0. Registration of attendance

Attendees signed in the WebEx chat window throughout the meeting.
The attendees list is provided in Attachment 1.

1. Call to Order

Meeting called to order at 8.12 AM EST.

2. Approval of Agenda

Ziskin moved; Butcher seconded. Agenda approved unanimously.
The agenda is provided in Attachment 2.

3. Approval of July 15, 2021 TC95 minutes¹

Kavet moved; Kihlstrom seconded. Approved.

4. Call for Patents*

The TC95 Chairman informed participants on their duty to inform the IEEE of holders of essential patent claims if they or their affiliations hold such claims. The Chairman informed participants that the IEEE SA patent policy is explained at:

https://development.standards.ieee.org/myproject/Public/mytools/mob/slideset.ppt

No participant informed about applicable patent claims.

5. IEEE copyright policy⁸

The TC95 Chairman informed participants on the IEEE copyright policy, which can be consulted at:

https://standards.ieee.org/ipr/copyright-materials.html

6. ICES Chairman’s Report

Dr. Keshvari could not attend this meeting and deliver his remarks.

7. TC95 Chairman’s Report

The report is provided in Attachment 3.

¹ Minutes of the prior meetings are posted on the ICES website.
8. Secretary’s Report  
   The report is provided in Attachment 4.  
   Faraone

9. Treasurer’s Report  
   The report is provided in Attachment 5.  
   Chou

10. Membership Chairman’s Report  
    The report is provided in Attachment 6.  
    Escobar

11. IEEE GetProgram Report  
    The report is provided in Attachment 7.  
    Colville

12. IEEE Staff Reports  
    The report is provided in Attachment 8.  
    Roder/Wiggins

13. Topic presentations  
    a) Plan on “Develop one or more ‘guides’ on anticipated EMF in the Environment”  
       The presentation is provided in Attachment 9.  
       Zollman
    
   b) Plan on “Potential Guide for Safety Levels with Respect to Small-Animal Exposure to Electromagnetic Fields, 1 GHz to 300 GHz.”  
       The presentation is provided in Attachment 10.  
       Tell
    
   c) Origin of SAR and safety factors  
       The presentation is provided in Attachment 11.  
       Chou
    
   d) Update on actual RF exposure levels of mobile phones and base stations  
       The presentation is provided in Attachment 12.  
       Chou

14. Subcommittee Reports  
    a) SC1 (Measurements and computations)  
       The report is provided in Attachment 13.  
       Zollman/Butcher
    
    b) SC2 (Safety programs)  
       The report is provided in Attachment 14.  
       Tell
    
    c) SC3 (Safety levels – 0 Hz to 3 kHz)  
       The joint SC3-4 report is provided in Attachment 15.  
       Kavet/Legros/Ziskin/Thansandote
    
    d) SC4 (Safety levels – 3 kHz to 300 GHz)  
       The chair could not attend this meeting and delivered the report by email.  
       Attachment 16.  
       Harmon/Visser
    
    e) SC5 (Effects of EM fields on blasting operations)  
       The chairs could not attend this meeting and delivered the report by email.  
       Attachment 16.  
       Hirata
    
    f) SC6 (EMF dosimetry modeling)  
       The chair could not attend this meeting and delivered the report by email.  
       Attachment 17.  
       Hirata

15. ICES Website Update  
    The report is provided in Attachment 18.  
    Glembo/Zhao

16. New Business  
    No new business.  
    Chou

17. Future Meetings  
    The next meeting will be conducted at Nagoya, Japan on June 18, 2022.  
    Chou

18. Adjourn  
    Meeting adjourned at 11.00am US EST.
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<tr>
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<td>Kun</td>
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<td>Tell</td>
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<td>Vecchi</td>
<td>Giuseppe</td>
<td>Polytechnic University of Turin, Italy</td>
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<td>Zoliman</td>
<td>Peter</td>
<td>PZC (Consultant)</td>
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0. Registration of attendance (sign in at Chat, name and affiliation, email if new)
1. Call to Order
2. Approval of Agenda
3. Approval of July 15, 2021 TC95 minutes
4. Call for Patents*
5. IEEE copyright policy#
6. ICES Chairman’s Report
7. TC95 Chairman’s Report
8. Secretary’s Report
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   e) SC5 (Effects of EM fields on blasting operations)
   f) SC6 (EMF dosimetry modeling)
15. ICES Website Update
16. New Business
17. Future Meetings
18. Adjourn

* Participants have a duty to inform the IEEE of holders of essential patent claims if they or their affiliations hold such
claims. Check the web link on the agenda for more details. If anyone in this meeting is personally aware of any patent claims that
are potentially essential to implementation of the proposed standard(s) under consideration by this group and that are not already the subject of an Accepted Letter of Assurance, please speak to the committee chair today.

The IEEE SA patent policy is explained at the following links:
https://development.standards.ieee.org/myproject/Public/mytools/mob/slideset.ppt

*Copyright
https://standards.ieee.org/ipr/copyright-materials.html

IEEE SA COPYRIGHT POLICY

By participating in this activity, you agree to comply with the IEEE Code of Ethics, all applicable laws, and all IEEE policies and procedures including, but not limited to, the IEEE SA Copyright Policy.

- Previously Published material (copyright assertion indicated) shall not be presented/submitted to the Working Group nor incorporated into a Working Group draft unless permission is granted.
- Prior to presentation or submission, you shall notify the Working Group Chair of previously Published material and should assist the Chair in obtaining copyright permission acceptable to IEEE SA.
- For material that is not previously Published, IEEE is automatically granted a license to use any material that is presented or submitted.
TC95 Chairman’s Report

C-K. Chou

January 20, 2022
IEEE Exposure Standards History

1960: USASI C95 Radiation Hazards Project and Committee chartered
1966: USAS C95.1-1966 (2 pages)
    10 mW/cm² (10 MHz to 100 GHz)
    based on simple thermal model
1974: ANSI C95.1-1974 (limits for $E^2$ and $H^2$)
1982: ANSI C95.1-1982 (incorporates dosimetry)
2002: IEEE C95.6-2002 (0-3 kHz)
2014: IEEE C95.1-2345-2014 (0-300 GHz) (NATO/IEEE agreement)
2015: NATO adopted C95.1-2345-2014
2019: IEEE C95.1-2019 (0-300 GHz) published on October 4, 2019
    (310 pages, 1550 ref.)
Dr. B Jon Klauenberg, NATO/IEEE standard leader and Ex-Membership Chairman of ICES passed away

August 16, 2021

BERTRAM JON KLAUENBERG was born in Baltimore, MD, USA, on August 16, 1947. He passed away on August 8, 2021 in San Antonio, TX due to Covid-19. B Jon, as he was known to his ICES colleagues, received a dual B.S. degree in psychology-anthropology from Towson University, Baltimore, in 1972, the M.A. degree in physiological psychology, in 1977, and the interdisciplinary Ph.D. degree in neuropsychology and human physiology from Wayne State University, Detroit, MI, in 1980. 

...
August 15, 2018 in Eureka Springs, AR

B Jon was in both January and July 2021 TC95 virtual meetings
Congratulations to Peter and Matt for their IEEE recognitions of their contributions in the publication of C95.3-2021 on 5/30/2021.

• **Matthew J. Butcher**: For dedication and perseverance in contributing to and fostering the development of a substantially revised and improved IEEE C95.3™-2021

• **Peter Zollman**: For outstanding effort and steadfast persistence in leading the development of a substantially revised and improved IEEE C95.3™-2021

IEEE C95 Get Program statistics

Statistics of 2021

Thanks to Department of Defense
Interest survey results on the two proposed projects from SC5:

a) Potential study area to develop one or more “guides” on anticipated EMF in the environment
   
   20 supports and 27 no

b) Potential Guide for Safety Levels with Respect to Small-Animal Exposure to Electromagnetic Fields, 1 GHz to 300 GHz

   15 supports and 30 no
Meetings:

- **August 29**: NCRP advisory panel meeting, “Poor Bioelectromagnetics Research and Other Contributing Factors on Electromagnetic Safety Controversy”.


- **September 29**: BioEM2021 meeting: “SAR origin and safety/reduction factors of radio frequency exposure limits”

- **September 29**: BioEM2021 Plenary session: A comparison between the recently released IEEE and ICNIRP radiofrequency guidelines/standards: What are the differences, and do they make a difference?
  - “Difference of exposure restrictions between new IEEE C95.1 standard and ICNIRP guidelines” Akimasa Hirata.


- **December 1**: VI International EMF Conference, Warsaw, Poland “Assessing Levels of RF Exposure from Mobile Phones and Base Stations” Organized by the National Institute of Telecommunications in cooperation with the Chancellery of the Prime Minister of Poland.
BioEM2021 meeting
Ghent, Belgium and online, 27-30 September 2021

**All Attendees, On-site and Online (283)**

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165 Abstracts
30 Countries
Plenary Sessions

- **Plenary 1: 5G Overview and what next**
  - Speaker: Rahim Tafazolli (Department of Electrical and Electronic Engineering, University of Surrey, Guildford, UK)

- **Plenary 2: Exploring the potentials of EM waves from body-scale to nanocommunications for healthcare applications**
  - Speaker: Akram Alomainy (Department of EECS, Queen Mary University of London, London, UK)

- **Plenary 3: A comparison between the recently released IEEE standard and ICNIRP radiofrequency guidelines: What are the differences, and do they make a difference?**
  - New IEEE C95.1-2019 standard and ICNIRP 2020 guidelines
    - Speaker: C. K. Chou (C-K. Chou Consulting, Dublin, CA, USA)
  - Difference of exposure restrictions between new IEEE C95.1 standard and ICNIRP guidelines
    - Speaker: Akimasa Hirata (Department of Electrical and Mechanical Engineering, Nagoya Institute of Technology, Nagoya, Japan)

- **Plenary 4: Electrogene transfer: challenges and recent advances in DNA-based vaccines**
  - Thursday September 30, 2021 • 11:15 - 12:15
  - Speaker: Simona Salati (IGEA Biophysics Laboratory, Carpi, Italy)
Workshops

- Workshop 1: Local exposure in the context of risk assessment: Theory and practical demonstration
- Workshop 2: Effects of low-intensity RF on thermal regulation
- Workshop 3: Ultraweak and weak static, ELF, and RF field effects on biological systems
- Workshop 4: Sensitivity to EMF: The Present and The Future
Tutorials

- **Tutorial 1:** Endogenous bioelectric networks underlie embryogenesis, regeneration and cancer: from basic mechanisms to electroceuticals
  Speaker: Michael Levin (Allen Discovery Center, Tufts University, Medford, MA, USA)

- **Tutorial 2:** Systematic reviews in Bioelectromagnetic research
  - Assessing health risks from exposure to RF-EMF: The WHO approach
    Speaker: Emilie van Deventer (Department of Environment, Climate Change and Health, World Health Organization, Geneva, Switzerland)
  - Introducing COSTER: recommendations for conducting systematic reviews of environmental health questions
    Speaker: Paul Whaley (Lancaster Environment Centre, Lancaster University, Lancaster, UK)

