BRITISH STANDARD

BS EN 60819-2:2002
IEC 60819-2:2001

Non-cellulosic papers for electrical purposes —

Part 2: Methods of test

The European Standard EN 60819-2:2001 has the status of a British Standard

ICS 29.035.10

National foreword

This British Standard is the official English language version of EN 60819-2:2001. It is identical with IEC 60819-2:2001.

The UK participation in its preparation was entrusted by Technical Committee GEL/15, Material specification, to Subcommittee GEL/15/3/10, Flexible composites and textiles, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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This British Standard, having been prepared under the direction of the Electrotechnical Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 22 January 2002

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EUROPEAN STANDARD **EN 60819-2**

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English version

Non-cellulosic papers for electrical purposes
Part 2: Methods of test
(IEC 60819-2:2001)

Papiers non cellulosiques
à usages électriques
Partie 2: Méthodes d'essai
(CEI 60819-2:2001)

Vliesstoffe auf Kunststofffaserbasis
für elektrotechnische Zwecke
Teil 2: Prüfverfahren
(IEC 60819-2:2001)

CENELEC
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Foreword

The text of document 15C/1183/FDIS, future edition 1 of IEC 60819-2, prepared by SC 15C, Specifications, of IEC TC 15, Insulating materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60819-2 on 2001-09-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2002-06-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2004-09-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annex ZA is normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60819-2:2001 was approved by CENELEC as a European Standard without any modification.

CONTENTS

INTRODUCTION

This International Standard is one of a series which deals with non-cellulosic papers for electrical purposes.

The series consists of three parts:

Part 1: Definitions and general requirements (IEC 60819-1)

Part 2: Methods of test (IEC 60819-2)

Part 3: Specifications for individual materials (IEC 60819-3)

NON-CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES –

Part 2: Methods of test

1 Scope

This part of IEC 60819 contains the test methods to be used in testing non-cellulosic papers for electrical purposes to meet the requirements prescribed in the specification sheets of IEC 60819-3.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60819. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60819 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

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 60819-3 (all parts), *Specification for non-cellulosic papers for electrical purposes – Part 3: Specifications for individual materials*

ISO 186:1994, *Paper and board – Sampling to determine average quality*

ISO 534:1988, *Paper and board – Determination of thickness and apparent bulk density or apparent sheet density*

ISO 536:1995, *Paper and board – Determination of grammage*

ISO 1924 (all parts), *Paper and board – Determination of tensile properties*

3 General notes on tests

In this standard, reference is made in several places to ISO publications accompanied by a short description of the method used. It is to be understood that this short description is meant for identification purposes only and that all details should be taken from the ISO publication itself.

In this standard, the definitions of “specimen” and “test piece” as defined in ISO 186 are used.

– specimen: a rectangle of paper or board cut to given dimensions from sheets drawn from selected units.

  NOTE Adapted from 3.4 of ISO 186.

– test piece: the quantity of paper or board on which the determination is carried out in accordance with the method of test. It may be taken from a specimen; in some instances it may be the specimen itself.

  NOTE Adapted from 3.6 of ISO 186.

3.1 Unless otherwise specified, cut the specimen and condition the test pieces for not less than 16 h in an atmosphere of (23 ± 2) °C and (50 ± 5) % r.h. Perform the tests on the test pieces in this atmosphere.

3.2 In cases of dispute use the following procedure.

Prior to conditioning, dry all specimens at 70 °C to a moisture content below 4 %. Condition these pieces for a minimum of 18 h at (23 ± 1) °C and (50 ± 2) % r.h.

Unless otherwise specified, make tests on three specimens.

4 Thickness

4.1 Measure thickness on a single test piece in accordance with ISO 534 using a precision dial micrometer that applies to the test piece a static load equivalent to (100 ± 10) kPa.

