



IEEE Standard for Electromagnetic Energy Safety Programs, 0 Hz to 300 GHz

IEEE Standards and Standards Innovations (S&SI)
Strategic Management and Delivery Committee (SMDC)

Developed by the
International Committee on Electromagnetic Safety (ICES)

IEEE Std C95.7™-2022
(Revision of IEEE Std C95.7-2014)



STANDARDS

IEEE Standard for Electromagnetic Energy Safety Programs, 0 Hz to 300 GHz

Developed by the

International Committee on Electromagnetic Safety (ICES)

of the

**IEEE Standards and Standards Innovations (S&SI) Strategic Management and
Delivery Committee (SMDC)**

Approved 3 December 2022

IEEE SA Standards Board

THIS IS A REDLINE DOCUMENT PRODUCED BY TECHSTREET, AN ASME COMPANY.

This document is intended to provide users with an indication of changes from one edition to the next. It includes a full-text version of the new document, plus an indication of changes from the previous version.

Redlines are designed to save time and improve efficiencies by using the latest software technology to find and highlight document changes. More professionals are using valuable new technologies like redlines, to help improve outcomes in a fast paced global business world.

Because it may not be technically possible to capture all changes accurately, it is recommended that users consult previous editions as appropriate. In all cases, only the current base version of this publication is to be considered the official document.

This Redline is produced solely by Techstreet. IEEE has not prepared this Redline and is not responsible for its accuracy.

Redline Processing Notes:

1. ~~Red Text~~ - Red strikethrough text denotes deletions.
2. Blue Text - Blue underlined text denotes modifications and additions.

Abstract: The required elements for developing, implementing, and administering effective electromagnetic energy (EME) safety programs (SPs) to achieve compliance with applicable human exposure limits are specified. Concomitant EME hazards, such as those caused by interference to medical devices, ignition of flammable atmospheres, and detonation of explosive devices, are also addressed. Well-established safety processes are used to manage potential EME hazards from known EME sources in the 0 Hz to 300 GHz frequency range. SP elements for identifying EME hazard locations, implementing needed controls, and training personnel, are included. Additional descriptions and examples of the SP elements and various factors that can be helpful when assessing potential hazards and creating SPs are annexed.

Keywords: access restriction, electro-explosive device (EED), electromagnetic energy (EME), electromagnetic exposure, electromagnetic fields (EMF), EME awareness education, EME exposure, EME protection, EME safety committee, EME safety officer (ESO), EME safety program (SP), EME safety training, exposure assessment, exposure categorization, flammable atmosphere, hazard assessment, hazard communication, IEEE C95.7™, non-ionizing radiation (NIR), personal monitors, personal protective equipment (PPE), radio frequency (RF), radio frequency safety program, restricted environment, signage, unrestricted environment

*This standard is dedicated to the memory of our
friend and colleague Marvin C. Ziskin, MD.*

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

Copyright © 2023 by The Institute of Electrical and Electronics Engineers, Inc.
All rights reserved. Published 16 March 2023. 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 978-1-5044-9390-1 STDGT25923
Print: ISBN 978-1-5044-9391-8 STDPD25923

IEEE prohibits discrimination, harassment, and bullying.

For more information, visit <https://www.ieee.org/about/corporate/governance/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.

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 IEEE Societies and subcommittees of IEEE Standards Association (IEEE SA) Board of Governors. 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 makes no warranties or representations concerning its standards, and expressly disclaims all warranties, express or implied, concerning this standard, including but not limited to the warranties of merchantability, fitness for a particular purpose and non-infringement. 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. Statements made by volunteers may not represent the formal position of their employer(s) or affiliation(s).

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 subcommittees of the IEEE SA Board of Governors 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 & Interests area of the [IEEE SA myProject system](#).¹ An IEEE Account is needed to access the application.

Comments on standards should be submitted using the [Contact Us](#) form.²

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.

¹ Available at: <https://development.standards.ieee.org/myproject-web/public/view.html#landing>.

² Available at: <https://standards.ieee.org/content/ieee-standards/en/about/contact/index.html>.

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, neither IEEE nor its licensors 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](#).³ 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](#).⁴ 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.

³ Available at: <https://ieeexplore.ieee.org/browse/standards/collection/ieee>.

⁴ Available at: <https://standards.ieee.org/standard/index.html>.

Patents

IEEE Standards are developed in compliance with the [IEEE SA Patent Policy](#).⁵

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 <https://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.

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.

⁵ Available at: <https://standards.ieee.org/about/sasb/patcom/materials.html>.

Participants

This IEEE standard was prepared by Subcommittee 2 (Terminology, units of measurement, and hazard communication) of IEEE ICES TC95 (TC95 SC2). The following persons contributed to the development of the standard or participated in the TC95 balloting:

Richard A. Tell, *Chair**
Donald L. Haes, Jr, *Vice Chair**

Vitas Anderson
Marco Azpurua
Aymen Ben Saada
Klaus Bender
Ian Brooker
Jerrold Bushberg
Matthew Butcher
Chung-Kwang Chou
Robert Cleveland
Francis Colville
David Cotton
Robert Curtis*
Mario Cvetkovic
John deFrank
Rene De-Seze
Amnon Duvdevany
Roel Escobar
Antonio Faraone
Richard Findlay
Kevin Fisher*
Kyle Fisher

Ken Foster
James Futch
Sami Gabriel
Romeo Gallamoza
Martin Gledhill
Jose Gomez
Kevin Graf
Donald Haes
Tim Harrington†
Jim Hatfield
Tamera Hay
Michel Israel
Robert Johnson*
Sheila Johnston
Kenneth Joyner
Rod Julian
Kim Kantner
Efthymios Karabetsos
Robert Kavet
Jafar Keshvari
Cory Kihlstrom
B. Jon Klauenberg

Greg Lapin
Ae-Kyoung Lee
Jeffrey Lodwick
Rajat Mathur*
David Maxson*
Timothy Mikulski
Brett Moule
John Osepchuk
Josee Paquin
Jack Rowley
Asher Sheppard
Darang Tech
Paul Testagrossa
Artnarong Thansandote
Peter Valberg
Eric Wandel
Soichi Watanabe
Marvin Wessel
Xun Zhao
Marvin Ziskin
Peter Zollman*

*Editorial Working Group

†Editing assistant

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

Curtis Ashton
Earle Bascom III
Jason Bellamy
Bill Brown
Gustavo Brunello
Jerrold Bushberg
Matthew Butcher
Suresh Channarasappa
Zhiman Chen
Chung-Kwang Chou
Robert Curtis
Kurniawan Diharja
Kevin Fisher
Carl Fredericks
Avraham Freedman
Shubhanker Garg
George Gela
Kevin Graf
Donald Haes
Edward Hare

James Hatfield
Werner Hoelzl
Daniel Hoolihan
Richard Jackson
Robert Johnson
Randy Jost
Kenneth Joyner
Laszlo Kadar
Wolfgang Kainz
Efthymios Karabetsos
Piotr Karocki
Robert Kavet
Nam Kim
Chung-Yiu Lam
Wang Lei
Arthur H. Light
Jon Martens
John Martin
Rajat Mathur

David Maxson
Teruo Onishi
John Osepchuk
Sivaraman P
Bansi Patel
Howard Penrose
Andrew Podgorski
Bartien Sayogo
Cole Scott
Jerry Smith
Richard Tell
Artnarong Thansandote
James Tomaseski
James Van De Ligt
Raul Velazquez
John Vergis
Robert Weller
Nicholas Zagrodnik
Marvin Ziskin
Peter Zollman

When the IEEE SA Standards Board approved this standard on 3 December 2022, it had the following membership:

David J. Law, *Chair*
Ted Burse, *Vice Chair*
Gary Hoffman, *Past Chair*
Konstantinos Karachalios, *Secretary*

Edward A. Addy
Ramy Ahmed Fathy
J. Travis Griffith
Guido R. Hiertz
Yousef Kimiagar
Joseph L. Koepfinger*
Thomas Koshy
John D. Kulick

Johnny Daozhuang Lin
Kevin Lu
Daleep C. Mohla
Andrew Myles
Damir Novosel
Annette D. Reilly
Robby Robson
Jon Walter Rosdahl

Mark Siira
Dorothy V. Stanley
Lei Wang
F. Keith Waters
Karl Weber
Sha Wei
Philip B. Winston
Daidi Zho

*Member Emeritus

Introduction

This introduction is not part of IEEE Std C95.7-2022, IEEE Standard for Electromagnetic Energy Safety Programs, 0 Hz to 300 GHz.

