

1215™

IEEE Guide for the Application of Separable Insulated Connectors

IEEE Power Engineering Society

Sponsored by the
Transmission & Distribution Committee



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

22 March 2002

Print: SH94953
PDF: SS94953

IEEE Guide for the Application of Separable Insulated Connectors

Sponsor
**Transmission & Distribution Committee
of the
IEEE Power Engineering Society**

Approved 30 January 2002
American National Standards Institute

Approved 10 October 2001
IEEE-SA Standards Board

Abstract: This guide provides general information on the application and operation of separable connectors. It is intended to be basic, and supplement the manufacturer's specific recommendations and established utility practices.

Keywords: connectors, power distribution, switchgear

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

Copyright © 2002 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 22 March 2002. Printed in the United States of America.

Print: ISBN 0-7381-3003-6 SH94953
PDF: ISBN 0-7381-3004-4 SS94953

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 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. When a document is more than five years old and has not been reaffirmed, 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 the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations 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.

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. Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
USA

Note: 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 shall not be responsible for identifying patents for which a license may be required by an IEEE standard or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

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 a part of IEEE Std 1215-2001, IEEE Guide for the Application of Separable Insulated Connectors.)

This document is the first IEEE guide issued that addresses the application and operation of separable insulated connectors. This application guide is the product of close collaboration between representatives of both users and manufacturers of separable connectors. The Separable Connectors Working Group of the Insulated Connector Committee provided valuable input to this guide.

This application guide is intended to be used in concert with ANSI/IEEE Std 386-1995,^a which defines the ratings, construction specifications, service conditions, and qualification tests for separable insulated connectors.

Participants

At the time this guide was completed, the Separable Connectors Working Group had the following membership:

Richard H. Arndt, *Chair*

Andrew Boatwright	Roy Jazowski	Orville Plum
Vince Boliver	Tom Kulas	Joe Rempe
Walker Brown	Joe Lapoint	Robert Resuali
Joe Buch	Michael Lynch	Ed Rogers
James J. Burke	John Makal	Frank Stepniak
Ray Capra	Dale Metzinger	Daniel J. Ward
Thomas Champion	David Mintz	Edward West
Massoud Ghaemi	Paul Orehek	Matt Williams
Harry Hayes	Ward Peterson	Sanford Yoder

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

Roy W. Alexander	George Gela	Robert C. Peters
R. Allen Bernstorff	Edwin J. Goodwin	Radhakrishna V. Rebbapragada
Gernot K. Brandt	Edward Jankowich	John Rumble
Kristine K. Buchholz	Ralph O. Jones	Donald R. Ruthman
James J. Burke	Nestor Kolcio	Donald Sandell
Frederick W. Burtelson	Gary L. Michel	Neil P. Schmidt
Frank A. Denbrock	Daleep C. Mohla	Roger A. Schoneman
John Farrington	Robert G. Oswald	Mohamed H. Shwehdi
Frank Ferracane	Carlos O. Peixoto	Daniel J. Ward

^aInformation on references can be found in Clause 2.

When the IEEE-SA Standards Board approved this standard on 10 October 2001, it had the following membership:

Donald N. Heirman, *Chair*
James T. Carlo, *Vice Chair*
Judith Gorman, *Secretary*

Satish K. Aggarwal
Mark D. Bowman
Gary R. Engmann
Harold E. Epstein
H. Landis Floyd
Jay Forster*
Howard M. Frazier
Ruben D. Garzon

James H. Gurney
Richard J. Holleman
Lowell G. Johnson
Robert J. Kennelly
Joseph L. Koepfinger*
Peter H. Lips
L. Bruce McClung
Daleep C. Mohla

James W. Moore
Robert F. Munzner
Ronald C. Petersen
Gerald H. Peterson
John B. Posey
Gary S. Robinson
Akio Tojo
Donald W. Zipse

*Member Emeritus

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

Alan Cookson, *NIST Representative*
Donald R. Volzka, *TAB Representative*

Savoula Amanatidis
IEEE Standards Managing Editor

Contents

1. Overview.....	1
1.1 Scope	1
2. References	1
3. Definitions	2
3.1 Cautions, notes, and warnings	2
3.2 Parts of a bushing	2
3.3 Parts of a bushing well.....	3
3.4 Parts of an elbow	3
3.5 Separable connectors.....	3
3.6 Tools	4
4. Design considerations	4
4.1 Systems	4
4.2 Environmental	7
5. Construction and installation.....	8
5.1 Use of loadbreak versus deadbreak	8
5.2 Grounding of components and shields	8
5.3 Lubrication.....	9
5.4 Tightening requirements.....	10
5.5 Elbow/bushing assembly	11
5.6 Compression lugs	11
5.7 Solvents	12
5.8 Cleanliness (avoiding contamination)	13
5.9 Cable training.....	15
5.10 Clearances for operation	15
5.11 Operator/bushing location	16
5.12 Stacking 600 A Tees	16