4.2 Exceptions to ISO 534

– Make one determination on each of the three conditioned test pieces.
– Take the central value as the result of the thickness of a single sheet; the other two determinations shall be reported.
– Use the millimetre as the unit of thickness.
– Reporting of the standard deviation is optional.

5 Grammage (mass per unit area, basic mass)

5.1 Measure the grammage in accordance with ISO 536.

Principle: The area of each test piece and its mass are measured on conditioned test pieces. Mass per unit area is calculated.

5.2 Exceptions to ISO 536

– Ignore clauses 5 and 6.
– Make one determination on each of the three conditioned test pieces having an area of not less than 0,05 m^2.
– Determine the mass to an accuracy of 0,5 %.
– Take the central value as the result; report the other two values.

6 Dissipation factor and permittivity

6.1 Use any appropriate apparatus described in IEC 60250 for measurement of dissipation factor and permittivity. Test at least three specimens. Unless otherwise specified, condition test pieces as per 3.1.

6.2 Unless otherwise specified, test at room temperature in accordance with 3.1 using alternating voltage at a frequency between 48 Hz and 62 Hz which provides a stress of approximately 0,4 MV/m.

6.3 Report the median values for dissipation factor and permittivity.

7 Tensile strength and elongation

7.1 Determine tensile strength and elongation in accordance with ISO 1924 unless otherwise specified in the specific sheets of IEC 60819-3.

Principle: Test pieces approximately 15 mm wide and 250 mm long, cut in each of the principal directions of the paper, are conditioned, clamped in a tension-testing machine, and exposed to tensile forces sufficient to cause the test piece to break.

7.2 Exceptions to ISO 1924

– Test nine test pieces cut so that the long dimension is parallel to the machine direction of the paper. These results are MD tensile strength.
– Test nine test pieces cut so that the long dimension is parallel to the cross direction of the paper. These results are CD tensile strength.
– Take the central value of the nine determinations as the result for each direction.
– Report the highest and the lowest values.
– Alternatively, the results may be expressed as breaking strength in metres rounded off to the nearest 100 m.

8 Edge-tearing resistance

8.1 Test apparatus

The test apparatus consists of

– an edge-tear stirrup frame (see figure 1);
– a V-notched plate with a thickness of (1,25 ± 0,05) mm, for use with the stirrup frame;
– a V-notched plate with a thickness of (2,50 ± 0,05) mm, for use with the stirrup frame;
– a tension-testing machine in accordance with clause 7.

8.2 Test pieces

Cut nine test pieces 15 mm to 25 mm wide and at least 250 mm long in such a way that the long direction is parallel to the machine direction of the paper. Label these as MD test pieces.

Cut nine additional test pieces having the same dimensions but with the long direction parallel to the cross direction of the paper. Label these as CD test pieces.

Examine the edges of each test piece. Discard and replace any test pieces which contain a nick or other defects due to the cutting that would influence the test results.

Condition and test all test pieces in accordance with 3.1.

8.3 Procedure

If papers having a thickness of 0,75 mm or less are to be tested, attach the 1,25 mm thick plate to the edge tear stirrup frame. If thicker papers are to be tested, attach the 2,50 mm thick plate.

Fasten the thin tang of the stirrup frame in the lower clamp (see note) of the tension-testing machine so that

– the vertical centre line of the stirrup coincides with the line connecting the mid-points of the upper and lower clamps of the testing machine, and
– the sides of the V-notch are symmetrically located relative to the line through the mid-points of the clamps.

NOTE The stirrup frame may be fastened to the upper clamp, if desired. This arrangement will require re-calibration of the zero point of the machine to compensate for the mass of the stirrup assembly.

Place the lower clamp of the machine such that the lower edge of the upper clamp is about 90 mm above the V-notched plate.

Thread the test piece through the stirrup, under the plate, and bring the two ends together and fasten them in the upper clamp. This procedure will result in the elimination of most of the slack in the strip. Take care not to apply any tearing forces to the test piece during this step of the procedure.

