IEEE STANDARDS ASSOCIATION

IEEE Guide for Moisture Measurement and Control in SF_6 Gas-Insulated Equipment

IEEE Power and Energy Society

Sponsored by the
Substations Committee

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

IEEE Std C37.122.5™-2013
(Revision of
IEEE Std 1125™-1993)

IEEE Std C37.122.5™-2013
(Revision of
IEEE Std 1125™-1993)

IEEE Guide for Moisture Measurement and Control in SF_6 Gas-Insulated Equipment

Sponsor

Substations Committee
of the
IEEE Power and Energy Society

Approved 31 October 2013

IEEE-SA Standards Board

Grateful Acknowledgements: Thanks to CEATI International for permission to use Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Table 1, and Table 2 in this guide.

Abstract: Guidelines for moisture level measurement, moisture data interpretation, and moisture control in gas-insulated switchgear (GIS) are provided.

Keywords: circuit breakers, gas-insulated substation, gas-insulated switchgear, GIS, GIS design, GIS equipment, GIS installation, GIS testing, IEEE 1125™, IEEE C37.122.5™, moisture measurement, SF_6, SF_6 analysis, SF_6 handling, sulfur hexafluoride

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

PDF: ISBN 978-0-7381-8760-0 STD98462
Print: ISBN 978-0-7381-8761-7 STDPD98462

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 guide was completed, the K8 Working Group had the following membership:

David F. Giegel, *Chair*
Brian Withers, *Vice Chair*

John Boggess
Philip Bolin
Ravi Dhara
Matt Dunn
Markus Etter
John Eastman
Arnaud Ficheux
Patrick Fitzgerald
Noboru Fujimoto
Peter Grossman
Charles L. Hand
Bob Hardy
Gregory Harquail
Hermann Koch
Steve Laberge
Robert Laverne
David Lin
Jorge Marquez
James Massura
Daniel Mutter
Lukas Rothlisberger
Scott Rummans
Alex Salinas
Devki Sharma
David Solhtalab
Ryan Stone
Ronald Wampole
Ian Wylie
Russ Yeckley

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

Ficheux Arnaud
Arun Arora
Senthil Kumar Asok Kumar
Peter Balma
George Becker
Wallace Binder
Frank Blalock
William Bloethe
Anne Bosma
Eldridge Byron
Paul Cardinal
Robert Christman
Gary Donner
Randall Dotson
Denis Dufournet
Edgar Dullni
Donald Dunn
Patrick Fitzgerald
Doaa Galal
Frank Gerleve
David F. Giegel
Randall Groves
Charles Hand
John Harley
David Harris
Gary Heuston
Werner Hoelzl
Andrew Jones
Laszlo Kadar
Gael Kennedy
James Kinney
Hermann Koch
Joseph L. Koepfinger
Jim Kulchisky
Chung-Yiu Lam
Michael Lauxman
Hua Liu
Jorge Marquez
Georges Montillet
Michael Newman
Charles Ngethe
Lorraine Padden
Larry Putman
Michael Roberts
Oleg Roizman
Jesse Rorabaugh
Bartien Sayogo
Devki Sharma
James Smith
David Solhtalab
John Spare
Gary Stoedter
James Swank
John Vergis
Jane Verner
Mark Waldron
Kenneth White
James Wilson
Brian Withers
Xi Zhu

When the IEEE-SA Standards Board approved this guide on 31 October 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
Wael William Diab
Stephen Dukes
Jean-Philippe Faure
Alexander Gelman
Mark Halpin
Gary Hoffman
Paul Houzé
Jim Hughes
Michael Janezic
Joseph L. Koepfinger*
Oleg Logvinov
Ron Petersen
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

Erin Spiewak
IEEE Standards Program Manager, Technical Program Development

Introduction

This introduction is not part of IEEE Std C37.122.5™-2013, IEEE Guide for Moisture Measurement and Control in SF6 Gas-Insulated Equipment.

The objectives of this guide are to introduce the importance of moisture and control in the design, manufacture, installation, operation and maintenance of transmission class gas-insulated switchgear and to provide guidance for measurements of moisture in gas-insulated switchgear.

Contents

IEEE Guide for Moisture Measurement and Control in SF_6 Gas-Insulated Equipment

1. Overview

1.1 General

Moisture measurement (in the form of humidity) and control constitute a major part of an effective commissioning and maintenance program for gas-insulated substations (GIS) and other SF_6 gas-insulated equipment (GIE). Note that the term GIS is used throughout this guide as a simplified term, but is also meant to include other types of GIE as applicable. There are two separate and distinct issues relating to moisture within GIS:

a) Very high levels of humidity increase the possibility that water molecules will condense into the liquid phase, adversely affecting the dielectric withstand strength of GIS [B14][1] and significantly increasing the possibility of flashover. Therefore, humidity in GIS should be maintained at a level such that the humidity does not condense in the form of liquid water over the entire range of the expected operating temperatures and gas pressures.

b) The formation of corrosive and toxic decomposition by-products occurs in reactions between moisture and dissociated SF_6 found in the high energy arcs during normal switching operations. Higher concentrations of humidity can result in higher concentrations of decomposition by-products [B3]. These by-products cause corrosion and may degrade insulators and other internal components within the GIS, and pose a safety hazard.

[1] The numbers in brackets correspond with those in Annex B.