In 1960, the American Standards Association approved the initiation of the Radiation Hazards Standards project under the co-sponsorship of the Department of the Navy and The Institute of Electrical and Electronics Engineers (IEEE). Prior to 1988, C95 standards were developed by Accredited Standards Committee C95 and submitted to the American National Standards Institute (ANSI) for approval and issuance as ANSI C95 standards. Between 1988 and 1990, the committee was converted to Standards Coordinating Committee 28 (SCC28) under the sponsorship of the IEEE Standards Board. In 2001, the IEEE Standards Association Standards Board approved the name “International Committee on Electromagnetic Safety” (ICES) for SCC28 to better reflect the scope of the committee and its international membership. In accordance with policies of IEEE, C95 standards are issued and developed as IEEE standards, as well as submitted to ANSI for recognition. Standards development is conducted under the policies of the IEEE Standards Association, which require consensus, openness, due process, and balance in the standard-setting process.⁶

In June 1995, the IEEE Standards Board approved the establishment of “Standards Coordinating Committee 34 (SCC34), Product Performance Standards Relative to the Safe Use of Electromagnetic Energy.” Standards developed by SCC34 do not specify limits for human exposure to electromagnetic fields but refer to established limits found in science-based standards such as IEEE Std C95.1™-2019,⁷ IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 0 Hz to 300 GHz and IEEE Std C95.1-2345™-2014, IEEE Standard for Military Workplaces—Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz. In 2005, SCC28 and SCC34 became “Technical Committee 95” (TC95) and “Technical Committee 34,” (TC34) respectively, under a new IEEE Standards Coordinating Committee, SCC39, which is now called ICES.⁸ In 2022, SCC39 became designated as an IEEE Standards Committee, ICES.

The present scope of IEEE ICES is the:

“Development of standards to protect against established hazards of exposure to electromagnetic energy in the range of 0 Hz to 300 GHz; including exposure limits, assessment techniques, product compliance assessment, and safety practices.”

There are six subcommittees concerned with:

- 1) Techniques, procedures, and instrumentation
- 2) Terminology, units of measurement, and hazard communication
- 3) Safety levels with respect to human exposure, 0 Hz to 3 kHz
- 4) Safety levels with respect to human exposure, 3 kHz to 300 GHz
- 5) Safety levels with respect to electro-explosive devices
- 6) EMF modeling and dosimetry

Subcommittee 2 of ICES TC95 is responsible for this standard.

⁶ https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/sa_om.pdf

⁷ Information on references can be found in Clause 2.

⁸ Standards Coordinating Committees are established by the IEEE SA Standards Board and provide a mechanism to oversee the development of standards that are beyond the scopes of individual technical committees within IEEE’s societies.

Current versions of the ICES TC95 standards are:

IEEE Std C95.1TM-2019 (Revision of IEEE Std C95.1-2005/ Incorporates IEEE Std C95.1-2019/Cor 1-2019, Cor 2-2020), IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz.

IEEE Std C95.1-2345TM-2014, IEEE Standard for Military Workplaces—Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz.

IEEE Std C95.2TM-2018 (Revision of IEEE Std C95.2-1999), IEEE Standard for Radio-Frequency Energy and Current Flow Symbols.

IEEE Std C95.3TM-2021 (Revision of IEEE Std C95.3-2002 and IEEE Std C95.3.1TM-2010), Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic Fields with Respect to Human Exposure to Such Fields, 0 Hz to 300 GHz.

IEEE Std C95.7TM-2022, IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz.

IEEE Std 2889TM-2021, IEEE Guide for the Definition of Incident Power Density to Correlate Surface Temperature Elevation.

The predecessor to this standard, Recommended Practice for Radio Frequency Safety Programs, IEEE Std C95.7-2014 [B54],⁹ has been serving the radiofrequency (RF) safety field since 2005. Before then, no single document provided guidance for the development of appropriate safety programs (SPs) in RF environments. While electromagnetic energy (EME) exposure limits are prescribed in IEEE Std C95.1-2019 and IEEE Std C95.1-2345-2014, EME measurement techniques in IEEE Std C95.3-2021, and EME safety signs and labels in IEEE Std C95.2-2018, none of those documents provide specific insight on how to integrate the subjects of those standards with exposure assessment to arrive at practical methods for controlling exposure of persons subject to EME. Moreover, the independent work of Subcommittee 3 (0 Hz to 3 kHz) and Subcommittee 4 (3 kHz to 300 GHz) was merged in the 2019 revision of IEEE Std C95.1. This revision of the standard broadens the scope to include frequencies from 0 Hz to 300 GHz. The principles of safety planning are universal, enabling the broader frequency span to be addressed herein. This standard outlines the elements of the process of performing hazard assessments, followed by the creation of a safety program, including establishing, documenting, implementing, and maintaining controls and policies. To aid in the process of setting effective controls, a table is provided that helps the categorization of potential exposure conditions and establishes the appropriate controls in an SP. A proper SP is written and supported by hazard assessment. SP controls and policies are governed by the characteristics of the site to which it applies.

Acknowledgments

During the development of this standard, a special task force on barriers was led by Robert Johnson, a member of the workgroup that developed this document. The SC2 Barrier Task Force was charged with formulating the descriptions for indicative and positive access control barriers that were ultimately incorporated in this document. The Task Force developed an informational report because its work and selected narrative from their report was adapted for inclusion in Annex A. Mr. Johnson's leadership on this important, and sometimes unclear, component of EME safety programs is acknowledged.

⁹ The numbers in brackets correspond to those of the bibliography in Annex I.

Contents

1. Overview	13
1.1 Scope	13
1.2 Purpose	13
1.3 Background to this revision	14
1.4 Structure of this document	14
1.5 Word usage	14
2. Normative references	15
3. Definitions, acronyms, and abbreviations	15
3.1 Definitions	15
3.2 Acronyms and abbreviations	24
3.3 Letter symbols for quantities	26
3.4 Unit symbols	27
3.5 Frequency bands	27
4. Required elements of a safety program	28
4.1 Context	28
4.2 General requirements	30
4.3 Applicability of the standard	32
4.4 EME safety program elements	33
4.5 EME safety program administration	38
4.6 EME hazard assessment (human exposure)	43
4.7 Safety program controls	44
4.8 EME awareness education and EME safety training	55
4.9 Response to EME overexposure incidents	58
5. Safety program development	60
5.1 General principles of safety program development	60
5.2 A roadmap for developing, implementing, and maintaining an EME safety program	61
5.3 Hazard determination	63
5.4 Mapping and categorizing	65
5.5 Population identification process	66
5.6 Establishment of controls	67
5.7 Documenting the process and composing the safety program	70
5.8 Implement, monitor, and maintain the SP	71
Annex A (informative) Electromagnetic environmental safety barrier characteristics and use	72
A.1 Introduction	72
A.2 Application of barriers	72
A.3 Exposure risk assessment	73
A.4 Definitions of EME safety barriers	73
A.5 Hierarchy of barrier (controls) implementation	74
A.6 Design considerations	75
A.7 Recommendations and conclusions	75
A.8 Joint responsibilities	76
Annex B (informative) Example references for developing an EME safety program	77
B.1 General	77
B.2 References that include exposure limits and the EME hazards they address	77
B.3 Overview of IEEE Std C95.3-2021 on measurements and computations	79

Annex C (informative) Concomitant EME hazards	82
C.1 Introduction.....	82
C.2 Establishing the SP scope	82
C.3 Electromagnetic interference (EMI)	85
C.4 Electro-explosive device, explosives, and munitions.....	88
C.5 Ignition of flammable atmospheres.....	89
C.6 Electrical power phenomena.....	90
C.7 Static magnetic field interactions.....	90
Annex D (informative) Identifying EME sources and categorization of exposure environments.....	92
D.1 General.....	92
D.2 Potential maximum EME exposure and exposure environment categorization.....	93
D.3 Examples of how environments might be designated using EME exposure categories	94
Annex E (informative) Example ranking of SP responsibilities.....	103
Annex F (informative) Topics for inclusion in EME awareness education and EME safety training.....	105
F.1 Basics in EME awareness education and EME safety training	105
F.2 Topics for in-depth EME safety training for ESOs, safety managers and/or supervisors	108
Annex G (informative) Examples of key aspects of SPs for exemplary exposure scenarios	111
G.1 General.....	111
G.2 Example EME exposure scenarios and example elements for corresponding SPs	111
G.3 Example short RF safety program for an FM broadcast tower	119
G.4 Use of site-specific guidance in EME safety sheets.....	125
Annex H (informative) Example report of potential SP non-conformance or EME overexposure	129
Annex I (informative) Bibliography.....	131

IEEE Standard Recommended Practice for Electromagnetic Energy Radio Frequency Safety Programs, 0 Hz 3-kHz to 300 GHz

~~IMPORTANT NOTICE: IEEE Standards documents are not intended to ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers 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.~~

~~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 standard presents the required elements for the development, implementation, and administration of electromagnetic energy (EME) safety programs (SPs), in the frequency range of 0 Hz to 300 GHz. SPs can help mitigate established health and safety risks that might arise from unintended interaction of electromagnetic fields (EMFs), currents, and/or contact voltages with a) people (human exposure), and/or b) electronics, materials, substances, or structures (concomitant EME hazards).

This standard uses compliance with appropriate limits, as well as design and operational practices, as the criteria for the required mitigation where the use of EME might result in exceeding the EME exposure limits specified in the SP scope. Compliance limits are not defined in this standard but are expected to be specified in the SP scope based on regulations, other standards, guidelines, or analyses of science/engineering knowledge.

This standard provides examples to assist the development of site-specific or environment-specific SPs.

~~This recommended practice presents guidelines and procedures that could form the basis of a radio frequency exposure safety program¹ (RFSP) that provides reasonable and adequate guidance for preventing exposures above applicable radio frequency (RF) limits associated with RF sources that operate in the frequency range of 3 kHz to 300 GHz under many circumstances. This is a general-purpose document intended for application in most RF exposure scenarios with the goal of avoiding potentially hazardous exposures to electromagnetic fields, currents, and/or contact voltages. In some complex cases, however, the required elements of an adequate RFSP may exceed those described in this document. In such cases, additional guidance may be necessary to affect a satisfactory RF safety solution. There are many ways of accomplishing the goal of a satisfactory RF safety program. While this recommended practice outlines certain schemes for providing a safe environment for persons who may be exposed to excessive levels of electromagnetic energy, other schemes may be equally effective.~~

1.2 Purpose

The purpose of this standard is to:

- Complement the International Committee on Electromagnetic Safety (ICES) IEEE C95™ family of standards on electromagnetic safety
- Provide a framework for the development, implementation, and maintenance of EME safety programs that:
 - Specifies practices for managing compliance with applicable EME limits for qualified individuals (QIs) and the general public.

~~¹For the purposes of this document, the term “RF safety” is a shorthand notation used to mean “RF exposure safety.” See definitions.~~

- Is applicable internationally by enabling SPs to integrate the requirements of EME health and safety regulations, standards, guidelines of the authority having jurisdiction.
- Can address other established EME hazards, called “concomitant EME hazards,” such as medical device interference or EME operations potentially affecting explosive material or flammable atmospheres in the vicinity of an EME source.

~~These guidelines are provided to assist in the development of RF safety programs for the safe use of RF energy producing devices, equipment, and systems, and to prevent exposures in excess of applicable RF limits for workers or the public. The means for accomplishing this are by first characterizing areas into one of four exposure categories according to the potential risk for exposure above prescribed RF exposure limits, as described in 1.3, and then, where relevant, specifying the appropriate controls to reduce the likelihood of over exposure. For many situations, this guidance will assist in the development of site specific RF safety programs, while in others the programs may be developed to apply across a wide range of exposure environments. These guidelines are designed to complement the ICES TC 95 family of standards on electromagnetic safety, but may find use in the development of effective programs for conformance with other guidelines, standards, or regulations for controlling human exposure to electromagnetic energy. This recommended practice provides guidelines for establishing RF safety programs, but other recommendations may already exist that are deemed sufficient by local regulatory authorities for achieving RF safety in particular environments. Hence, other recommendations could potentially replace or be used in conjunction with the recommendations in this document. Guidelines developed for specific applications, for example, radio amateur operations [B4]² and electrical transmission/distribution personnel working near mobile phone base station antennas installed on electric utility structures [B22], represent two such examples.~~

1.3 Background to this revision

This revised standard builds on the guidance provided in the previous edition, IEEE Std C95.7™-2014 [B54].¹⁰ It is consistent with best practices as they have evolved. It retains the practice of categorizing EME exposure environments or situations according to ranges of potential exposure levels and the development of SPs appropriate to the assigned categories. This approach to the development of safety programs is useful to a wide range of EME exposure situations.

This edition codifies previous recommended practice and includes new material on the hazard assessment task, the arrangement of barriers to manage access to and within restricted environments where exposure may exceed limits, and the clarification of the two complementary objectives: EME awareness education (for informed consent) and safety training (to control exposure). It also introduces guidance on how concomitant EME hazards can be included in the SP.

This standard also follows the expansion of IEEE Std C95.1™-2019¹¹, which extends the covered frequency range below radio frequencies down to 0 Hz, hence the change from “RF” to “EME” safety programs.

Experienced users are still able to use the “roadmap” to develop appropriate SPs. Thus, this edition builds on the previous edition while offering greater latitude in organizing the process of controlling potential exposures. Through the use of a wider range of options as described in this document, more targeted, efficient, and cost-effective SPs should result.

¹⁰ ² The numbers in brackets correspond to those of the bibliography in Annex I.

¹¹ ³ Information on references can be found in Clause 2.

1.4 Structure of this document

This standard is divided into five distinct clauses. The first three clauses contain the overview, list of normative references, and definitions, acronyms, and abbreviations. Clause 4 describes the required SP elements. Clause 4 introduces the context and general requirements for the standard before defining the elements of the safety program and how they relate to exposure categories. Clause 5 presents best practices for development and implementation of SPs. Additional descriptions and examples of the SP elements and various factors that can be helpful when assessing potential hazards and creating SPs are provided in the annexes.

1.5 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*).^{12, 13}

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*).

¹² The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

¹³ The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

1.3 Application

The objective of this recommended practice is to provide guidance for the implementation of an RF safety program. Such programs are recommended whenever exposures have the potential to exceed a defined action level or exposure limit (also called the RF safety program initiation level—RFSPIL). RFSPILs, or action levels or exposure limits, are typically defined in the applicable safety standard. How the levels or limits are defined and controlled is an important part of an RFSP. For purposes of this recommended practice, the RFSPIL is any of the following criteria (where applicable):

- The lower tier exposure levels of IEEE Std C95.1³
- The general public reference levels (lower tier) of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines [B16]
- The general population/uncontrolled maximum permissible exposures of the U.S. Federal Communications Commission (FCC) [B12]
- One fifth of the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs) [B2]

The assessment of the RFSPIL includes all applicable aspects of temporal and spatial averaging as specified in the associated standards, guidelines, and regulations. It also includes a consideration of the precedence of fundamental limits [such as basic restrictions (BRs)] over derived limits (such as MPE levels, investigation levels, and reference levels). For example, devices or systems that have been determined to not be capable of producing exposures that would exceed the BRs of the relevant exposure limits may need no RF safety program, even though the external fields may exceed the RFSPIL. Exposure conditions may also consist of the presence of an RF field and/or the potential to touch or grasp objects energized by RF fields.

~~A practical means for developing an RF safety program is to first categorize the RF sources and systems according to their potential for producing RF exposure above the RFSPIL or exposure limits, and then to specify appropriate controls for each category. The term “controls” refers to both engineering and administrative means for preventing exposure above defined RF exposure limits. (See Clause 4 for details on possible controls.)~~

~~Differentiation between uncontrolled, or general public, exposure environments, and controlled, or occupational, exposure environments, is primarily a matter of awareness and informed acceptance. The design of an RFSP should carefully address the characteristics of the population defined as “general public” to ensure that the administrative and engineering controls implemented are sufficient to protect that population. For example, if a controlled area is otherwise easily accessible by a visually handicapped person, signage may not be sufficient to delineate the boundary between uncontrolled and controlled areas.~~

~~In simple situations, the examples in Annex B and Annex C can be used to determine the exposure category. Some circumstances may require only a very minimal program, while others could require exposure assessment by a competent RF safety professional. It should be noted, however, that the operation of many RF sources and systems may be such that an RFSP is not needed at all (see Table 1, Category 1). RF sources and systems with the potential for producing greater exposures in accessible locations (Table 1, Category 2, Category 3, and Category 4), e.g., near RF dielectric heaters or high power broadcast antennas, will normally require additional RFSP elements. The categories shown in Table 1 are based on the potential for producing exposures in accessible areas in excess of the RFSPIL or applicable exposure limit (see definition of “RFSPIL” relative to the potential for RF shocks and/or burns). Situations should be evaluated by sequentially determining which set of exposure conditions applies, beginning first with those for Category 1. A summary of the recommended actions for each category is also included in Table 1.~~

Table 1—Summary of RFSP categories based on RF exposure conditions

RFSP category	Maximum potential exposure condition ^a	Control actions required
1	Operational characteristics of source(s) would not cause the RFSPIL or lower tier limit to be exceeded.	None, unless maintenance or other conditions alter category
2	Operational characteristics of source(s) may cause the lower tier exposure limit to be exceeded in accessible areas, but the upper tier limit would <i>not</i> be exceeded.	See Table 3
3	Lower tier exceeded and potential to exceed the upper tier exposure limit in accessible areas unless mitigating controls are applied.	See Table 3
4	Exposure will exceed <i>ten times</i> the upper tier exposure limit in accessible areas.	Restrict source output to achieve Category 3, 2, or 1 conditions, or prevent personnel access (see Table 3)

(Deleted)

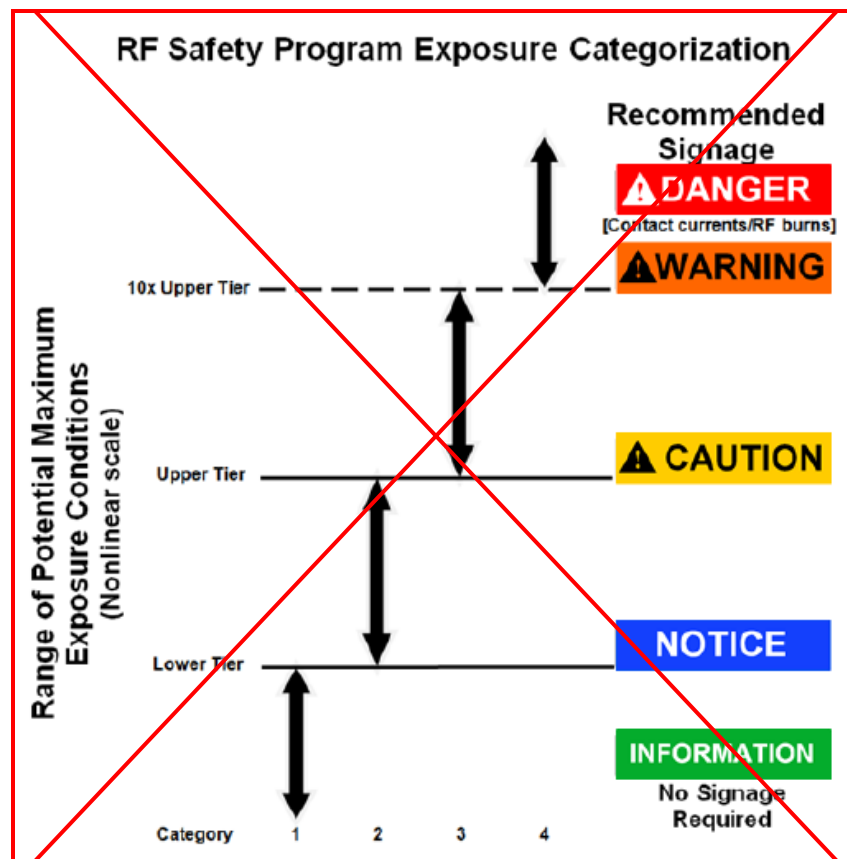
^aIn assessing the characteristics of an RF environment, consideration should be given to the potential for excessive exposure in the case of an accidental failure of systems that normally preclude excessive exposure such as breaks in waveguides. See text in this subclause for more information.

An effective RFSP can be used to ensure that employees and the general public are provided adequate protection against RF exposure in excess of applicable limits contained in applicable standards or guidelines, a few of which are listed in Annex I [B2], [B6], [B7], [B9], [B12], [B16], [B17], [B26]. This document describes the various elements that can be included in an RFSP. It also recommends when a specific element of the RFSP is needed based on the potential risks from RF hazards. While most of the recommendations contained in this document focus on occupational exposure situations, they will also be found applicable to public exposure settings. An RFSP is generally recommended anytime and anywhere persons may have the opportunity to occupy areas wherein RF exposures can exceed the exposure limits or RFSPIL as defined in the applicable standards or regulations. For purposes of this recommended practice, the applicable exposure limits are those values that are relevant to the appropriate level of control, be it for occupational or controlled environment exposures, or for general public or uncontrolled environment exposures.

Owners and operators of equipment that produce (intentional or incidental) RF emissions and any consequent exposure of persons will generally be responsible for the development of an RFSP. It should be recognized, however, that there may be similar responsibilities carried by those who simply own, operate, or manage facilities in or on which RF sources may be located [B28]. While the actual legal assignment of liabilities between these parties may vary between different countries and even between local and/or state jurisdictions, the provider or owner of the RF source equipment should inform facility management of those actions that they deem important for compliance with applicable exposure limits and, where relevant, provide necessary guidance for any required action. For example, property management organizations having locations with RF sources, but who bear no direct operational responsibilities, should share a common goal of ensuring the safety of both their own employees (and any subcontractors) and the general public. Furthermore, in many cases, the successful implementation of an RFSP can be highly dependent on the level of cooperation between property management and the regulated entities operating the RF sources [B28]. This same concept extends to broadcast sites where independent but multiple broadcast stations use but do not own the site [B10]. To this end, this recommended practice offers guidance to such organizations relative to the administrative and technical considerations of RFSPs.

A device with potentially higher exposure capability might be placed in Table 1, Category 1 due to its operational characteristics. For example, the inherent duty factor characteristics of a radar transmitter may produce time-averaged RF fields that are less than the RFSPIL level in accessible areas (source-based time averaging). Repetitive antenna rotations may also play a significant role in reduction of time-averaged exposures (e.g., exposure from a rotating antenna versus a non-rotating antenna). However, Category 1 is not intended to include situations in which compliance with the applicable exposure limit requires some action by the exposed person, such as limiting the amount of time spent in certain locations (time averaging). Furthermore, there may be situations in which high power systems may be incapable of producing significant exposure under normal conditions, but could produce serious exposures under other than normal conditions. Examples of such systems include waveguides carrying high power, which do not produce significant exposures as long as the waveguide remains intact with no leaks due to breaks in the waveguide itself or at the flange seals. Alternatively, high power systems that are protected with interlocks to avoid significant exposures may be considered of no special consequence, but may produce high level exposures if the interlock system fails. When evaluating the characteristics of an RF exposure environment for purposes of categorization, consideration should be given to the potential significance of an equipment failure relative to the requirement of an appropriate RFSP. Figure 1 provides a graphical representation of the categorization process described above and shows recommended RF safety signage appropriate to the exposure category.

The guidance of Table 1 is formulated to permit adaptation to either one-tier or two-tier RF exposure limits. An example of one-tier exposure limits is found in the ACGIH threshold limit values for exposure to RF fields [B2]. Examples of two-tier exposure limits are IEEE Std C95.1™-2005 [B17], FCC regulations [B11], the ICNIRP guidelines [B16], and the National Council on Radiation Protection and Measurements (NCRP) recommendations [B26].



(Deleted)

Figure 1—Graphical representation of the RF safety program categorization process corresponding to Table 1, Category 1 through Category 4

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they ~~shall~~**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.

IEEE Std C95.1™, IEEE Standard for Safety Levels ~~with~~ ~~With~~ Respect to Human Exposure to ~~Electric, Magnetic and Radio-Frequency~~ Electromagnetic Fields, ~~0 Hz 3 kHz~~ to 300 GHz. ~~14, 15, 16 4,~~
5

IEEE Std C95.1-2345™, IEEE Standard for Military Workplaces—Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz.

IEEE Std C95.2™, IEEE Standard for Radio-Frequency Energy and Current Flow Symbols.

IEEE Std C95.3™, IEEE Recommended Practice for Measurements and Computations of ~~Electric, Magnetic, and Radio-Frequency~~ Electromagnetic Fields with Respect to Human Exposure to Such Fields, ~~0 Hz to 100 kHz~~ 300 GHz.

~~IEEE Std C95.4™, IEEE Recommended Practice for Determining Safe Distances From Radio Frequency Transmitting Antennas When Using Electric Blasting Caps During Explosive Operations.~~

~~IEEE Std C95.6™, IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 3 kHz.~~

¹⁴ ⁴ The IEEE standards or products referred to in this clause are trademarks of The Institute of Electrical and Electronics Engineers, Inc.

¹⁵ ⁵ IEEE publications are available from The Institute of Electrical and Electronics Engineers, ~~445 Hoes Lane, Piscataway, NJ 08854~~ (<http://standards.ieee.org>).

¹⁶ The IEEE C95 family of standards can also be obtained at no cost from the IEEE Get Program at <https://ieeexplore.ieee.org/browse/standards/get-program/page>.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.^{17 6}

access control: A practice of managing entry ~~restricting access to areas wherein RF exposure environments may exceed applicable exposure limits via physical means such as indicative or areas.~~ See also: positive access control; indicative boundary; indicative barrier; exposure environment barriers or by the installation of appropriate signage. RF safety signage, when used in controlled environments and combined with appropriate RF safety training or information, can be a sufficient means of access control.

activity-based time-average control: The method of controlling an individual's exposure by controlling the amount of time an individual spends in higher exposure conditions such that the average satisfies the applicable exposure limit. See also: source-based time-average control.

action level: ~~See: RFSPIL.~~

administrative controls: The policies, procedures and information used ~~provided to limit personnel for the risk purpose of exceeding EME reducing exposure limits. to potential RF hazards and that~~

^{17 6} *IEEE Standards Dictionary Online* ~~subscription~~ is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

NOTE—Administrative controls generally depend on the awareness and participation of qualified individuals ~~personnel for their effectiveness~~. Examples include hazard communication ~~warning/alerting~~ signs and visual/audible alarms, indicative barriers, indicative boundaries, safety ~~(e.g., rails and chains), standard~~ operating procedures, ~~(safe work practices), personal protective equipment (PPE),~~ time limits on the duration of exposure (time average control averaging), and EME RF safety training.¹⁸

adverse health effect: An effect detrimental to an individual's physical well-being due to exposure to an electric, magnetic, or electromagnetic field or to induced or contact currents or voltages. *See also:* concomitant EME hazard

NOTE 1—For the purposes of this standard, an adverse reaction to electrostimulation is also an adverse health effect.

NOTE 2—Adverse health effects do not include changes in subjective feelings of well-being or biological effects without a harmful health effect.

NOTE 3—Sensory perceptions *per se* are not necessarily considered adverse health effects. For example, a perception of warmth at millimeter and other wavelengths and the microwave auditory effect under the underlying special conditions are not recognized as effects to be protected against by this standard.

NOTE 4—Painful or aversive sensations are considered adverse.

averaging time (T_{avg}): The ~~appropriate~~ time period over which exposure is averaged for purposes of ~~determining~~ comparison with ~~the an~~ exposure reference level or dosimetric reference limit. *See also:* time average, ~~maximum permissible exposure (MPE), or reference level~~.

awareness education: The act of imparting knowledge to an individual to enable that individual to exercise informed consent. *See also:* informed consent.

¹⁸ ⁷ Notes to in-text, tables, and figures ~~of a standard are given~~ for information only and do not contain requirements needed to implement the ~~this~~ standard.

concomitant EME hazard: A hazard presented by the unintended interaction of EMFs, currents, and/or contact voltages with electronics, materials, substances, or structures. *See also:* **adverse health effect.**

NOTE—Examples of concomitant EME hazards include medical device interference, inadvertent ignition of flammable atmospheres, and incidental detonation of explosive devices.

contact current: The current flowing through a person contacting charged conducting objects. *See also:* **grasping contact; touch contact.**

NOTE 1—The SI unit of contact current is ampere (A).

NOTE 2—In IEEE Std C95.1™-2019, contact current is specified as either that associated with a grasping contact (contact area assumed to be 15 cm²) or a touch contact (contact area assumed to be 1 cm²).

contact voltage: An open-circuit voltage between two conducting objects that when bridged by a human would produce contact current. *See also:* **open-circuit voltage.**

NOTE—The SI unit of contact voltage is volt (V).

controls: A term referring to various means for reducing the risk of exceeding EME exposure limits in restricted environments. *See also:* **administrative controls; engineering controls.**

device-based time-average control: A form of source-based time-average control that relies on the emitter dynamically controlling its emissions to maintain compliance over a moving time-averaging window. *See also:* **source-based time-average control, time-average control.**

NOTE— Device-based time-average control is used in the design of some portable and body-worn emitters that are typically operated intermittently but that could be operated for such durations that time-averaged exposures would exceed a limit without the intervention of the device's internal control mechanism.

dosimetric reference limit (DRL): The exposure limit based on dosimetric thresholds for established adverse health effects expressed as electric field strength within human tissue (0 Hz to 5 MHz), specific absorption rate (100 kHz to 6 GHz), or epithelial power density (6 GHz to 300 GHz) and provides an adequate margin of safety.

NOTE 1—DRLs are defined in conjunction with specified spatial and temporal averaging requirements.

NOTE 2—DRLs are equivalent to the quantity previously referred to as “basic restrictions.”

duty factor: The ratio of pulse width to the pulse period of a periodic pulse train.

NOTE—A duty factor of 1.0 corresponds to continuous-wave (CW) operation.

~~**ancillary hazards:** Those hazards that are subordinate to the primary hazard. Ionizing radiation, toxic/hazardous chemicals and gases, electrical hazards, and mechanical hazards are examples of ancillary hazards. *Syn:* **associated hazard.**~~

~~**basic restrictions (BRs):** Exposure restrictions that are based on established adverse health effects that incorporate appropriate safety factors and are expressed in terms of the *in situ* electric field (3 kHz to 5 MHz), specific absorption rate (100 kHz to 3 GHz), or incident power density (3 GHz to 300 GHz). Depending upon the frequency of the electromagnetic field, the physical quantities used to specify these restrictions are internal electric field strength (E_{int}), current density (J), specific absorption rate (SAR), specific absorption (SA), and power density (S). They are formulated in metrics that quantify RF field induced inside the body, which consequently provide a more accurate measure of potentially harmful exposure compared to derived limits based only on ambient field strength (E and H) exposures. However, BR quantities are often difficult and impractical to measure.~~

~~**contact current (I_C):** Current induced at the point of contact between the body and an energized RF conductor. Contact current at a person's fingertip (touch contact) is typically estimated by measuring current at the wrist using a clamp-on type of current transformer instrument. Contact may be via a grasp or touch. See also: **grasp contact** and **touch contact**.~~

~~NOTE—Limits on contact currents are designed to protect against the possibility of RF shocks or burns that may result from high current densities at the point of contact, particularly at the fingertip.⁷~~

~~**contact voltage:** Voltage between a body and an energized RF conductor. In practice, the open circuit voltage that exists between an object, typically immersed in an RF field, and the body of a person about to touch the object.~~

~~**controlled environment:** An area where the occupancy and activity of those within is subject to control and accountability as established by an RF safety program for the purpose of protection from RF exposure hazards. See also: **general public exposure** and **occupational exposure**. Contrast: **uncontrolled environment**.~~

~~NOTE—Implementation of an effective RF safety program such as outlined in this recommended practice is intended to eliminate exposure of persons in excess of applicable exposure limits.~~

~~**derived limit:** Alternative basis of compliance with a BR limit for whole body SAR. A derived limit incorporates exposure metrics that can be measured outside of the body and are consequently easier and more practical to measure than exposure metrics used with BR limits. However, derived limits are also a less direct and less accurate means of determining induced RF exposures in the body but are formulated to comply with the BRs under typical or expected conditions for ambient exposures and body characteristics. Hence, RF exposures above the derived limits do not necessarily imply that the BRs on whole body SAR have been exceeded for particular circumstances. The MPE levels in the IEEE standards and the reference levels in the ICNIRP guidelines are derived limits. Derived limits include limits for ambient electric field strength (E), magnetic field strength (H), magnetic flux density (B), currents flowing through the limbs (I_L), and contact current (I_C). See also: **maximum permissible exposure**.~~

electro-explosive device (EED): An explosive or pyrotechnic component that initiates an explosive, burning, electrical, or mechanical exothermic event and is activated by the application of electrical energy. An electric blasting cap is an example of an electro-explosive device.

electromagnetic energy (EME): The capacity to do work by electric and magnetic fields, electromagnetic fields, induced and contact currents and contact voltages across the spectrum from 0 Hz to 300 GHz. *See also:* **EME health and safety policy; EME safety officer; safety program.**

electromagnetic field (EMF): For the purposes of this standard, any field consisting of electric and/or magnetic components, regardless of whether it is propagating (radiating) or not.

NOTE—IEEE Std C95.1™-2019 defines this as a radiating field with both components.

EME safety committee: A group of persons responsible for the development of policies relative to EME safety programs for one or more specific EME exposure situations.

NOTE—In larger organizations, it is common for the EME safety committee to include representation from the health and safety, legal, human resources, property management, physical plant/facilities, and field operations departments. The actions of an EME safety committee may be included in the activities and responsibilities of an existing general safety committee. The size of the EME safety committee is determined by the needs of the organization.

EME safety management policy: For an organization that either uses EME or can be affected by the use of EME, that part of the organization's policy structure that describes the EME hazards, the management objectives, and responsibilities. *See also:* **safety program; SP scope.**

NOTE—A large organization with multiple sites might generate a comprehensive policy covering various aspects within the organization's accountability, such as SP implementation and maintenance, internal/external communications protocols, general SP elements and site-specific SPs, delegation of controls and accountability for SP management, and the like. For a small organization with one or a few sites, the policy might contain a simple recitation of the EME hazards and associated accountability upon which the SP is to be developed.

EME safety officer (ESO): A person who has knowledge and authority to administer and enforce an SP.

NOTE 1—Throughout this standard, it is assumed that wherever duties or responsibilities of the ESO are specified, it is taken to mean that the ESO either performs the stated task or delegates authority to other persons to perform the task under the ESO's direction.

NOTE 2—Alternative titles might be given to this role according to the organization e.g., RF Safety Officer (RFSO), Radiation Safety Officer (RSO) or Nonionizing Radiation Safety Officer.

engineering controls: Methods for limiting ~~Controls and performance guidelines to reduce RF exposures~~ by design and that do not require the participation of individuals to provide protection.

NOTE 1—Examples include ~~as implemented by use of specific types of equipment, such as interlocks, protective housings, radomes, positive access~~ controls, preprogrammed controls reliant on sensors ~~control barriers, software,~~ or the configuration of equipment at a site. ~~Engineering controls do not depend on the awareness of personnel for their effectiveness in reducing exposure.~~

NOTE 2— Engineering controls can prevent those who are not qualified individuals from entering restricted environments or limit the ability of qualified individuals to inadvertently exceed exposure limits.

epithelial power density: The power flow through the epithelium per unit area directly under the body surface (i.e., in stratum corneum of the skin or corneal epithelium of eyes).

NOTE—The SI unit for epithelial power density is watt per square meter (W/m²).

exposure: The state of being in the presence of EME in the form of electric, magnetic, or electromagnetic fields, or in contact with a current or voltage source.

exposure environment: A defined physical area that is characterized by the maximum potential specified EME exposure that could occur within it.

NOTE—It is convenient to use the boundary of a higher-category exposure environment as the threshold for implementing an access control protocol.

(A) **restricted environment**: An environment in which exposure might exceed the LEL.

NOTE 1—Implementation of an effective EME SP is to help ensure that persons are not exposed above the DRL or ERL for the restricted environment.

NOTE 2—In some documents, exposure in restricted environments is referred to as “upper tier” or “controlled environment” or “occupational” exposure.

NOTE 3—Restricted environments include Category 2, Category 3, and Category 4 areas as disclosed herein.

NOTE 4—Members of the general public are not permitted in restricted environments unless they meet the applicable requirements for qualified individuals and become subject to the applicable EME safety program, at which time they are qualified individuals and no longer considered members of the “general public.” See also: **qualified individual (OI)**.

(B) **unrestricted environment**: An environment in which exposures do not exceed the LEL.
See also: **general public**.

NOTE 1—The exposures can occur in living quarters or workplaces where there are no expectations that the DRL or ERL for unrestricted environments would be exceeded and where the induced currents, contact currents and contact voltages do not exceed the limits for unrestricted environments.

NOTE 2—In some documents, the unrestricted environment is referred to as a “lower tier” or an “uncontrolled environment” or a “general public” exposure area.

NOTE 3—Unrestricted environments are also called Category 1 environments herein and are to be separated by appropriate barriers from any contiguous area of a higher category.

exposure limit: A threshold value such as a dosimetric reference limit (DRL) or exposure reference level (ERL) including, when applicable, frequency dependency and spatial and temporal aspects (e.g., averaging). See also: lower exposure limit; upper exposure limit.

exposure reference level (ERL): An exposure limit derived from fundamental DRLs, in terms of EME quantities that are more readily measured or calculated.

NOTE 1—ERLs provide an adequate margin of safety against established adverse health effects.

NOTE 2—The ERL is expressed as the metric appropriate to the frequency and temporal and spatial characteristics of the exposure under consideration.

NOTE 3—The ERL is measured, estimated, or derived from the DRL (electric field strength within human tissue, SAR, or epithelial power density).

NOTE 4—The ERL may be exceeded if it can be demonstrated that the corresponding DRL is not exceeded.

NOTE 5—The ERLs and DRLs for contact current are the same.

NOTE 6—In some documents, ERLs are called reference levels, derived limits, maximum permissible exposure limits, maximum permissible exposure values, action levels, or investigation levels.

general public: All members of the human population who have inadequate awareness education or control of their EME exposure and are, consequently, not permitted in a restricted environment, i.e., an area with potential exposure above the LEL. Contrast: qualified individual. See also: unrestricted environment.

NOTE—The term “general public” applies to all persons who are not qualified individuals.

~~**exposure limit:** For purposes of this recommended practice, the root-mean-square (rms) or peak electric and magnetic field strengths, their squares, or the plane-wave equivalent power densities associated with these fields, and the induced and contact currents and contact voltages that are used to define the exposure categories and to which a person may be exposed without harmful effect and with an acceptable safety factor. See also: **derived limit, maximum permissible exposure, reference level, and basic restrictions.**~~

~~**general public exposure:** For purposes of this recommended practice, RF exposure of persons who have not received any form of RF safety awareness information or training. Typically, general public exposure occurs in uncontrolled environments and includes individuals of all ages and varying health status, including children, pregnant women, individuals with impaired thermoregulatory systems, individuals equipped with electronic medical devices, and persons using medications that may result in poor thermoregulatory system performance. See also: **uncontrolled environment.** Syn: **general population exposure.**~~

Grasping grasp **contact:** An electrical connection with an ~~a large~~ energized conductor made by firmly holding the conductor in the hand.

NOTE—For the purposes of computation ~~In this standard,~~ a contact area of 15 cm² ~~square centimeters~~ is assumed for a grasping ~~such~~ contact.

hazard: An intrinsic property or condition ~~of a device, or location,~~ that has the potential to cause an adverse impact on human health or safety ~~harm to people or damage to property.~~

hazard assessment: A structured process to gather the information necessary to develop a SP.

NOTE 1—Typically consists of the following elements: the location, extent, severity, and other aspects of each potential hazard are determined and recorded; risks and potential consequences of hazards relating to a situation are evaluated; populations potentially affected by the situation and their prospective activities are determined; the extant safety policies and controls are considered; the findings are documented.

NOTE 2—Exposure limits are commonly used as conservative indicators of the presence of potential EME hazards.

hot spot: A term commonly used to describe a highly localized area of relatively more intense EME that manifests in two principal ways: 1) near a conductive object that is the immediate source of intense electric or magnetic fields and is surrounded by ambient fields of lower intensity (often referred to as re-radiation) the intensity of which diminishes at a substantially greater rate than free-space inverse square-law attenuation, and 2) from reflections and/or narrow beams produced by high-gain radiating antennas or other highly directional sources. In both cases, there are rapid changes in field strength over distances that are small with respect to the objects and wavelength.

NOTE—EME hot spots are normally associated with non-uniform exposure of the body (i.e., resulting in elevated local exposure). This does not refer to an actual thermal hot spot within the absorbing body.

indicative barrier: An indicative boundary that obstructs movement but is easily bypassed, such as chains/ropes, rails, or unlocked gates. *See also:* **indicative boundary**.

NOTE—Indicative barriers are not robust enough to qualify as a positive access control.

indicative boundary: An administrative control that involves a sensory indicator that is easily crossed and serves to mark a perimeter. *See also:* **indicative barrier**.

NOTE—Indicative boundaries might be visual (e.g., signage, symbols, and markings such as painted stripes), or tactile (e.g., raised or textured surfaces), collectively positioned to indicate a perimeter without obstructing movement across it.

induced current: Electric current flowing in the body of a person in a freestanding condition due to an electromagnetic field. *See also:* **limb current**.

NOTE 1—The SI unit for induced current is ampere (A).

NOTE 2—For compliance with standards, this is normally measured as the current through the feet or ankles of the person to ground with the use of current transformers having a sufficient aperture size to fit around the ankle.

NOTE 3—In some documents, induced currents within specific extremities are referred to as limb currents.

informed consent: conscious acceptance by a competent person of increased risk after becoming aware of the risks and potential consequences of entering a restricted environment. *See also:* awareness education.

NOTE 1—In some circumstances, informed consent requires only awareness education of the risks and potential consequences, while other circumstances might also require training to control exposure before a person is sufficiently knowledgeable to make an informed decision.

NOTE 2—Informed consent is sometimes formally documented, recording each person that has been informed and made a conscious decision to accept the increased risk.

~~**incidental radiator:** A device that is not intentionally designed to emit RF energy but does so as a byproduct of its operation.~~

~~**indicative barriers:** Barriers, such as chains, rails, and demarcated areas that require awareness and participation of personnel as a form of administrative controls.~~

~~**industrial hygiene:** A science devoted to the protection and improvement of the health and well-being of workers exposed to chemical and physical agents in their work environment.~~

~~**insignificant radiator:** An RF device that cannot under any circumstances emit RF energy sufficient to cause exposures that exceed the applicable limits.~~

~~**intended use:** The use of a device over its full range of functions, in accordance with the instructions provided by the manufacturer.~~

~~NOTE—Intended use, i.e., the way a manufacturer specifies that a device should be used, and the way that a device is actually used, may not be the same.~~

intentional radiator: A device whose purpose is to generate and emit EME. Usually, an intentional radiator consists of an EME that intentionally generates and emits radio frequency energy by radiation or induction. This term generally means “radio transmitter connected directly or indirectly to an antenna.”

limb current (~~IL~~): Electric RF current induced in a person’s extremity limb. Limits on limb currents are designed to protect against excessive RF heating in the wrists and ankles and are most often measured using RF current transformers.

NOTE—The SI unit for limb current is ampere (A).

lower exposure limit (LEL): An exposure limit that applies to the general public, based on ERL or DRL, evaluation of which includes any applicable time and spatial averaging. Contrast: upper exposure limit. See also: exposure limit.

NOTE 1—Prior terms for lower exposure limit include the lower tier or unrestricted tier, or the general population or uncontrolled exposure limit.

NOTE 2—The term general public is associated with the terminology “persons in unrestricted environments” in IEEE Std C95.1-2019.

maintenance: Any activity such as tests, measurements, replacements, adjustments, and repairs intended to retain or restore a functional unit, including a device, system, or an SP, ~~in or~~ to a specified state in which the unit can perform its required functions.

open-circuit voltage: A difference of electrical potential between two points not electrically connected.

See also: contact voltage.

operation: 1. Work or a task, as in tower maintenance operations. 2. Causing an EME source to emit energy, as in transmitter operation.

operator: A person or organization that has the authority and/or ability to control the operation of an EME emitting device or system.

NOTE—In many cases, the operator of an EME source is not the owner of the facility in or on which the emitter is installed. For example, mobile phone base station antennas are often installed on towers or buildings that are owned by other entities.

overexposure: Exposure that exceeds the applicable dosimetric reference limits (DRLs) defined in the applicable standard as including any applicable time or spatial averaging.

overexposure incident: An event in which an individual is believed to have experienced overexposure.

~~**maximum permissible exposure (MPE):** Derived limits in RF exposure standards for time averaged and peak exposures to ambient electric (E) and magnetic (H) fields, e.g., the root mean square (rms) or peak electric and magnetic field strengths, their squares, or the plane wave equivalent power densities associated with these fields, and the induced and contact currents and contact voltages to which a person may be exposed without harmful effect and with an acceptable safety factor for protection from such effects. See also: **derived limit**. Syn: **permissible exposure level**, **radio frequency protection guide**, **investigation level**.~~

NOTE—Effects are those identified and described in this standard.

~~**normally accessible area:** For RF protection purposes, an area that can be accessed without recourse to special actions, special equipment, or personal protective equipment without which access is not feasible.~~

NOTE—Any location can be made accessible using sufficient effort, ancillary equipment, or personal protective equipment.

~~occupational exposure: RF exposure of persons resulting as a consequence of their employment who have been made fully aware of the potential for exposure and can exercise control over their exposure such as through the use of administrative or engineering controls or safe work practices (e.g., use of personal protective equipment or time averaging of exposures). See also: **controlled environment.**~~

~~NOTE 1—Awareness can be affected by the owner, operator, or party responsible for the source or site, by the RF safety officer (RFSO) or RF safety professional, and through specific training as part of an RFSP in which written and/or verbal information has been provided about appropriate safe work practices for controlling or mitigating personal exposures.~~

~~NOTE 2—Occupational exposure typically occurs only in controlled environments.~~

~~**operation, source:** The performance of the RF source or system over the full range of its intended functions (normal operation). This does not include *maintenance or service* as defined in this clause. See: **maintenance, service.**~~

~~**overexposure incident:** An incident in which RF exposure of a person exceeds the exposure limit after spatial averaging and time averaging have been taken into account. Documentation of overexposure incidents is a requirement of an RFSP.~~

~~**permissible exposure level (PEL):** See: **maximum permissible exposure.**~~

personal protective equipment (PPE): [Articles worn to reduce an individual's exposure to hazardous agents.](#)

~~NOTE— Equipment designed to protect personnel from serious workplace injuries or illnesses resulting from exposure to RF energy, contact with chemical, radiological, and physical agents, and electrical, mechanical, and other workplace hazards. For purposes of [EME](#) RF safety, PPE includes [personal monitors for detecting ambient EME levels as well as](#) electrically insulating gloves and [EME](#) RF-attenuating clothing in the form of coveralls, gloves, socks, and shielding hood assemblies.~~

personnel: Individuals who require access to restricted environments ~~For purposes of this recommended practice, persons responsible for operating, servicing, or maintaining RF sources or those requiring access to areas wherein RF exposure may occur during the course of their work.~~

NOTE 1—Personnel are usually workers with employment-related reasons to be given access. However, personnel may include individuals with non-work-related reasons to be given access.

NOTE 2—Usually, personnel are subject to the provisions of an SP through which they can become qualified individuals.

NOTE 3—In some jurisdictions personnel must have an “occupational,” i.e., work-related, reason to access a restricted environment.

physically restricted: Accessible only if an individual enters via positive access controls or employs special means required for access such as portable ladders, chairs, man-lifts, bucket trucks, cranes, or other equipment.

plane-wave-equivalent power density: The calculated power density of an electromagnetic wave that is equal in magnitude to the power density of a plane wave having the same electric field strength or magnetic field strength. Syn: equivalent-plane-wave power density.

NOTE 1—The SI unit of plane-wave-equivalent power density is watt per square meter (W/m²).

NOTE 2—Plane-wave-equivalent power density is computed as follows:

$$S_e = \frac{|E|^2}{\eta_0} \text{ W/m}^2 \text{ or } S_H = |H|^2 \eta_0 \text{ W/m}^2$$

(New)

where $|E|$ and $|H|$ are the root-mean-square values of the electric- and magnetic field strengths, respectively, and η_0 is the wave impedance of a plane wave in a vacuum.

population identification: In a hazard assessment, the process of identifying classes of individuals who may be present at a site based on the activities they conduct at the site.

positive access control: A two-component system for preventing entry by unqualified individuals consisting of a) physical barriers not easily breached by unauthorized persons, and b) access limitation enabling only qualified individuals to enter.

NOTE—Positive access control components include engineering controls such as locked doors/gates/covers/ladder cages, fences, walls, enclosures and shelters and administrative controls such as assigning qualified individuals passcodes, keys, or IDs for access that could be self-service or controlled by supervisors.

potential exposure: The maximum foreseeable total exposure ratio that could occur at a location assuming the full evaluation of any spatial and/or temporal elements specified by the relevant exposure limits. *See also:* **total exposure ratio.**

power density: Electromagnetic power per unit area crossing a surface of interest. *See also:* **plane-wave-equivalent power density.**

NOTE 1—The SI unit of power density is watt per square meter (W/m^2).

NOTE 2—The surface of interest is frequently chosen to be orthogonal to the electromagnetic wave direction of propagation.

practitioner: A role that is fulfilled by a person or persons qualified by knowledge, training, and experience to perform EME hazard assessments and formulate recommendations for an SP. *See also:* **EME safety Officer.**

qualified individual (QI): A person who has met the requirements specified by the SP to enter a restricted environment. *Contrast:* **unqualified individual.** *See also:* **personnel.**

NOTE 1—Such SP requirements typically address awareness education, training to control exposure, adherence to procedures, use of personal protective equipment, and ability to behave safely under a specific exposure situation. Other requirements such as age, occupation (e.g., as required by FCC, ICNIRP), and reliance on medical devices susceptible to EM interference might be included.

NOTE 2—Some exposure situations can employ more than one exposure-control protocol depending on the training and activity of each individual, such that there may be more than one type of qualified individual allowed to enter a certain restricted environment.

~~**positive access control barriers:** Locked doors and ladder cages, positive access control fences, etc., that are a form of engineering controls and that provide a positive restriction on access.~~

radio frequency (RF): A portion of the electromagnetic spectrum that is useful for radio transmission ~~frequency or band of frequencies suitable for telecommunications.~~

NOTE—For purposes of this standard recommended practice and for simplification, radio frequency refers to the frequency range extending from 3 kHz to 300 GHz, a part of the electromagnetic spectrum.

reradiated field: An electromagnetic field resulting from currents induced in a secondary, predominantly conducting object by electromagnetic waves incident on that object from one or more primary radiating sources.