Make the application of the first increments of load to the test piece very slowly so as to minimize abnormal strains due to inertia effects. Adjust the applied load to a rate that will produce tearing within 5 s to 15 s.

At the time of observation of the first tearing in the strip, record the load in newtons (N).

8.4 Results

Report the central values for each of the two directions of the paper. Include the width and thickness of the test pieces and the rate of loading. The unit for edge-tearing resistance is the newton (N).

Report the highest and lowest values.

9 Shrinkage due to heating in air

9.1 Test apparatus

The test apparatus consists of

– an instrument capable of measuring 250 mm distances to within ±0,2 mm;
– a temperature-controlled oven that maintains air within the oven within ±5 °C at any set temperature between 130 °C and 300 °C.

9.2 Test pieces

Cut three rectangular test pieces, each having a dimension greater than 245 mm on any edge. One edge shall be parallel to the machine direction of the paper.

Mark each test piece so as to identify the machine direction.

9.3 Procedure

a) Before measuring any dimension, condition all test pieces in accordance with 3.1 and then place them upon a smooth flat surface located in a room or chamber maintained at the conditioning atmosphere.

b) Measure and record the dimensions of each test piece in the machine and cross-directions.

c) Set the oven to the temperature specified in IEC 60819-3 and allow it to come to thermal equilibrium.

d) Place the test pieces in the oven in such a way that each is suspended vertically in the chamber with a light weight attached to the bottom of each test piece to minimize curling during the heat exposure.

e) Count the beginning of exposure time from the time at which the oven has reached thermal equilibrium.

f) After an exposure time of (40 ± 1) min, remove and let the test pieces cool in a dessicator.

g) After a time of 4 h in the dessicator, repeat the determination of the dimensions in each direction on each test piece in accordance with 9.3.

h) Calculate in per cent the shrinkage MD for each test piece as follows:

$$\frac{(\text{MD dimension before heating}) - (\text{MD dimension after heating}) \times 100}{(\text{MD dimension before heating})}$$

i) Calculate in per cent the shrinkage CD for each test piece by substituting the CD dimensions for the MD dimensions of 9.3h).

9.4 Results

Take the central value of the three values in each direction as the result. Report the other two values of percentage shrinkage for each direction.

Identify the exposure temperature used.

10 Electric strength

10.1 Apparatus

Measure the electric strength using the apparatus in accordance with clause 7 of IEC 60243-1. The preferred electrodes are the 25/75 mm electrodes described in 4.1.1.1 of IEC 60243-1. In cases where the test pieces have dimensions too small for use by these electrodes it is permissible to use the 6 mm diameter electrodes of 4.1.2 of IEC 60243-1.

Use electrodes that are parallel and free from pits or other imperfections.

10.2 Test pieces

Condition all test pieces in accordance with 3.1 prior to testing.

Area dimensions of each test piece shall be large enough to prevent flashover around the test piece.

From each specimen prepare one or more test pieces having sufficient area to obtain a total of nine breakdown voltage readings.

10.3 Procedure

Measure and record the thickness of each test piece in accordance with clause 4.

Make nine breakdown tests in air in accordance with 9.1 of IEC 60243-1. Record the voltage for each breakdown.

For criterion of breakdown, use clause 10 of IEC 60243-1.

10.4 Results

Calculate the electric strength for each test piece by dividing the breakdown voltage by the measured thickness.

Report in accordance with clause 12 of IEC 60243-1.

Report the maximum, central and lowest values.

Report the electric strength in kilovolts per millimetre (kV/mm) or as megavolts per metre (MV/m).

Report the dimensions of the electrodes used.

11 Conductivity of aqueous extract

11.1 Test apparatus

The test apparatus consists of

– a conductivity cell with a known cell constant;
– a measuring instrument capable of determining conductance to a minimum value of 1 μS with an accuracy of 5 % in the frequency range 50 Hz to 3 000 Hz. Alternatively, the resistance may be measured with the same accuracy;
– flasks, glass, acid- and alkali-resistant, 250 ml capacity, wide mouth, conical;
– reflux condenser, glass, acid- and alkali-resistant, for use with the wide-mouth flasks above;
– analytical balance capable of weighing to ±0,05 g.

