IEEE STANDARDS ASSOCIATION

IEEE Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems

IEEE Power and Energy Society

Developed by the
Switchgear Committee

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

IEEE Std C37.20.9™-2019

IEEE Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems

Developed by

Switchgear Committee
of the
IEEE Power and Energy Society

Approved 21 March 2019

IEEE-SA Standards Board

Abstract: Metal-enclosed switchgear assemblies incorporating gas insulating systems containing, but not limited to, such devices as interrupter switches; selector switches; fuses; circuit breakers; control, instrumentation, and metering devices; and protective equipment are covered in this standard. Equipment for the control and protection of apparatus used for distribution of electrical power is also included, but not specifically limited to, in this standard.

Keywords: IEEE C37.20.9™, metal-enclosed power switchgear, metal-enclosed switchgear incorporating gas insulating systems (MEGIS), switchgear, switchgear assembly

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

PDF: ISBN 978-1-5044-5685-2 STD23627
Print: ISBN 978-1-5044-5686-9 STDPD23627

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 https://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.

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 the IEEE Xplore at https://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 https://standards.ieee.or.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: https://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 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 standard was submitted to the IEEE-SA Standards Board for approval, the IEEE Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems Working Group had the following membership:

Eldridge R. Byron, *Chair*
George Becker, *Vice Chair*
Terrance Woodyard, *Co-Secretary Switchgear*
Steven Scott Scharf, *Co-Secretary Substations*

Charles Ball
Paul Barnhart
Diego Berenguela
Russell Boyce
Jim Bowen
Ted Burse
Vincent Chiodo
Michael Colesanti
Patrick Dillilo
Edgar Dullni
Douglas J. Edwards
Donald Elliott
Sergio Flores
Robert Foster
Douglas Giraud
Peter Glaesman
Sahadev Gohil
Jared Hines
Allan Jacobs
Wolfgang Jung
Hermann Koch
Hua Liu
Albert Livshitz
Deepak Mazumdar
Steven Meiners
David Mitchell
Thomas Mulcahy
Terry Neighboros
T. W. Olsen
Miklos Orosz
Rahul Pawar
Ahmat Qasem
Lukas Rothlisberger
Carl Schneider
Devki Sharma
John Shullaw
Michael Skidmore
Chand Tailor
Michael Wactor
Robert Warren
Eddie Wilkie
Xi Zhu

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

Charles Ball
Radoslav Barac
Paul Barnhart
George Becker
David Beseda
Steven Bezner
Wallace Binder
Russell Boyce
Chris Brooks
Demetrio Bucaneg Jr.
Ted Burse
Eldridge R. Byron
Paul Cardinal
Nancy Chilton
Michael Chirico
Robert Cohn
Randall Crellin
Glenn Davis
Gary Donner
Louis Doucet
Edgar Dullni
Donald Dunn
Douglas J. Edwards
Markus Etter
Sergio Flores
Robert Foster
David Giegel
Paul Gingrich
Douglas Giraud
Mietek Glinkowski
James Graham
J. Travis Griffith
Randall Groves
John Harley
Jeffrey Helzer
Jared Hines
Werner Hoelzl
Richard Jackson
Rahul Jain
Jose Jarque
Joseph Jasinski
Wolfgang Jung
Laszlo Kadar
John Kaminski
Yuri Khersonsky
James Kinney
Boris Kogan
Jim Kulchisky
Mikhail Lagoda
Chung-Yiu Lam
William Larzelere
John Leach
Hua Liu
Albert Livshitz
Reginaldo Maniego
Frank Mayle
William McBride
Steven Meiners
David Mitchell
Daleep Mohla
Charles Morse
Thomas Mulcahy
Michael Newman
Michael Novev
T. W. Olsen
Lorraine Padden
Branimir Petosic
Christopher Petrola
Anthony Picagli
Craig Preuss
Iulian Profir
Anthony Ricciuti
Jesse Rorabaugh
Charles Ross
Thomas Rozek
Ryandi Ryandi
Bartien Sayogo
Robert Seitz
Nikunj Shah
Devki Sharma
John Shullaw
Vinod Simha
Garett Sims
James Smith

Jeremy Smith
Jerry Smith
Philip Spotts
Ralph Stell
K. Stump
Paul Sullivan
C. Tailor
David Tepen
Dennis Thonsgard
Francois Trichon
Marcelo Valdes
James Van De Ligt
John Vergis
William Walter
John Webb
Kenneth White
Matthew Williford
Terrance Woodyard
Robert Yanniello
Matthew Zeedyk
Xi Zhu

When the IEEE-SA Standards Board approved this standard on 21 March 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
Thomas Koshy
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 Zho

*Member Emeritus

Introduction

This introduction is not part of IEEE Std C37.20.9-2019, IEEE Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems.

This standard provides the requirements for switchgear that incorporate gas (typically SF_6) at higher than ambient pressure as an insulation medium for alternating-current applications rated above 1 kV up to 52 kV. This standard recognizes the growing use of gas-insulated switchgear and is one of a series covering switchgear assemblies as follows (see Figure 1):

a) IEEE Std C37.20.2™, IEEE Standard for Metal-Clad Switchgear[1]

b) IEEE Std C37.20.3™, IEEE Standard for Metal-Enclosed Interrupter Switchgear (1 kV to 38 kV)

c) IEEE Std C37.20.4™, IEEE Standard for Indoor AC Switches (1 kV to 38 kV) for Use in Metal-Enclosed Switchgear

d) IEEE Std C37.20.6™-2015, IEEE Standard for 4.76 kV to 38 kV Rated Ground and Test Devices Used in Enclosures [B33][2]

e) IEEE Std C37.20.1™-2015, IEEE Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear [B32]

f) IEEE Std C37.20.9™-2019, IEEE Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems (this standard)

g) IEEE Std C37.21™-2017, IEEE Standard for Control Switchboards [B34]

h) IEEE Std C37.23™-2015, IEEE Standard for Metal-Enclosed Bus [B35]

[1]Information on references can be found in Clause 2.
[2]The numbers in brackets correspond to those of the bibliography in Annex K.

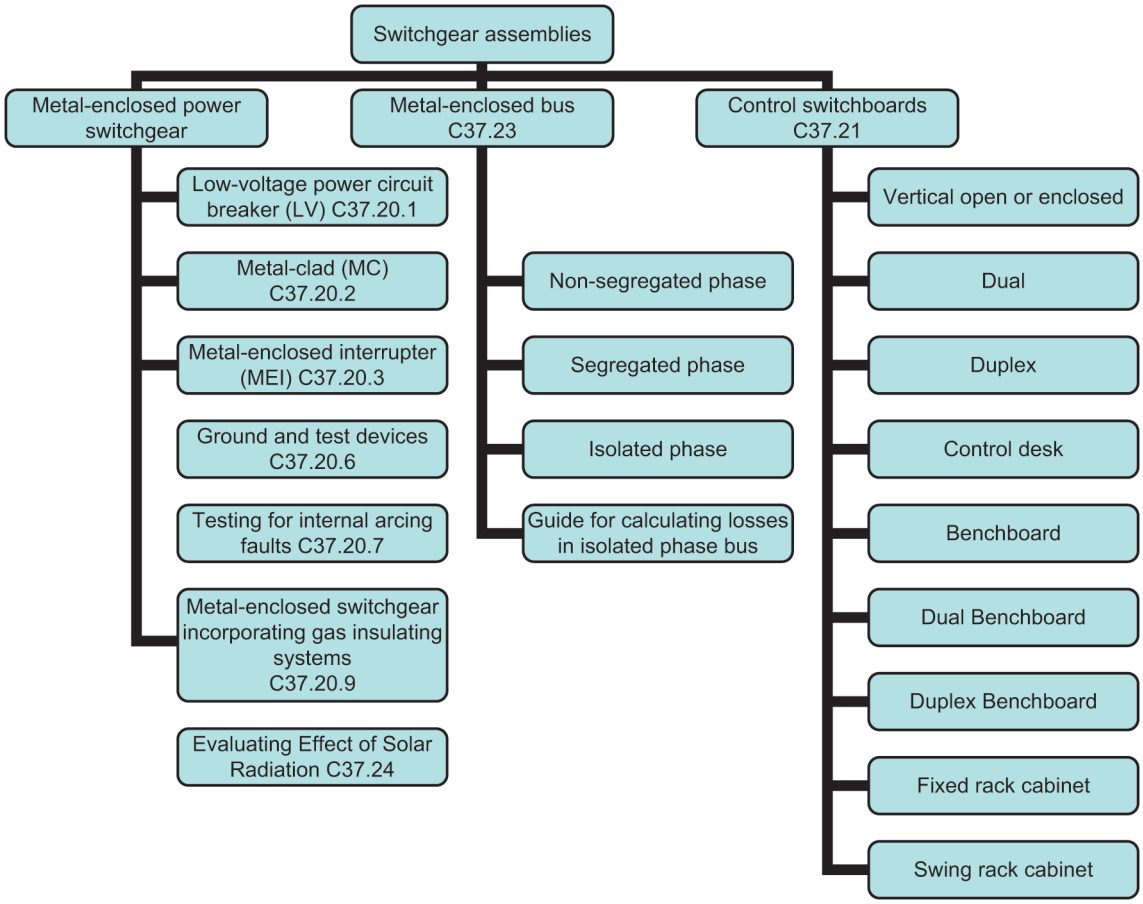

Figure 1—Publications about switchgear assemblies

There was much discussion about voltage transformer protection during the development of this document. The agreement was made to require primary fuse protection for the transformer based mainly on the National Electric Code® (NEC®) requirement. Similar IEC documents do not have a requirement for fuses. Many IEC-based MV and HV designs do not use fuses and have decades of installed service. The debate has been whether the fuse protects the system when the transformer fails or whether the transformer is protected by the fuse. The first position indicates that higher performances from and reliability of the transformers are needed. The second position suggests that investigations into both the transformers and the fuses used are needed. As the primary voltage increases, the ability of the fuse to protect the transformer is reduced. This is because the primary wire used inside some voltage transformers may melt before the primary fuse interrupts the circuit. Some internal transformer and secondary faults are also not protected by primary fuses. Work will be conducted in the future with the National Fire Protection Association (NFPA) and the transformer committee in an attempt to address these issues.

SF_6 is recognized worldwide as having a very high global warming potential (GWP) of 22 800 years (as benchmarked with the 1.0-GWP value of CO_2 gas); thus, other gases are currently being developed and studied for use in metal-enclosed, gas-insulated switchgear (MEGIS) equipment. There is not a leading candidate for a replacement gas at this time; however, consideration and requirements for future gases have been included in this document.

Acknowledgments

The working group thanks the International Electrotechnical Commission (IEC) for permission to reproduce information from its International Standard IEC 62271-206 ed.1.0 (2011). 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 and contents are reproduced by the author, nor is IEC in any way responsible for the other content or accuracy therein.

Contents

IEEE Standard for Metal-Enclosed Switchgear Rated 1 kV to 52 kV Incorporating Gas Insulating Systems

1. Scope

This standard covers the design, testing, and installation of metal-enclosed switchgear that incorporates gas (typically SF_6) at higher than ambient pressure as an insulation medium for alternating-current applications rated above 1 kV to 52 kV. The contents of the switchgear may include but are not limited to circuit breakers, switches, bushings, buses, instrument transformers, cable terminations, instrumentation, metering and controls, and protective relays. In a vertical section of the switchgear, some or all of the medium-voltage compartment(s) shall be composed of a gas pressure system for the primary insulating medium. This standard covers both indoor and outdoor installations.

This standard covers switchgear using sealed pressure systems or closed pressure systems. Switchgear employing controlled pressure systems is not covered by this standard.

This standard also does not cover switchgear that is covered under IEEE Std C37.20.2™[3], IEEE Std C37.20.3™, or IEEE Std C37.74™-2014 [B38][4] that uses individual components that are gas-insulated such as switches, circuit breakers, and other equipment, nor does it fully cover those components that are covered by their individual component standards.

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.

Accredited Standards Committee C2, National Electrical Safety Code®(NESC®).[5,6]

ANSI (NEMA) C37.85, Alternating-Current High-Voltage Power Vacuum Interrupters—Safety Requirements for X-Radiation Limits.[7]

[3]Information on references can be found in Clause 2.
[4]The numbers in brackets correspond to those of the bibliography in Annex K.
[5]The NESC is available from The Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (https://standards.ieee.org/).
[6]National Electrical Safety Code and NESC are both registered trademarks and service marks of The Institute of Electrical and Electronics Engineers, Inc.
[7]ANSI publications are available from the American National Standards Institute (http://www.ansi.org/).