Proceedings of the 28th IEEE
EMBS Annual International Conference
New York City, USA, Aug 30-Sept 3, 2006

Developing Safety Standards for Electromagnetic Energy: The IEEE International Committee on Electromagnetic Safety (ICES)

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Abstract— **ICES develops (1) standards for the safe use of electromagnetic energy in the range of 0 Hz to 300 GHz relative to the potential hazards of exposure to humans, volatile materials, and explosive devices, (2) standards for products that emit electromagnetic energy by design or as a by-product of their operation, and (3) standards for environmental limits. ICES history, goals, organization, leadership, and products are described.**

I. WHAT IS ICES?

THE International Committee on Electromagnetic Safety (ICES) develops (1) standards for the safe use of electromagnetic energy in the range of 0 Hz to 300 GHz relative to the potential hazards of exposure to humans, volatile materials, and explosive devices, (2) standards for the assessment of human exposure to electromagnetic energy in the range of 0 Hz to 300 GHz, (3) product standards relative to the safe use of electromagnetic energy, and (4) standards for environmental limits. ICES is a Standards Coordinating Committee (SCC39) sponsored by the IEEE Standards Association Standards Board (SASB) and operates under its rules and oversight. ICES follows an open consensus process, with a balanced representation from the medical, scientific, engineering, industrial, government, and military communities. As of 30 March 2006, membership of the central governing and the technical committees (TC34 and TC95) was 150 professionals representing 25 countries. ICES strives to achieve consensus among all the stakeholders in the safe use of electromagnetic energy, thereby producing practical standards that are readily accepted and applied.

II. ICES BACKGROUND

With roots dating back to 1884, the IEEE is today the world's largest technical professional society, with almost 360,000 members, approximately one third of whom are from outside the US, representing 175 countries. The development of internationally recognized voluntary standards, through an open consensus process, has long been a major effort of the IEEE. In 1960, IEEE co-sponsored the first US radio frequency (RF) safety standard project (C95), which led to the first US national standard (C95.1-1966). Later, C95.1-1982 was the first standard in which field limits were derived from the frequency-dependant dosimetric quantity, specific absorption rate (SAR). Dosimetry and a threshold SAR of 4 W/kg are now the bases for most RF safety standards and guidelines, including those of ICNIRP, NATO, NRPB, and the US DoD.

Until 1990, the committee was an ANSI-Accredited Standards Committee (C95); in 1990 it became an IEEE committee (SCC28) sponsored by the IEEE SASB. In 1995, IEEE SCC34, concerning standards for products using or producing electromagnetic energy, was established with ties to SCC28. The name ICES was approved by the IEEE SASB in 2001 for use by SCC-28, and in 2005, SCC34 and SCC28 were combined under the name ICES; a placeholder was provided for a future technical committee for the development of environmental standards for EM energy. Figure 1 diagrams the ICES organization.

IEEE standards are "living" documents that continue to be refined through the worldwide volunteer efforts of stakeholders in the safe use of electromagnetic energy.

III. ICES ADMINISTRATIVE COMMITTEE (ADCOM) CURRENT MEMBERS:

Chairman: Ronald C. Petersen
r.c.petersen@ieee.org

Past Chairman/Executive Secretary: Dr. Eleanor R. Adair
eadair@comcast.net

Chairman Emeritus: Dr. John M. Osepchuk
j.m.osepchuk@ieee.org

Vice Chairman: Dr. Ralf Bodemann
ralf.bodemann@siemens.com

Treasurer: Arthur G. Varanelli
a.g.varanelli@ieee.org

Membership: Dr. Sheila Johnston
sajohnston@btclick.com

International Liaison: Dr. Michael R. Murphy
michael.murphy@brooks.af.mil

IEEE Staff: William Ash
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Manuscript received April 3, 2006.

