IEEE Guide for RF Protection of Personnel Working in the Vicinity of Wireless Communications Antennas Attached to Electric Power Line Structures

IEEE Power & Energy Society

Sponsored by the
Power System Communications Committee

1654™

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

30 June 2009

IEEE Std 1654™-2009

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

IEEE Guide for RF Protection of Personnel Working in the Vicinity of Wireless Communications Antennas Attached to Electric Power Line Structures

Sponsor

Transmission and Distribution Committee
of the
IEEE Power & Energy Society

Approved 19 March 2009

IEEE-SA Standards Board

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

Acknowledgements

Appreciation is extended to Bonneville Power Administration and American Electric Power for providing data for determining the immunity of personal RF monitors to power-frequency magnetic and electric fields. Also many thanks to all the electric utilities that provided information about their RF safety programs and contributed to preparation of the RF safety program recommendations described in this guide.

Abstract: Information on establishing an effective safety program to ensure compliance with the applicable regulations for radio frequency (RF) protection of electrical workers in the vicinity of wireless communication antennas adjacent or attached to electrical power line structures is presented. The guide also provides information on power-frequency electric and magnetic field immunity of RF personal monitors and RF protective clothing.
Keywords: electrical workers, immunity, power frequency, RF personal monitors, RF protective clothing, RF safety program

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

Copyright © 2009 by the Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 30 June 2009. 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.

PDF: ISBN 978-0-7381-5943-0 STD95926
Print: ISBN 978-0-7381-5944-7 STDPD95926

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.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

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.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

Introduction

This introduction is not part of IEEE Std 1654-2009, IEEE Guide for RF Protection of Personnel Working in the Vicinity of Wireless Communications Antennas Attached to Electric Power Line Structures.

The rapid expansion of the wireless communications industry has led to new impacts on the power transmission industry. Wireless companies are looking to share the advantages of existing power line rights-of-way. Thousands of power transmission structures have been modified to perform a dual role as communications towers. This dual role places an additional burden on electrical workers who must install and maintain the communications antennas while performing their usual duties in the maintenance of the power transmission lines. Maintenance personnel are now faced with issues regarding possible hazards arising from working in the presence of high-intensity RF fields.

The U.S. Federal Communications Commission (FCC) performed scientific studies and produced reports and recommendations, and regulations,[a] which have also resulted in the promulgation of regulations by the Occupational Safety and Health Administration (OSHA) to address worker exposures in RF fields. Utility companies are obligated to develop plans, training, policies, and work practices to protect their workers from excessive exposures to RF fields. In addition, it is incumbent upon utilities to evaluate the necessity of equipping their workers with personal protective equipment, such as RF detectors and shielding apparel.

Questions and concerns about RF exposures of electrical workers were discussed at meetings of the IEEE Power Engineering Society (PES), Engineering in the Safety, Maintenance, and Operation of Lines (ESMOL) Subcommittee in Las Vegas 2000 and Columbus 2001, as well as in panel presentations in Edmonton, Montreal, and Vancouver, Canada, all of which provided foundation material for this guide. The main decisions and recommendations arrived at during the Vancouver meeting were the following:

a) An RF exposure safety program should be developed by an electric utility if it plans to permit use of its structures for attachment of RF antennas and/or the associated transmitters.

b) Personal RF monitors should be worn by each employee when RF antennas are located on structures where he or she is working, or on other structures in the vicinity.

A next milestone was the publication in 2003 of an IEEE conference paper entitled “RF Protection of Personnel Working in the Vicinity of Wireless Communications Antennas Attached to Electric Power Line Structures” (ESMOL Subcommittee [B7]).[b] The purpose of this paper was to present a summary of present electric utility practices and proposed minimum requirements pertaining to RF protection of personnel working in the vicinity of wireless communications antennas attached to electric power line structures. In this respect, the paper provided information on RF exposure limits, RF safety compliance steps, power-frequency electric and magnetic field immunity of RF personal monitors, and RF protective clothing. The 2003 paper served as the main basis for this guide. IEEE Std 1654-2009 was prepared by the ESMOL Subcommittee Task Force entitled “Protection of Line Workers from RF Radiation Fields Emitted from Antenna/Transmitter Arrays.”

[a] Information on references can be found in Clause 2.

[b] The numbers in brackets correspond to those of the bibliography in Annex A.

Copyright © 2009 IEEE. All rights reserved.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

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.