- **Tutorial 3:** Study Quality and Reproducibility – Pillars for safety assessments and medical applications in Bioelectromagnetics
  - Quality analysis in EMF research, where are we and why does quality matters?
    Speaker: Myrtil Simko (SciProof International AB, Östersund, Sweden; Institute for Advanced Studies, Strömstad Akademi, Strömstad, Sweden)
  - Implications of “metascience” research to improve the quality of bioelectromagnetics research
    Speakers: Vijayalaxmi (Department of Radiology, San Antonio, TX, USA) & Kenneth Foster (Department of Bioengineering, University of Pennsylvania, Philadelphia, PA, USA)
BioEM 2022
JUNE 19-24, NAGOYA, JAPAN | HYBRID EVENT
The Joint Annual Meeting of the Bioelectromagnetics Society and the European Bioelectromagnetics Association
Secretary’s Report

20 January 2022 Meeting

Webex @ World

Antonio Faraone
ICES TC95 Structure

TC95 is comprised of six subcommittees:

1. Techniques, Procedures, Instrumentation and Computation (IEEE Stds C95.3, C95.3.1)
2. Terminology, Units of Measurements and Hazard Communication (IEEE Stds C95.2, C95.7)
3. Safety Levels with Respect to Human Exposure, 0 Hz–3 kHz (IEEE Std C95.6)
4. Safety Levels with Respect to Human Exposure, 3 kHz–300 GHz (IEEE Stds C95.1, C95.1-2345)
5. Safety Levels with Respect to Electro-Explosive Devices (IEEE Std C95.4)
6. EMF Modeling (IEEE Std 2889™-2021)
ICES TC95 Standards: Status

C95.1-2019: (Safety levels, 0 Hz – 300 GHz)
- Published in October 2019
- C95.1-2019 / Corrigenda 1 - 2019 included in C95.1-2019
- C95.1-2019 / Corrigenda 2 - 2020 not included in C95.1-2019

C95.1-2345-2014: (Safety levels, 0 Hz – 300 GHz)
- Approved 16 May 2014; published 30 May 2014
- NATO STANAG 2345 Ed.4, November 2015
- Expires in 2024 – 5 years for revision & NATO endorsement
- To be revised based on IEEE C95.1-2019
- Provisions are not expected to impair theater operations
**ICES TC95 Standards: Status**

**C95.2-2018:** (RF energy and current flow symbols)
- Expires in 2028.

**C95.3-2021:** (RF exposure assessments, measurements and computations: 100 kHz to 300 GHz)
- Published in May 2021 [https://standards.ieee.org/standard/C95_3-2021.html](https://standards.ieee.org/standard/C95_3-2021.html)
- Currently looking at potential study areas for the next revision
ICES TC95 Standards: Status

C95.4-2002: (Safe distances during blasting operations)
- Reaffirmed 2008
- PAR for Revision – approved in September 2016;
- PAR expired on 31 December 2020
- Requested approval to withdraw the standard Nov 2020
- IEEE SA Standards Board approved the request 3 Dec 2020

C95.6-2002: (Safety levels – 0 to 3 kHz)
- Obsolete
C95.7-2014: (RF safety programs)
- Revision of C95.7-2005
  - Approved 12 June 2014; published 8 August 2014
    - Working Group formed to improve guidance consistency with the rationale of the newly revised C95.1-2019 standard
  - New draft circulated with reviewers responses by 5 December 2020
    - Addressed 770 comments in 2021 with major restructuring of document.
    - Distributed to SC2 on January 9.
    - Will be transmitted to TC95 for parent committee balloting within 6 weeks.

IEEE Std 2889™-2021: (Guide for the Definition of Incident Power Density)
- Published in Dec. 2021 !!
Get C95™ Standards

C95.1-2019
C95.1-2019 - IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz

C95.1-2019/Cor 2-2020
C95.1-2019/Cor 2-2020 - IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz - Corrigenda 2

C95.1-2019/Cor 2-2020
C95.1-2019/Cor 2-2020 - IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz

C95.1-2019-2245
C95.1-2019-2245 - IEEE Standard for Military Workplaces—Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz

C95.2-2018

C95.3-2021
C95.3-2021 - IEEE 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

C95.3-2021/Cor 2-2020
C95.3-2021/Cor 2-2020 - IEEE 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

C95.7-2014
C95.7-2014 - IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz

THE LINK ACTUALLY WORKS ☺

"To download these standards, you must sign in with an IEEE Account. If you do not already have an IEEE Account, you can create one by clicking on the "Create Account" link located in the top right of this page."

https://ieeexplore.ieee.org/browse/standards/get-program/page/series?id=82

*Sponsorship of the Get IEEE C95 no-cost-to-public web access of the IEEE C95 standards does not imply that the Department of Defense nor its Component Services endorse or are obligated in any manner to adopt the covered standards current or future versions.
ICES Annual Report, and Policies and Procedures

Annual Report:
2021 ICES Report submitted to SASB

Policies and Procedures (P&Ps):

- **Sponsor P&Ps:** Due to the transition of SCC39 from an SCC to an SC, the SCC39 P&Ps need to be revised using the SC P&P baseline template by 12/31/2022
  - The TC34 and TC95 P&Ps will need to be revised accordingly after the SC P&P is completed

* https://development.standards.ieee.org/pub/view-sponsor-pnps
Questions?
Interim Treasurer’s Report

January 20, 2022 Meeting

C-K. Chou
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AdCom (1/27/2022) will decide

- Meeting time and place
- Participation fees
  - Onsite
  - Internet
Membership Update

Roel Escobar
20 Jan 2022
Location: Binary Space
AGENDA

• Member Report

• Membership Model
Reports

• 179 Members

• 3 New members

Gregory D. Lapin, Ph.D. (Independent Consultant)
- Former professor in Neurology and Biomedical Engineering, Northwestern University
- Principal research engineer, Children’s Memorial Hospital, Chicago.

Klaus Bender, PE (Principal Engineer, KGBender Engineering)
- Provides consulting services related to radio frequency safety issues. Services include safety report review and expert testimony. Licensed Professional Engineer in AZ, CA, CO, MD, NC, SC, VA and WA

Yujuan Zhao, Ph.D. (Senior Hardware Engineer, Intel Corporation)
- Influence and drive international standards and regulations for new RF and AI technologies.
- Lead Corporate Product Regulations & Standards RF/Wireless Center of Excellence activities.
- Design/develop products to ensure compliance of RF/EMC/safety requirements
Country Demographics – July 2021

- US: 94
- CA: 7
- AU: 6
- JP: 6
- UK: 6
- CH: 6
- FR: 4
- GR: 4
- KR: 4
- IE: 3
- IL: 3
- IT: 3
- MY: 3
- BE: 2
- DE: 2
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- AT: 1
- BG: 1
- CN: 1
- CZ: 1
- FI: 1
- HU: 1
- NZ: 1
- PL: 1
- SE: 1
- SI: 1
- TH: 1
- TR: 1
Membership Model

• Promote diversity and recruit active members
• Provide value proposition to new, prospective members while doing the same for current active members
• Policies and Procedures being reviewed
• Recruit additional members with medical and biology expertise
• Require a streamlined electronic membership management system
Recruiting Goals

• Recruit additional members

• Promote recruitment and advancement of more diverse membership

• Consider additional or alternative organization of members to more readily identify applicable personnel, including trees of teams based on scientific expertise
Future Goals

• Working with Yujuan to have a more formal / digital way of maintaining membership list.
By Standard

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IEEE SA STAFF UPDATE: SCC39 TC95 WINTER MEETING

PAT RODER
JANUARY 20TH, 2022
P.RODER@IEEE.ORG
732-253-2704
AGENDA

- PAR & Standards statistics
- TC95 P&P Status
- IEEE SA Policies Update
  - Mandatory Training
  - Participation Behavior Slide Deck
  - Commercial Terms and Normative References for Standards
- Contributors Collection offering
PAR STATISTICS

- **TC95 currently has 2 active PARs:**
  - PC95.7, *Standard for Electromagnetic Energy Safety Programs, 0 Hz to 300 GHz*. The PAR expires on 31 Dec 2024 and is currently in the Draft Development stage.
  - PC95.1-2345, *Standard for Military Workplaces -- Force Health Protection Regarding Personnel Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz*. The PAR expires on 31 Dec 2023 and the current status is unknown.
TC95 currently has 7 active standards:

- C95.1-2019/Cor 1 2019, IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic and Electromagnetic Fields, 0 Hz to 300 GHz - Corrigendum 1 (becomes inactive on 31 Dec 2029)
- C95.1-2019/Cor 2 2020, IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz - Corrigenda 2 (becomes inactive on 31 Dec 2029)
- 2889-2021, IEEE Guide for the Definition of Incident Power Density to Correlate Surface Temperature Elevation (becomes inactive on 31 Dec 2031)
- C95.7 2014, IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz (becomes inactive on 31 Dec 2024)
- C95.3 2021, IEEE 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 (becomes inactive on 31 Dec 2031)
- 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 (becomes inactive on 31 Dec 2024)
POLICIES AND PROCEDURES UPDATE

- SCC39 is transitioning to a Standards Committee.
- The SCC39 Policies and Procedures (P&P) must be revised and placed in the SC baseline template format by the end of 2022.
- TC34 and TC 95 P&Ps will need to be revised accordingly once the SC P&P is finalized.
There was a Procedures Committee AdHoc on Strengthening Direction and Training Regarding Dominance. The SASB approved the AdHoc’s proposed changes and the policies will be updated to:

- Ensure that all Working Group Officers have taken
  1. the IEEE SA Standards Working Group Chair Fundamentals training and
  2. the Understanding IEEE SA's Antitrust, Competition, and Commercial Terms Policies training
  prior to or within 60 days of appointment, or as assigned

- Implementation Date: June 2022
  1. All Standards Committee officers serving at the implementation date of 1 June 2022 have until 31 December 2022 to complete this training
  2. All Working Group officers serving at the implementation date of 1 June 2022 have until 31 December 2022 to complete this training.

Note: IEEE SA Staff will keep SCC39 informed on updates as the implementation date approaches
IEEE SA ProCom Strengthening Direction and Training Regarding Dominance ad hoc also proposed additional changes that the IEEE SASB has approved to clause 5.3.3 of the IEEE SASB Operations Manual.

5.3.3 Standards development meetings

The IEEE SA Individual method or Entity method participant behavior slide set, as applicable, shall be either presented at the beginning of every IEEE SA standards development meeting, or distributed prior to the meeting along with the meeting agenda. If the slides are distributed with the meeting agenda, all meeting participants shall be informed at the beginning of the meeting that participant behavior shall comply with the outlined requirements.

Slides are located at:

https://standards.ieee.org/content/ieee-standards/en/about/policies/index.html
PARTICIPANTS IN THE IEEE SA - INDIVIDUAL METHOD

- Participants in the IEEE-SA “individual process” shall act independently of others, including employers.

