IEEE STANDARDS ASSOCIATION

IEEE Standard Test Procedure for Thermal Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery

IEEE Power and Energy Society

Sponsored by the
Rotating Machinery Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 117™-2015
(Revision of IEEE Std 117-1974)

IEEE Std 117™-2015
(Revision of IEEE Std 117-1974)

IEEE Standard Test Procedure for Thermal Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery

Sponsor

Rotating Machinery Committee
of the
IEEE Power and Energy Society

Approved 5 December 2015

IEEE-SA Standards Board

Recognized as an American National Standard

Abstract: The standard test procedure for the thermal evaluation and qualification of electrical insulation systems (EISs) for random-wound ac electric machinery, where thermal degradation is the dominating aging factor, is described. The relative thermal performance of a candidate EIS is compared to that of a reference EIS. Insulation systems for such machinery with input voltage of up to 600 V at 50/60 Hz are described in this standard. A statistical method for establishing a relative life-temperature relationship for an insulation system is also described. To have any significance, the reference insulation system must be supported with adequate field service data. Evaluation of insulation systems for use in air-cooled, random-wound ac electric machinery with "usual service conditions" is this procedure's intent. This procedure, on its own, does not cover insulation systems such as exposure to conducting contaminates, radiation, inverter applications, or operation in oils, refrigerants, or other media that potentially degrades insulating materials.

Keywords: ac electric machinery, IEEE™, insulation system, random-wound, thermal evaluation

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

PDF: ISBN 978-1-5044-0688-8 STD20795
Print: ISBN 978-1-5044-0689-5 STDPD20795

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 Notice" or "Important Notices and Disclaimers Concerning IEEE Standards Documents."

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. Volunteers 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 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

Photocopies

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 the IEEE-SA Website at http://ieeexplore.ieee.org/xpl/standards.jsp 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 all IEEE standards can be accessed on the IEEE-SA Website at the following URL: http://standards.ieee.org/findstds/errata/index.html. Users are encouraged to check this URL for errata periodically.

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 http://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 standard was completed, the P117 Materials Subcommittee Working Group had the following membership:

Nancy Frost, *Chair*
Shawn Filliben, *Vice Chair*

David Agnew
Kevin Alewine
Adam Balaweijer
Ray Bartnikas
David Cain
William Chen
Ian Culbert
Paul Gaberson
George Gao
Bal Gupta
Gary Heuston
Claude Hudon
Jeff Hudson
Marcelo Jacobs
Alexandra Jeremic
Aleksandr Khazonov
Lou Little
Thom Mayerhofer
William McDermid
David L. McKinnon
G. Harold Miller
Charles Millet
Ramtim Omranipour
Clive Reed
Bill Simpson
Dave Stankes
Greg Stone
Ed Van Vooren
Roger Wicks
Joe Williams
Chuck Wilson
Mark Winkeler
Martin Zgraggen

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

Thomas Bishop
William Bloethe
Weijen Chen
Matthew Davis
Gary Donner
James Dymond
Rostyslaw Fostiak
Nancy Frost
Randall Groves
Bal Gupta
David Horvath
Jeffrey Hudson
Innocent Kamwa
Yuri Khersonsky
Joseph L. Koepfinger
Robert Konnik
Greg Luri
Michael May
Omar Mazzoni
William McCown
William McDermid
David Mckinnon
James Michalec
G. Harold Miller
Daleep Mohla
Michael Newman
Lorraine Padden
Christopher Petrola
Bartien Sayogo
James Smith
Gary Stoedter
Gregory Stone
Remi Tremblay
John Vergis
Kenneth White
Roger Wicks
James Wilson

When the IEEE-SA Standards Board approved this standard on 5 December 2015, it had the following membership:

John D. Kulick, *Chair*
Jon Walter Rosdahl, *Vice Chair*
Richard H. Hulett, *Past Chair*
Konstantinos Karachalios, *Secretary*

Masayuki Ariyoshi
Ted Burse
Stephen Dukes
Jean-Philippe Faure
J. Travis Griffith
Gary Hoffman
Michael Janezic
Joseph L. Koepfinger*
David J. Law
Hung Ling
Andrew Myles
T. W. Olsen
Glenn Parsons
Ronald C. Petersen
Annette D. Reilly
Stephen J. Shellhammer
Adrian P. Stephens
Yatin Trivedi
Phillip Winston
Don Wright
Yu Yuan
Daidi Zhong

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 117™-2015, IEEE Standard Test Procedure for Thermal Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery.

This standard is provides an evaluation of the thermal capability of an unsealed random-wound insulation system. Other aging factors—electrical, mechanical, and environmental—are also known to be important. Test procedures for evaluating those factors, both individually and in combination with each other, will be pursued by other working groups.

This standard was updated in 2015, with specific limitations noted here:

— Consideration of uprating for usage to 1000 V was discussed, but not implemented in the 2015 version. This was due to concerns about uprating without adequate test data. Publications and data collection of testing up to 1000 V should be completed prior to placing it into an IEEE standard.

— The use of a condensation chamber is listed herein. There is a round-robin study pending that will investigate the alternate use of a humidity chamber for testing. At present this standard remains with the wording of condensation chamber.

Comments on, and suggestions for the improvement of, this standard are welcome, and should be sent to the IEEE Standards Board (see Participants).

Acknowledgements

The committee would like to gratefully acknowledge ELTEK International Laboratories, Shermco Industries, and Von Roll USA for their contributions of photos and images for this standard.

Contents

IEEE Standard Test Procedure for Thermal Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery

1. Overview

1.1 Scope

This is a standard test procedure for the thermal evaluation and qualification of electrical insulation systems (EISs) for random-wound ac electric machinery, where thermal degradation is the dominating aging factor. This procedure compares the relative thermal performance of a candidate EIS to that of a reference EIS. This standard covers insulation systems for such machinery with operating voltage of up to 600 V at 50/60 Hz. This standard provides a statistical method for establishing a relative life-temperature relationship for an insulation system. To have any significance, the reference insulation system must be supported with adequate field-service data. This procedure is intended to evaluate insulation systems for use in air-cooled, random-wound ac electric machinery with "usual service conditions." This procedure, on its own, does not cover insulation systems such as exposure to conducting contaminates, radiation, inverter applications, or operation in oils, refrigerants, or other media that potentially degrade insulating materials.

1.2 Purpose

The purpose of this standard procedure is to classify insulation systems in accordance with their temperature limits by test, rather than by chemical composition. This test procedure has been prepared to outline useful methods for the evaluation of systems of insulation for random-wound stators of rotating electric machines. The motorette procedure described is used for the evaluation of EISs.