IEEE STANDARDS ASSOCIATION

IEEE Guide for Switchgear—Unit Substation—Requirements

IEEE Power and Energy Society

Sponsored by the
Switchgear Committee

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

22 February 2013

IEEE Std C37.121™-2012
(Revision of
IEEE Std C37.121-1989)

IEEE Std C37.121™-2012
(Revision of
IEEE Std C37.121-1989)

IEEE Guide for Switchgear—Unit Substation—Requirements

Sponsor

Switchgear Committee
of the
IEEE Power and Energy Society

Approved 5 December 2012

IEEE-SA Standards Board

Abstract: The basis for the coordination of equipment in unit substations by assisting in the selection of components is intended as the use of this guide. A variety of designs for unit substations are possible using various combinations of incoming sections, transformer sections, outgoing sections, and transition sections. It is intended that the incoming, outgoing, transformer, and transition sections included in a unit substation meet the basic requirements of applicable industry standards for those sections. This guide covers three-phase unit substations for step-down operation in the range of 112.5 kVA or greater at primary voltages of 601 V through 38 kV.

Keywords: control, dead-front switchboard, distribution, fuse, IEEE C37.121™, metal-clad switchgear, metal-enclosed switchgear, metering, mobile unit substation, molded-case circuit breaker, motor control center, power circuit breaker, primary unit substation, radial substation, rectifier-type substation, secondary selective substation, secondary unit substation, spot-network substation, substation, surge protection, switchgear, transformer, transition section, unit substation

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

PDF: ISBN 978-0-7381-8186-8 STD98116
Print: ISBN 978-0-7381-8187-5 STDPD98116

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 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

Updating of IEEE 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Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata.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. 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://standards.ieee.org/index.html or contact the IEEE at the address listed previously.

For more information about the IEEE Standards Association or the IEEE standards development process, visit IEEE-SA Website at http://standards.ieee.org/index.html.

Errata

Errata, if any, for this and all other standards can be accessed 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.

Introduction

This introduction is not part of IEEE Std C37.121-2012, IEEE Guide for Switchgear—Unit Substation—Requirements.

C37.121-1989 was originally developed by a working group sponsored by the Power Switchgear Assemblies Technical Committee of the Switchgear Section (8SG) of the National Electrical Manufacturers Association (NEMA/SG/5). The document was transferred from NEMA to the IEEE Power and Energy Society Switchgear Committee, Switchgear Assemblies Subcommittee, in January of 2003. IEEE Std C37.121 was reaffirmed by the IEEE Standards Association Standards Board in 2006.

The Switchgear Assemblies Subcommittee Task Force, created to review this document, determined that this document did not meet the intent of a standard as it references applicable IEEE Standards for all requirements that must be met by each component of a Unit Substation. Based on this review, the Task Force recommended that this document be changed from a Standard to a Guide. The recommendation was accepted by the Switchgear Assemblies Subcommittee.

In the revision of this document from a standard to a guide, the document has been revised to reflect needed technical changes and to update the reference documents to the latest revisions. Other significant changes are as follows:

- Subclauses 1.1 and 1.3 of IEEE Std C37.121-1989 have been combined to form the Scope and subclauses 1.2 and 1.4 have been combined to form the Purpose of the new document.
- Clause 2, Normative references, has been changed to remove dates and all informative standard references have been moved to Annex A.
- Clause 3, Definitions, has been arranged in alphabetical order.
- Table 1 has been redrawn and Table 2 through Table 5 have been combined into a new Table 2–Primary unit substation transformers and Table 3–Secondary unit substation transformers.
- Metal-enclosed bus as described in IEEE Std C37.23 has been added to Clause 6—Incoming section, Clause 7—Outgoing section, 11.2—Unusual service conditions, and 11.5.2—Loading guides.
- All of the existing referenced figures in Clause 6, Clause 7, and Clause 10 have been redrawn, and moved into their respective sections. Figures that had previously shown a fused and unfused figure have now been combined to show a figure with a fuse (when used) designation.
- Clause 8, Ratings, has been updated to reflect the latest rating names and definitions.

Participants

At the time this guide was submitted to the IEEE-SA Standards Board for approval, the C37.121 Working Group had the following membership:

James Smith, *Chair*
Douglas Edwards, *Vice-Chair*

P. Barnett
Paul Barnhart
J. Baskins
Ted Burse
L. Farr
M. Flack
Keith Flowers
S. Gohil
D. Hrncir
A. Jivanani
Harry Josten
M. Lafond
D. Lemmerman
A. Livshitz
D. Mazumdar
S. Meiners
A. Morgan
Charles Morse
Ted Olsen
R. Parthasarathi
A. Patel
P. Sullivan
C. Tailor
J. Toney