The IEEE-SA Standards Board Bylaws require that “participants in the IEEE standards development individual process shall act based on their qualifications and experience”

- This means participants:
  - Shall act & vote based on their personal & independent opinions derived from their expertise, knowledge, and qualifications.
  - Shall not act or vote based on any obligation to or any direction from any other person or organization, including an employer or client, regardless of any external commitments, agreements, contracts, or orders.
  - Shall not direct the actions or votes of other participants or retaliate against other participants for fulfilling their responsibility to act & vote based on their personal & independently developed opinions.

- By participating in standards activities using the “individual process”, you are deemed to accept these requirements; if you are unable to satisfy these requirements then you shall immediately cease any participation.
PARTICIPANTS IN THE IEEE SA “ENTITY METHOD”

Participants in the IEEE-SA “entity process” represent the entity that appointed them

• The IEEE-SA Standards Board Bylaws (clause 5.2.1) states, “entity representative participants in the IEEE standards development entity process are appointed by an entity to represent that entity and act on its behalf”

• This means such participants:
  – May take actions based upon instructions from the entity for which they have been appointed as an entity representative
  – Shall not direct the actions or votes of participants representing another entity or retaliate against other participants for fulfilling their responsibility to act on behalf of another entity

• By participating in activities using the “entity process”, you are deemed to accept these requirements; if you are unable to satisfy these requirements then you shall immediately cease any participation
POLICY UPDATES – COMMERCIAL TERMS AND NORMATIVE REFERENCES

Update to Clause 6.4.6 Normative references of the IEEE SASB Operations Manual:

Standards participants shall not contribute material that contains commercial terms and conditions (see 6.2.2) of which they are aware for inclusion in any draft IEEE standard or that is intended as a normative reference. If the submitter becomes aware of commercial terms and conditions in their Contribution thereafter, they shall promptly inform the Working Group Chair or IEEE SA Program Manager. Any participant who is personally aware of commercial terms and conditions in an IEEE standard, or in material that is normatively referenced, should promptly inform the Working Group Chair or IEEE SA Program Manager.

Note: If you are going to include a Normative Reference (Standards, Papers, Books, etc.) in an IEEE Draft Standard it shall not include commercial terms.

An SASB AdHoc was created and chartered to recommend updates to policy and training material where appropriate.

IEEE SA Staff will keep you informed as this SASB AdHoc completes its work.
IEEE SA CONTRIBUTORS COLLECTION OVERVIEW

IEEE SA Contributor Collection is a free, publicly accessible platform dedicated to publishing the documents contributed by participants during the development of IEEE standards.

- Contributions may be different types of documents ranging from pure research to technical analysis, complete technical specifications and use cases.
- These Contributions may or may not be directly implemented or referenced in the final standard.
- Contributions should be previously submitted to a Standards Project, or will be submitted to a Standards Project when uploaded to the Contributors Collection.
- The contribution submitted will be discoverable, accessible and searchable via the Contributors Collection.
- The Contributor will be provided with a referenceable, permanent link that points to your contribution.
WHO CAN CONTRIBUTE?

Any IEEE SA Working Group participant who wants to provide a referenceable document that is available to the general public may upload documents to the platform.

- Submitted documents must be created by the contributor, cannot contain material taken from or owned by another source unless documented permission is provided to IEEE SA that permits publication under the selected Creative Commons license.

- The documents are vetted for plagiarism and appropriateness prior to acceptance on the platform.
There are four types of Creative Commons (CC) licenses that contributors can select as part of their submission:

- **CC BY 4.0 (Attribution only)** allows others to copy, reuse, adapt, and build upon your work, including for commercial purposes, as long as the content is attributed to you.

- **CC BY-SA 4.0 (Attribution-ShareAlike)** allows others to copy, reuse, adapt, and build upon your work, including for commercial purposes, as long as the content is attributed to you and the adapted work is distributed under the same license as the original.

- **CC BY-NC-SA 4.0 (Attribution-Noncommercial-ShareAlike)** allows others to copy, reuse, adapt, and build upon your work for non-commercial purposes, as long as the content is attributed to you and the adapted work is distributed under the same license as the original.

- **CC0 1.0 (Public Domain Dedication)** allows others to copy, reuse, adapt, and build upon your work for any purpose without attribution; all your rights in the work are waived and the work is dedicated to the public domain.
IEEE SA Contributors Collection,
Submit your documents to the IEEE SA Collaborators Collection.
Submission Guidelines
Frequently Asked Questions
QUESTIONS?
Update on potential study area to develop “guides” on non-biological safety aspects of EMF

Prepared by: Peter Zollman

1On behalf of SC-5
Recap: Filling a gap in ICES scope

• ICES AdCom reviewing ICES polices, procedures. ICES scope:

  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.

• ICES currently (with the exception SC5) covers proven human health (biological) hazards

• July 2021 TC95 proposal to cover “safety practices” for non-biological EMF hazards
Recap:

Electronic device designer / installer / provider
How do I assure that my device will function safely in the real world?

“Victim” device user
I expect my device to work everywhere unless advised otherwise.

EMF Safety program manager
How do I assure that all relevant hazards have been adequately mitigated?

Guide on foreseeable EMF Levels
What man-made EMF fields are likely to be present in the real world?
Where might they be expected?

Guide on achieved EMC
What is the achieved EMC of safety-related electronic devices?
Where are they used?
Recap: Guide on foreseeable EMF levels

• Establish EMF levels from *intentional radiofrequency* EMF generators/radiators\(^1\) currently, or anticipated to become, widespread
  • Broadcast, telecommunications, RADAR, wireless power transfer....
• Establish relevant field characteristics such as field levels, frequency, time-variation (modulation, longer duration?)\(^2\)
• Investigate the critical metrics associated with adverse interference effects since they might be different than for human exposure\(^2\)

Notes:
\(^1\) This is purely from the perspective of the sources in the absence of any “victim”.
\(^2\) Review EMC materials from [https://www.c63.org/documents/misc/matrix/c63_standards.htm](https://www.c63.org/documents/misc/matrix/c63_standards.htm) and from IEC
Recap: Guide on achieved EM compatibility and triggers for safety program consideration

• Consider a range of devices and systems\(^1\):
  • Establish a range of devices that might be adversely affected by EMC resulting in a tangible impact on health
  • Establish the foreseeable EMF environments where such devices are deployed
  • Collate information on the anticipated level of immunity achieved by relevant devices so that if applicable, there is a basis for defining adequate mitigation\(^2\)
  • Guide when a potential hazard triggers risk management as part of an EMF safety program

Notes:

\(^1\) This might usefully be extended to include detonation of electro-explosive devices and ignition of flammable gas hazards

\(^2\) Review EMC materials from https://www.c63.org/documents/misc/matrix/c63_standards.htm and from the IEC
Example Medical

- Immunity levels expressed in IEC 2014
- Caution figure needs careful interpretation and probable update!

Derived from IEC 60601-1-2: 2014 Table 9, immunity test level values
Example potential use cases

1. **EME Safety manager (cellular)** where might additional safety evaluations be needed and what is the basis for clearance?
   - On/near medical facilities
   - Fuel stations / industrial facilities / granaries
   - Explosives/munitions
   - Information needed on site access (e.g., personal medical devices)

2. **EME Safety manager (broadcast) & equipment manufacturer**
   - What immunity is required for on/nr tower intercom system?

3. **Personal medical device manufacturer**
   - What field levels might the public be exposed to?
     - E.g., radio handsets, broadcast, cellular, Wi-Fi, amateur radio, RADAR
   - What situations do I need to alert my user to avoid?
TC-95 Inquiry on expression of interest

• TC95 Chair inquiry on the proposed area of work “Potential study area to develop one or more ‘guides’ on anticipated EMF in the environment”
  • 49 people responded, 22 indicated interest in participating
  • For the people indicating they were not interested, the issues raised:
    • Need to check overlap with existing EMC/EMI standards
    • Too busy
    • Enough work to do on existing standards
    • Need more details before committing to put effort

Conclusions:

• Sufficient potential interest expressed to continue to investigate this area of work
• More preliminary investigation needed before forming a PAR study group
**Recommendation for next steps**

Before seeking to form a PAR study group\(^1\), PZ seek assistance from IEEE_SA secretariat to identify relevant EMC contacts and initiate engagement to:

a) **review scope** of potential activity with IEEE EMCS so that any new ICES activity complements existing (IEEE/IEC) EMC work and is *reasonably bounded*

b) explore if/how ICES and EMC experts might collaborate

c) guide how to identify and collate data from existing material\(^2\), possibly augmented by modelling

---

**Notes:**

\(^1\) The IEEE_SA allow only 6 months for a formal “PAR study group”; this might be too constraining.

\(^2\) A challenge is obtaining the material that is not freely available from the IEEE, IEC, ISO
But...Could RF affect birds?
What is this all about?
It is a proposal drafted by R Tell and D Maxson and presented at the ICES TC95 meeting on 7-15-2021.
Recommendation: ICES should determine if a PAR is appropriate for developing a Guide for safe exposure limits for animals.
Why?
Human exposure limits are many times presumed to be safe for exposure of animals and this may not be the case.
Background and benefit of the project

- The proposed project would provide the world’s first scientifically based Guide for gauging the impact of animal exposure to microwave energy.

- IEEE has never developed recommended electromagnetic field exposure levels that would be deemed safe for exposure of animals. Yet, TC95 in its Subcommittees 3 and 4 has routinely relied upon dosimetric reference limits (DRLs) determined for a range of laboratory animals that could result in a presumed adverse health effect when setting standards for humans.

- The matter of safe electromagnetic field exposure for animals is a common theme in the preparation of Environmental Assessments (EAs) and Environmental Impact Statements (EISs) for projects that have the potential for high level exposure from, typically, government operated microwave facilities. Examples include high power radar sites.

D Maxson (1-20-2022)
"Environmental studies are needed since any adverse influence of EMF on plants, animals such as birds, and other living organisms, while important in their own right, could also ultimately impact on human life and health. ...while there is a small but active research effort in this area, it would be informative to: develop environmental guidelines for EMF exposure at different frequencies, drawing on information from well-performed studies. Such guidelines might resemble those developed for human health, but with appropriately adapted thresholds to ensure that EMF levels are below those producing adverse consequences in the environment."

D Maxson (1-20-2022)

R Tell (1-20-2022)
Effects of non-ionizing electromagnetic fields on flora and fauna, part 1: Rising ambient EMF levels in the environment

https://doi.org/10.1515/reveh-2021-0026
Received February 19, 2021; accepted March 20, 2021; published online May 27, 2021

Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2: Impacts: How species interact with natural and man-made EMF

https://doi.org/10.1515/reveh-2021-0050
Received April 20, 2021; accepted May 26, 2021; published online July 8, 2021

Long-term chronic low-level EMF exposure standards, which do not now exist, should be set accordingly for wildlife, and environmental laws should be strictly enforced.
There is a great need for a systematic collation of all the available evidence on whether anthropogenic RF EMF has a negative impact on animals and plants in the environment.

