003).

a) Nominal external diameter ≤ 100 mm

An external screw type micrometer with an accuracy of $\pm 0,02$ mm or better, according to ISO 3611, having faces with diameters between 6 mm and 8 mm.

b) Nominal external diameter > 100 mm and ≤ 500 mm

A slide gauge (Vernier caliper) in accordance with ISO 3599.

c) Nominal external diameter > 500 mm

A steel tape, graduated in divisions of 0,5 mm with an accuracy of $\pm 0,1$ mm or better.

Any other means of measurement with the same or better accuracy may be used. In case of dispute, the specified apparatus shall be used.

4.2.2 Procedure

For tubes or rods with nominal external diameter ≤ 500 mm, measure the external diameter at three points along the length, but not less than 20 mm from the ends, generally at both ends and the middle. At each of these points, a minimum of three readings equally distributed around the circumference shall be taken.

For tubes or rods with nominal external diameter > 500 mm, measure the circumference at three places along the length, distributed as above, and calculate the diameter.

4.2.3 Results

For nominal external diameters ≤ 100 mm, the measured values shall be recorded to the nearest 0,02 mm.

For nominal external diameters > 100 mm and ≤ 500 mm, the measured values shall be recorded to the nearest 0,1 mm.

For nominal external diameters > 500 mm, the diameters shall be calculated from the measured circumferences and recorded to the nearest millimetre.

4.2.4 Report

The arithmetic mean of the recorded values shall be reported as the diameter of the tube or rod.

4.3 Internal diameter

4.3.1 Test apparatus

The internal diameter of tubes shall be determined using one of the instruments listed below.

a) For tubes with nominal internal diameter ≤ 10 mm

A tapered plug gauge or pin type micrometer with an accuracy of $\pm 0,02$ mm or better.

b) For tubes with nominal internal diameter > 10 mm and ≤ 500 mm

A slide gauge (Vernier caliper) in accordance with ISO 3599.

c) For tubes with nominal internal diameter > 500 mm

A graduated steel tape to measure the external circumference in accordance with 4.2.1 c).

A slide gauge (Vernier caliper) to measure the wall thickness in accordance with 4.2.1 b).

Any other means of measurement having the same accuracy as specified above or better may be used. In case of dispute, the specified apparatus shall be used.

4.3.2 Procedure

- a) For tubes with nominal internal diameter ≤ 10 mm

Measure the internal diameter of the tube at both ends using a tapered plug gauge, or at three points equally spaced around the inside circumference at both ends using a pin type micrometer.

- b) For tubes with nominal internal diameter > 10 mm and ≤ 500 mm

Measure the internal diameter of the tube at a minimum of three points equally spaced along the inside circumference at both ends.

- c) For tubes with nominal internal diameter > 500 mm

The internal diameter shall be calculated from the external diameter determined according to 4.2 and the wall thickness determined according to 4.4.

4.3.3 Results

For tubes with nominal internal diameter ≤ 10 mm measured using a tapered plug gauge or pin type micrometer, the values measured at the two ends shall be recorded to the nearest 0,02 mm.

For tubes with nominal internal diameter > 10 mm and ≤ 500 mm, measured using a slide gauge, the three values measured at the two ends shall be recorded to the nearest 0,1 mm.

For tubes with nominal internal diameter > 500 mm, calculate the internal diameters using the measured outside diameters and the corresponding measured wall thicknesses and record the calculated values to the nearest millimetre.

4.3.4 Report

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<https://standards.iteh.ai/catalog/standards/sist/24c26f44-ed12-4cb7-9a75->

For tubes with nominal internal diameter ≤ 10 mm measured using a tapered plug gauge, the arithmetic mean of the two values recorded shall be reported as the internal diameter of the tube. For tubes with nominal internal diameter ≤ 10 mm measured using a pin type micrometer, the arithmetic mean of the six values recorded shall be reported as the internal diameter of the tube.

For tubes with nominal internal diameter > 10 mm and ≤ 500 mm, the arithmetic mean of the six recorded values shall be reported as the internal diameter of the tube.

For tubes with nominal internal diameter > 500 mm, the arithmetic mean of the recorded values shall be reported as the internal diameter of the tube.

4.4 Wall thickness

4.4.1 Test apparatus

The wall thickness of the tube shall be measured using a pin type micrometer, or universal micrometer according to ISO 3611, or a suitable Vernier caliper reading to 0,02 mm according to ISO 6906.

Any other means of measurement having the same accuracy as specified above or better may be used. In case of dispute, the specified apparatus shall be used.

4.4.2 Procedure

Measure the wall thickness of the tube at a minimum of three points equally spaced around the circumference at each end of the tube.

