IEEE ICES
TC95 SC1

Sub-Committee 1 Minutes January 2024

IEEE/ICES TC95 Subcommittee 1
Techniques, Procedures, Instrumentation and Computation
09:00 – 12:00 EST: 23 January 2024
Holiday Inn Express, Plantation, Florida & via WebEx web conference

1) Introduction and call to order

Subcommittee 1 (SC-1) on Techniques, Procedures, Instrumentation and Computation meeting convened on 23 January 2024 at the Holiday Inn Express, Plantation FL, and via WebEx. At 09:00 EST the meeting was called to order by SC-1 Co-Chair, (Butcher). Pre-registered attendees were welcomed, and attendance checked using the sign-in sheet, chat function of WebEx, and email notification. SC-1 Co-Chair, (Butcher) clarified that following the publication of C95.3 in May 2021, SC-1 is currently a forum for sharing experience, best practice and establishing collaborative activities relating to EMF assessments and is complementary to the other ICES sub-committees.

2) Approval of agenda

The draft SC-1 agenda was proposed and accepted by the committee on a motion from Bushberg with Lapin seconding and was approved. (Attachment 1)

3) Approval of the June 2023 SC-1 meeting minutes / matters arising

The June 2023 SC1 meeting minutes were accepted unamended by acclimation.

June 2023 SC-1 action: The action on SC1 co-chairs to organize a webinar dedicated to the topic of spatial averaging was completed with the 15 November Webinar.

June 2023 SC-1 action: Keshvari to report on ITU EMF activities. Jafar was not present at the SC1 meeting. *(Post-meeting note - He reported on these matters in the ICES Chairman's report to TC95 on 25 January)*

4) Co-Chairs' report

a) Update of SC-1 membership

The SC-1 Co-Chair (Butcher) called the SC-1 membership on hand to provide their contact information in the chat function of WebEx, send an email as indicated in the agenda or via the sign-in sheet at the meeting. 53 people participated in the meeting (Attachment 2). Butcher reported that there are 66 SC-1 "Members" and 57 "Observers".

b) Review of spatial averaging workshop

The SC-1 Co-Chair (Zollman) reported that there was lots of interest with 47 participants at November 2023 webinar and the presentations are posted under SC1 on the members' area of the ICES website. He reported the following items from the workshop for SC1 to note:

- SA uncertainty needs to be considered – especially if there are insufficient samples for a highly-spatially-variable field distribution.
- Vertical-line sampling was supported by all presenters at the workshop. All presenters concluded that planar SA scheme limitations outweigh any potential advantages.
- The number of field strength samples taken in a SA scheme is important for multipath/multisource environments especially for computer models giving vector field values.
- SA provides an improved representation of WBA exposure.
- Numerical integration techniques for sample processing have been investigated and compared with SAR modelling data.
- Two different valid approaches were presented at the workshop to support different access control strategies: a) compliance boundary for "No-part-of-body in here" control around antennas; b) compliance for "Area is Okay" or "Don't walk here" controls around accessible areas.
- There is a need to be careful in defining the SA scheme and data processing to gain a consistent and repeatable result for a given situation.
- Alternative assessment methods should be allowed with priority (as required by the IEC) given to the method determined to have the lowest uncertainty. This applies to measurement and computation.

5) Presentations

a) Induced RF Currents from Exposure to RF Electric Fields: An Amateur's Quandary – Ric Tell (Attachment 3)

Ric Tell gave a presentation on the historical evolution of interest in measurement of the short-circuit current from the body of an RF field exposed human in good conductive contact with ground. He referenced measurement data he acquired beginning in 1979, and the development of different methods of measuring the short-circuit current using platform type stand-on meters to clamp-on transformers that can be placed around the leg or arm. His key objective, however, was to highlight what appears to be a disconnect between measured and FDTD calculated values of current. For example, most measurement data on induced current near body resonance are approximately a factor of two greater than values found when using FDTD with detailed voxelized models of the human body. The primary parameter of interest is expressed as the magnitude of short-circuit current divided by the electric field strength in the unit milliamperes per volt per meter (mA/V/m). The relevant electric field strength is the vertical polarization component aligned with the vertical axis of a standing person. Ric's concern is that since the induced current within the body is directly related to the magnitude of the RF electric

field strength, future regulatory limits on induced currents might use electric field strength as a surrogate for the actual current and it is important that calculational models get correct answers. While the IEEE C95.1-2019 standard applies a formula for calculating induced currents that is not based on anatomical models but, rather, electric field strength and a relatively simple homogeneous model, the resulting calculated induced currents accurately correspond to measured currents. However, he argued, other calculations based on more sophisticated models should also produce results similar to measurements

