Insulating materials – Industrial rigid laminated sheets based on thermosetting resins for electrical purposes –
Part 2: Methods of test
FINAL DRAFT INTERNATIONAL STANDARD (FDIS)

PROJECT NUMBER:
IEC 60893-2 ED3

DATE OF CIRCULATION: 2023-09-08
CLOSING DATE FOR VOTING: 2023-10-20

SUPERSEDES DOCUMENTS:
15/948/CDV, 15/1001/RVC

IEC TC 15: SOLID ELECTRICAL INSULATING MATERIALS

SECRETARIAT:
United States of America

SECRETARY:
Mr Solomon Chiang

OF INTEREST TO THE FOLLOWING COMMITTEES:

FUNCTIONS CONCERNED:
☐ EMC
☐ ENVIRONMENT
☐ QUALITY ASSURANCE
☐ SAFETY

☐ SUBMITTED FOR CENELEC PARALLEL VOTING

Attention IEC-CENELEC parallel voting

The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Final Draft International Standard (FDIS) is submitted for parallel voting.

The CENELEC members are invited to vote through the CENELEC online voting system.

This document is a draft distributed for approval. It may not be referred to as an International Standard until published as such.

In addition to their evaluation as being acceptable for industrial, technological, commercial and user purposes, Final Draft International Standards may on occasion have to be considered in the light of their potential to become standards to which reference may be made in national regulations.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to consider for future work to include relevant "In Some Countries" clauses. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (See AC/22/2007 or NEW GUIDANCE DOC).

TITLE:
Insulating materials - Industrial rigid laminated sheets based on thermosetting resins for electrical purposes - Part 2: Methods of test

PROPOSED STABILITY DATE: 2026

NOTE FROM TC/SC OFFICERS:

WG6 under the leadership of Mr. D'Arcy has addressed and accepted majority of the CDV comments, there are two rejected comments with reasons. Detailed work by WG6 in resolving comments can be found in the additional file called "15_1001e_RVC with MDA responses to CDV comments". Individual footnotes added under 2. Normative Reference as well. Solomon Chiang TC15 Secretary

Copyright © 2023 International Electrotechnical Commission, IEC. All rights reserved. It is permitted to download this electronic file, to make a copy and to print out the content for the sole purpose of preparing National Committee positions. You may not copy or "mirror" the file or printed version of the document, or any part of it, for any other purpose without permission in writing from IEC.
CONTENTS

FOREWORD .......................................................................................................................... 5

INTRODUCTION .................................................................................................................. 7