6. Operation	17
6.1 Use of loadbreak versus deadbreak	17
6.2 Deadbreak operating practices	17
6.3 Loadbreak operating practices.....	18
6.4 Capacitive test point	22
6.5 Switching.....	23
6.6 Fault duty	25
6.7 Use of accessories	26
6.8 Grounding accessories.....	29
6.9 Inspection of separable connectors.....	30
Annex A (informative) Bibliography	31

IEEE Guide for the Application of Separable Insulated Connectors

1. Overview

This guide covers the application of separable connectors—rated 601 V and above, 600 A or less—for use on power distribution systems. Included are design considerations and guidelines for the construction, installation, and operation of 200 A loadbreak connectors and for 200 A and 600 A deadbreak (non-loadbreak) connectors.

This guide is intended as a supplement to the training in high-voltage electrical equipment, established safe operating procedures, and the manufacturer's instructions for the application of separable insulated connectors. Installers and operators of separable connectors require formal training in the use of high-voltage electrical equipment. It is the user's responsibility to establish safe operating procedures and provide training. The manufacturers are required to provide installation and operating instructions for their products.

1.1 Scope

This guide provides general information on the application and operation of separable connectors. It is intended to be basic, and to supplement the manufacturer's specific recommendations and established utility practices.

2. References

This guide shall be used in conjunction with the following publications. If the following standards are superseded by an approved revision, the revision shall apply.

ANSI C2-1997, National Electrical Safety Code, American National Standards Institute.¹

ANSI/IEEE Std 386-1995, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.

¹ANSI 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/>).

ANSI/IEEE Std 516-1995, IEEE Guide for Maintenance Methods on Energized Power Lines.

ASTM F 855-1997, Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electrical Power Lines and Equipment.²

CFR 29 Part 1910.269, Occupational Safety and Health Standards—Electric Power Generation, Transmission, and Distribution.³

IEEE Std C62.22-1997, IEEE Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.⁴

NEMA CC 4-1986 (Reaff 1992), 8.3 kV and 8.3/14.4 kV Probe for Separable Insulated Loadbreak Connectors.⁵

NFPA 70-2002, National Electrical Code[®] (NEC[®]).⁶

3. Definitions

For the purposes of this Guide, the following terms and definitions apply. IEEE 100, *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition, [B1]⁷ should be referenced for terms not defined in this clause. Also refer to the definitions and terms listed in ANSI/IEEE Std 386-1995.

3.1 Cautions, notes, and warnings

3.1.1 caution: A potentially hazardous situation which, if not avoided, may result in minor or moderate injuries. It may also be used to alert against unsafe practices.

3.1.2 note: Provides additional information or explanation on a topic.

3.1.3 warning: A potentially hazardous situation which, if not avoided, could result in serious injury or death.

3.2 Parts of a bushing

3.2.1 bore: The inner channel of the bushing into which the elbow probe is inserted.

3.2.2 canister: The support tube that forms the inner wall of a bushing. In a loadbreak bushing, the piston slides along the wall of the canister during a fault-close operation.

3.2.3 finger contact: The female contact of a separable connector bushing into which the elbow probe is inserted to make an electrical connection.

²ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, USA (<http://www.astm.org/>).

³CFR publications are available from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082, USA (<http://www.access.gpo.gov/>).

⁴IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

⁵NEMA publications are available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>).

⁶The NEC is published by the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269, USA (<http://www.nfpa.org/>). Copies are also available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

⁷The numbers in brackets correspond to those of the bibliography in Annex A.

3.2.4 nose: The part of a loadbreak bushing constituting the elbow probe entrance. The nose section can include a plastic cap or valve assembly with O-ring seals on the exterior end of the bore. The locking ring on the bushing mating interface is also included.

3.2.5 piston: The movable contact assembly within a separable connector bushing that allows the snuffer tube and finger contact to move outward in the event of a fault-close operation. This contact is typically located near the bottom end of the snuffer tube. The finger contact is generally threaded into the piston. The piston contact slides on the metal canister that forms the internal wall of the bushing.

3.2.6 shoulder: The step at the base of the mating interface on the exterior surface of a bushing where the elbow cuff overlaps the bushing to provide a watertight seal.