Copyright © 2009 IEEE. All rights reserved.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

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. 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

At the time this guide was submitted to the IEEE-SA Standards Board for approval, the RF Protection Guide for Electrical Workers Working Group had the following membership:

Nestor Kolcio, *Chair*
Ken Brown, *Vice Chair*

Kris Buchholtz
Thomas Buonincontri
James Christensen
Ed Davis
Frederick Doering
George Gela
Jim Gillies
Ernie Jones
Clayton King
George Niles
Tom Rasler
James Tomaseski
Tom Verdecchio

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

William J. Ackerman
Ali Al Awazi
Kraig Bader
Harvey Bowles
Gernot Brandt
Gustavo Brunello
Thomas Buonincontri
William Byrd
Weijen Chen
Keith Chow
Robert Christman
Michael Clodfelder
Tommy Cooper
F. A. Denbrock
Bostjan K. Derganc
Ernest Duckworth
Gary Engmann
Rabiz Foda
George Gela
William Goldbach
Charles Grose
Randall Groves
Richard W. Hensel
Werner Hoelzl
Edward Hunt
Efthymios Karabetsos
Gael Kennedy
Robert O Kluge
Joseph L. Koepfinger
Nestor Kolcio
Jim Kulchisky
Lisardo Lourido
Gary Michel
Abdul Mousa
Dennis Neitzel
Michael S. Newman
Gary Nissen
Tim Olson
Carl Orde
Donald Parker
Percy Pool
Charles Rogers
Bartien Sayogo
Mark Simon
Jerry Smith
Richard Tell
James Tomaseski
Joseph Tumidajski
John Vergis
Daniel Ward
William Wessman
James Wilson
Larry Young
Theodore Zeiss

Copyright © 2009 IEEE. All rights reserved.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

When the IEEE-SA Standards Board approved this guide on 19 March 2009, it had the following membership:

Robert M. Grow, *Chair*
Thomas Prevost, *Vice Chair*
Steve M. Mills, *Past Chair*
Judith Gorman, *Secretary*

John Barr
Karen Bartleson
Victor Berman
Ted Burse
Richard DeBlasio
Andy Drozd
Mark Epstein
Alexander Gelman
Jim Hughes
Rich Hulett
Young Kyun Kim
Joseph L. Koepfinger*
John Kulick
David Law
Ted Olsen
Glenn Parsons
Ron Petersen
Narayanan Ramachandran
Jon Rosdahl
Sam Sciacca

*Member Emeritus

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

Howard Wolfman, *TAB Representative*
Michael Janezic, *NIST Representative*
Satish Aggarwal, *NRC Representative*

Lisa Perry
IEEE Standards Program Manager, Document Development

Malia Zaman
IEEE Standards Program Manager, Technical Program Development

Copyright © 2009 IEEE. All rights reserved.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

Contents

1. Overview 1

1.1 Scope 1

1.2 Purpose 1

2. Normative references 2

3. Definitions 2

4. Application 3

5. RF exposure—FCC and OSHA guidelines and requirements 3

6. Exposure situations 4

7. RF emitters—Typical measurements 4

8. Electric utility RF safety practices 5

8.1 Background 5

8.2 RF exposure safety compliance steps 5

9. RF safety considerations for third-party antennas and transmitters 8

9.1 Establishing RF safety in third-party situations 8

9.2 RF safety for other nearby third-party RF antennas 9

10. RF safety standard work procedures 9

11. Documentation and training 9

12. Immunity of RF personal monitors to electric and magnetic fields from transmission lines 10

12.1 General information 10

12.2 RFPM immunity to power-frequency electric fields 10

12.3 Immunity to power-frequency magnetic fields 11

13. Available RF protection methods 11

13.1 General 11

13.2 Conductive clothing 11

Annex A (informative) Bibliography 13

Copyright © 2009 IEEE. All rights reserved.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.

IEEE Guide for RF Protection of Personnel Working in the Vicinity of Wireless Communications Antennas Attached to Electric Power Line Structures

IMPORTANT NOTICE: This standard is not intended to ensure safety, security, health, or environmental protection in all circumstances. Implementers of the standard are responsible for determining appropriate safety, security, environmental, and health practices or regulatory requirements.

This IEEE document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notice" or "Important Notices and Disclaimers Concerning IEEE Documents." They can also be obtained on request from IEEE or viewed at http://standards.ieee.org/IPR/disclaimers.html.

1. Overview

1.1 Scope

This guide presents information on establishing an effective safety program to ensure compliance with the applicable regulations for radio frequency (RF) protection of electrical workers in the vicinity of wireless communication antennas adjacent or attached to electrical power line structures. The guide also provides information on power-frequency electric and magnetic field immunity of RF personal monitors (RFPM) and RF protective clothing.

1.2 Purpose

Electric utilities are required to meet the requirements established by applicable regulations [e.g., Occupational Safety and Health Administration (OSHA), Federal Communications Commission (FCC)] for protection of electrical workers in the vicinity of wireless communication antennas adjacent or attached to

Copyright © 2009 IEEE. All rights reserved.

Authorized licensed use limited to: Thomson Techstreet. Downloaded on August 30, 2009 at 19:02 from IEEE Xplore. Restrictions apply.