What research has been conducted to assess the impact of anthropogenic RF EMF exposure on animals and plants in the environment?
Applying Human RF Exposure Standards to Animals

SAR (W/kg)/(mW/cm²)

~0.4 W/kg

~1.8 W/kg

5-yr old child

110 MHz

mouse

2 GHz

Adapted from the Radiofrequency Radiation Dosimetry Handbook (4th edition)

D Maxson (1-20-2022)

Richard Tell Associates, Inc.

Madison, AL USA

R Tell (1-20-2022)
RF Exposure Limits: Mice, Humans and Body Resonance (assuming that the mouse has been made fully aware of his exposure and has been trained to reduce exposure if desired)

**Human**

- SAR at resonance: 0.4 W/kg/mW/cm²
- IEEE 2019 power density limit for humans (restricted environment): 1.0 mW/cm² @human resonance
- SAR at IEEE limit: 0.4 W/kg

**Mouse**

- SAR at resonance: 1.8 W/kg/mW/cm²
- IEEE 2019 power density limit for humans (restricted environment): 5.0 mW/cm² @mouse resonance
- SAR at IEEE limit: 9.0 W/kg

SAR of mouse relative to human ~ 23 times greater when applying the human exposure limit!
WBA SAR in Animals Relative to 2019 DRL for Humans

(Restricted and Unrestricted Environments)
Factors relevant to development of a Guide for Safety Levels with Respect to Small-animal Exposure to Electromagnetic Fields, 1 GHz to to 300 GHz.

- Biological and dosimetric knowledge related to effects of increased thermal loading on the body of small animals
- Whether the current basis of the IEEE standard is applicable to other animal species
- Additional dosimetric information on animals, potentially beyond the current database with additional modeling likely necessary
- Judgments as to appropriate identification of what constitutes an *adverse effect* and what *safety factors* to apply to the derived threshold exposure levels
- If approved by ICES, a new Workgroup in SC4 should be assigned overall responsibility for the project and, where needed, new volunteers with relevant expertise recruited to augment other volunteers in development of the Guide.

D Maxson (1-20-2022) R Tell (1-20-2022)
What folks in TC95 thought about this idea

Good idea: 15

Bad idea: 30

D Maxson (1-20-2022)
Status of thinking on this proposal

More time is necessary to determine:

1. Practicality of setting such a guide
2. Better understanding of potential impact (actual adverse effects) of RF exposure on animals in the real world
3. Observe thinking/recommendations in an upcoming consideration of the concept within EPRI

D Maxson (1-20-2022)

R Tell (1-20-2022)
Tentative conclusion

Use the next six months to evaluate the proposition and then determine IF a PAR study group should be formed.

D Maxson (1-20-2022)
SAR origin and safety/reduction factors of radio frequency exposure limits

C-K. Chou
C-K. Chou Consulting
Dublin, CA, USA, 94568
Before 1975, absorbed power density (mW/cm$^3$ or W/kg) was a term to quantify energy rate absorption in the body. (Johnson and Guy, 1972; Guy et al., 1975)

Don Justesen questioned the English of the term “absorbed power density” and suggested to change it to “energy dose-rate”. (Justesen D: “Toward a prescriptive grammar for the radiobiology of non-ionizing radiations: Quantities, definitions and units of absorbed electromagnetic energy –An essay” J. of Microwave Power, 10(4), December 1975)

### TABLE 2
**PROPOSED QUANTITIES, DEFINITIONS, AND UNITS FOR DOSING OF BIOLOGICAL BODIES WITH NON-IONISING ELECTROMAGNETIC RADIATION**

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</tr>
<tr>
<td>The energy dosage $Q_{ab}$ is the energy imparted to a biological body from irradiation by electromagnetic energy.</td>
<td>joule</td>
<td>J</td>
</tr>
<tr>
<td>The energy dosage-rate $Q_{ab}$ is the time rate at which energy is imparted to a biological body from irradiation by electromagnetic energy.</td>
<td>watt</td>
<td>W</td>
</tr>
<tr>
<td>The energy-dose $D_{ab}$ is the energy imparted to an element of mass of a biological body from irradiation by electromagnetic energy. $D_{ab} = Q_{ab}M^{-1}$</td>
<td>joule per kilogram</td>
<td>J·kg$^{-1}$</td>
</tr>
<tr>
<td>The energy dose-rate $D_{ab}$ is the time rate at which energy is imparted to an element of mass of a biological body from irradiation by electromagnetic energy. $\dot{D} = \frac{dD_{ab}}{dt}$</td>
<td>watt per kilogram</td>
<td>W·kg$^{-1}$</td>
</tr>
</tbody>
</table>
Response from Professor Charles Süsskind

To return to the confusion between absorbed power density and absorbed-power density, we could do away with it by avoiding compound adjectives altogether and calling it simply density of absorbed power. However, many writers may find this grammatically impeccable term unwieldy. Accordingly, let us use (instead of Justesen’s energy dose and energy dose-rate) specific absorption (J/kg) and specific absorption rate (W/kg = mW/g); and let power density (W/m² or mW/cm²) continue to mean what it has always meant in the literature of microwave bioeffects, namely the incident (that is, free-field) power per unit area.

CHARLES SÜSSKIND
University of California, Berkeley
July 16, 1975
Rather than ignore Dr. Justesen’s criticism on the engineering terminology, however, this writer has discussed the possibility of using a less controversial name for the quantity “absorbed power density” with several of his engineering colleagues, who find it quite acceptable. It appears not to suffer from the problem of literally translating into terms involving substandard grammar, nor does it introduce non-ionizing radiation terms, such as dose. This term is “specific absorption density”, abbreviated simply as “SAR”. The word “absorption” accurately specifies the formation of EM energy into a different form in the tissue, the word “rate” indicates the time rate at which this is happening, and the word “specific” indicates the quantity as specified in terms of unit mass. With such a definition, there should not be any confusion between it and densimetric quantities such as incident power density, nor with ionizing radiation concepts such as dose.*

ARThUR W. GUY
Professor and Director
Bioelectromagnetics Research Laboratory
Rehabilitation Medicine
University of Washington
Seattle, Wash. 98195

* Received September 2, 1975. Dr. Guy is Associate Editor of the Journal of Microwave Power.
The first to use the term SAR

and rotations of dipole molecules, such as water or protein molecules, in accordance with the frequency of the applied EM fields. The first effect causes a conduction current loss due to the electrical resistance, and the second induces a displacement current loss due to the viscosity of the medium. These effects are related to the dielectric constant and the conductivity of the tissues as described above. The rate of dissipated or absorbed energy per unit volume or mass of tissue resulting from both ionic conduction and vibration of dipole molecules in the tissue, is defined as specific absorption rate (SAR).

The total amount and distribution of the absorbed EM energy in tissues exposed to EM fields is a function of many factors, including the dielectric properties of the tissues, the frequency and polarization of the applied fields, the size and shape of the object and the EM energy source, the incident power density, and the exposure time. The heating pattern in the exposed object is further modified by the thermal properties of the tissues, the thermoregulatory system and environmental factors.

1.4 Methods of measurement

When different tissues are exposed to the same applied EM fields, the energy absorption in them can differ by several orders of magnitude for objects of different size, shape and orientation. It is therefore important to measure both the internal and external fields to quantify the biologic effects of EM radiation.

The incident power density in air can be measured using radiation survey meters such as the Narda meter, models 8100 and 8300 [15], [16], and the NBS (National Bureau of Standards) meter [17].

The measurements of SAR in tissues are generally assessed by measuring the tissue temperature rise when the effects of ambient temperature
ANSI C95.1-1982 standard
one tier standard

- Exposure limits changed from incident power density only (since C95.1-1966) to include dosimetry
- Whole body exposure limit based on animal behavior effects
- Whole body SAR of 4 W/kg as the threshold
- Safety factor of 10 to set exposure limit for whole body exposure at 0.4 W/kg
- For local exposures, based on dosimetry data on human models and animals a factor of 20 was applied, therefore 0.4x20 = 8 W/kg limit was established, which is averaged over 1 g based on temperature measurements.
IEEE C95.1-1991 two tier standard

- Controlled environment (safety factor of 10)
  - whole body exposure limit 0.4 W/kg
  - Local exposure 8 W/kg averaged over 1 g (extremities 20 W/kg per 10g)
- Uncontrolled environment (additional 5 folds safety factor of 50)
  - whole body exposure limit 0.08 W/kg
  - Local exposure 1.6 W/kg averaged over 1 g (extremities 4 W/kg per 10 g)

FCC adopted these limits in 1997 as US regulation
Reaffirmed in December 2019
IEEE C95.1-2005 (100 kHz to 3 GHz)

- Person in controlled environment (safety factor of 10)
  - whole body exposure limit 0.4 W/kg
  - Local exposure 10 W/kg averaged over 10 g (extremities and pinna x2)
  - Averaging time 6 min

- Action level (additional 5 folds safety factor of 50)
  - whole body exposure limit 0.08 W/kg
  - Local exposure 2 W/kg averaged over 10 g (extremities and pinna x2)
  - Averaging time 30 min

Harmonize with ICNIRP SAR limits:

The changes are from engineering approached to biological based limits. Cataract formation in rabbit eyes has a threshold level of 100 W/kg for an eye ball at 10 g mass.
100 kHz – 6 GHz Dosimetry Reference Limits- SAR limits

- Restricted environment (safety factor of 10)
  - whole body exposure limit 0.4 W/kg
  - Local exposure 10 W/kg averaged over 10 g (extremities and pinna x2)

- Unrestricted environment (additional 5 folds safety factor of 50)
  - whole body exposure limit 0.08 W/kg
  - Local exposure 2 W/kg averaged over 10 g (extremities and pinna x2)

Whole body exposure averaging time 30 min, local exposure averaging time 6 min

6 GHz to 300 GHz Dosimetry Reference Limit- Epithelial power density (ICNIRP named it absorbed power density)

Limits were set based on thermal analysis, safety factors are different
Safety factors (IEEE)

- below approximately 100 kHz (but possibly up to 5 MHz for pulsed fields), where the adverse effect being minimized is electrostimulation,
- In the transition region of 100 kHz to 5 MHz, both electrostimulation and heating can occur.
- above 100 kHz where the adverse effects being protected against are related to tissue heating.
- For frequencies above 6 GHz, the effect being protected against is tissue surface heating.
### Table B.1—Application of “safety factors” to DRLs for whole-body exposure to environmental fields

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Adverse effect</th>
<th>Safety factor (Divisor)</th>
<th>Applied metric</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Upper tier SF\text{\textsubscript{U}}</td>
<td>Lower tier SF\text{\textsubscript{L}}</td>
</tr>
<tr>
<td>(\leq 100 \text{ kHz} \text{ CW; }\leq 5 \text{ MHz (pulsed)}</td>
<td>Pain (PNS)</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Synapse Modulation (CNS)</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>(100 \text{ kHz} \text{ to } 6 \text{ GHz}</td>
<td>Thermal stress (e.g., as reflected in work stoppage)</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>(&gt;6 \text{ GHz}</td>
<td>Thermal pain in skin</td>
<td>2 to 5</td>
<td>10 to 25</td>
</tr>
</tbody>
</table>

**NOTE 1**—Safety factors in this table apply to DRLs for whole-body exposures to environmental fields. See B.3.2 for special exceptions for localized exposure.

**NOTE 2**—The safety factors at low frequencies (first row in table) apply to the internal electric field strength. Factors at radio frequencies apply to power, and therefore are applied to the square of the internal or surface electric field strength.

\(^{a}\)See B.3.2.
Different sizes and grounding conditions

Figure B.8—Safety factor for the unrestricted environment for the condition of conductive contact between the body and the ground (grounded), determined by the ratio of 4 W/kg (the hazard exposure level) to the calculated WBA SAR resulting from exposure to the ERLs of this standard.

Figure B.9—Safety factor for the unrestricted environment for the condition of no conductive contact between the body and the ground (ungrounded), determined by the ratio of 4 W/kg (the hazard exposure level) to the calculated WBA SAR resulting from exposure to the ERLs of this standard.
ICNIRP 1998 guidelines
(SAR limits for 100 kHz to 10 GHz)

- Occupational exposure
  - Whole body exposure 0.4 W/kg
  - Local exposure 10 W/kg averaged over 10 g (based on University of Washington Study on cataract formation in rabbits, 100 W/kg as the threshold, a reduction factor of 10)

- General public exposure
  - Whole body exposure 0.08 W/kg
  - Local exposure 2 W/kg averaged over 10 g (a reduction factor of 50)

Did not explain how the local exposure limits were derived. Ex-members said cataract formation was the basis for local exposure limits.
Local exposure: tissues

- Tissue damage can occur at local temperatures >41-43 °C (time-dependent)

- ICNIRP: adverse health effect threshold:
  Local temperature >41 °C

- **Type-1 tissues** (normal temperature < 33-36 °C): max increase 5 °C
  - upper arm, forearm, hand, thigh, leg, foot, pinna, cornea, anterior chamber and iris of the eye, epidermal, dermal, fat, muscle and bone tissue

- **Type-2 tissues** (normal temperature < 38.5 °C): max increase 2 °C
  - all tissues in the head, eye, abdomen, back, thorax and pelvis, excluding those defined as Type-1 tissue
ICNIRP 2020 guidelines

Local exposure: adverse health effect levels

- Modelling/extrapolation:
  - $\leq 6$ GHz: SAR$_{10g}$ of 20 W/kg: temperature increase max. 2 °C
  - $>6$ GHz: absorbed power density ($S_{ab}$) of 200 W/m$^2$: temperature increase max. $\sim 5$ °C in superficial, less in deeper tissue
- ICNIRP: adverse health effect levels:
  - 100 kHz - 6 GHz:
    - Head & Torso: local SAR$_{10g}$ 20 W/kg (averaged over 6 min)
    - Limbs: local SAR$_{10g}$ 40 W/kg (averaged over 6 min)
  - $>6$-300 GHz: $S_{ab}$ 200 W/m$^2$ (averaged over 6 min and 4 cm$^2$)
  - Focal beam exposure: $>30$-300 GHz: $S_{ab}$ 400 W/m$^2$ (averaged over 6 min and 1 cm$^2$)
- Also (complex) limits for short (pulsed) exposures
**Basic restrictions and differences with 1998 values**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Freq. range</th>
<th>$\Delta T$</th>
<th>Spatial</th>
<th>Aver. time</th>
<th>Health effect level</th>
<th>RF Occup.</th>
<th>RF RF</th>
<th>General public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core $\Delta T$</td>
<td>100 kHz-300 GHz</td>
<td>1°C</td>
<td>WBA</td>
<td>30 min</td>
<td>4 W/kg</td>
<td>10</td>
<td>0.4 W/kg</td>
<td>50 0.08 W/kg</td>
</tr>
<tr>
<td>Local $\Delta T$ (Head &amp; Torso)</td>
<td>100 kHz-6 GHz 100 kHz-10 GHz</td>
<td>2°C</td>
<td>10 g</td>
<td>6 min</td>
<td>20 W/kg</td>
<td>2</td>
<td>10 W/kg</td>
<td>10 2 W/kg</td>
</tr>
<tr>
<td>Local $\Delta T$ (Limbs)</td>
<td>100 kHz-6 GHz 100 kHz-10 GHz</td>
<td>5°C</td>
<td>10 g</td>
<td>6 min</td>
<td>40 W/kg</td>
<td>2</td>
<td>20 W/kg</td>
<td>10 4 W/kg</td>
</tr>
<tr>
<td>Local $\Delta T$ (Head, Torso, Limbs)</td>
<td>&gt;6-300 GHz 30-300 GHz 10-300 GHz</td>
<td>5°C</td>
<td>4 cm$^2$ 1 cm$^2$ 20 cm$^2$</td>
<td>6 min 6 min 68/F$^{105}$</td>
<td>200 W/m$^2$ (absorbed, incident)</td>
<td>2</td>
<td>100 W/m$^2$ 200 W/m$^2$ 50 W/m$^2$</td>
<td>10 20 W/m$^2$ 40 W/m$^2$ 10 W/m$^2$</td>
</tr>
</tbody>
</table>
Conclusions

- Safety or reduction factor of exposure limits varies with frequency range, body size and ground conditions, etc.
- When the basis of the limits is different, the safety factors or reduction factors vary accordingly.
- IEEE ICES standard and ICNIRP guidelines differ in interpretation of the safety factor or reduction factors for local exposures.
- No need to emphasize specific numbers of the factors. It depends on various situations.
- Safety factors or reduction factors are to provide safety margins, based on expert judgment.
- Expert groups and health agencies agree that no adverse health effects have been confirmed below the current international RF safety guidelines or exposure standard (ICNIRP, IEEE).
Assessing Levels of RF Exposure from Mobile Phones and Base Stations

Dr. C-K. Chou*
TC95 Chairman
International Committee on Electromagnetic Safety (ICES)
Institute of Electrical and Electronics Engineers (IEEE)
Piscataway, NJ, USA

*Speaking as an individual and not for the IEEE
Mobile Telephony RF Exposures
Outline

- How does mobile wireless communication work?
- Internal and external intensities
- How to measure them?
- Level of exposures
- Conclusions
Mobile communication system

- Area divided into cells serviced by antennas
- Smaller cells in urban areas
- Network evolves over time in response to subscriber usage
## Types of cell sites

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Typical range of coverage</th>
<th>Power to Antennas (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro</td>
<td>1 - 30 km</td>
<td>20 - 160 W (40 W)</td>
</tr>
<tr>
<td>Micro</td>
<td>500 m - 2 km</td>
<td>2 - 20 W (5 W)</td>
</tr>
<tr>
<td>Pico</td>
<td>4 - 200 m</td>
<td>250 mW - 2 W</td>
</tr>
<tr>
<td>Femto</td>
<td>10 m</td>
<td>10 - 200 mW</td>
</tr>
</tbody>
</table>
Base stations – broadcast horizontally

Does not beam down like a light pole.
Higher-speed data rates closer to antennas

Ericsson Mobility Report, June 2013
More internet and more use indoors

120x more data

79% indoors

OFCOM, 2012; ITU, 2012
Mobile Phone Generations

1G
- 2.4 Kbps
- Analog Voice

2G
- 64 Kbps
- Digital Voice + Simple Data

3G
- 2,000 Kbps
- Mobile Broadband

4G
- 100,000 Kbps
- Faster and Better

5G
- 1 Gbps
- Real World Applications
5G wireless communication

- **Low-band:**
  - 600–900 MHz
  - range and coverage area similar to 4G towers

- **Mid-band:**
  - 2.3–4.7 GHz
  - up to several kilometers in radius

- **High-band:**
  - 24–47 GHz (24.25–29.5 GHz)
  - a more limited range, requiring many small cells, to deploy these cells only in dense urban environments and areas where crowds of people congregate such as sports stadiums and convention centers
SOURCE

QUANTITIES AND UNITS

E (Volts/meter)
(V/m)

P (milliwatts/square centimeter)
(mW/cm²)

H (amperes/meter)
(A/m)

EXPOSED
SUBJECT

SPECIFIC ABSORPTION RATE
(SAR) (W/KG)

\[ P = \frac{E^2}{1200\pi} \text{ or } P = 12\pi H^2 \]
Exposure Standards

- **ICNIRP (International Commission on Non-Ionizing Radiation and Protection) guidelines**
  - 2010: For limiting exposure to time-varying electric and magnetic fields (1Hz – 100 kHz)
  - 2020: For limiting exposure to electromagnetic fields (100 kHz – 300 GHz)

- **IEEE ICES (International Committee on Electromagnetic Safety) standard**
  - C95.1-2019: IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz

Both are developed to protect against substantiated or established adverse health effects
Exposure Parameters

- **Internal intensity:** Basic Restriction, Dosimetry Reference Limit (DRL)
  - In situ or internal electric field V/m (0-5 MHz or 10 MHz)
  - Specific Absorption Rate W/kg (0.1 MHz to 6 GHz)
    - Whole body exposure: averaged over the whole body
    - Localized exposure: averaged over 10 g tissue
  - Epithelial (absorbed) power density W/m² (6-300 GHz)

- **External intensity:** Reference Level, Exposure Reference Level (ERL)
  - Electric field in V/m
  - Magnetic field A/m
  - Power density W/m²
RF exposure limits include substantial safety factors (whole body exposure)

- Worker Limit: 4 W/kg
- Public Limit: 0.4 W/kg (10X)
- Mobile Network: 0.08 W/kg (50X)

Adverse effects threshold: less than 0.02% of limit
Compare 1998 and 2020 guidelines

**Basic restrictions and differences with 1998 values**

<table>
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<tr>
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<tbody>
<tr>
<td>Core $\Delta T$</td>
<td>100 kHz-300 GHz</td>
<td>1°C</td>
<td>WBA</td>
<td>30 min 6 min</td>
<td>4 W/kg</td>
<td>10</td>
<td>0.4 W/kg</td>
<td>50</td>
</tr>
<tr>
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<td>100 kHz-6 GHz 100 kHz-10 GHz</td>
<td>2°C</td>
<td>10 g</td>
<td>6 min</td>
<td>20 W/kg</td>
<td>2</td>
<td>10 W/kg</td>
<td>10</td>
</tr>
<tr>
<td>Local $\Delta T$ (Limbs)</td>
<td>100 kHz-6 GHz 100 kHz-10 GHz</td>
<td>5°C</td>
<td>10 g</td>
<td>6 min</td>
<td>40 W/kg</td>
<td>2</td>
<td>20 W/kg</td>
<td>10</td>
</tr>
<tr>
<td>Local $\Delta T$ (Head, Torso, Limbs)</td>
<td>&gt;6-300 GHz 30-300 GHz 10-300 GHz</td>
<td>5°C</td>
<td>4 cm² 1 cm² 20 cm² 6 min 6 min 68/f°.05</td>
<td>200 W/m² (absorbed, incident)</td>
<td>2</td>
<td>100 W/m² 200 W/m² 50 W/m²</td>
<td>10</td>
<td>20 W/m² 40 W/m² 10 W/m²</td>
</tr>
</tbody>
</table>
Regulatory Public Limits of Localized “peak” SAR for Portable Devices

SAR < 1.6 W/kg per 1 g (FCC)
SAR < 2 W/kg per 10 g

Note: Information from public sources except where indicated.
Last updated: 23 March 2021

Regulatory Public Whole Body Exposure
RF limits – Mobile Networks

ICNIRP 135
FCC 11
Other 37

‘Other’ limits differ and lack consistent scientific rationale.