Collaborating with Peter Zollman, Co-chair of SC1, Ric described their efforts during the past several years to identify the reason for the apparent difference between measurements and modeling of short-circuit currents. In 2023, they found help from two different volunteer researchers, Dr. Jerdvisanop (Jerd) Chakarothai, with the National Institute of Information and Communications Technology in Japan, and Dr. Andreas Christ, a project leader at the IT'IS Foundation in Zürich, Switzerland. Both of these individuals are experts in the application of the FDTD method of calculating short-circuit currents. Initial efforts were directed to examining the contact area of the foot of anatomical models that might contact a conductive ground plane. While the anatomical models are based on MRI cross section slices of the body, they do not correctly represent depression of the foot of a standing person where full weight bearing is placed on the feet that increases the contact area with the ground. FDTD calculations by both Jerd and Christ revealed that the magnitude of short-circuit current is increased with greater foot contact area, but the increase appears to be in the range of, perhaps, 25%-30% depending on the particular anatomical model used. Interestingly, as Peter Zollman found from an evaluation of the NORMAN voxel model used in early-on analyses of induced currents and SAR, the foot area for the standing person can significantly increase above the weight unloaded contact area. This is similar to what Tell found in the literature where the ratio of the full weight-bearing contact area to non-weight bearing contact area was found to be 1.54.

While the foot contact area has been found to be important to the calculation of short-circuit currents in actual humans, Tell noted that depending on the model used in the various FDTD studies, very significant differences can exist because of the very wide range of the contact areas associated with the various models. Clearly, adjustments to the model must be made to make the model represent the more realistic condition of a standing human.

Other avenues of investigation now include a detailed look at how the voxelized anatomical models actually represent the various conductive pathways within the body. Through support from Jerd, visual depictions of the most conductive pathways in both the

Duke (IT'IS) and Taro (Japanese) models illustrate points at which there appear to be breaks in certain pathways. These breaks, potentially the result of the voxelization process, can result in high impedances that do not exist in reality and could be at least one of the reasons for the models resulting in lower currents.

A preliminary insight included in Tell's presentation suggests that an unnaturally high impedance in the lower leg, beneath the knee, could result in the same trend found when comparing FDTD model results to measurements: the FDTD calculated currents are always somewhat less than the measured values, but the difference becomes greatest near body resonance. Further investigation is needed to better identify the reason for the disparity between measured and modeled results (when using presumably anatomically accurate models).

b) EMF Assessment in LF environment Spatial Averaging - Jordi Accensi and John Afa (Attachment 4)

In this presentation, we reviewed the procedure and requirements for performing electromagnetic field assessment in a low frequency environment in accordance with the European Directive 2013/35/EU. The Weighted Peak Method (which is the recommended approach) and frequency range for electrostimulation effects (up to 10 MHz) were also discussed.

c) Continuing discussion of C95.3-2021 Appendix I - Items for further study – Bring your ideas! - Matt Butcher (Attachment 5)

In the continuing pursuit of what to cover in the next update to C95.3 we reviewed ideas from a 2022 poll and solicited comments on areas of study.

In the following discussion, it was suggested that there is a need for better information from antenna manufacturers on how their beamforming is implemented so that appropriate compliance methods can be determined and included in standards – perhaps in a timelier manner. It was observed that test modes for beam steering are available, but these are not always requested by the customer. Test methods are needed that do not require such test modes and that have no or minimal impact on cell service while testing is performed. It was noted that it would be helpful if antenna manufacturers were represented in SC1.

Jan 2024 SC1 Action: Butcher agreed to approach antenna manufacturers to seek their greater involvement in standardization activities, especially for beam-forming implementations.

A brief discussion ensued on how health and safety managers might interpret compliance boundaries using statistically based maxima. It was reported that there are control algorithms within cells that hard-limit the transmit power to maintain compliance at such boundaries. It was also noted that it was not possible for an independent assessment of whether such capability is implemented or is practically effective on a site under investigation.

6) Any other business

No other business was discussed.

7) Time and Place of Next Meeting

Next meeting will either be in person, currently scheduled for Crete, and via WebEx in Jun 2024 prior to the next scheduled TC95 meeting or will be a WebEx in the period mid-May to mid-June 2024. In the meantime, if SC-1 participants are willing to present on a suitable topic, the Co-chairs are prepared to organize additional topic-focused meetings prior to then.

8) Adjourn

The meeting adjourned at 11:50 EST.