4.4.3 Results

Record the measured values to the nearest 0,02 mm.

4.4.4 Report

Report the arithmetic mean of the values recorded as the wall thickness of the tube.

4.5 Departure from straightness – Applicable to all tubes up to 300 mm diameter

4.5.1 Test specimens

The test specimen shall be the tube under test. Where appropriate, the tube shall be trimmed to length in order to remove excess resin or flashing from the ends prior to carrying out the test.

4.5.2 Procedure

The length of the tube or rod shall be measured with an accuracy of ± 1 mm and recorded. The tube or rod shall then be placed on a flat, horizontal surface and rolled until the maximum gap occurs between it and the flat surface. The tube or rod shall be maintained in this position without applying any pressure that could deform it. The maximum gap shall be measured using feeler or slip gauges.

4.5.3 Results

Record the measured value in millimetres to the nearest 0,1 mm as the departure from straightness of the rod or tube under test. The limit for departure of straightness as a function of length is given in IEC 61212-3.

[IEC 61212-2:2006](https://standards.iteh.ai/catalog/standards/sist/24c26f44-ed12-4cb7-9a75-61ced55e4e73/iec-61212-2-2006)

4.5.4 Report

Report the value obtained in millimetres as the departure from straightness together with the length.

5 Mechanical tests

5.1 Flexural strength perpendicular to laminations

The flexural strength shall be determined by the method specified in ISO 178.

NOTE 1 This method provides information, which is useful for the specification of materials, but the information should not be used for structural calculations. Preparation of specimens may release residual stresses in the tube or rod and the results may not correlate with the true flexural properties.

NOTE 2 For the materials described in this standard, the flexural strength and the flexural stress at rupture can be regarded as identical properties.

5.1.1 Test specimens

Three specimens shall be tested.

5.1.1.1 Tubes

The test is applicable to tubes of nominal internal diameter greater than 100 mm and other tubes from which satisfactory specimens as defined below can be produced. In the case of moulded tubes with visible mould closing lines, at least one specimen shall be cut from the region of each mould-closing line.

The test specimens shall be of rectangular cross-section and shall be cut from the wall of the tube. The length axis of the specimens shall be parallel to the main axis of the tube. The

dimensions of the specimens shall be as described in ISO 178. The thickness shall lie between 3 mm and 5 mm. The preferred thickness is 4 mm.

The other specimen dimensions shall be as described in ISO 178. See Figure 1.

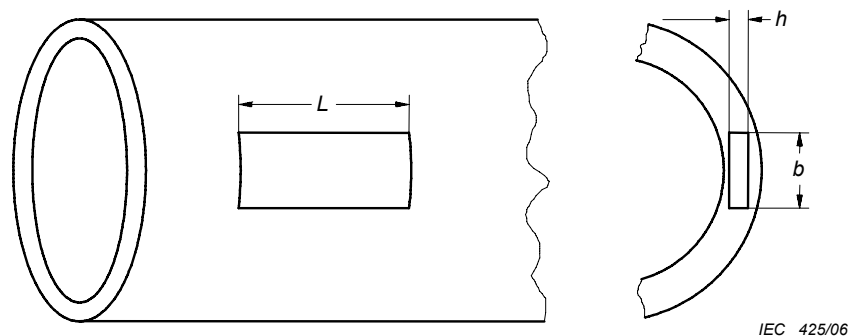


Figure 1 – Preparation of test specimen from a large tube for testing flexural strength

5.1.1.2 Rods

Each specimen shall be a piece of rod under test except that, if the diameter of the rod exceeds 13 mm, it shall be reduced concentrically to (13 ± 1) mm by machining. The length of each specimen shall be not less than 20 times its diameter.

5.1.2 Procedure

5.1.2.1 Tubes

Perform the test as described in ISO 178. <https://standards.iteh.ai/catalog/standards/sist/24c26f44-ed12-4cb7-9a75-4e73/iec-61212-2-2006>

The cross-head speed shall be (5 ± 1) mm/min.

5.1.2.2 Rods

The diameter of the test specimen shall be measured according to 4.2.1.

The length of the span, L , shall be $(16 \pm 1) D$ (D = diameter of the rod or the diameter of the test specimen cut from the rod). The length of the span shall be measured to the nearest 0,5 mm.

Load the test specimen as a simple beam at mid-span without impact.

The cross-head speed shall be (5 ± 1) mm/min.

Record the load, F , at the moment of rupture.

5.1.3 Results

5.1.3.1 Tubes

Calculate the flexural strength of the rectangular specimens as described in ISO 178 and record the three results obtained in MPa.

5.1.3.2 Rods

σ_F , the flexural stress at load F , is calculated in MPa from the formula: