IEC 60331-4

Edition 1.0 2024-12

INTERNATIONAL STANDARD

colour inside

GROUP SAFETY PUBLICATION

Tests for electric cables under fire conditions – Circuit integrity – Part 4: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1kV up to and including 30 kV

Documents
Document Sharing Hub

IEC 60331-4:2024-12(en)

Full document details: IEC 60331-4 2024

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Documents
Document Sharing Hub

Full document details: IEC 60331-4 2024

IEC 60331-4

Edition 1.0 2024-12

INTERNATIONAL STANDARD

colour inside

Tests for electric cables under fire conditions – Circuit integrity – Part 4: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1kV up to and including 30 kV

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.060.20; 13.220.40

ISBN 978-2-8327-0072-3

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

Documents
Document Sharing Hub

Full document details: IEC 60331-4 2024

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 8
3 Terms and definitions 8
4 Test conditions 8
5 Test apparatus 9
5.1 Test equipment 9
5.2 Test ladder and mounting 12
5.3 Source of heat 13
5.3.1 Burner 13
5.3.2 Flow meters and flow rates 14
5.3.3 Verification 15
5.4 Shock producing device 15
5.5 Positioning of source of heat 16
5.6 Voltage supply arrangement 16
6 Test specimen 16
6.1 Test specimen preparation 16
6.2 Test specimen mounting 16
7 Test procedure 17
7.1 Test equipment and arrangement 17
7.2 Electrical connections and electrification 17
7.3 Flame, shock application and voltage supply 18
7.4 Optional water spray or water jet 18
8 Performance requirements 18
8.1 Flame application time 18
8.2 Acceptance criteria 18
9 Retest procedure 18
10 Test report 19
11 Cable marking 19
Annex A (normative) Verification procedure for the source of heat 20
A.1 Measuring equipment 20
A.2 Procedure 20
A.3 Evaluation 21
A.4 Further verification 21
A.5 Verification report 21
Annex B (informative) Guidance on the choice of recommended test apparatus 22
Annex C (informative) Guidance for using optional water spray or water jet protocol 23
C.1 General 23
C.2 Modifications for optional water spray or jet protocols 23
C.2.1 Water spay device – Option A 23
C.2.2 Water jet device – Option B 24
C.3 Additional inclusion for test report 27
C.4 Additional cable marking 27
Annex D (informative) Guidance for using 1 000 °C temperature testing 28

AVA Documents
Document Sharing Hub
Full document details: IEC 60331-4 2024

D.1 General ... 28
D.2 Test apparatus ... 28
D.3 Verification procedure for the source of heat ... 28
D.4 Additional marking ... 28
Bibliography ... 29

Figure 1 – Schematic diagram of test configuration (not to scale) ... 10
Figure 2 – Plan view of fire test equipment ... 11
Figure 3 – End elevation of fire test equipment (not to scale) ... 12
Figure 4 – Typical rubber bush for supporting the test ladder ... 13
Figure 5 – Burner face ... 14
Figure 6 – Schematic diagram of an example of a burner control system ... 15
Figure 7 – Method of mounting test specimen ... 17
Figure A.1 – Temperature measuring arrangement ... 20
Figure C.1 – Water spray tube ... 24
Figure C.2 – Water spray application ... 24
Figure C.3 – Hose nozzle ... 25
Figure C.4 – Water jet application ... 26
Figure C.5 – End elevation of water jet application ... 26

Documents
Document Sharing Hub
Full document details: IEC 60331-4 2024

INTERNATIONAL ELECTROTECHNICAL COMMISSION

TESTS FOR ELECTRIC CABLES UNDER FIRE CONDITIONS – CIRCUIT INTEGRITY –

Part 4 – Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1 kV up to and including 30 kV

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 60331-4 has been prepared by IEC technical committee 20: Electric cables. It is an International Standard.

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

Draft	Report on voting
20/2194/FDIS	20/2215/RVD

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.

Documents
Document Sharing Hub

Full document details: IEC 60331-4 2024

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.

It has the status of a group safety publication in accordance with IEC Guide 104.

A list of all parts in the IEC 60331 series, published under the general title *Tests for electric cables under fire conditions – Circuit integrity*, 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.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

Documents
Document Sharing Hub

Full document details: IEC 60331-4 2024

INTRODUCTION

The IEC 60331 series consists of the following parts:

IEC 60331-1, *Tests for electric cables under fire conditions – Circuit integrity – Part 1: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*

IEC 60331-2, *Tests for electric cables under fire conditions – Circuit integrity – Part 2: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm*

IEC 60331-3, *Tests for electric cables under fire conditions – Circuit integrity – Part 3: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV tested in a metal enclosure*

IEC 60331-4, *Tests for electric cables under fire conditions – Circuit integrity – Part 4: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1 kV up to and including 30 kV*

IEC 60331-11, *Tests for electric cables under fire conditions – Circuit integrity – Part 11: Apparatus – Fire alone at a flame temperature of at least 750 °C*

IEC 60331-21, *Tests for electric cables under fire conditions – Circuit integrity – Part 21: Procedures and requirements – Cables of rated voltage up to and including 0,6/1,0 kV*

IEC 60331-23, *Tests for electric cables under fire conditions – Circuit integrity – Part 23: Procedures and requirements – Electric data cables*

IEC 60331-25, *Tests for electric cables under fire conditions – Circuit integrity – Part 25: Procedures and requirements – Optical fibre cables*

NOTE 1 IEC 60331-21, IEC 60331-23 and IEC 60331-25 relate to fire-only conditions at a flame temperature of at least 750 °C.