11.2 Reagents

Distilled or deionized water that meets all of the following requirements at 25 °C:

– volume resistivity greater than 0,01 MΩm;
– pH between 6,20 and 7,50;
– total mass fraction of solids less than 10^{-6}.

11.3 Procedure

NOTE It is essential that all specimens, test pieces, apparatus, and reagents be handled and stored in such a manner that they are not contaminated either by contact with hands or exposure to contaminating atmospheres that may exist within a chemical laboratory.

a) Make all determinations on the material as received.

b) Make one conductance measurement on each of three extractions.

c) Confirm that the glass flask which will hold the extract solution during the conductance measurement is suitable for use in this method. The procedure for the determination of confirmation follows.

d) From a reservoir of reagent water, pour approximately 125 ml of reagent water into the glass flask that will be used to hold the aqueous extract solution during the measurement of the conductance. Attach the reflux condenser.

e) Boil this water for approximately 60 min.

f) Stopper the flask to prevent carbon dioxide absorption and allow the contents to cool to room temperature.

g) If the conductivity exceeds 200 μS/m, repeat the procedure on the same flask or another flask. If the conductivity is below 200 μS/m, the flask is suitable for use. Use only flasks that conform to the above criterion. Record the acceptable conductance value of the flask contents and use this as the conductance value for the blank determination in the calculation of 11.4.

h) From a 20 g specimen, cut pieces of about 10 mm × 10 mm.

i) Weigh (5,0 ± 0,5) g of the paper and place it in a wide-mouth flask which is fitted with a reflux condenser.

j) Add 100 ml of reagent water.

k) Heat the flask to boiling and boil gently.

l) After gentle boiling for approximately 60 min, remove the flask and its contents from the heat.

m) Remove the reflux condenser and stopper the flask to prevent absorption of carbon dioxide from the air.

n) Cool to room temperature.

o) Decant a few millilitres of the extract so that the liquid rinses the electrodes of the conductivity cell as the extract flows into that flask upon which the blank determination was made.

p) Rinse the flask with a small volume of the extract, then discard the liquid.

q) Repeat this rinsing process twice; then as quickly as possible transfer the remaining extract into the flask and measure the conductance at (23 ± 0,5) °C.

11.4 Calculate the conductivity of the extract solution as follows:

$$\gamma = K\,(G_1 - G_2)$$

where

γ is the conductivity of extract solution in microsiemens per metre (μS/m);

K is the cell constant in units of m^{-1};

G_1 is the conductance of extract solution in microsiemens (μS);

G_2 is the conductance of blank in microsiemens (μS).

Report the median value as the result.

Report the highest and lowest conductivity.

12 Percentage of moisture content

12.1 From unconditioned specimens, take test pieces of convenient dimensions with mass in excess of 10 g. Weigh on a balance having an accuracy of ±0,05 %. Record the initial mass. Place test pieces in a laboratory oven maintained at (105 ± 3) °C. Determine the final mass after drying to a constant mass. Test pieces shall be taken from at least two specimens.

12.2 Calculate the percent moisture content:

$$\frac{(\text{initial mass} - \text{final mass}) \times 100}{\text{initial mass}}$$

12.3 Report the average value from all of the test pieces.

13 Loss of mass on ignition (LOI)

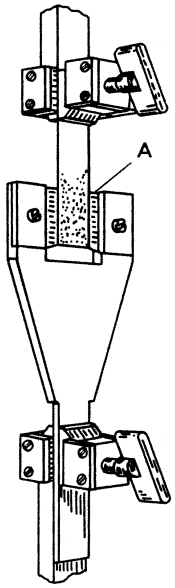
Also known as ash content, this test procedure determines the loss of mass after exposure to an extremely high temperature.