Assessment standards

➢ Mobile phone (near field)
  - IEC/IEEE 62209-1528:2020 “Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-worn wireless communication devices - Human models, instrumentation and procedures (Frequency range of 4 MHz to 10 GHz)"
  - IEC/IEEE 62704-3:2017 “Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 3: Specific requirements for using the finite difference time domain (FDTD) method for SAR calculations of mobile phones”

➢ Base station (far field in most cases)
  - IEC 62232: 2017 “Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure”
Phone testing for two positions

NOTE: The reference points for the right ear reference point (RE), left ear reference point (LE), and mouth (M), which establish the Reference Plane for DUT positioning, are indicated. This device position shall be maintained for the sagittal phantom test set-up shown in Figure G.4.

Figure 16 a) Phone position 1 – cheek position

Key
M Mouth reference point
LE Left ear reference point
RE Right ear reference point

This device position shall be maintained for the phantom test set-up.

Figure 17 – Tilt position of the DUT on the left side of SAM
Testing on a flat phantom

Figure 6 – Test positions for body-worn devices
Experimental Methods

- Follow the procedures of IEC/IEEE 62209-1528:2020 measurement standard
- Obtain the peak SAR in left and right head phantoms, and flat phantom under maximum power condition for all possible modes and combinations
- Results approved by regulators before marketing

December 1, 2021
Warsaw, Poland
Field intensity measurements

Measure power density in mW/cm² or μW/cm² with a survey meter

Compare with Reference Limits or ERL
Field strength measurements

Broadband: survey meter

Narrow band: spectrum analyzer
Assessment of RF exposure – active antenna

Far-field estimation of field strengths

\[ S = \frac{PG}{4\pi d^2} \text{ W/m}^2 \]

*Far-field estimation of field strengths*

- \( P \) = Power to antenna (W)
- \( G \) = Linear isotropic gain
- \( d \) = Distance from antenna (m)

Technical guidance:
- IEC 62232:2017
- IEC TR62269:2011/2019
- ITU-T K Suppl. 16 (05/2019)
Smart antenna technologies

- Maintain high data throughput in more efficient ways
- Reduce network interference and electromagnetic energy in unintended directions
- More variability of exposure levels in space and time
- Updated compliance procedures
Mobile Phone Exposure Levels (3G)

- All phones must be tested at maximum power (24 dBm) according to the standards, and within national adopted limits.
- The average terminal output power for 3G voice calls was below 1 mW for any environment including rural, urban, and dedicated indoor networks. This is <1% of the maximum available output power.
- Average length of a mobile phone call has decreased from about 3 minutes in 2003-2006 to 1.8 minutes in 2012 (US) and is about the same in Europe.
Actual handset transmitted power (3G)

- Gati et al., Exposure induced by WCDMA mobiles phones in operating networks, IEEE Transactions on Wireless Communications, 8(12):5723-5727, December 2009. IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, VOL. 8, NO. 12, DECEMBER 2009

Fig. 3. Distribution of mobile phone transmitted power in different areas.
Correlation of handset output power with received power from a base station (3G)

Fig. 4. Distribution of transmitted power samples as a function of the received power for all aggregated measurements (indoor and outdoor). Measurements are collected for a voice call connexion.

Gati et al. [2009]
4G and 5G mobile phones

The study on 4G devices took measurements from 7000 devices over a 7-day period from a network in Sweden. The study of 5G devices took 545 million power samples from networks in Australia and South Korea.

The mean is the same as average. The median is the middle number in the data. 95th Percentile means that 95% of all levels recorded were at or below this level. All values are time averaged.
Actual Output Power Levels (5G mid band and high band mobile phones)

- Actual time-averaged 5G UE output power levels are significantly below the maximum available for both FR1 and FR2.

<table>
<thead>
<tr>
<th></th>
<th>FR1 (3.5 GHz)</th>
<th>FR2 (28 GHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>&lt;3%</td>
<td></td>
</tr>
<tr>
<td>95th percentile</td>
<td>&lt;12%</td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>&lt;55%</td>
<td></td>
</tr>
<tr>
<td>Number of samples</td>
<td>&gt; 1 billion</td>
<td></td>
</tr>
</tbody>
</table>

- The results for different frequency ranges (mid band and high band) are comparable.

- Due to very conservative estimation of the number of uplink scheduled users, presented actual time-averaged output power levels are very conservative.

- Actual 5G UE output power levels from this study are similar to previous 5G FR1 study and are comparable to the UE output power levels in 3G and 4G networks.

Joshi et al. Network-based measurements of actual output power levels of UE in commercial 5G networks. BioEM 2021 Poster
Actual exposure and output power of base stations

- **Exposure from base stations:**
  - Base stations operating power depends on usage.
  - Analyses of data from surveys of radio base stations in 23 countries across five continents from the year 2000 onward and includes over 173,000 individual data points.
  - Global average more than 5,500 times below ICNIRP limit values.
  - Only areas are very close antennas where compliance levels could be exceeded

- **Output power from base stations:**
  - For the 3G network, the 90th percentile of the averaged output power during high traffic hours was found to be 43% of the maximum available power. The corresponding number for 2G, with two or more transceivers installed, was 65% or below.
  - For a 4G network, the mean, the median, and the 90th percentile RBS output power values were found to be 6.8%, 6.4%, and 8.2%, respectively, of the maximum available power.

Environmental radio signals

- FM
- TETRA
- T-DAB
- GSM900
- GSM1800
- 3G
- LTE

Graph showing frequency bands and signal emissions.
Small daily variation in radio signal levels

- Small variation due to traffic activity.
- Sample audit measurements to build trust.
- Benefits of fixed monitors not independently evaluated.

Joseph et al, BEMS, June 2010
Ground level distance does not predict exposure

For example, at 100 m, the measured levels differ by more than 1,000 times.

Exposure similar for all countries (3G)

Global average more than 5,500 times below limit values.

Based on Rowley and Joyner, 2012
Mobile levels similar to other radio sources

Based on Valberg et al., 2007
5G Beamforming reduces compliance distance

Example – massive MIMO @ 28 GHz (Macro)

Perspective view

Without considering the effect of beamforming

All transmitted power assumed directed in the same beam for several minutes
Process repeated for all beams

Considering the effect of beamforming

Distribute the power per beam to obtain statically conservative compliance boundaries

Array antenna with $8 \times 8$ elements

$f = 28$ GHz
60° horizontal scan range
15° vertical scan range
$EIRP_{\text{max}} = 72$ dBm

See also BioEM 2018 poster PB 26
5G: Measurements from Around the World

Measurements from 5G operating in 1-6 GHz range. Average EMF measurements are expressed as a percentage of the ICNIRP limits.

- **United Kingdom**: < 0.0039%
- **Norway**: < 0.097%
- **France**: < 0.3%
- **Colombia**: < 0.37%
- **Australia**: < 1.12%
- **New Zealand**: < 1.175%

*Sources: NZ Ministry of Health, ACMA, ANFR, Ofcom, Nkom, ANE, GSMA*
No significant change in RF exposure from networks

Median level 4,500 times below limit

Median values (blue), mean values (red) and 99% percentiles (green) versus year

‘This review does not indicate a noticeable increase in everyday RF-EMF exposure since 2012 despite increasing use of wireless communication devices.’
- Jalilian et al., 2019
Most personal exposure is from nearby devices

- **Far-field:**
  - Total - 1 V/m

- **Near-field:**
  - Wi-Fi access point - 24 h/day
  - Laptop - 8 h/day
  - Tablet - 1 h/day
  - Smartphone on or near body – 1 h/day
  - VR set - 0.5 h/day
  - Smartphone Wi-Fi browsing 1 h/day

Liorni et al., 2020
WHO Fact Sheet on Mobile Phones (2014)

- Are there any health effects?

A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use.

‘Studies to date provide no indication that environmental exposure to RF fields, such as from base stations, increases the risk of cancer or any other disease.’
Conclusions

➢ Both science-based exposure and assessment standards have been developed by international committees.

➢ Mobile phones are tested at maximum power to pass compliance test. Actual usage has much smaller exposure.

➢ General public exposure to base stations is very low.

➢ Personal exposure is mostly due to portable devices.

➢ WHO: “To date, no adverse health effects have been established as being caused by mobile phone use.”

➢ WHO: “Studies to date provide no indication that environmental exposure to RF fields, such as from base stations, increases the risk of cancer or any other disease.”
Acknowledgements

- Dr. Jack Rowley of GSMA for information on base stations
- Mr. Michael Milligan of MWF for information on mobile phone typical usage data
Contact
ck.chou@ieee.org
ICES TC95 - SC1 Techniques, Procedures, Instrumentation, and Computation
ICES TC95 - SC1
Techniques, Procedures, Instrumentation, and Computation

- Co Chairs: Peter Zollman (UK), Matt Butcher (US)
- Forum for sharing experience, best practice, and establishing collaborative activities relating to EMF assessments
- Main deliverable is C95.3 - *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* (published May 2021)
- WebEx meetings encouraging increased participation. Now 64 SC-1 Members / 22 Observers with 55 attending the Jan 2022 SC1 WebEx meeting
- SC1 Jan 22 meeting
  - Two technical presentations on spatial averaging (measurement robot & SA validation)
  - Discussion of informal polling to identify & prioritise subjects for study for next revision
1. SC2 met on Wednesday, 12 January 2022 chaired by R. Tell.

2. There was a high of 46 attendees at the meeting.

3. Meeting topics:
   - Lack of response from OSHA on RF inspections on rooftops.
     - It is clear that "inspection" does not include performing actual work in terms of making RF field measurements.
     - R. Curtis suggested contacting the local (e.g., the host building) Safety Officer for rooftop sites.
     - J. Bushberg and D. Haes effected a discussion of OSHA’s general industry §1910 and §1926 construction standards in the chat log.
   - Progress on revision of C95.7-2014
     - The Document received enough votes for APPROVAL, nonetheless ALL the comments were addressed in writing during 2021 with improved draft completed December 2021.
     - The revised draft distributed to SC2 on January 9, 2022.
   - Discussion of revision draft by meeting attendees
     - C-K. Chou notified the group that if the document is ready for TC95 balloting, there is a 30-day notice requirement for the balloting group.
     - R. Tell mentioned that the document is undergoing final review for technical and grammatical corrections.

4. Technical presentation
   - Management of Effective and Efficient RF Safety Compliance Using Accurate Power Measurement and Other System Monitoring by Bob Tarsio, President; Broadcast Devices, Inc.; Buchanan, NY.

5. Request for suggestions on topics for future technical presentations
   - Suggestions included RADAR systems, Smart antenna systems (i.e., beam forming), and an updated status of the FCC’s exposure limits.