NOTE—Reradiated fields are sometimes called “reflected” or more correctly “scattered fields.” The scattering object, sometimes called a “reradiator,” “secondary radiator,” or “parasitic radiator” can be a source of contact currents.

RF burn: An injury that has occurred when contact with, or spark discharge from, an RF energized conductor results in painful heating of tissue commensurate with visible skin damage and is usually accompanied by an involuntary withdrawal.

safety operating procedure: Formal written description of the safety and administrative procedures to be followed in performing a specific task. See also: work safety practice

NOTE—The safety operating procedure is a component of the work safety practice

~~**radio-frequency exposure limit:** See: **maximum permissible exposure**, **specific absorption rate**.~~

~~**radio-frequency hazard area:** For purposes of this recommended practice, an area in which RF fields or contact/induced currents or contact voltages may exceed the exposure limit or reference levels of an RF exposure regulation, standard, or guideline. See also: **hazard**.~~

~~**radio-frequency protection guide (RFPG):** See: **maximum permissible exposure**.~~

~~**radio-frequency safety:** A shorthand term widely used to mean safety with respect to exposure to RF energy.~~

~~**radio-frequency safety committee (RFSC):** A group of persons having overall responsibility for the development of policies relative to RF safety programs. In larger organizations, it is common that the RFSC could include representation from the health and safety, legal, human resources, property management, and field operations departments. The actions of an RFSC may be included in the activities and responsibilities of an existing general safety committee.~~

~~NOTE—An RFSC may have only a very few members or numerous members, depending on the nature of the organization.~~

~~**radio-frequency safety officer (RFSO):** One who has authority to monitor and enforce the control of RF hazards and affect the knowledgeable evaluation and control of RF hazards. See also: **occupational exposure**.~~

~~NOTE—Throughout this recommended practice, it should be understood that wherever duties or responsibilities of the RFSO are specified, it is taken to mean that the RFSO either performs the stated task or ensures that the task is performed.~~

~~**radio-frequency safety professional:** A person who is designated by the employer, site owner, or regulatory body to take appropriate actions to correct unsafe conditions including, if necessary, removal of workers.~~

~~NOTE—A radio frequency safety professional should be considered competent by way of training and experience, knowledgeable of applicable standards and guidelines, and capable of identifying hazards relating to the specific operation. See also: occupational exposure.~~

~~reference level: Limits for the exposure field strength and contact current values derived or estimated from the BRs. The reference levels associated with direct effects are electric field strength (E), magnetic field strength (H), magnetic flux density (B), power density (S), and currents flowing through the limbs (I_L); reference levels associated with perception and other indirect effects are contact current (I_C) and, for pulsed fields, incident energy density. See also: derived limit, maximum permissible exposure.~~

~~NOTE 1—In any particular exposure situation, measured or calculated values of any of these quantities can be compared with the appropriate reference level or MPE.~~

~~NOTE 2—Compliance with a reference level generally ensures compliance with the relevant BR. If the measured or calculated exposure exceeds the reference level, it does not necessarily follow that the BR will be exceeded. However, whenever a reference level is exceeded, further analysis may be used to evaluate compliance with the relevant BR to determine whether additional protective measures are necessary.~~

~~NOTE 3—Compliance with electric field reference levels or MPE values of an exposure standard may not ensure compliance with MPE values for induced currents.~~

~~radio frequency safety program (SP RFSP): An organized system of policies, protocols, procedures, practices, and plans designed to protect against hazards associated with human use of EME from 0 Hz to 300 GHz RF fields, contact voltage, and contact and induced currents. RFSPs shall be documented in writing.~~

~~NOTE 1—Implementation of—An effective RF safety program is documented and implemented to reduce the risk probability that persons might may be exposed in excess of applicable exposure limits and to reduce risks from concomitant hazards identified in the SP scope the MPEs of the upper tier.~~

NOTE 2—~~An EME safety A~~ program typically includes ~~EME RF~~ awareness ~~education, work safety practice~~ training, implementation of protective measures such as ~~access control~~, signage and the use of ~~personal protective equipment (PPE)~~, incident response, periodic evaluation of program effectiveness, and assigned responsibilities for implementing the program, ~~which collectively are similar to~~ the ~~subject of elements described in~~ this ~~standard recommended practice~~.

safety program initiation level (SPIL): The lowest potential exposure limit above which an SP is required; usually the LEL. *See also: lower exposure limit.*

~~**radio frequency safety program initiation level (RFSPIL):** The values of the electric and magnetic field strength, the incident power density, contact and induced current, and contact voltage above which steps should be initiated to avoid exposures that exceed the upper tier of the applicable standards, guidelines, and regulations, and in areas that are in close proximity (e.g., < 2 m) to RF conductors that may cause shock and/or burn hazards on contact.~~

~~**safe work practice:** Those operating and maintenance procedures that are effective in preventing accidents and preventing excessive RF exposure.~~

~~**service:** *See: maintenance.*~~

~~**secured enclosure:** An enclosure to which casual access is impeded by secure engineering controls, e.g., a door secured by a mechanical lock, magnetically or electrically operated lock or latch, or by fasteners that can only be removed with a tool.~~

~~**service, RF source:** The performance of those procedures or adjustments described in the manufacturer's service manuals/instructions which may affect any aspect of the performance of an RF source or system. *See: maintenance.*~~

signal word: The ~~verbiage~~ ~~word or words~~ in a sign or label that ~~designates~~ ~~designate~~ a degree of safety alerting.

NOTE—[See American National Standard for Environmental and Facility Safety Signs \(ANSI/ASSP \[B10\]\).](#)

safety training: Instruction on how to control exposure and otherwise behave safely in a restricted environment.

site: A place or premises for which it is prudent to conduct a hazard assessment.

~~NOTE—Signal words include: (A) DANGER indicates an imminently hazardous situation that, if not avoided, will result in serious injury or death. This signal word is to be limited to the most extreme situations. (B) WARNING indicates a potentially hazardous situation that, if not avoided, could result in serious injury or death. (C) CAUTION indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. (D) NOTICE indicates a statement of policy relating directly or indirectly to the safety of personnel or protection of property.~~

source-based time-average control: The reliance on an inherent intermittency or variability of an EME source to produce a time-average exposure that is compliant with the applicable exposure limit. *See also*: activity-based time-average control; device-based time-average control; time-average control.

~~NOTE 1— source-based time averaging: The result of the normal operation of a device or system such that~~ The time-averaged value of the associated exposure is related to the ~~inherent~~ duty factor cycle of a periodic ~~the~~ source.

~~NOTE 2—~~Examples include pulsed radars, dynamic beam (forming) antennas, the ~~intermittent~~ operation of portable radio communications devices that have a predictable intermittency, intermittent transmissions of radio beacons ~~smart (electric power) meters~~, and sources with continuously moving antennas.

NOTE 3—Can be considered an engineering control if properly protected from inadvertent or malicious adjustment, and an administrative control when used temporarily to reduce potential exposure under an SP.

source equipment: Equipment, ~~RF: RF-generating equipment~~ that ~~can~~ ~~may~~ emit ~~EME~~ ~~RF fields~~ into the environment either intentionally, such as a broadcast antenna, or unintentionally, such as a dielectric heat sealer or induction heater. *Syn: source; emitter. See also: intentional radiator; unintentional radiator.* ~~Syns: source, emitter.~~

spatial average: The characteristic of certain exposure limits that evaluate the mean exposure over a defined area or volume.

NOTE—Refer to IEEE Std C95.1™-2019 Annex B for details and IEEE Std C95.3™-2021 for measurement guidance.

specific absorption rate (SAR): The time derivative $\left(\frac{d}{dt}\right)$ of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) within an elemental volume (dV) of a medium having a mass ~~given~~ density (ρ). ~~SAR is expressed by the unit of watt per kilogram (W/kg).~~

$$SAR = \frac{d}{dt} \left(\frac{dW}{dm} \right) = \frac{d}{dt} \left(\frac{dW}{\rho dV} \right)$$

NOTE—The SI unit of SAR is watt per kilogram (W/kg).

SP scope: An expression of, or reference to, the EME safety management policy defining the EME hazards to be addressed through the SP and the associated compliance bases. See also: EME safety management policy.

time average: The average of exposure over a defined time duration for a relevant exposure limit, relying on the mean of a series of time-samples. See also: time-average control.

~~**spatial average, field strength or power density:** The ambient field squared exposure (E^2 or H^2), or power density (S) averaged over a number of spatial locations. Different spatial averaging schemes are defined in various standards and guidelines. For frequencies up to 3 GHz, the average of the field strength squared or equivalent power density over an area equivalent to the vertical cross section of the adult human body, as applied to the measurement of electric or magnetic fields in the assessment of whole body exposure.~~