

IEEE Standard for High Voltage Gas-Insulated Substations Rated Above 52 kV

IEEE Power & Energy Society

Sponsored by the
Substations and Switchgear Committees

IEEE
3 Park Avenue
New York, NY 10016-5997
U.S.A.

IEEE Std C37.122™-2010
(Revision of
IEEE Std C37.122-1993)

21 January 2011

Currently in preview, click buy full version

IEEE Standard for High Voltage Gas-Insulated Substations Rated Above 52 kV

Sponsor

**Substations and Switchgear Committees
of the
IEEE Power & Energy Society**

Approved 30 September 2010

IEEE-SA Standards Board

Abstract: The technical requirements for the design, fabrication, testing, and installation of a gas-insulated substations are covered. The parameters to be supplied by the purchaser are set, and the technical requirements for the design, fabrication, testing, and installation details to be furnished by the manufacturer are established.

Keywords: IEEE C37.122, gas-insulated metal enclosed switchgear, gas-insulated substation, gas-insulated switchgear, GIS, GIS design, GIS equipment, GIS installation, GIS testing, SF₆, sulfur hexafluoride

The IEEE thanks the International Electrotechnical Commission (IEC) for permission to reproduce information from its International Standards IEC 60517 ed 3.0 (1990), IEC 62271-1 ed 1.0 (2007), IEC 62271-102 ed 1.0 (2001), and IEC 62271-203 ed 1.0 (2003). All such extracts are copyright of IEC, Geneva, Switzerland. All rights reserved. Further information on the IEC is available from www.iec.ch. IEC has no responsibility for the placement and context in which the extracts are reproduced by the author, nor is IEC in any way responsible for the other content or accuracy therein.

IEC 60517: Subclause: 6.108.

IEC 62271-1: Subclauses: 5.6, 5.17, 5.101, 5.102, 6.2.3, 6.2.4, 6.2.5, 6.10.6, and 7.2.

IEC 62271-102: Subclauses: 6.103, Annexes A, B, C, D, E, and F.

IEC 62271-203: Subclauses: 5.3.101, 5.3.102, 5.3.104, 6.2.3.101, 6.2.9.103, 6.6.1, 6.6.101, 6.6.102, 6.8, 6.101, 6.102, 6.103, 6.104, 6.105, 7.1, 7.101, 7.102, 7.103, 7.104, 10.2, and Annex A.

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

Copyright © 2011 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 21 January 2011. Printed in the United States of America.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-0-7381-6464-9 STD97020
Print: ISBN 978-0-7381-6465-6 STDPD97020

IEEE prohibits discrimination, harassment, and bullying. For more information, visit <http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html>. No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the 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.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.

The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied "AS IS."

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. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation, or every ten years for stabilization. When a document is more than five years old and has not been reaffirmed, or more than ten years old and has not been stabilized, 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 publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon his or her 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.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretation is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received 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 interpretation requests except in those cases where the matter has previously received formal consideration. A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered the official position of IEEE or any of its committees and shall not be considered to be, nor be relied upon as, a formal interpretation of the 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, explanation, or interpretation of the IEEE.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Recommendations to change the status of a stabilized standard should include a rationale as to why revision or withdrawal is required. Comments and recommendations on standards, and requests for interpretation, should be addressed to:

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

Authorization to photocopy portions of any individual standard for internal or personal use is granted by The Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, 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.

Introduction

This introduction is not part of IEEE Std C37.122-2010, IEEE Standard for High Voltage Gas-Insulated Substations Rated Above 52 kV.

IEEE Std C37.122-1983 was initiated in the early 1970s when the first gas-insulated substations were introduced. The reliability of gas-insulated substations has improved greatly since the first installation in the late 1960s. Utilities have taken advantage of the greater flexibility offered by gas-insulated substations to locate substations closer to load centers with considerable savings in sub-transmission systems costs and reduced system losses. In addition, gas-insulated substations typically offer 25 to 30 years or more of operation before major overhaul is required. To address IEEE policy that IEEE standards should be harmonized with international standards whenever possible a study was conducted by a joint task force of the Substations Committee and IEC. This included a comparison of IEEE and IEC gas-insulated switchgear standards. The recommendations of that task force and joint working group were a series of recommendations to modify both IEEE and IEC gas-insulated switchgear standards to move toward harmonization. This document is a step in that process.

Notice to users

Laws and regulations

Users of these documents should consult all applicable laws and regulations. Compliance with the provisions of this standard does not imply compliance with 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

This document is copyrighted by the IEEE and made available for a wide variety of both public and private uses. These include both use, with reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making this document available for use and adoption by public authorities and private users, the IEEE does not waive any rights in copyright to this document.

Updating of IEEE documents

Users of IEEE standards 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. 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 Standards Association web site at <http://ieeexplore.ieee.org/xpl/standards.jsp>, or contact the IEEE at the address listed previously.

For more information about the IEEE Standards Association or the IEEE standards development process, visit the IEEE-SA web site at <http://standards.ieee.org>.

Errata

Errata, if any, for this and all other standards can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/updates/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Interpretations

Current interpretations can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/interp/index.html>.