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

William Ackerman
Peter Balma
Paul Barnhart
Robert Beavers
George Becker
Steven Bezner
Wallace Binder
Ted Burse
William Bush
William Byrd
Stephen Conrad
Gary Donner
Edgar Dullni
Douglas Edwards
Gary Engmann
Patrick Fitzgerald
Keith Flowers
Frank Gerleve
David Gilmer
Mietek Glinkowski
James Graham
Randall Groves
Timothy Hayden
Jeffrey Helzer
Gary Heuston
Scott Hietpas
Andrew Jones
Harry Josten
John Kay
Chad Kennedy
Yuri Khersonsky
Joseph L. Koepfinger
Jim Kulchisky
Saumen Kundu
Chung-Yiu Lam
Albert Livshitz
Frank Mayle
Kenneth McClenahan
Gary Michel
Georges Montillet
Charles Morse
Jerry Murphy
K. R. M. Nair
Dennis Neitzel
Arthur Neubauer
Michael S. Newman
Joe Nims
Ted Olsen
Lorraine Padden
Mirko Palazzo
Bansi Patel
Christopher Petrola
Iulian Profir
Robert Puckett
Reynaldo Ramos
John Roach
Michael Roberts
Thomas Rozek
Bartien Sayogo
Gil Shultz
Veselin Skendzic
James Smith
James Smith
Jeremy Smith
Jerry Smith
Gary Stoedter
James Swank
David Tepen
Wayne Timm
Joe Uchiyama
John Vergis
Yingli Wen
Kenneth White
Larry Yonce
Jian Yu

When the IEEE-SA Standards Board approved this guide on 5 December 2012, it had the following membership:

Richard H. Hulett, *Chair*
John Kulick, *Vice Chair*
Robert Grow, *Past Chair*
Konstantinos Karachalios, *Secretary*

Satish Aggarwal
Masayuki Ariyoshi
Peter Balma
William Bartley
Ted Burse
Clint Chaplin
Wael Diab
Jean-Philippe Faure
Alexander Gelman
Paul Houzé
Jim Hughes
Young Kyun Kim
Joseph L. Koepfinger*
David J. Law
Thomas Lee
Hung Ling
Oleg Logvinov
Ted Olsen
Gary Robinson
Jon Walter Rosdahl
Mike Seavey
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*

Catherine Berger
IEEE Standards Program Manager, Document Development

Erin Spiewak
IEEE Program Manager, Technical Program Development

Contents

IEEE Guide for Switchgear—Unit Substation—Requirements

1. Overview

1.1 Scope

This guide covers three-phase unit substations for step-down operation in the range of 112.5 kVA or greater at primary voltages of 601 V through 38 kV.

This guide does not cover the following installations:

a) Substations in which the transformer section includes load-tap-changing equipment.

b) Substations in which the transformer section is described and defined as "network," "subway," "vault," or "underground" in IEEE Std C57.12.24™ [B14] and IEEE Std C57.12.40™ [B18].

c) Substations in which the transformer section is described and defined as "pad-mounted" in ANSI C57.12.22 and IEEE Std C57.12.27™ [B16].

d) Gas-insulated substations as described in IEEE Std C37.122™ [B13].

e) Rectifier-type substations.

f) Mobile unit substations.

g) Installations in ships, watercraft, railway rolling stock, aircraft, or automotive vehicles.

h) Installations for mines.

i) Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock, or for installations used exclusively for signaling and railway communication purposes.

j) Installations of communication equipment that is under the exclusive control of communication utilities, located outdoors or in building spaces used exclusively for such installations.

k) Installations under the exclusive control of electric utilities for the purpose of communication, or metering; or for the generation, control, transformation, transmission, and distribution of electric energy located in buildings used exclusively by utilities for such purposes or located outdoors on property owned or leased by the utility or on public highways, streets, roads, etc; or outdoors by established rights on private property.

1.2 Purpose

The guide is intended for use as the basis for the coordination of equipment in unit substations by assisting in the selection of components. A variety of designs for unit substations are possible using various combinations of incoming sections, transformer sections, outgoing sections, and transition sections.

It is intended that the incoming, outgoing, transformer, and transition sections included in a unit substation shall meet the basic requirements of applicable industry standards for those sections. In addition, this guide provides suggested requirements when used as part of a unit substation.

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 C37.51, American National Standard for Switchgear—Metal-Enclosed Low-Voltage AC Power Circuit Breaker Switchgear Assemblies—Conformance Test Procedures.[1]

ANSI C84.1, American National Standard for Electric Power Systems and Equipment—Voltage Ratings (60 Hz).[2]

ANSI/UL 845, Motor Control Centers.[3]

ANSI/UL 891, Dead-Front Switchboards.

IEEE Std C37.010™, IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.[4, 5]

IEEE Std C37.20.1™, IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

[1]NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA. (http://global.ihs.com).

[2]ANSI publications are available from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org).

[3]UL Standards are available from Comm-2000, 1414 Brook Drive, Downers Grove, IL 60515, USA (http://www.comm-2000.com).

[4]IEEE publications are available from the Institute of Electrical and Electronic Engineers, Service Center, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://www.standards.ieee.org).

[5]The IEEE standards or products referred to in this clause are trademarks of the Institute of Electrical and Electronics Engineers, Inc.