13.1 Condition specimens according to 3.1 and take test pieces with mass in excess of 10 g. Weigh on a balance having an accuracy of ±0,05 %. Record the initial mass for at least three test pieces. Place test pieces in a laboratory oven maintained at (650 ± 5) °C for 1 h. (Use a tared crucible if necessary.) Remove test pieces from the oven, place in a dessicator, and cool to room temperature.

13.2 Remove the test piece from the dessicator and weigh immediately. Record as final mass. Calculate the LOI as a percentage:

$$\frac{(\text{initial mass} - \text{final mass}) \times 100}{\text{initial mass}}$$

13.3 Report the average value of all test pieces.



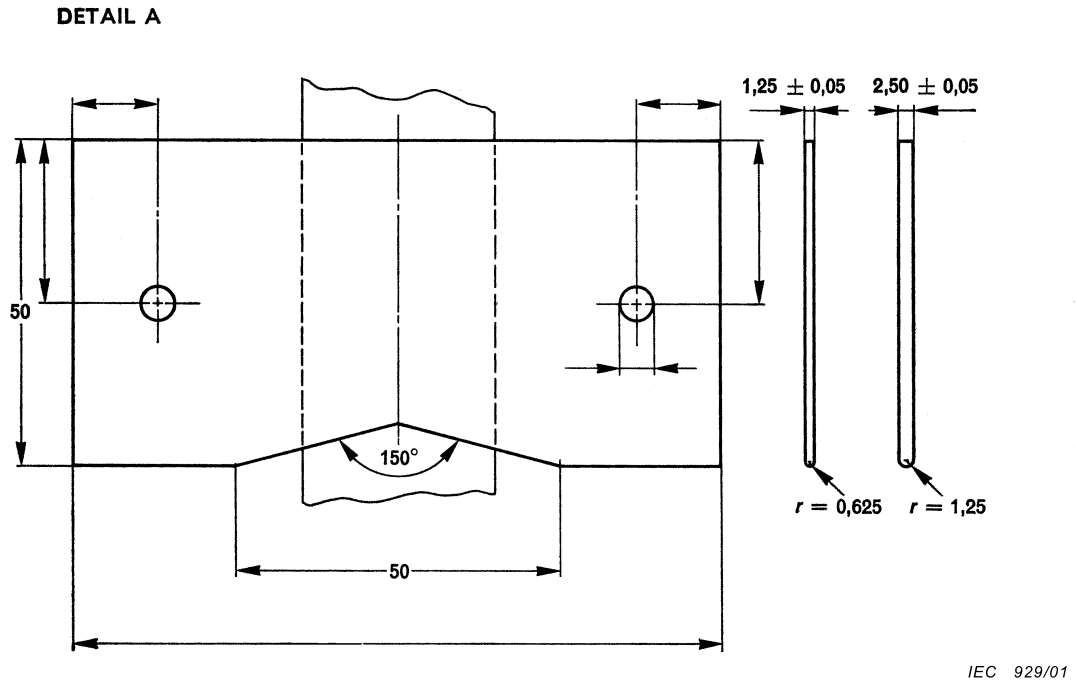


Figure 1 – Edge-tearing stirrup

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60243-1	1998	Electrical strength of insulating materials - Test methods Part 1: Tests at power frequencies	EN 60243-1	1998
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 60819-3-2	2001	Non-cellulosic papers for electrical purposes Part 3: Specifications for individual materials -- Sheet 2: Hybrid inorganic-organic paper	EN 60819-3-2	2001
ISO 186	1994	Paper and board Sampling to determine average quality	EN ISO 186	1996
ISO 534	1988	Paper and board - Determination of thickness and apparent bulk density or apparent sheet density	-	-
ISO 536	1995	Paper and board Determination of grammage	-	-
ISO 1924	Series	Paper and board - Determination of tensile properties	-	-

blank

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