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 with respect to the existence or validity of any patent rights in connection therewith. 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 standard was submitted to the IEEE-SA Standards Board for approval, the High Voltage Gas-Insulated Substation Working Group had the following membership:

John H. Brunke, *Chair*

Ryan Stone, *Vice Chair*

Arun Arora
Paul Barnett
George Becker
Philip Bolin
Markus Etter
Arnaud Ficheux
Patrick Fitzgerald

Noboru Fujimoto
David F. Giegel
Peter Grossmann
Charles L. Hand
Robert Jeanjean
Hermann Koch
Jorge Marquez
Venkatesh Minisandram

Jeffrey Nelson
T. W. Olsen
Darin Penner
Devki Sharma
David Solhtalab
Brian Withers
Peter Wong

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

William J. Ackerman
S. Aggarwal
Michael Anderson
Ficheux Arnaud
Stan Arnot
Arun Arora
Thomas Barnes
G. Bartok
George Becker
W. J. Bill Bergman
Wallace Binder
William Bloethe
Steven Brockschink
John H. Brunke
Eldridge Byron
Chih Chow
Jerry Corkran
Gary Donner
Michael Dood
Randall Dotson
Denis Dufournet
Edgar Dullni
Donald Dunn
Kenneth Edward
Gary Engmann
Markus Etter
James Fairris
Patrick Fitzgerald
David Giegel
Tietek Ginkowski

Jalal Gohari
Edwin Goodwin
James Graham
Randall Groves
Paul Hamer
Charles L. Hand
David Harris
Helmut Heiermeier
Steven Hensley
Lee Herron
Gary Heuston
Scott Hietala
Andrew Jones
Richard Keil
Ramesh Chandra Ketharaju
Hermann Koch
Joseph L. Koepfinger
Jim Kulchisky
Chung-Yiu Lam
Stephen Lambert
Hua Liu
Albert Livshitz
G. Luri
Jorge Marquez
William McBride
Daleep Mohla
Georges Montillet
Kimberly Mosley
Dennis Neitzel
Jeffrey Nelson
Michael S. Newman
T. W. Olsen

David Peelo
Darin Penner
Christopher Petrola
Anthony Picagli
John Randolph
Michael Roberts
Tim Rohrer
Anne-Marie Sahazizian
Bartien Sayogo
Dennis Schlender
Hamidreza Sharifnia
Devki Sharma
Gil Shultz
Hyeong Sim
James Smith
Jerry Smith
John Spare
Ralph Stell
Gary Stoedter
Ryan Stone
David Tepen
John Toth
Eric Udren
John Vergis
Waldemar Von Miller
Loren Wagenaar
Kenneth White
Thomas Wier
James Wilson
Brian Withers
Richard York

When the IEEE-SA Standards Board approved this standard on 30 September 2010, it had the following membership:

Robert M. Grow, *Chair*
Richard H. Hulett, *Vice Chair*
Steve M. Mills, *Past Chair*
Judith Gorman, *Secretary*

Karen Bartleson
Victor Berman
Ted Burse
Clint Chaplin
Andy Drozd
Alexander Gelman
Jim Hughes

Young Kyun Kim
Joseph L. Koepfinger*
John Kulick
David J. Law
Hung Ling
Oleg Logvinov
Ted Olsen
Ronald C. Petersen

Thomas Prevost
Jon Walter Rosdahl
Sam Sciacca
Mike Seavey
Curtis Siller
Don Wright

*Member Emeritus

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

Satish Aggarwal, *NRC Representative*
Richard DeBlasio, *DOE Representative*
Michael Janezic, *NIST Representative*

Don Messina
IEEE Standards Program Manager, Document Development

Soo Kim
IEEE Standards Program Manager, Technical Program Development

Contents

1. Overview	1
1.1 Scope	1
1.2 Normative references.....	1
2. Normal (usual) and special (unusual) service conditions	4
2.1 Normal (usual) service conditions	4
2.2 Special (unusual) service conditions for both indoor and outdoor switchgear	4
3. Definitions.....	5
4. Ratings.....	7
4.1 Rated maximum voltage (V) or (U_r)	8
4.2 Rated insulation level (U_b , U_s , U_p).....	8
4.3 Rated power frequency (f_r)	10
4.4 Rated continuous (normal) current and temperature rise.....	10
4.5 Rated short-time withstand current (I_k).....	11
4.6 Rated peak withstand current (I_p)	11
4.7 Rated duration of short-circuit (t_k).....	11
4.8 Rated supply voltage of closing and opening devices and of auxiliary and control circuits (U_a).....	11
4.9 Rated supply frequency of closing and opening devices and of auxiliary and control circuits	11
4.10 Rated bus-transfer voltage and current	11
4.11 Rated induced current and voltage for grounding switches.....	12
4.12 Rated short-circuit making current for grounding switches.....	13
5. Design and construction	13
5.1 Requirements for liquid in switchgear.....	14
5.2 Requirements for gases in switchgear	14
5.3 Grounding and bonding of switchgear.....	14
5.4 Auxiliary and control equipment.....	15
5.5 Dependent power operation.....	15
5.6 Stored energy.....	15
5.7 Independent manual operation	15
5.8 Operation of releases	15
5.9 Low- and high-pressure interlocking and monitoring devices.....	16
5.10 Nameplates	16
5.11 Interlocking devices.....	21
5.12 Position indicators.....	22
5.13 Degree of protection of enclosures.....	22
5.14 Creepage distance for outdoor insulators.....	22
5.15 Gas and vacuum tightness	22
5.16 Liquid tightness (insulating medium)	22
5.17 Flammability.....	22
5.18 Electromagnetic compatibility (EMC).....	22
5.19 X-ray emission.....	22
5.20 Design of pressurized enclosures.....	22
5.21 Access for operations and maintenance.....	25
5.22 Bus expansion joints.....	25
5.23 Insulators, partitions, gas pass through insulators, and operating rods.....	26
5.24 Partitioning	27
5.25 Interfaces	27
5.26 Seismic requirements.....	28
5.27 High-voltage circuit breakers.....	28

