

IEEE Guide for the Preparation of a Transmission Line Design Criteria Document

IEEE Power & Energy Society

Sponsored by the
Transmission and Distribution Committee

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

IEEE Std 1724™-2011

27 May 2011

IEEE Guide for the Preparation of a Transmission Line Design Criteria Document

Sponsor

**Transmission and Distribution Committee
of the
IEEE Power & Energy Society**

Approved 31 March 2011

IEEE-SA Standards Board

Approved 27 March 2012

American National Standards Institute

Abstract: A suggested outline for information that should be included in a design criteria for overhead transmission lines is presented in this guide. This guide is not a design criteria or a design manual, it is a listing of the information that is required during the design of a transmission line, and provides guidance for line designers in the collection and documentation of how the line was designed; including the sources of information used in design and the design approach used.

Keywords: design criteria, IEEE 1724, load factors, structure loads

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 27 May 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.

National Electrical Code® (NEC®) is a registered trademark in the U.S. Patent & Trademark Office, owned by The National Fire Protection Association.

PDF: ISBN 978-0-7381-6617-9 STD97100
Print: ISBN 978-0-7381-6638-4 STDPD97100

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 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. 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 a revision or withdrawal is required. Comments and recommendations on standards, and requests for interpretations 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 1724-2011, IEEE Guide for the Preparation of a Transmission Line Design Criteria Document.

The Line Design Methods Working Group of the Towers, Poles, and Conductors Subcommittee of the Transmission and Distribution Committee determined that guidance in the preparation and documentation of the data, methods of design, design approach, and sources of information used in the design of a transmission line was desirable to assist transmission line designers in gathering and documenting the material used in design so that a coherent design of the line structures, conductors, conductor support systems, and foundations would result. This guide does not cover every possible consideration in line design, but includes topics covering most of the considerations that a line designer will encounter. It does not offer design guidance, but rather offers guidance in the documentation of the basis of design.

The purpose of a design criteria is to gather and document the information required for the design of a transmission line in one convenient document. The information contained in a design criteria should include general information about the line, ambient conditions that the line will operate within, clearances, and electrical and structural requirements. This guide incorporates a representative list of items that could be included in design criteria. Not all of the topics listed in this guide are applicable to all lines. For example, ice-loading criteria are not applicable in certain warm climates. The outline of this guide is the suggested outline for any project-specific design criteria.

In designing a transmission line it is useful to consider the forces acting on a line and the response of the line to those forces separately. The environmental forces acting on a line are wind, ice, lightning, and pollution. These forces are resisted structurally by the physical strengths of the line structural components. They are resisted electrically by the electrical properties of the insulators, grounding system, and structure configuration.

The sections of this guide discuss the forces and reactions in regard to electrical and structural actions and reactions. This separation of forces from reactions recognizes that the forces are outside of the control of the line designer. The environment determines the ambient loads that will impact a line. Ambient loads are statistical in nature and are characterized by their severity and frequency. Knowledge of the ambient loads allows the line designer to determine how to resist the loads. If a line is required to be very reliable, it can be designed to resist severe loads that happen infrequently. If a line has a lower reliability requirement it can be designed to resist only loads that occur commonly, with the realization that there is a greater possibility of the line experiencing a more severe load during its operational life, and experiencing failure.

The line designer is responsible for determining the philosophy of design. One philosophy is that the line should not fail under the most severe anticipated conditions. This requires designing for the historically worst loading conditions, combined with appropriate safety factors or load factors. Another philosophy is that the line should be as low cost as possible. This philosophy may lead to selection of design loads that will occur more frequently, combined with lower safety or load factors. There is no “standard” guideline for the “right” philosophy which is more dependent on the business philosophy of the utility. This business case philosophy has to be applied by the line designer to suit the particular requirements of a line. It is equally wasteful to over design an unimportant line, as it is to undersign an important line. The first case can be classed as an “economic failure” and the second as a “physical failure.”

Transmission lines are designed subject to safety codes, such as the National Electrical Safety Code[®] (NESC[®])^a [B1].^b

^aNational Electrical Safety Code[®] (NESC[®]) is a registered trademark in the U.S. Patent & Trademark Office owned by The National Fire Protection Association.

^bThe numbers in brackets correspond to those of the bibliography in Annex A.

These codes specify loads and load factors that are considered necessary for the safety of employees and the public under specified conditions. The safety codes require the line designer to consider additional severe loads that are anticipated in a particular area. This design criteria guideline is prepared to assist line designers in the process of determining and systematically documenting loads and load factors applicable to a specific transmission line or transmission system.

The design criteria should list the philosophy of design, and the sources of information and data used to select the loads and strengths of the line components.

The outline of this guide is a suggested outline for a project-specific design criteria.