1 Scope .................................................................................................................................. 8
2 Normative references ......................................................................................................... 8
3 Terms and definitions ......................................................................................................... 9
4 Conditioning of test specimens ......................................................................................... 10
5 Dimensions ....................................................................................................................... 10
   5.1 Thickness .................................................................................................................. 10
      5.1.1 General ............................................................................................................. 10
      5.1.2 Test apparatus for reference method ............................................................. 10
      5.1.3 Procedure for reference method .................................................................. 10
      5.1.4 Results .......................................................................................................... 10
   5.2 Flatness ...................................................................................................................... 10
      5.2.1 General ........................................................................................................... 10
      5.2.2 Test specimens .............................................................................................. 10
      5.2.3 Test method ................................................................................................... 11
      5.2.4 Results .......................................................................................................... 11
6 Mechanical tests ................................................................................................................. 11
   6.1 Flexural strength ....................................................................................................... 11
      6.1.1 General .......................................................................................................... 11
      6.1.2 Test specimens .............................................................................................. 11
      6.1.3 Test method ................................................................................................... 11
      6.1.4 Results .......................................................................................................... 11
   6.2 Modulus of elasticity in flexure .................................................................................. 11
      6.2.1 General ........................................................................................................... 11
      6.2.2 Test specimens .............................................................................................. 12
      6.2.3 Test method ................................................................................................... 12
      6.2.4 Results .......................................................................................................... 12
   6.3 Compressive strength .................................................................................................. 12
      6.3.1 General .......................................................................................................... 12
      6.3.2 Test specimens .............................................................................................. 12
      6.3.3 Test method ................................................................................................... 12
      6.3.4 Results .......................................................................................................... 12
   6.4 Impact strength .......................................................................................................... 12
      6.4.1 General .......................................................................................................... 12
      6.4.2 Charpy Impact strength .............................................................................. 12
      6.4.3 Izod impact strength .................................................................................... 13
   6.5 Shear strength parallel to laminations ........................................................................ 13
      6.5.1 General .......................................................................................................... 13
      6.5.2 Test specimens .............................................................................................. 13
      6.5.3 Test method ................................................................................................... 14
      6.5.4 Results .......................................................................................................... 14
   6.6 Tensile strength .......................................................................................................... 14
      6.6.1 General .......................................................................................................... 14
      6.6.2 Test specimens .............................................................................................. 14
6.6.3 Test method ................................................................. 14
6.6.4 Results ................................................................. 14
7 Electrical tests ................................................................. 14
  7.1 Electric strength and breakdown voltage ... 14
      7.1.1 General ................................................................. 14
      7.1.2 Test specimens ......................................................... 15
      7.1.3 Test method ................................................................. 15
  7.2 Permittivity and dissipation factor ............................................ 15
      7.2.1 General requirements ..................................................... 15
      7.2.2 Methods ................................................................. 16
      7.2.3 Principles of the methods ................................................. 16
      7.2.4 Measuring instruments .................................................. 17
      7.2.5 Method A: Direct measurement technique .......................... 17
      7.2.6 Method B: Air substitution technique ............................... 19
      7.2.7 Method C: Two fluid immersion technique ....................... 22
      7.2.8 Test report ................................................................. 25
  7.3 Insulation resistance after immersion in water ............................ 26
      7.3.1 General ................................................................. 26
      7.3.2 Test specimens ......................................................... 26
      7.3.3 Test method ................................................................. 26
      7.3.4 Results ................................................................. 26
  7.4 Comparative and proof tracking indices ..................................... 26
      7.4.1 General ................................................................. 26
      7.4.2 Test specimens ......................................................... 26
      7.4.3 Test method ................................................................. 26
      7.4.4 Results ................................................................. 27
  7.5 Tracking and erosion resistance .................................................... 27
      7.5.1 General ................................................................. 27
      7.5.2 Test specimens ......................................................... 27
      7.5.3 Test method ................................................................. 27
      7.5.4 Results ................................................................. 27
8 Thermal tests ........................................................................ 27
  8.1 Thermal endurance ............................................................. 27
      8.1.1 General ................................................................. 27
      8.1.2 Test specimens ......................................................... 27
      8.1.3 Test method ................................................................. 27
      8.1.4 Results ................................................................. 27
  8.2 Flammability ................................................................. 27
      8.2.1 General ................................................................. 27
      8.2.2 Test specimens ......................................................... 28
      8.2.3 Test method ................................................................. 28
      8.2.4 Results ................................................................. 28
9 Other tests ........................................................................ 28
  9.1 Density ........................................................................ 28
      9.1.1 General ................................................................. 28
      9.1.2 Test specimens ......................................................... 28
      9.1.3 Test method ................................................................. 28
      9.1.4 Results ................................................................. 28
  9.2 Water absorption ................................................................ 28
9.2.1 General .................................................................................................................. 28
9.2.2 Test specimens .................................................................................................... 28
9.2.3 Test method ........................................................................................................ 28
9.2.4 Results ................................................................................................................. 28
Annex A (informative)  Modes of representation of capacitance ....................................... 34
Annex B (informative)  Liquids of known permittivity values ........................................... 35
Bibliography ..................................................................................................................... 36

