IEEE SA
STANDARDS ASSOCIATION

IEEE Recommended Practice for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electrical Equipment

IEEE STANDARDS

IEEE Standards Coordinating Committee 4

Developed by the
IEEE Standards Coordinating Committee 4 on
Electrical Insulation

IEEE Std 99™-2019
(Revision of IEEE Std 99-2007)

IEEE

IEEE Std 99™-2019
(Revision of IEEE Std 99-2007)

IEEE Recommended Practice for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electrical Equipment

Developed by the

IEEE Standards Coordinating Committee 4 on Electrical Insulation

Approved 7 November 2019

IEEE SA Standards Board

Abstract: A general form for the preparation of test procedures is provided in this standard. Points to be considered by technical committees in the preparation of specific instructions for the thermal evaluation of insulation systems for electric equipment are suggested. The test procedures involve accelerated thermal aging of insulation systems and specify tests that the committees deem pertinent based on conditions of use. The objective of the procedures is to provide for the functional evaluation, by test, of insulation systems for electric equipment.

Keywords: diagnostic factor, EIS, electrical insulation system, IEEE 99™, insulation system, test procedures, test specimen, thermal aging, thermal endurance, thermal evaluation

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

PDF: ISBN 978-1-5044-6329-4 STD23990
Print: ISBN 978-1-5044-6330-0 STDPD23990

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning IEEE Standards Documents." They can also be obtained on request from IEEE or viewed at http://standards.ieee.org/ipr/disclaimers.html.

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association ("IEEE SA") Standards Board. IEEE ("the Institute") develops its standards through a consensus development process, approved by the American National Standards Institute ("ANSI"), which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed through scientific, academic, and industry-based technical working groups. Volunteers in IEEE working groups are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers and users of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under US and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every 10 years. When a document is more than 10 years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit IEEE Xplore at http://ieeexplore.ieee.org/ or contact IEEE at the address listed previously. For more information about the IEEE SA or IEEE's standards development process, visit the IEEE SA Website at http://standards.ieee.org.

Errata

Errata, if any, for IEEE standards can be accessed via https://standards.ieee.org/standard/index.html. Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Details section. Errata are also available in IEEE Xplore: https://ieeexplore.ieee.org/browse/standards/collection/ieee/. Users are encouraged to periodically check for errata.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE SA Website at https://standards.ieee.org/about/sasb/patcom/patents.html. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Participants

At the time this IEEE recommended practice was completed, the P99 Working Group had the following membership:

Evanne Wang, *Chair*

Casey Ballard
Jerry Corkran
Randy Groves
Jeff Hudson
Alan Iversen
Robert Konnik
Rick Marek
Paulette Payne
Mark Raymond
Ed Van Vooren
Loren Wagenaar
Roger Wicks
Mark Winkeler

The following members of the individual balloting committee voted on this recommended practice. Balloters may have voted for approval, disapproval, or abstention.

Robert Ballard
Barry Beaster
William Bloethe
Gustavo Brunello
Demetrio Bucaneg Jr.
William Byrd
Eldridge Byron
Paul Cardinal
William Chen
Nancy Chilton
John Crouse
Namal Fernando
John Fish
Rostyslaw Fostiak
George Frimpong
Nancy Frost
Jalal Gohari
Edwin Goodwin
James Graham
J. Travis Griffith
Randall Groves
Attila Gyore
John Harley
Hamidreza Heidarisafa
Jeffrey Helzer
Werner Hoelzl
Philip Hopkinson
Laszlo Kadar
Gael Kennedy
Sheldon Kennedy
Yuri Khersonsky
Thomas Koshy
Jim Kulchisky
Chung-Yiu Lam
Benjamin Lanz
James Lau
Yung-chiang Lee
William Lockley
Richard Marek
Lee Matthews
William McDermid
Joseph Melanson
James Michalec
Ali Naderian Jahromi
Arthur Neubauer
Michael Newman
Lorraine Padden
Bansi Patel
Dhiru Patel
Paulette Payne Powell
Brian Penny
Howard Penrose
Christopher Petrola
Alvaro Portillo
Moises Ramos
Lakshman Raut
Ryandi Ryandi
Bartien Sayogo
Hyeong Sim
Jeffrey Sisson
Jerry Smith
John Smith III
Gary Smullin
David Stankes
Gary Stoedter
James Thompson
Remi Tremblay
James Van De Ligt
John Vergis
David Wallace
Roger Wicks
Jonathan Woodworth

When the IEEE SA Standards Board approved this recommended practice on 7 November 2019, it had the following membership:

Gary Hoffman, *Chair*
Ted Burse, *Vice Chair*
Jean-Philippe Faure, *Past Chair*
Konstantinos Karachalios, *Secretary*

Masayuki Ariyoshi
Stephen D. Dukes
J. Travis Griffith
Guido Hiertz
Christel Hunter
Joseph L. Koepfinger*
Thomas Koshy
John D. Kulick
David J. Law
Joseph Levy
Howard Li
Xiaohui Liu
Kevin Lu
Daleep Mohla
Andrew Myles
Annette D. Reilly
Dorothy Stanley
Sha Wei
Phil Wennblom
Philip Winston
Howard Wolfman
Feng Wu
Jingyi Zhou

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 99-2019, IEEE Recommended Practice for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electrical Equipment.

The previous version, IEEE Std 99-2007, had been revised substantially to coordinate with both relevant IEC standards and the recently revised IEEE Std 98™.[1] These revisions include:

- Definitions and references
- Detail on examples of thermal endurance testing, including how to plot temperature index and relative temperature index
- Updated table for exposure temperatures and times
- Methodology for life requirements different than the 20 000 h life on which Table 2 is based
- Detail on how to interpret aging data
- Addition of Annex B, which provides a historical basis for discussions on the repeatability of systems testing.

[1]Information on references can be found in Clause 2.

Contents

IEEE Recommended Practice for the Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electrical Equipment

1. Overview

1.1 Scope

This recommended practice provides criteria for the preparation of test procedures for accelerated thermal aging of insulation systems for electrical equipment and for the specification of tests based on conditions of use. The objective of these test procedures is to provide for the functional evaluation, by test, of insulation systems for electrical equipment.

1.2 Purpose

This recommended practice provides a general format for the preparation of test procedures and suggest the points to be considered by technical committees in the preparation of specific instructions for the thermal evaluation of insulation systems for electrical equipment. The thermal evaluation of an insulation system involves the following thermal factors of influence:

— Exposure temperature

— Ambient temperature

— Temperature gradient

— Rate of temperature change

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEC 60505, Evaluation and Qualification of Electrical Insulation Systems.[2]

[2]IEC publications are available from the International Electrotechnical Commission (http://www.iec.ch/) and the American National Standards Institute (http://www.ansi.org).