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Attachment 1

IEEE/ICES TC95 Subcommittee 1

Techniques, Procedures, and Instrumentation

Accepted Agenda: 23 January 2024 Meeting

Holiday Inn Express, 1701 North University Drive. Plantation, Florida.

	Los Angeles	New York	London	Amsterdam	Jerusalem	Beijing	Tokyo	Melbourne	Auckland
Start Time	Tue 06:00	Tue 09:00	Tue 14:00	Tue 15:00	Tue 16:00	Tue 22:00	Tue 23:00	Wed 01:00	Wed 03:00
Start Date	Tuesday 23 January 2024							Wednesday 24 January 2024	
Duration	Up to 3 Hrs. (depending on presentations TBA)								
Attendance:	Face-to-Face: Please register prior to meeting and fill in the attendance sheet at start of meeting Web: Please register prior to meeting and, when joining meeting please enter your Name, Affiliation, Country in chat message or send email to c95.3@sublight.net Subject: Present at TC95-SC1 Jan '24, and your Name, Affiliation, Country								

1. **Introduction & Call to Order**
2. **Modifications and approval of agenda**
3. **Approval of SC-1 Minutes (Jun 2023 meeting) and matters arising**
4. **Co-Chairs Report**
    a. **Update of SC-1 Membership**
    b. **Review of Spatial Averaging Workshop**
5. **Presentations**
    a. **Induced RF Currents from Exposure to RF Electric Fields: An Amateur's Quandary – Ric Tell**
    b. **EMF Assessment in LF environment Spatial Averaging - Jordi Accensi and John Afa**
    c. **Continuing discussion of C95.3-2021 Appendix I - Items for further study – Bring your ideas! - Matt Butcher**
6. **Any other business**
7. **Time and Place of Next Meeting**
8. **Adjourn**

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Attachment 2

Participants in SC-1 23 January 2024 meeting

53 Attendees (based on attendance sheet, chat reports, and email notifications):

Attendance in person:
Jordi Accensi, Wavecontrol Inc.
Bill Bailey, Exponent
Goga Bit-Babik, Motorola Solutions Inc.
Jerrold Bushberg, UC, Davis
Matt Butcher, Sublight Engineering PLLC
C-K. Chou, C-K. Chou Consulting
Dave Cotton, Waterford Consultants
Mark Douglas, IT'IS Foundation
Roel Escobar, US Air Force Research Laboratory
Antonio Faraone, Motorola Solutions Inc.
James Futch, Florida Dept. Health, Bureau of Radiation Control
Romeo Gallamoza, Defense Centers for Public Health – Aberdeen
Bryan Gamboa, Air Force Research Lab
Kevin Graf, US FCC
Ray Harmon, Amentum
Robert Johnson, EME Safety, LLC
Cory Kihlstrom, Verizon Wireless
Stephen S. Lockwood, Hatfield & Dawson Consulting Engineers
Danie Ludick, Stellenbosch University (and IXUS)
David Maxson, Isotrope
Michael Fischer, Centerline
Timothy Mikulski, U.S. Army
Roberto Rodriguez, General Dynamics Information Technology
Auke Visser, Royal NL Navy
Robert Weller, IEEE-BTS
Xun Zhao, DND/QETE

Attendance (online):
Robert Acacio, FCC
Abdelelah Alzahed, Health Canada
Vitas Anderson, Two Fields Consulting
Jerdvisanop Chakarothai, National Institute of Information and Communications Technology, Japan
Chrysanthos Chrysanthou, FCC
Benjamin Cotts, Exponent Inc.
Anastacio Dalde, Defense Center for Public Health
Amnon Duvdevany, Israel Institute for Occupational Safety and Hygiene
Hamideh Esmaeili, Hamburg University of Technology

Kyle Fisher, Smith and Fisher, LLC.
Petter Gärdin, Swedish Armed Forces
Joe Gilbert, AltaLink, Canada
Don Haes, Consultant
Ahmed Kamel, AT&T Mobility
Efthymios Karabetsos, Greek Atomic Energy Commission (EEAE)
Jolanta Karpowicz Central Institute for Labour Protection, National Research Institute (CIOP-PIB)
Greg Lapin, ARRL
Rajat Mathur, US FCC
Gulmira Mustapaeva, FCC
Asher Sheppard, Asher Sheppard Consulting
Stephen Simms, Leonardo UK
Richard Tell, Richard Tell Associates, Inc.
Don Nilantha Wijayasinghe, Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)
David Witkowski, Oku Solutions LLC
Cheng Yang, TUHH
Yujuan Zhao, Intel
Peter Zollman, Peter Zollman consultancy