IEEE 3000
STANDARDS COLLECTION®

IEEE 3004 STANDARDS:
PROTECTION & COORDINATION

IEEE Std 3004.7™-2021

Recommended Practice for Conductor Protection in Industrial and Commercial Power Systems

IEEE STANDARDS ASSOCIATION
IEEE

IEEE Recommended Practice for Conductor Protection in Industrial and Commercial Power Systems

Developed by the

Industrial and Commercial Power Systems Standards Development Committee
of the
IEEE Industry Applications Society

Approved 9 February 2021

IEEE SA Standards Board

Abstract: The protection of power cables used in industrial and commercial power systems is covered in this recommended practice. It is likely to be of greatest value to the power-oriented engineer with limited experience in the area of protection and control. It can also be an aid to all engineers responsible for the electrical design of industrial and commercial power systems.

Keywords: conductors, IEEE 3004.7™, overcurrent protection, power distribution protection, power system protection, wire

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

PDF: ISBN 978-1-5044-7401-6 STD24613
Print: ISBN 978-1-5044-7402-3 STDPD24613

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE Standards documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page (https://standards.ieee.org/ipr/disclaimers.html), appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning IEEE Standards Documents."

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through an accredited consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed by volunteers with scientific, academic, and industry-based expertise in technical working groups. Volunteers are not necessarily members of IEEE or IEEE SA, 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 completeness 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. In addition, IEEE does not warrant or represent that the use of the material contained in its standards is free from patent infringement. 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: THE NEED TO PROCURE 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 is 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, nor 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 the presenter's views should be considered the personal views of that individual rather than the formal position of IEEE, IEEE SA, the Standards Committee, or the Working Group.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE or IEEE SA. However, **IEEE does not provide interpretations, 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 evaluating comments or in revisions to an IEEE standard is welcome to join the relevant IEEE working group. You can indicate interest in a working group using the Interests tab in the Manage Profile and Interests area of the IEEE SA myProject system. An IEEE Account is needed to access the application.

Comments on standards should be submitted using the Contact Us form.

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 constitute 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.

Data privacy

Users of IEEE Standards documents should evaluate the standards for considerations of data privacy and data ownership in the context of assessing and using the standards in compliance with applicable laws and regulations.

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 licensing fees, 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; https://www.copyright.com/. 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 IEEE Xplore or contact IEEE. For more information about the IEEE SA or IEEE's standards development process, visit the IEEE SA Website.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE SA Website. Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Details section. Errata are also available in IEEE Xplore. Users are encouraged to periodically check for errata.

Patents

IEEE Standards are developed in compliance with the IEEE SA Patent Policy.

IMPORTANT NOTICE

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. IEEE Standards development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. 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.

Participants

At the time this IEEE recommended practice was completed, the Protection of Conductors Used in Industrial and Commercial Power Systems Working Group had the following membership:

Rasheek Rifaat, *Chair*
Robert Hoerauf, *Vice Chair*

Carson Bates	Danny Kliebert	Lorraine Padden
Nehad El-Sherif	Ed Larsen	Saleh Saleh
Gary Fox	Claudio Mardegan	Marcelo Valdes
John Kay	Daniel Neeser	F.Keith Waters

The 3004.7 Editorial Working Group had the following membership:

Ed Larsen, *Chair*
Donald McCullough II, *Vice Chair*
Jeremy Smith, *Secretary*
Ed LarsenDraft Editor,

Dave Bradley	Chris Hunter	Tom Papallo
Thomas Domitrovich	Duane Leschert	Marcelo Valdes
Gary Fox	Lorraine Padden	F.Keith Waters

The following members of the individual Standards Association balloting group voted on this recommended practice. Balloters may have voted for approval, disapproval, or abstention.

Saleman Alibhay	Kevin Fellhoelter	Ed Larsen
Curtis Ashton	H.Landis Floyd	Michael Lauxman
Radoslav Barac	Paul Fortuer	Wei-Jen Lee
Thomas Barnes	Rostyslaw Fostiak	Duane Leschert
Frank Basciano	Gary Fox	Poojit Lingam
Philip Beaumont	Carl Fredericks	Albert Livshitz
Steven Bezner	Mietek Glinkowski	Arturo Maldonado
Kenneth Bow	Jalal Gohari	William McBride
Brian Boysen	Stephen Grier	Joseph Melanson
Jeffrey Brogdon	Randall Groves	Charles Morse
Gustavo Brunello	Paul Guidry	William Moylan
Demetrio Bucaneg Jr.	Roger Hedding	Jerry Murphy
William Bush	Chris Heron	Paul Myers
William Byrd	Lee Herron	K.R. M. Nair
Thomas Campbell	Erling Hesla	Alexandre Nassif
Paul Cardina	Werner Hoelzl	Warren Naylor
Raymond Catlett	Robert Hoerauf	Daniel Neeser
Suresh Channarasappa	Richard Holub	Dennis Neitzel
Nancy Chilton	Gerald Irvine	Arthur Neubauer
Michael Chirico	Richard Jackson	Joe Nims
Ku Clemente	Laszlo Kadar	Lorraine Padden
Daryld Crow	John Kay	Bansi Patel
Davide De Luca	Peter Kelly	Iulian Profir
Mamadou Diong	Yuri Khersonsky	Samala Santosh Reddy
Gary Donner	James Kinney	Timothy Robirds
Michael Dood	Boris Kogan	Charles Rogers
Neal Dowling	Jim Kulchisky	Thomas Rozek
Donald Dunn	Mikhail Lagoda	Ryandi Ryandi
Gearold O. H. Eidhin	Chung-Yiu Lam	