5.28 Disconnect switches	28
5.29 Grounding switches	29
6. Design tests (type tests)	30
6.1 General	30
6.2 Dielectric tests	33
6.3 Radio influence voltage (RIV) test	38
6.4 Measurement of resistance of circuits	38
6.5 Temperature rise tests (continuous current test)	38
6.6 Short-time withstand current and peak withstand current tests	39
6.7 Verification of the degrees of protection provided by enclosures	40
6.8 Tightness test	40
6.9 Electromagnetic compatibility tests	40
6.10 Verification of making and breaking capacities	40
6.11 Mechanical and environmental tests	41
6.12 Pressure test on partitions	43
6.13 Test under conditions of arcing due to an internal fault	43
6.14 Insulator tests	43
6.15 Circuit breaker design tests	44
6.16 Fault-making capability test for high-speed grounding switches	44
6.17 Interrupting tests—bus-transfer current switching capability for disconnect switches (special duty only)	45
6.18 Interrupting tests—switching of bus charging currents by disconnect switches	45
6.19 Interrupting tests—induced current switching of grounding switches	48
6.20 Mechanical tests for disconnect and grounding switches	50
6.21 Operation at the temperature limits for outdoor equipment (if required by user)	50
6.22 Operation under severe ice conditions	51
7. Routine testing	53
7.1 Dielectric test of main circuit	53
7.2 Tests on auxiliary and control circuits	53
7.3 Measurement of the resistance of the main circuit	54
7.4 Tightness tests	54
7.5 Pressure tests of enclosures	54
7.6 Mechanical operation tests	55
7.7 Tests on auxiliary circuits, equipment, and interlocks in the control mechanism	55
7.8 Pressure test on partitions	55
8. Gas handling	55
9. Field testing	55
9.1 Mechanical tests: leakage	56
9.2 Mechanical tests: gas quality (moisture, purity, and density)	56
9.3 Electrical tests: continuity, conductivity, and resistivity	56
9.4 Electrical tests: low frequency ac voltage withstand	56
9.5 Electrical tests: low frequency ac voltage withstand requirements and conditions	57
9.6 Electrical tests: low frequency ac voltage withstand configurations and applications	57
9.7 Electrical tests: dc voltage withstand tests	58
9.8 Electrical tests: assessment of the ac voltage withstand test	58
9.9 Electrical tests: tests on auxiliary circuits	58
9.10 Mechanical and electrical functional tests: checks and verifications	58
9.11 Mechanical and electrical tests: documentation	59

Annex A (normative) Switch testing procedures.....	60
A.1 Bus-transfer making and breaking tests.....	60
A.2 Switching of bus charging currents by disconnect switches 72.5 kV and above.....	62
A.3 Induced current switching of grounding switches	66
A.4 Tests on the power kinematic chain.....	71
A.5 Test on the position-indicating kinematic chain	73

IEEE Standard for High Voltage Gas-Insulated Substations Rated Above 52 kV

IMPORTANT NOTICE: This standard is not intended to ensure safety, security, health, or environmental protection. Implementers of the standard are responsible for determining appropriate safety, security, environmental, and health practices or regulatory requirements.

This IEEE document is made available for use subject important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading “Important Notice” or “Important Notices and Disclaimers Concerning IEEE Documents.” They can also be obtained on request from IEEE or viewed at <http://standards.ieee.org/IPR/disclaimers.html>.

1. Overview

1.1 Scope

This standard establishes ratings and requirements for planning, design, testing, installation, and operation of gas-insulated substations for alternating-current applications above 52 kV. Typical installations are assemblies of specialized devices such as circuit breakers, switches, bushings, buses, instrument transformers, cable terminations, instrumentation and controls, and the gas-insulating system. It does not include certain items that may be directly connected to gas-insulated substations, such as power transformers and protective relaying. This standard does not apply to gas-insulated transmission lines.

1.2 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.

ANSI/ASME Boiler and Pressure Vessel Code, Section VIII: Pressure Vessels, Division 1. ^{1 2}

¹ANSI Standards are available from the American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

² The IEEE standards or products referred to in Clause 2 are trademarks owned by the Institute of Electrical and Electronics Engineers, Incorporated.