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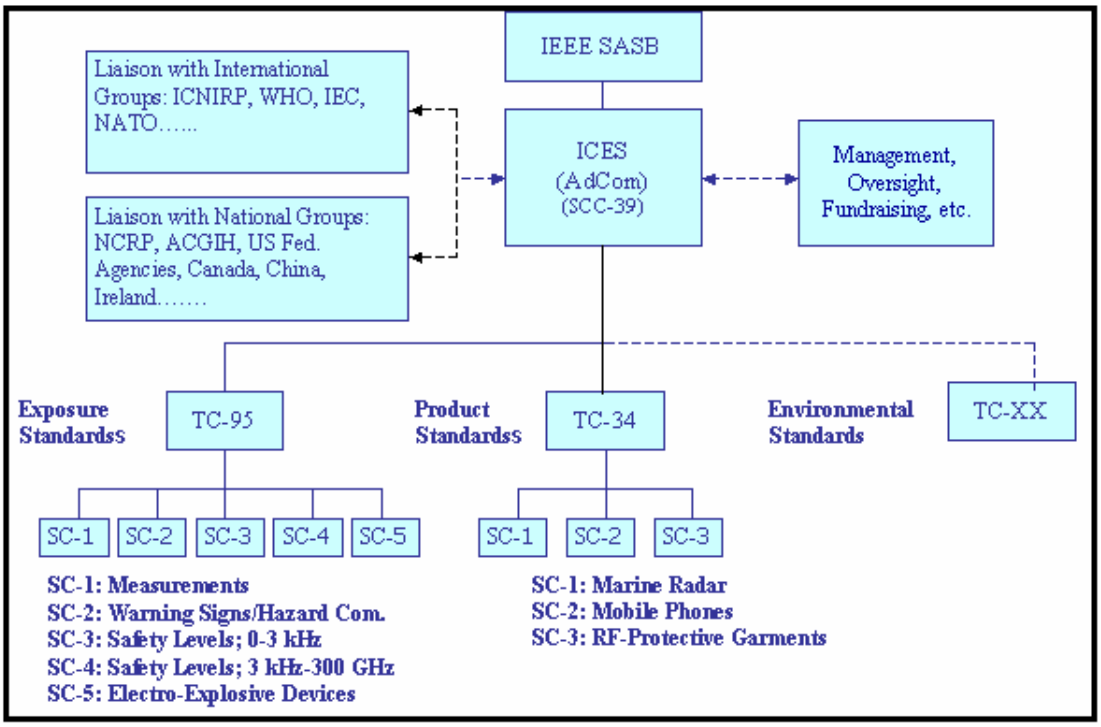

Figure 1: Diagram of ICES organization approved 2005.

IV. ICES TECHNICAL COMMITTIES (TC) AND SUBCOMMITTEES (SC)

Technical Committee 95 (TC95)

SC1: Techniques, Procedures, and Instrumentation, Howard I. Bassen, howard.bassen@fda.hhs.gov

SC2: Terminology, Units of Measurements, and Hazard Communication Richard A. Tell, rtell@radhaz.com

SC3: Safety Levels with Respect to Human Exposure, 0-3 kHz, Philip Chadwick, phil.Chadwick@mcluk.org, and Thanh Dovan, tdovan@spipowernet.com.au

SC4: Safety Levels with Respect to Human Exposure, 3 kHz-300 GHz, Dr. Art Thansandote, Art_Thansandote@hc-sc.gc.ca and Dr. Marvin Ziskin, ziskin@temple.edu

SC5: Safety Levels with Respect to Electro-Explosive Devices, Robert Needy, robert.needy@navy.mil and G. Drew Koban, gkoban@relay.nswc.navy.mil

Technical Committee 34 (TC34)

Chairman: Kathy MacLean kathym@aprel.com

SC1: Small Boat Radar, Arthur G. Varanelli, a.g.varanelli@ieee.org

SC2: Wireless Handset Certification, Dr. Mark Douglas, mark.douglas@motorola.com and Dr. Wolfgang Kainz, wolfgang.kainz@fda.hhs.gov

SC3: RF Protective Garments, Richard A. Tell, rtell@radhaz.com

V. ICES EXPOSURE STANDARD FOR EXTREMELY LOW FREQUENCY EMF (C95.6)

In 2002 IEEE C95.6-2002 "IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz" was published. This standard, developed by the members of SC3, was the first C95 standard to prescribe limits for exposure to electric and magnetic fields for the ELF portion of the spectrum. The C95.6-2002 basic restrictions and the derived limits (maximum permissible exposure values—MPEs) were scientifically derived to avoid: (1) aversive or painful stimulation of sensory neurons; (2) muscle excitation that might lead to injuries while performing potentially hazardous activities; (3) excitation of neurons or direct alteration of synaptic activity within the brain; (4) cardiac excitation (heart contraction that might lead to fibrillation); and (5) magneto-hydrodynamic effects.

VI. ICES EXPOSURE STANDARD FOR THE RADIO FREQUENCY RANGE (C95.1)

C95.1-1991, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," was reaffirmed in 1997, an amendment to address ambiguities in the induced current limits was published in 1999, a second amendment to address SAR limits for the pinna was published in 2004 and a complete revision of the standard, C95.1-2005, was published in April 2006. More than 1300 relevant scientific papers were reviewed for this revision. In 2002, just before the annual meeting of the Bioelectromagnetics Society, the Air Force held a Workshop to review the RFR bioeffects literature being evaluated by SC4 for the revision of C95.1-1991. The authors of these review presentations were invited to submit manuscripts for peer review and publication in the journal Bioelectromagnetics (Supplement 6, S1-S213, 2003). One goal of the revision was to harmonize with other standards and guidelines where scientifically defensible, e.g., the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines. A comparison of ICNIRP and the "old" and "new" ICES C95.1 safety levels is shown in Fig. 2. The basic restrictions and MPEs of C95.1-2005 protect against *established* adverse health effects in humans as identified in the reviewed studies that are associated with exposure to electric, magnetic and electromagnetic fields, and induced and contact currents. In the frequency range of 3 kHz to 5 MHz, the limits protect against adverse effects associated with electrostimulation; in the frequency range of 100 kHz to 300 GHz, the limits protect against adverse health effects associated with heating. In the transition region of 0.1 to 5 MHz, each of the two sets of limits must be applied.

VII. OTHER RECENTLY PUBLISHED STANDARDS FROM ICES:

TC95 Standards

C95.7-2005, "IEEE Recommended Practice for Radio Frequency Safety Programs,"

C95.4-2002, "IEEE Recommended Practice for Determining Safe Distances from Radio Frequency Transmitting Antennas when Using Electric Blasting Caps"

C95.3-2002, "IEEE Recommended Practice for Measurements & Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz to 300 GHz" (replaced C95.3-1991)

C95.2-1999, "IEEE Standard for Radio Frequency Energy & Current-Flow Symbols" (reaffirmed in 2005)

PC95.3.1, "Draft Recommended Practice for Measurement and Computation of Electric, Magnetic and Electromagnetic Fields with Respect to Human Exposure to Such Fields, 0 – 100 kHz"

TC34 Standards

1528-2003: IEEE Recommended Practice for Determining the Peak Spatial –Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

1528a-2005: IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, Amendment 1: CAD File for Human Head Model (SAM Phantom)

VIII. HOW TO PARTICIPATE IN ICES

All are welcome to participate in the meetings of ICES and to join and vote on the Subcommittees. To apply for voting membership on the ICES parent committee, send a letter and resume to:

Dr. Sheila Johnston, ICES Membership Chair
10 Queens Mew
London 2, England or sajohnston@btclick.com

IX. JOIN ICES AT ITS NEXT MEETING

ICES and its Technical Subcommittees hold several meetings a year. A schedule can be obtained from any of the individuals named in this paper. For additional information, visit our website at: http://grouper.ieee.org/groups/scc28/.

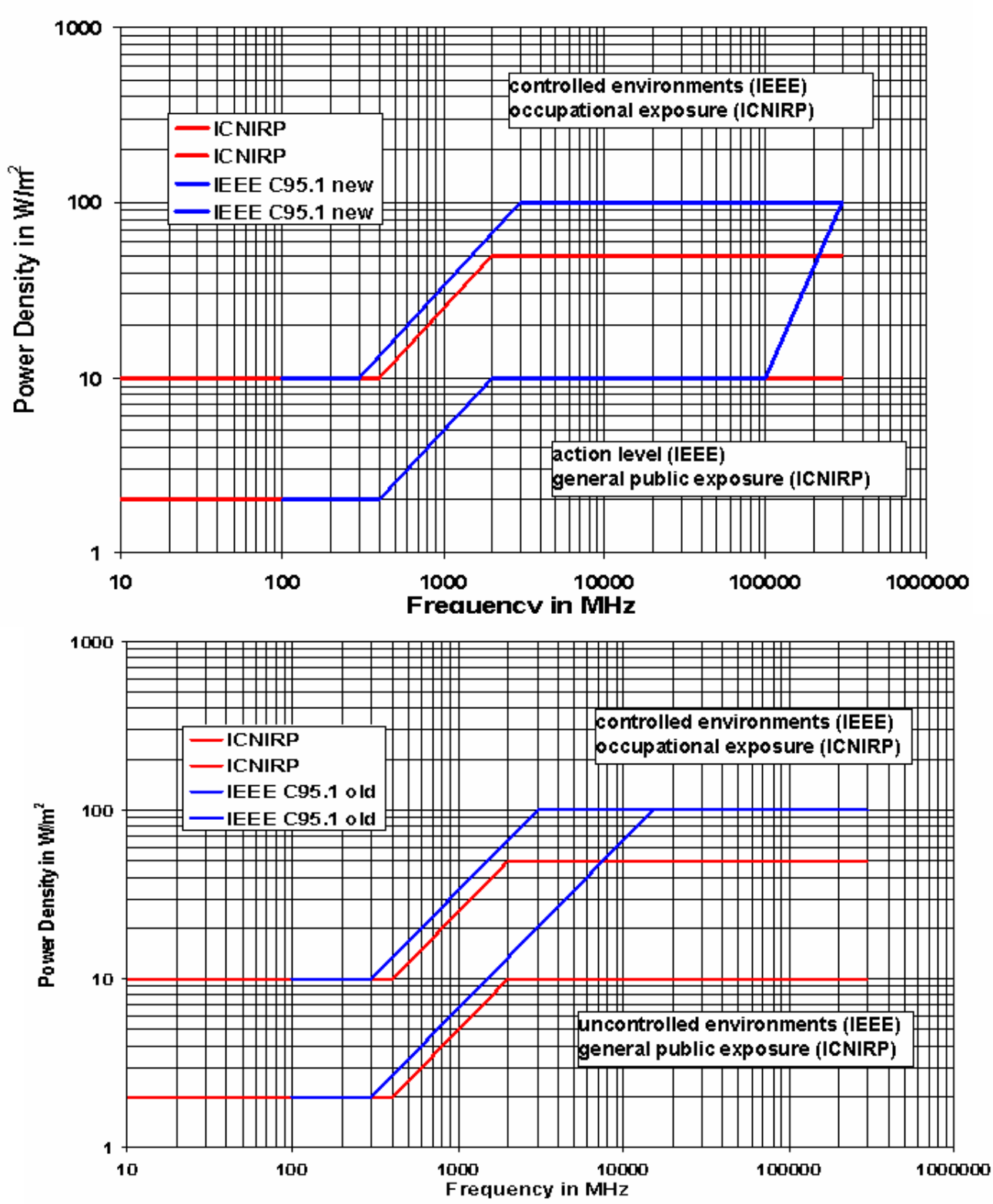

Figure 2: Comparison between "Old" (1991) and "New" (2005) IEEE C95.1 with ICNIRP Limits for RFR. (Figure developed by Dr. Ralf Bodemann)