IEEE STANDARDS ASSOCIATION

IEEE Recommended Practice for Testing Insulation Resistance of Electric Machinery

IEEE Power and Energy Society

Sponsored by the

Electric Machinery Committee

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

IEEE Std 43™-2013
(Revision of
IEEE Std 43-2000)

IEEE Std 43™-2013
(Revision of
IEEE Std 43-2000)

IEEE Recommended Practice for Testing Insulation Resistance of Electric Machinery

Sponsor

Electric Machinery Committee
of the
IEEE Power and Energy Society

Approved 11 December 2013

IEEE-SA Standards Board

Acknowlegements

The working group would like to acknowledge Eric David, of Ecole de Technologie Superieure for his contribition to the Figures and Tables in this document.

The working group would like to acknowledge Laurent Lamarre of Hydro Québec for his contribition to the Figures and Tables in this document.

Abstract: The dc voltage tests procedures for the measurement of the insulation resistance and polarization index of insulated stator, and rotor windings and how to interpret the results are described in this recommended practice.

Keywords: armature winding, dc, field winding, IEEE 43™, insulated, insulation resistance, polarization index, rotor winding, stator winding, voltage

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

PDF: ISBN 978-0-7381-8937-6 STD98551
Print: ISBN 978-0-7381-8938-3 STDPD98551

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 ten years. When a document is more than ten 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 recommended practice was completed, the P43 Working Group had the following membership:

Ian Culbert, *Chair*
Eric David, *Vice Chair*

David Agnew
Kevin Alewine
Adam Balawejder
Raymond Bartnikas
Kevin Becker
Tom Bishop
Stefano Bomben
Andy Brown
Mark Bruintjies
Donald Campbell
William Chen
Doug Conley
Marcelo Jacob Da Silva
Mario Dumouchel
Jeff Fenwick
Namal Fernando
Shawn Filliben
Steve Francese
Nancy Frost
Paul Gaberson
Michel Gagné
Bal Gupta
Gary Heuston
Fon Hiew
Richard Huber
Claude Hudon
Aleksandra Jeremic
Aleksandr Khazanov
Amir Khosravi
Ken Kimura
Thomas Klamt
Inna Kremza
Luc Lafortune
Laurent Lamarre
James Lau
Ben Leblanc
Gerhard Lemesch
Bill McDermid
David McKinnon
Charles Millet
Beant Nindra
Sophie Noel
Ramtin Omranipour
Cyrl Paynot
Howard Penrose
Sean Pollard
Helene Provencher
John Schmidt
Emad Sharifi
Jeff Sheaffer
Reza Soltani
Greg Stone
Meredith Stranges
Remi Tremblay
Roger Wicks
Joe Williams
Chuck Wilson
John Wilson
Hugh Zhu

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

Thomas Bishop
William Bloethe
Andrew Brown
Bill Brown
Derek Brown
Gustavo Brunello
Donald Campbell
Antonio Cardoso
Weijen Chen
Ian Culbert
Marcelo da Silva
Matthew Davis
Gary Donner
Randall Dotson
Marcus Durham
Robert Durham
James Dymond
Ahmed El Serafi
Jeffrey Fenwick
Jorge Fernandez Daher
Sudath Fernando
William Finley
Rostyslaw Fostiak
Frank Gerleve
Randall Groves
Bal Gupta
Ajit Gwal
Gary Heuston
Scott Hietpas
David Horvath
Richard Huber
Innocent Kamwa
John Kay
Yuri Khersonsky
Heshmatollah Khosravi
Saumen Kundu
Chung-Yiu Lam
James Lau
Michael Lauxman
Albert Livshitz
William Lockley
Michael May
Omar Mazzoni
John Mcalhaney Jr.
William Mc Cown
William McDermid
Don Mclaren
Nigel Mcquin
James Michalec
Charles Millet
Jerry Murphy
Michael Newman
Charles Ngethe
Lorraine Padden
Christopher Petrola
Ulrich Pohl
Alvaro Portillo
Iulian Profir
John Rama
Moises Ramos
Daniel Leland Ransom
Johannes Rickmann
Michael Roberts
Bartien Sayogo
Jeffrey Sheaffer
James Smith
Reza Soltani
Gary Stoedter
Gregory Stone
James Timperley
Remi Tremblay
John Vergis
Yingli Wen
Kenneth White
Roger Wicks
James Wilson
Larry Yonce
Jian Yu
Hugh Zhu