Figure 1 – Test specimens for impact strength test ........................................................... 29
Figure 2 – Device for testing parallel shearing strength .................................................... 30
Figure 3 – Example of electrode system for method A ...................................................... 31
Figure 4 – Example of electrode system for method B ...................................................... 32
Figure 5 – Example of electrode system for method C ...................................................... 33
Figure A.1 – Equivalent parallel and series representation of a capacitor ....................... 34

Table 1 – Sequence employed for routine measurements ............................................... 24
Table B.1 – Liquids of known permittivity values ............................................................ 35
INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSULATING MATERIALS –
INDUSTRIAL RIGID LAMINATED SHEETS
BASED ON THERMOSETTING RESINS
FOR ELECTRICAL PURPOSES –

Part 2: Methods of test

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60893-2 has been prepared by IEC technical committee 15: Solid electrical insulating materials. It is an International Standard.

This third edition cancels and replaces the second edition published in 2003. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) removal of reference to withdrawn specification IEC 60167:1964;
b) inclusion of reference to IEC 62631-3-3:2015, which supersedes IEC 60167:1964. Details in 6.3 have been updated accordingly. The actual performance of the test has not changed;
c) normative references have been updated.

The text of this International Standard is based on the following documents:

<table>
<thead>
<tr>
<th>Draft</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/XX/FDIS</td>
<td>15/XX/RVD</td>
</tr>
</tbody>
</table>

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60893 series, published under the general title Insulating materials – Industrial rigid laminated sheets based on thermosetting resins for electrical purposes, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.
INTRODUCTION

This document is one of a series which deals with industrial rigid laminated sheets based on thermosetting resins for electrical purposes.

This series consists of four parts:

- Part 1: Definitions, designations and general requirements (IEC 60893-1);
- Part 2: Methods of test (IEC 60893-2);
- Part 3: Specifications for individual materials (IEC 60893-3);
- Part 4: Typical values (IEC TR 60893-4).
1 Scope

This part of IEC 60893 describes methods of test for the materials defined in IEC 60893-1 (referred to also as Part 1).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60112, Method for the determination of the proof and the comparative tracking indices of solid insulating materials

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


IEC 60296:2012\(^1\), Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear

IEC 60587:2007\(^2\), Electrical insulating materials used under severe ambient conditions – Test methods for evaluating resistance to tracking and erosion

IEC 60695-11-10:2013, Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods

IEC 60893-1, Insulating materials – Industrial rigid laminated sheets based on thermosetting resins for electrical purposes – Part 1: Definitions, designations and general requirements

IEC 60893-3 (all parts), Insulating materials – Industrial rigid laminated sheets based on thermosetting resins for electrical purposes – Part 3: Specifications for individual materials

\(^1\) A fifth edition of this standard has been published in 2020.

\(^2\) A fourth edition of this standard has been published in 2022.
IEC FDIS 60893-2 © IEC 2023

IEC TR 60893-4, Insulating materials – Industrial rigid laminated sheets based on thermosetting resins for electrical purposes – Part 4: Typical values

IEC 62631-3-3:2015, Dielectric and resistive properties of solid insulating materials – Part 3-3: Determination of resistive properties (DC methods) – Insulation resistance


ISO 178:20103, Plastics – Determination of flexural properties


ISO 180:20006, Plastics – Determination of Izod impact strength

ISO 527-1:20127, Plastics – Determination of tensile properties – Part 1: General principles


ISO 3611:201010, Geometrical product specifications (GPS) – Dimensional measuring equipment: Micrometers for external measurements – Design and metrological characteristics

---

3 A sixth edition of this standard has been published in 2019.
4 A third edition of this standard has been published in 2023.
5 A second edition of this standard has been published in 2020.
6 A fifth edition of this standard has been published in 2023.
7 A third edition of this standard has been published in 1999.
8 A third edition of this standard has been published in 2023.
9 A third edition of this standard has been published in 2019.
10 A third edition of this standard has been published in 2023.