C95.3.1™

IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic Fields with Respect to Human Exposure to Such Fields, 0 Hz to 100 kHz

IEEE Standards Coordinating Committee 39

Sponsored by the
IEEE International Committee on Electromagnetic Safety

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Abstract: Techniques and instrumentation for the measurement and computation of electric, magnetic, and electromagnetic (EM) fields in the near field of an EM field source are presented in this recommended practice. Descriptions of the concepts, techniques, and instruments that can be applied to the measurement of the electric and magnetic fields and the currents induced in the human body by these fields are provided. Techniques for determining the current density and the electric field strength within the human body are discussed. This recommended practice is intended primarily for use by engineers, biophysicists, and other specialists who are familiar with basic EM field theory and practice, and the potential hazards associated with EM fields. It will be most useful to bioeffects researchers, instrumentation developers and manufacturers, those developing calibration systems and standards, and persons involved in critical hazard assessments or hazard surveys.

Keywords: contact current measurement, electric field computation, electric field measurement, electromagnetic field computation, electromagnetic field measurement, ELF/VLF/RF survey instruments, exposure assessment, induced current measurement, magnetic field computation, magnetic field measurement, nonionizing radiation, RF/ELF/VLF hazard assessment

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Introduction

This introduction is not part of IEEE Std C95.3.1-2010, IEEE Recommended Practice for Measurements and Computations of Electric, Magnetic, and Electromagnetic Fields with Respect to Human Exposure to Such Fields, 0 Hz to 100 kHz.

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, Inc. (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 (SCC 28) 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 SCC 28 to better reflect the scope of the committee and its international membership. In accordance with policies of the IEEE, C95 standards are issued as IEEE developed as IEEE standards, as well as submitted to ANSI for recognition.

In 2005, SCC 28 and SCC 34 became Technical Committees 95 and 34, respectively, under a new IEEE Standards Coordinating Committee (SCC), SCC 39, which is now called ICES. [a]

The present scope of IEEE ICES is as follows:

"Development of standards for the safe use of electromagnetic energy in the range of 0 Hz to 300 GHz relative to the potential hazards of exposure of man, volatile materials and explosive devices to such energy. It is not intended to include infrared, visible, ultraviolet, or ionizing radiation. The committee will coordinate with other committees whose scopes are contiguous with ICES."

There are five TC95 subcommittees, each of whose area of responsibility is described as follows in correspondence with its designated subcommittee number:

I Techniques, Procedures, Instrumentation and Computation
II Terminology, Units of Measurements and Hazard Communication
III Safety Levels with Respect to Human Exposure, 0 Hz–3 kHz
IV Safety Levels with Respect to Human Exposure, 3 kHz–300 GHz
V Safety Levels with Respect to Electro-Explosive Devices

Subcommittee I of ICES Technical Committee 95 (TC95) is responsible for this recommended practice. Three standards, four recommended practices, and one guide have been issued. Present versions are as follows:

— IEEE Std C95.1™-2005 [B55][b]
— IEEE Std C95.2™-1999 [B56]
— IEEE Std C95.3™-2002[c]
— IEEE Std C95.3.1™-2010
— IEEE Std C95.4™-2002 [B57]
— IEEE Std C95.6™-2002 [B58]
— IEEE Std C95.7™-2005 [B59]
— IEEE Std 1460™-1996 [B54]

[a] 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.
[b] The numbers in brackets correspond to those of the bibliography in Annex D.
[c] Information on references can be found in Clause 2.

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1. Overview

1.1 Scope

This recommended practice describes 1) methods for measuring external electric and magnetic fields and contact currents to which persons may be exposed, 2) instrument characteristics and the methods for calibrating such instruments, and 3) methods for computation and the measurement of the resulting fields and currents that are induced in bodies of humans exposed to these fields. This recommended practice is applicable over the frequency range of 0 Hz to100 kHz.

1.2 Purpose

The purpose of this recommended practice is to describe preferred measurement techniques and computational methods that can be used to ascertain compliance with contemporary standards for human exposure to electric and magnetic fields in the frequency range of 0 Hz to 100 kHz such as