3.2.7 snuffer tube: The tubular part of a loadbreak separable connector bushing into which the elbow probe is inserted. This tube contains both the arc quenching material essential for circuit interruption and the female part of the main current contact.

3.2.8 stop ring: A feature that limits the outward motion of the piston during fault-close operation of a bushing.

3.3 Parts of a bushing well

3.3.1 stud: A threaded metal rod located in the bushing well that mates into the base section of a bushing insert.

3.4 Parts of an elbow

3.4.1 arc follower: The polymeric tip on the apparatus end of a loadbreak elbow probe that decomposes when exposed to an electric arc. Decomposition of the arc follower material aids in cooling the arc and deionizing the hot gases produced during circuit interruption.

3.4.2 compression lug: The internal current carrying part of an elbow designed for the transition of the current path from the cable conductor to the probe.

3.4.3 housing: The molded polymer shell consisting of the insulation, insulation shield, and conductor shield of an elbow. The housing encloses the probe and compression lug.

3.4.4 probe: The male contact on an elbow or protective cap, typically in the form of a metal rod.

3.5 Separable connectors

3.5.1 component: An individual assembly within a separable connector system. Individual components of a separable connector system include: elbows, bushings, junctions, caps, bushing wells, plugs, etc.

3.5.2 mating interface: The surfaces on a separable connector that are designed to provide an interference fit between two parts of the connector system. Typically, these surfaces require application of a lubricant and form either rubber-to-rubber or rubber-to-nonelastomeric contacting surfaces.

3.5.3 part: A subassembly of a separable connector component. For example, the individual parts of an elbow (a type of separable connector component) include a molded polymer housing, a compression lug, and a probe.

3.5.4 types: Separable connectors are classified into three types; 200 A loadbreak, 200 A deadbreak, and 600 A deadbreak.

3.5.5 shipping cap: A plastic cover that is used during transport to prevent contamination of the mating interface and internal parts. A shipping cap is not designed for installation on an energized circuit.

3.6 Tools

3.6.1 live-line tool: An insulating tool, typically made of fiberglass, that is designed for use on, or in the vicinity of, high-voltage equipment. As used in the context of this standard, the live-line tool additionally provides a means of mechanically attaching to and locking onto the pulling eye of a separable connector and provides a means of transferring mechanical force between two or more points. Common names for live-line tools used to operate separable connectors include shotgun stick, switching stick, clamp stick, shotgun tool, etc.

3.6.2 probe wrench: A tool designed for use in installing the probe into the compression lug of an elbow. Some types include a mechanism for limiting the maximum torque applied during installation of the probe.

4. Design considerations

4.1 Systems

4.1.1 Underground distribution systems

Numerous types of distribution systems exist. In North America, the most common type of distribution system is the three-phase, four-wire multigrounded-neutral system. This system consists of three-phase conductors and a neutral conductor. The neutral conductor is grounded to earth at numerous locations. In most cases, the source supplying three-phase, four-wire distribution circuits is a wye-connected transformer with the neutral solidly connected to earth. Where the source is a delta-connected transformer, a grounding or zigzag transformer of sufficiently low impedance to limit the phase-to-ground voltages is also installed. To provide single-phase service, transformers are connected between one phase conductor and neutral.

Another distribution system is the three-phase, three-wire ungrounded system. This system consists of only three phase conductors. The source supplying these systems is either delta- or wye-connected transformers. To provide single-phase service, transformers are connected between two of the phases.

Continuous operating voltage across the separable connector is not to exceed the rated line-to-ground voltage.

4.1.2 Single-phase versus three-phase rating

Unlike cable voltage ratings, separable connector voltage ratings are based on the maximum line-to-ground voltage of the circuit and the maximum line-to-line voltage. Consequently, separable connectors are marked with either a single or a dual rating. For example, a separable connector with a single rating of 8.3 kV is suitable for use on single-phase circuits where the maximum phase-to-ground voltage is 8.3 kV or less. The single rating is the maximum voltage allowed across the connector insulation from the conductor to the insulation shield. Since the insulation shield is grounded, this is the maximum phase-to-ground voltage. Both deadbreak and loadbreak connectors can be single rated. For loadbreak connectors that are single rated, the normal recovery voltage across the contacts during a loadbreak operation cannot exceed the single rating (8.3 kV in the example). Consequently, loadbreak separable connectors with a single rating can be applied on single-phase circuits where the transformers are connected line-to-ground.

Only loadbreak separable connectors are dual rated because the second rating number is the maximum voltage that can appear across the contacts of a connector. These connectors are referred to as three-phase rated because they can withstand the higher voltage that will appear across the contacts when