NOTE 2 IEC 60331-11, IEC 60331-21, IEC 60331-23 and IEC 60331-25 are no longer subject to maintenance. The relevant test procedures are given in IEC 60331-1 and IEC 60331-2.

Since its first edition (1970), the IEC 60331 series has been extended and has introduced a range of test apparatus in order that a test can be carried out on large and small power, control, data and optical fibre cables.

Successful tests carried out in accordance with this document will enable an identification to be marked on the product.

AVA Documents
Document Sharing Hub

Full document details: IEC 60331-4 2024

TESTS FOR ELECTRIC CABLES UNDER FIRE CONDITIONS – CIRCUIT INTEGRITY –

Part 4 – Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage higher than 1 kV up to and including 30 kV

1 Scope

This part of the IEC 60331 series specifies the test apparatus and procedure, and gives the performance requirements, including recommended flame application times and flame temperatures, for power cables of rated voltage higher than 0,6/1,0 kV up to and including 18/30 kV for maintaining circuit integrity when subject to fire and mechanical shock under specified conditions.

The test method in this document is restricted to conductor sizes up to and including 120 mm^2. The test results for 120 mm^2 size conductors constructions qualify larger cross-sections of the same cable construction.

In the case of preassembled three-core cables, then the complete cable is considered as tested when a complete single-core of the cable has been tested.

This document includes details for the specific point of failure, continuity checking arrangement, test sample, test procedure and test report relevant to electric power cables with a rated voltage higher than 0,6/1,0 kV up to and including 18/30 kV.

Annex A provides the method of verification of the burner and control system used for the test. Annex B provides a choice of the recommended test apparatus.

Annex C provides, as an option, guidance for using either water spray or water jet protocols.

Annex D provides, as an option, the flame temperature of 1 000 °C, which is applicable for special applications.

Requirements are stated for an identification that can optionally be marked on the cable to signify compliance with this document.

This group safety publication focusing on the test method for circuit integrity safety for power cables of rated voltage higher than 1 kV up to and including 30 kV under fire conditions, is primarily intended to be used as a product safety standard for the products mentioned in the scope, but is also intended to be used by TCs in the preparation of publications for products similar to those mentioned in the scope of this group safety publication, in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a TC is, wherever applicable, to make use of either BSPs or GSPs, or both, in the preparation of its publications.

WARNING – The test given in this document can involve the use of dangerous voltages and temperatures. Suitable precautions should be taken against the risk of shock, burning, fire and explosion that can arise, and against any noxious fumes that can be produced.

Documents
Document Sharing Hub
Full document details: IEC 60331-4 2024

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 60584-1, *Thermocouples – Part 1: EMF specifications and tolerances*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
circuit integrity
ability of an electric cable to continue to operate in a designated manner whilst subjected to a specified flame source for a specified period of time under specified conditions

3.2
draught-free environment
space in which the results of tests are not significantly affected by the local air speed

4 Test conditions

The test shall be carried out in a draught-free environment within a suitable chamber, of minimum volume 20 m^3, with facilities for disposing of any noxious gases resulting from the burning. Sufficient ventilation shall be available to sustain the flame for the duration of the test. Air inlets and the exhaust chimney should be located in such a way that the burner flame remains stable during the verification procedure and test. If necessary, the burner shall be shielded from any draughts by the use of draught shields. Windows may be installed in the walls of the chamber in order to observe the behaviour of the cable during the test. Fume exhaust should be achieved by means of natural draught through a chimney located at least 1 m from the burner. A damper may be used for adjustment of ventilation conditions.

NOTE Experience has shown a chamber similar to the "3 m cube" specified in IEC 61034-1 to be suitable, although other chambers of suitable volume can be used.

The chamber and test apparatus shall be at a temperature of between 10 °C and 40 °C at the start of each test.

The same ventilation and shielding conditions shall be used in the chamber during both the verification and cable test procedures.

Documents
Document Sharing Hub
Full document details: IEC 60331-4 2024

5 Test apparatus

5.1 Test equipment

The test equipment shall consist of the following:

a) a test ladder, onto which the test specimen is mounted, comprising a steel framework fastened to a rigid support as described in 5.2;

b) a source of heat comprising a horizontally mounted ribbon burner as described in 5.3;

c) a shock-producing device as described in 5.4;

d) a test wall equipped with thermocouples for verification of the source of heat as described in Annex A;

e) a voltage supply arrangement as described in 5.6;

f) and optionally: a water spray or water jet as described in Annex C.

A general arrangement of the test equipment is shown in Figure 1, Figure 2 and Figure 3.

Documents
Document Sharing Hub

Full document details: IEC 60331-4 2024