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

This document is copyrighted by the IEEE. It is made available 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 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 guide may require use of subject matter covered by patent rights. By publication of this guide, no position is taken with respect to the existence or validity of any patent rights in connection therewith. A patent holder or patent applicant has filed a statement of assurance that it will grant licenses under these 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. Other Essential Patent Claims may exist for which a statement 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 guide 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

The Task Force of the Line Design Working Group who prepared this guide had the following membership:

Glenn A. Davidson, *Chair*

Tom Alderton
Chuck Amrhyn
Mehmet Arslan
J. M. Asselin
Anthony Baker
Gordon Baker
Mike Beehler
Robert Bendall
Yair Berenstein
Nelson G. Bingel, III
Brian Booker
W. L. Calhoun
John Chan
Neal Chapman
Vern Chartier
Jerry Cheeks
Rob Christman
Bernie Clairmont
Allen Clapp
Eric Cleckley
Mike Clodfelder
Randy Cole
Rich Collins
F. Leonard Consalvo
Len Custer
Glenn A. Davidson
Nicholas DeSantis
Herve Deve
Anthony M. DiGioia, Jr.
Doug Dodson
Dale Douglass
William G. Eisinger
Maggie Emery
Jim Flood

Bruce Freimark
Elias Ghannoum
Waymon Goch
Tip Goodwin
Joseph Graziano
Tom Grisham
Asim Haldar
Doug Harms
Ibriham Hathout
David G. Havard
Donald Heald
Randy Hopkins
Jim Hunt
Magdi Ishac
Arjan Jagtiani
Doug Johnson
Herman Johnson
Mark Jurgemeyer
Robert O. Kluge
Don Koonce
Brian Lacoursiere
Hong-to Lam
Mark Lancaster
Robert Latham
Keith E. Lindsey
Vito J. Longo
Ming Lu
Otto Lynch
Tom McCarthy
Ray McCoy
Bob Millies
May Millies
David Mitchell
Roger Montambo

Shan Nandi
George B. Niles
Kim Nuckles
Juan Nuno
John Olenik
Wesley Oliphant
Carl Orde
Bob Oswald
Mohammad Pasha
Menelaos Pavlou
Zsolt Peter
Robert C. Peters
Erich Peyrot
Dave Phillips
Craig Pon
Douglas Proctor
C. B. Rawlins
Russell Raymond
Jerry Reding
Joe Renowden
John Ritter
Mark Ryan
Tapani Seppa
Doug Sherman
Larry Slavin
Ross Smith
Ronald Stelmak
Andy Stewart
Dean Stoddart
Carl Tamm
Ridley Thrash
Larry Vandergriend
Bruce Vaughn
Robert Whapham

At the time this IEEE guide was completed, the Line-Design Methods Working Group had the following membership:

Richard N. Collins, *Chair*

Syed Ahmed
Richard F. (Dick) Aichinger
Tom Alderton
Mehmet Arslan
Gordon Baker
Mike Beehler
Robert Bendall
Yair Berenstein
Nelson G. Bingel, III
W. L. Calhoun
John Chan
Neal Chapman
Vern Chartier
Jerry Cheeks
Rob Christman
Allen Clapp
Partick I. Clark
Mike Clodfelder
Randy Cole
Richard N. Collins
F. Len Consalvo
Len Custer
Glenn A. Davidson
Frank A. Denbrock
Nicholas De Santis
Anthony M. DiGioia, Jr.
Dale Douglass
William G. Eisinger
Jim Flood
Bruce Freimark

Ed Fridy
Elias Ghannoum
Waymon Goch
Tip Goodwin
Joseph Graziano
Tom Grisham
Asim Haldar
Doug Harms
Elizabeth Harris
Ibriham Hathout
David G. Havard
Donald Heald
Randy Hopkins
Weichih Huang
Jim Hunt
Magdi Ishac
Herman Johnson
Mark Jurgemeyer
Robert O. Kluge
Brian Lacoursiere
Robert Latham
Keith E. Lindsey
Vito J. Longo
Ming Lu
Otto Lynch
Tom McCarthy
Ray McCoy
Steve Miller
Bob Millies
May Millies
David Mitchell

Roger Montambo
Shan Nandi
George B. Niles
Kim Nuckles
John Olenik
Wesley Olipant
Carl Orde
Bob Oswald
Zsolt Peter
Robert C. Peters
Erich Peyrot
Dave Phillips
Craig Pon
Douglas O. Proctor
C. B. Rawlins
Russell N. Raymond
Jerry Reding
Joe Renowden
Tapani Seppa
Larry Slavin
Ross Smith
Paul Springer
Ronald Stelmak
Andy Stewart
Carl Tamm
Ridley Thrash
Larry Vandergriend
Nick Ware
Robert Whapham
Nancy Zhu