Hugo Ricardo Sanchez-Reategui
Vincent Saporita
Todd Sauve
Mervin Savostianik
Bartien Sayogo
Robert Schuerger
Robert Seitz
Nikunj Shah
Michael Simon
Jeremy Smith
Gary Smullin
Kris Sommerstad
Albert Spear
Wayne Stec
Bill Stewart
Gary Stoedter
David Tepen
Michael Thompson
Wayne Timm
Remi Tremblay
Marcelo Valdes
James Van De Ligt
Benton Vandiver
Luis Vargas
Eric Vaughn
John Vergis
Keith Waters
Kenneth White
Dean Yager
Jian Yu
Gaetano Zizzo

When the IEEE SA Standards Board approved this recommended practice on 9 February 2021, it had the following membership:

Gary Hoffman, *Chair*
Vacant Position, *Vice Chair*
John D. Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Edward A. Addy
Doug Edwards
Ramy Ahmed Fathy
J.Travis Griffith
Thomas Koshy
Joseph L. Koepfinger*
David J. Law
Howard Li
Daozhuang Lin
Kevin Lu
Daleep C. Mohla
Chenhui Niu
Damir Novosel
Annette Reilly
Jon Walter Rosdahl
Dorothy Stanley
Mehmet Ulema
Lei Wang
F.Keith Waters
Karl Weber
Sha Wei
Howard Wolfman
Daidi Zhong

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 3004.7™-2021, IEEE Recommended Practice for Conductor Protection in Industrial and Commercial Power Systems.

IEEE 3000 Standards Collection®

This recommended practice was developed by the Industrial and Commercial Power Systems Standards Development Committee of the Industry Applications Society, as part of a project to repackage the popular IEEE Color Books®. The goal of this project is to speed up the revision process, eliminate duplicate material, and facilitate use of modern publishing and distribution technologies.

When this project is completed, the technical material included in the 13 "color books" will be included in series of new standards. Approximately 60 additional "dot" standards, organized into the following categories, will provide in-depth treatment of many of the topics formerly covered in the color books:

— Power Systems Design (3001 series)
— Power Systems Analysis (3002 series)
— Power Systems Grounding (3003 series)
— Protection and Coordination (3004 series)
— Emergency, Standby Power, and Energy Management Systems (3005 series)
— Power Systems Reliability (3006 series)
— Power Systems Maintenance, Operations, and Safety (3007 series)

In many cases, the material in a dot standard comes from a particular chapter of a particular IEEE Color Book. In other cases, material from several IEEE Color Books has been combined into a new dot standard.

IEEE Std 3004.7™

This publication provides a recommended practice for the electrical design of commercial and industrial facilities. This recommended practice covers the protection of conductors used in industrial and commercial power systems. It is likely to be of greatest value to the power-oriented engineer with limited commercial or industrial plant experience. It can also be an aid to all engineers responsible for the electrical design of commercial and industrial facilities. However, it is not intended as a replacement for the many excellent engineering texts and handbooks commonly in use, nor is it detailed enough to be a design manual. It should be considered a guide and general reference on electrical design for commercial and industrial facilities.

Tables, charts, and other information that have been extracted from codes, standards, and other technical literature are included in this publication. Their inclusion is for illustrative purposes; where technical accuracy is important, the latest version of the referenced document should be consulted to assure use of complete, up-to-date and accurate information.

This publication is based on North American installation codes and product standards, primarily those in the United States and Canada, and thus will be most useful in those jurisdictions and in jurisdictions that follow North American codes and standards. Elsewhere similar codes and standards may apply, such as those published by the International Electrotechnical Commission (IEC).

The material in this recommended practice was originally published in Chapter 9 of IEEE Std 242™-2001 (*IEEE Buff Book*™) [B16] and has been updated as required based on US codes and standards.

Contents

IEEE Recommended Practice for Conductor Protection in Industrial and Commercial Power Systems

1. Overview

1.1 Scope

This recommended practice covers the protection of conductors used in main and branch power circuits in industrial and commercial power systems against damage from short circuits and overloads as well as against physical damage from mechanical hazards, adverse environmental conditions, and improper handling.

1.2 Purpose

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals is *required to*).[1,2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals is *recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals is *permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals is *able to*).

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.

[1]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.
[2]The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.