When the IEEE-SA Standards Board approved this recommended practice on 11 December 2013 it had the following membership:

John Kulick, *Chair*
David J. Law, *Vice-chair*
Richard H. Hulett, *Past Chair*
Konstantinos Karachalios, *Secretary*

Masayuki Ariyoshi
Peter Balma
Farooq Bari
Ted Burse
Stephen Dukes
Jean-Phillippe Faure
Alexander Gelman
Mark Halpin
Gary Hoffman
Paul Houzé
Jim Hughes
Michael Janezic
Joseph L. Koepfinger*
Oleg Logvinov
Ron Peterson
Gary Robinson
Jon Walter Rosdahl
Adrian Stephens
Peter Sutherland
Yatin Trivedi
Phil Winston
Yu Yuan

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Richard DeBlasio, *DOE Representative*
Michael Janezic, *NIST Representative*

Michelle Turner
IEEE Standards Program Manager, Document Development

Malia Zaman
IEEE Standards Program Manager, Technical Program Development

Introduction

This introduction is not part of IEEE Std 43™-2013, IEEE Recommended Practice for Testing Insulation Resistance of Electric Machinery.

Insulation resistance measurement has been recommended and used for more than half a century to evaluate the condition of electrical insulation. Whereas individual insulation resistance measurements may be of questionable value, the carefully maintained record of periodic measurements, accumulated over months and years of service, is of unquestioned value as a measure of some aspects of the condition of the electrical insulation. Originally, in 1950, this recommended practice was published by the AIEE as a guide to present the various facets associated with the measurement and understanding of electrical insulation resistance. The guide was revised in 1961 and again in 1974. During the 1970s, several changes were made to the types of insulation used in electric rotating machines. The insulation resistance characteristics of these newer THERMOSETTING insulation systems are different from the older THERMOPLASTIC systems, and therefore required this substantial revision to the standard for measuring insulation resistance. Other changes include the addition of further description of the testing theory and the removal of suggestions regarding maintenance dry-out procedures for older windings (previously Annex A). Recommendations for maintenance procedures are beyond the scope of this document. With this publication as a recommended practice, the IEEE is presenting and recommending electrical insulation resistance measurement as an important factor in monitoring the condition of electrical insulation in rotating machinery.

This recommended practice describes the theory, procedure, and interpretation of the insulation resistance test. It is intended for the following:

- Individuals or organizations who manufacture rotating machines
- Individuals or organizations who are responsible for the acceptance of new rotating machines
- Individuals or organizations who test and maintain rotating machines
- Individuals or organizations who operate rotating machines

This recommended practice is designed to help organizations and individuals

- Evaluate the condition of the electrical insulation used in rotating machines
- Determine if the electrical insulation of a rotating machine is suitable for return-to-service
- Determine if the electrical insulation of a rotating machine is suitable for high-potential testing

This recommended practice is intended to satisfy the following objectives:

- Promote consistency for insulation test procedures and interpretations
- Provide useful information on proper application of the insulation resistance test
- Provide useful information on the technical theory of insulation resistance testing

Contents

IEEE Recommended Practice for Testing Insulation Resistance of Electric Machinery

1. Overview

1.1 Scope

This document describes a recommended procedure for measuring insulation resistance of armature and field windings in rotating machines rated 750 W or greater. It applies to synchronous machines, induction machines, dc machines, and synchronous condensers. It does not apply to fractional-horsepower machines.

The document also describes typical insulation resistance characteristics of rotating machine windings and how these characteristics indicate winding condition. It recommends minimum acceptable values of insulation resistance for ac and dc rotating machine windings.

Other IEEE standards that include information on insulation resistance measurement are listed in Clause 2.