6. Time and place of next meeting.
   - More details will be available at the TC95 meeting.
Chairman’s Report

SC – 3 & 4

January 17-18, 2022
Teleconference
SC – 3: Safety Levels 0 Hz to 3 kHz
Co-Chairs: Rob Kavet
           Alexandre Legros

SC - 4: Safety Levels 3 kHz to 300 GHz
Co-Chairs: Art Thansandote
           Marv Ziskin

Secretary:
           Auke Visser
Welcome New Members

Anne-Sophie Bonnet
René De Sèze
Greg Lapin
Ilkka Laakso
Julien Modolo
Satoshi Nakasono
Florian Soyka
Dominik Stunder
Yujuan Zhao
**Day 1 - Monday January 17, 2022**

1. Register of attendees (WebEx) from start minus 15 min  
   Legros
2. Call to Order  
   Legros
3. Welcome Participants  
   Legros
4. Approval of Agenda  
   Legros
5. Approval of the Minutes (12-13 January 2022 Meeting)  
   Legros
6. Call for Patents*  
   Legros
7. Chairmen's Reports  
   SC3/SC4 Co-chairs
   a) ELF/RF literature surveillance  
      Elder / Ziskin
   b) Update on the revision of ICNIRP guidelines on LF fields  
      Hirata
9. Technical Presentations  
   a) Aligning Contact Current with Electric Field ERLs: Proposed Revisions to IEEE C95.1-2019  
      Kavet/Tell
Day 2 - Tuesday January 18, 2022

9. Technical Presentations (cont.)
   b) A new approach for safety evaluations of magnetic fields using the SENN model Soyka
   c) Human detection thresholds of electric fields Stunder
   d) Brief update on PNS threshold studies from Lawson Legros/Kavet

10. New Business Legros

11. Time and Place of Next Meeting Legros

12. Adjourn Legros
Major Tasks of SC – 3/4

C95.1-2019 Safety Standard (0 Hz – 300 GHz)
C95.1-2019 Corrigenda No. 1 and No. 2
C95.1-2345-2014 Military Safety Standard
Announcements to Major Regulatory Bodies
Data Base & Literature Surveillance
Communication with ICNIRP
C95.1-2019 Revision

Major Emphasis is now on Low Frequency

0 Hz to 100 kHz

Project Leaders

Alexandre Legros
Rob Kavet

Much Progress in Basic Science
C95.1-2019 Revision

Revisions to Contact Current and E-field ERLs

Project underway for past two years by Rob Kavet and Ric Tell
Establish consistency between contact current limits and E-Field ERLs

No Perfect Solution
- Need to protect against adverse effects
- Need to take real world conditions into account

Manuscript – Nearly completed
To be incorporated in next version of C95.1
Presentation to be given at this meeting
Progress in Basic Science

- **New Lab in MTP (Montpellier France)**
  Magnetophosphenes Replication
  CNS Threshold Studies (and PNS Threshold in Canada)
  Led by Legros

- **Utilities Threshold Initiative Consortium (UTIC)**
  Threshold Workshop with six speakers at BioEM2022
  Led by Legros

- **International Radiation Protection Association (IRPA)**
  New international Task Group
  Central Nervous System (CNS)
  Transcranial Electric Current Stimulation (tECS)
  IRPA 2022 in Budapest in March
  2 Presentations by Legros and Modolo
Technical Presentations This Meeting

Kavet / Tell
Aligning contact current limits with E-Field ERLs:
Proposed revisions to IEEE C95.1-2019

Soyka
A new approach for safety evaluations of magnetic fields using the SENN model

Stunder
Human detection thresholds of Electric Fields

Legros / Kavet
Brief Update on PNS threshold studies from Lawson
Progress on Standards Editorial Working Group (EWG)

- Bill Bailey
- Marom Biksom
- Bob Cleveland
- C-K Chou
- Antonio Faraone
- Ken Foster
- Aki Hirata
- Rob Kavet
- Ilkka Laakso
- Alexandre Legros, Chair
- David Maxson
- Julien Modolo
- Pat Reilly
- Florian Soyka
- Ric Tell
- Art Thansandote
- Marv Ziskin
- Peter Zollman
ICES Data Base
and Literature Surveillance

Joe Elder, Chair

Data Base Contains over 8000 citations

Included where possible:

- Links to abstracts and/or full papers
- PUbMed ID numbers and/or DOI numbers

(DOI = Digital Object Identifier)
Wireless phone use in childhood and adolescence and neuroepithelial brain tumours: Results from the international MOBI-Kids study.

G. Castano-Vinyals, and 54 Other Authors from 17 Countries

Progress on Standards

Invaluable Help from IEEE Staff

Thanks to Patricia Roder
C95.1-2019 Corrigendum 2

- C95.1-2019 / Cor 2- 2020
- Two figures corrected
- Available without charge through IEEE Get Program
- Not combined with C95.1-2019
- Must be requested and downloaded separately.
Progress on Standards

All C95.XX Standards are now available free of charge.
https://ieeexplore.ieee.org/browse/standards/get-program/page/series?id=82

Thanks to
US Air Force,
US Army
US Navy
C95.1-2345 Revision

- Military Safety Standard  (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
- Initial Leader - B. Jon Klauenberg
- Revision Leader – Roel Escobal
Communication with ICNIRP

International Commission on Non-Ionizing Radiation Protection

Significant Interaction with ICES Members

Aki Hirata on ICNIRP Commission Membership

Many ICES members have been Consultants and Presenters at ICNIRP Conferences

ICES interaction invited in early stages of setting limits
New Society formed from Union of:
Bioelectromagnetics Society (BEMS)
and
European BioElectromagnetics Association (EBEA)

Candidates for President Elect
Alexandre Legros
Azadeh Peyman
Maxim Zhadobov

BioEM 2022
Nagoya, Japan - June 19-24, 2022
BioEM 2022
JUNE 19-24, NAGOYA, JAPAN
HYBRID EVENT
1. **Call to Order**  
Harmon/Visser  
The meeting was called to order by the SC5 Co-Chair, Ray Harmon at 10:00 h GMT.

2. **Welcome and Introduction**  
All  
The participants were welcomed to the meeting and administrative details for the Webex meeting were given. In addition, meeting participants introduced themselves providing name, affiliation, and committee information. Attachment 1 provides the list of attendees.

3. **Approval of Agenda**  
Harmon/Visser  
The draft agenda was presented. Following a motion by Matt Butcher and seconded by C-K Chou, the agenda was unanimously approved. The agenda is provided as Attachment 2.

4. **Approval of the Minutes**  
Harmon/Visser  
The minutes of the WebEx meeting held on 24 June 2021 was discussed. Following a motion was made by David Maxson and seconded by Rick Tell, the 24 June 2021 meeting minutes were approved and provided as Attachment 3.

5. **Call for patents***  
Harmon/Visser  
SC5 Chair made a “call for patents” relating to the work performed by members of SC5 in making standards. (See bottom of the agenda). The chairman asked the SC if there were any such patents assigned to SC members; there was none.

6. **New Business**  
All  
a. **IEEE Guide for Safety Levels with Respect to Small-Animal Exposure to Electromagnetic Fields, 1 GHz to 300 GHz.**  
Tell/Maxson  
Ric Tell and David Maxson provided an update on the progress made in forming a study group for EM field exposure of small animals. The proposal was briefed to TC95 << need input for rick and David>>. Ric Tell and David Maxson will solicit support from ICES to form a group to study.
b. **Potential study area to develop one or more “guides” on anticipated EMF in the environment.**

Peter Zollman provided an update on the status of the proposed guide. Peter presented the “Potential study area to develop one or more “guides” on anticipated EMF in the environment” topic at the TC95 meeting held virtually on 15 July 2021 and provided a brief overview at this subcommittee meeting.

c. **SC5 Scope Change**

David Maxson, in response to an action, developed a brief document and led a discussion on SC5 scope change or repurposing the committee to become a central point within TC95 for the development of suggested topics of research related to the safety aspect of EM energy exposure. David presented the background, outline of scope redirection and recommended new name.

**Proposed new name for SC5:** SC5 - Other EM Exposure Safety Issues

**Proposed purpose of the new SC5:**

The revised purpose of SC5 is to launch new standards initiatives under the jurisdiction of ICES TC95, when such initiatives address a demonstrated need and fit the capabilities and resources of ICES.

**Proposed scope of the new SC5:**

Under the title *SC5 - Other EM Exposure Safety Issues*, the subcommittee will engage in dialog about EM issues not related to the impacts of EM energy exposure to human tissue and associated potential adverse health effects, which are addressed by other TC95 Subcommittees (collectively, “other” issues). To effect its purpose, SC5 will monitor “other” topics of EM exposure safety, decide whether there is a role for ICES in pursuing new standards or guidelines, recommend to TC95 that a PAR Study Group be formed, and take on the role of the PAR Study Group.

Initially, the subject matter within the scope includes

- consideration of establishing safety guidelines for exposure of animals to EM energy
- continued surveillance of the electro-explosive field in case new developments create a need for participation by SC5.

In the first instance, there are no recommendations that exist for quantifying potentially hazardous EM energy exposure levels for animals, domestic and wild. Should SC5 elect to pursue development of a PAR on this topic, it would represent the only effort, worldwide, to develop a quantitative guide for evaluating potential adverse impact of EM energy exposure to non-human animal species. Such considerations are directly relevant in the context of performing environmental studies of proposed EM operations, such as in the preparation of Environmental Assessments and Environmental Impact Statements under the US National Environmental Policy Act.
In the second instance, EM interaction with electro-explosive devices remains a subject of EM safety. While the role as a standards committee on this subject has been withdrawn, it is appropriate to continue to monitor the field.

About “spawning” new initiatives

It is recognized that ICES has finite resources, largely in the form of time and expertise contributed by its members. It is not the goal of this proposal to be generating a steady stream of proposals for developing standards and guidelines. Rather, by monitoring the various disciplines relating to EM exposure safety, SC5 can identify major societally relevant issues that lack initiatives and are suited to the capabilities of ICES. When an issue rises to the level of interest in developing a PAR, SC5 can recommend to TC95 the creation of a PAR Study Group under Standards Association guidelines. If the PAR Study Group, under the supervision of SC5, produces a PAR, it can be submitted to TC95 for SA approval. The approved PAR does not necessarily get handed back down to SC5, as it may be appropriate for a new subcommittee to be established to be the formal Working Group to administer the approved PAR.

For example, it is envisioned that SC5 will conduct a review of the need for animal safety guidelines. With a well-founded basis and an interest of the members in considering a PAR, SC5 would make a recommendation to establish a PAR Study Group. As the designated PAR Study Group for this topic, it would need to consist of a well-balanced membership, including an open call for expertise not presently participating in ICES, to develop a recommended PAR in an open, balanced, consensus framework with due process.

The discussion and paper was very helpful to the committee and the next step would be to run the proposal by the TC95 chair.

7. Open Discussion

All

There were no open discussion topics.

8. Time and Place of Next Meeting

Harmon/Visser

C-K Chou stated the next meeting may be conducted in Jun 2022 and may be in-person or virtual subject to change and based on the U.S. COVID. A definitive location and date will be provided after the Adcom meeting.

9. Adjourn

Harmon/Visser

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1 Note the distinction between “Subcommittee” and “Working Group.” A Subcommittee is a division of the ICES structure. When there is an active PAR, a Subcommittee is typically tasked with conducting the project. In doing so, the Subcommittee is designated as a Working Group in IEEE SA terminology.
There being no further business and following a motion by David Maxson, seconded by Rick Tell, and approved by the committee, the meeting was adjourned at 12:00 h GMT

*Participants have a duty to inform the IEEE of holders of essential patent claims if they or their affiliations hold such claims. Check the web link on the agenda for more details. If anyone in this meeting is personally aware of any patent claims that are potentially essential to implementation of the proposed standard(s) under consideration by this group and that are not already the subject of an Accepted Letter of Assurance, please speak to the committee chair today.*
# Sign-in Sheet

**SC5 Meeting, 13 January 2021, WebEx IEEE**

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<td>Peter</td>
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**Agenda (Approved)**

IEEE/ICES TC95 Subcommittee 5  
Safety Levels with Respect to Electro-Explosive Devices  
10.00 – 12.00 h  
Thursday, 13 Jan 2022

1. Call to Order     Harmon/Visser  
2. Welcome and Introduction     All  
3. Approval of Agenda     Harmon/Visser  
4. Approval of the Minutes     Harmon/Visser  
5. Call for patents*     Harmon/Visser  
6. New Business     All  
   a. IEEE Guide for Safety Levels with Respect to Small-Animal Exposure to Electromagnetic Fields, 1 GHz to 300 GHz.     Tell/Maxson  
   b. Potential study area to develop one or more “guides” on anticipated EMF in the environment.     Zollman  
7. Open Discussion     All  
8. Time and Place of Next Meeting     Harmon/Visser  
9. Adjourn     Harmon/Visser  

*Participants have a duty to inform the IEEE of holders of essential patent claims if they or their affiliations hold such claims. Check the web link on the agenda for more details. If anyone in this meeting is personally aware of any patent claims that are potentially essential to implementation of the proposed standard(s) under consideration by this group and that are not already the subject of an Accepted Letter of Assurance, please speak to the committee chair today.
Approved Meeting Minutes

IEEE/ICES TC95 Subcommittee 5
Effects of EM fields on Blasting Operations

10:00 – 12:00 h GMT
Thursday 24 June 2021
Electronic Meeting by WebEx

Call to Order
The meeting was called to order by the chair of SC5, Ray Harmon at 10:00 h GMT

Welcome Participants
The participants were welcomed and administrative details for this WebEx meeting were given. (See Attachment 1 for list of attendees.)

Approval of Agenda
The proposed agenda was presented. Following a motion by Rick Tell that was seconded by C-K Chou, the agenda was unanimously approved. (See Attachment 2.)

Approval of the Minutes (14 January 2021 Meeting)
The Minutes of the Webex meeting held on 14 January 2021 in Plantation (FL) were discussed. They were approved and are attached to this meeting minutes. (Attachment 3)

Call for Patents
SC5 chair Harmon made a “call for patents” relating to the work performed by members of SC5 in making standards. (See bottom of the agenda). The chairman asked the SC if there were any such patents assigned to SC members; there was none.

Chairmen’s Report
In the meeting held in January several action items were addressed. They were discussed during the meeting.
The withdrawal of C95.4-2002 is completed. What remains is the question what to do with SC5 and the manpower/capabilities it consists of.
However, the C95.4-2002 is not active anymore, the chair identified the need for a formal statement of the subcommittee to end activities or pursuing PAR’s for projects related to blasting caps, EED’s etc. This was put to a vote by a motion by Matt Butcher which was seconded by Dave Maxson. The statement that was voted on: A motion to close down the project pursuit for blasting caps and guidance relative to blasting caps.
The vote on the motion passed.
Two more possible project were discussed;
Broaden the scope to EME related hazards. This means establishing the Electromagnetic Environment and assess the vulnerabilities related to that. Following that Ric Tell presented his thought on possible harmonization with IEEE1848; IEEE Standard For Techniques and Measurement to Manage Functional Safety and Other Risks with Regards to electromagnetic Disturbances. His conclusion is that this standard is more related to TC95:SC2 and furthermore, that the scope of the document is more pointed to computer relates issues and product development, being it not really suitable for a new project for SC5 and beyond the scope of TC95. Peter Zollman will write a proposal for a potential new project consisting of developing guidance on hazards that can arise when electronic equipment is being exposed in an unintended matter with the consequence of a hazard to health of humans.
Broaden the subject to negative effects in general, for instance the effect of electromagnetic fields to animals. After a discussion Ric Tell proposes to write his ideas about the subject for discussion during the next meeting.
Other New Business

There was no further discussion and no action item.

Date and Place of Next Meeting

The next virtual meeting will be held on January 13\textsuperscript{th} 2022 at 10:00 GMT.

Adjourn

There being no further business, the meeting was adjourned at 12:00 h GMT, the motion was moved by Matt Butcher and seconded by Dave Maxson.
# International Committee on Electromagnetic Safety

**Sign-in Sheet**  
**SC5 Meeting, 24 June 2021, WebEx IEEE**

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<td>Innovations, Science and Economic Development, Canada</td>
<td>Staff Liaison</td>
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<tr>
<td>15</td>
<td>Roder</td>
<td>Patricia</td>
<td>IEEE SA</td>
<td>Yes</td>
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<tr>
<td>16</td>
<td>Tell</td>
<td>Ric</td>
<td>Richard Tell Associates, Inc.</td>
<td>Yes</td>
<td>✓</td>
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<tr>
<td>17</td>
<td>Tong</td>
<td>Zijun</td>
<td>NEMA</td>
<td>No</td>
<td>✓</td>
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<tr>
<td>18</td>
<td>Visser</td>
<td>Auke</td>
<td>Royal Netherlands Navy</td>
<td></td>
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<tr>
<td>19</td>
<td>Weller</td>
<td>Robert</td>
<td>IEEE-BTS liaison</td>
<td>No</td>
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<tr>
<td>20</td>
<td>Zollman</td>
<td>Peter</td>
<td>PZC (Consultant)</td>
<td>Yes</td>
<td>✓</td>
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</tbody>
</table>

*NOTE—Presenters/participants who intend to display MS PowerPoint/Word files, please send a copy to Auke Visser (ar.visser@mindef.nl) for the minutes.*
The IEEE guide has been published in December 2021 based on the results and conclusions of the work of WG5 regarding the definition of the incident power density.

WG4 reported on their study exploring the electro-stimulation threshold in brain.

Two new working groups have been launched; one is the epithelial power density definition (WG6) and the other is the low-frequency dosimetry method (WG7). They will have teleconferences to resolve the corresponding issues.

One technical presentation has been given on "Standardized method for conformity assessment with low frequency EMF safety guidelines".
## NEMA Website Analysis Form

Completed by NEMA\Sr. Digital Media Manager and provided to website liaison for their review and feedback.

<table>
<thead>
<tr>
<th>Year:</th>
<th>2021</th>
<th>January - December</th>
</tr>
</thead>
<tbody>
<tr>
<td>Website:</td>
<td>ICES (<a href="http://www.ices-emfsafety.org">http://www.ices-emfsafety.org</a>)</td>
<td></td>
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<tr>
<td>Liaison:</td>
<td>C-K. Chou</td>
<td></td>
</tr>
<tr>
<td>Reviewed By:</td>
<td>Bill Green</td>
<td></td>
</tr>
</tbody>
</table>

### Contents

2. Website Analytics Summary & Comparison .................................. [Error! Bookmark not defined.]

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[Logo: IEEE ICES, International Committee on Electromagnetic Safety]

[Links: Home, Past Meetings, Committees, Publications, About Us, Join, Contact Us, Members Only]

[Images: Promoting safe use of electromagnetic energy, Understanding Electromagnetic Safety, News, Next Meeting]
1. Website Analytics Charts (Jan 1 – Dec 31, 2021)

<table>
<thead>
<tr>
<th>Top 10 Pages</th>
<th>Pageviews¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>/home/</td>
<td>6,498</td>
</tr>
<tr>
<td>/electromagnetic-energy/</td>
<td>3,667</td>
</tr>
<tr>
<td>/expert-reviews/</td>
<td>887</td>
</tr>
<tr>
<td>/publications/standards/</td>
<td>570</td>
</tr>
<tr>
<td>/committees/tc95-subcommittees/</td>
<td>507</td>
</tr>
<tr>
<td>/the-ieee-std-c95-1-2019-is-published/</td>
<td>266</td>
</tr>
<tr>
<td>/committees/tc34-subcommittees/</td>
<td>248</td>
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<tr>
<td>/about-us/</td>
<td>247</td>
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<tr>
<td>/publications/reports/</td>
<td>242</td>
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<td>/join/</td>
<td>158</td>
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</table>

2. Website Analytics Summary & Comparison

<table>
<thead>
<tr>
<th></th>
<th>Pageviews</th>
<th>Sessions²</th>
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</thead>
<tbody>
<tr>
<td>Jan 1 – Dec 31, 2021</td>
<td>15,793</td>
<td>8,078</td>
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<tr>
<td>Jan 1 – Dec 31, 2020</td>
<td>18,931</td>
<td>8,885</td>
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<tr>
<td>% Change</td>
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<td>-9.08%</td>
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3. Traffic Sources (Jan 1 – Dec 31, 2021)

<table>
<thead>
<tr>
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<th>Percentage</th>
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<tbody>
<tr>
<td>Direct</td>
<td>34.5%</td>
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<tr>
<td>Referral</td>
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<tr>
<td>Search</td>
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</table>

4. Top Referral Sites (Jan 1 – Dec 31, 2021)

<table>
<thead>
<tr>
<th>Sites</th>
<th>Pageviews</th>
<th>Sessions</th>
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</thead>
<tbody>
<tr>
<td>spectrum.ieee.org</td>
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<tr>
<td>t.co</td>
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<td>64</td>
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<td>m.facebook.com</td>
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<tr>
<td>emf-portal.org</td>
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<td>cn.bing.com</td>
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<tr>
<td>ec.europa.eu</td>
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<td>ieee-emf.com</td>
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<td>30</td>
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<td>riefm.mcmc.gov.my</td>
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<td>18</td>
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<tr>
<td>blogs.scientificamerican.com</td>
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<td>18</td>
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</table>

5. Top Search Terms (Jan 1 – Dec 31, 2021)

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<th>Keyword</th>
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¹ Pageviews: The total number of pages viewed. Repeated views of a single page are counted.
² Sessions: The period time (not greater than 30 minutes) a user is actively engaged with your website.
<table>
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<tr>
<th>Topic</th>
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<tbody>
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<td>electromagnetic energy facts</td>
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<tr>
<td>ieee ices</td>
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<td>71</td>
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<td>facts about electromagnetic waves</td>
<td>70</td>
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<td>how do we use electromagnetic energy</td>
<td>50</td>
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<td>ieee c95 1 free download</td>
<td>50</td>
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</table>