International Committee on Electromagnetic Safety

Approved Minutes

IEEE/ICES TC95 Subcommittee 3
Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 Hz - 3 kHz

and

IEEE/ICES TC95 Subcommittee 4
Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

FDA Campus (White Oak), Silver Spring, Maryland
WO-Bldg 02, Room 2031
13 January 2010 (Wednesday)
0900 – 1530 h

1. Call to Order
   Co-chairman Ziskin called the meeting to order at 0930 h.

2. Introduction of those Present
   Each of the attendees introduced her/himself. (See Attachment 1 for list of attendees.)

3. Approval of Agenda
   Following a motion by D’Andrea and a second by Cotton the agenda was approved without change (see Attachment 2).

4. Approval of the Minutes (June 2009 Meeting)
   Following a motion by Bushberg and a second by Chou, the minutes of the June 2009 meeting were approved as presented.

5. Secretary's Report
   Petersen reported on the status of PC95.1a (amendment to include ceiling values on induced and contact current) and PC95.3.1 (low frequency measurements and computations). He reported that both documents were approved by the sponsor balloting group with 100% affirmative votes after recirculation. Specifically, balloting PC95.1a closed 22 October 2009 and the draft is on the 18 January SASB Review Committee (RevCom) early consideration agenda. If approved by RevCom, n letter ballot will be carried out for SASB approval. Balloting on PC95.3.1 closed 31 December and the draft will be on the March RevCom agenda. Petersen explained that a more detailed report on these and other items will be presented during the secretary’s report at the TC95 meeting on Friday.
6. Chairmen's Report

a) Recent ICNIRP reviews – RF bio-effects and mobile phones & tumor risks

Co-chairman Ziskin provided an update on the recent ICNIRP review “Exposure to high frequency electromagnetic fields, biological effects and health consequences (100 kHz-300 GHz)” and statement on the “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).” He briefly summarized the conclusions regarding the mobile phone/cancer risk issue by pointing out that there is considerable data available, most of which indicates a low risk. Many of the studies suffer from various biases including recall bias. The conclusions of the recent ICNIRP reviews conclude that there is weak evidence of a slight increase in glioma associated with the use of mobile telephones but these studies suffer from issues regarding exposure duration, recall bias, etc. and there are no clear explanations regarding a mechanism. He noted that the concept of causation versus association may be an issue in epidemiology. Bailey cautioned against making claims of possible associations from a single study unless the evidence is striking. Typically, weaker results should be followed by in vitro and animal studies before any associations can be made. Bowman agreed and added that epidemiology has limits. For example some of the studies in the Interphone Study suffered from recall and selection bias, unknowns such as output power during calls, the environment – urban/suburban – etc. Many of these issues are being examined during the evaluation of Interphone studies.

Morrissey reminded everyone that the Interphone Study resulted from public concern/pressure and was not initiated from a pure research point of view. He noted that when first proposed, the Interphone study was touted as being the beginning and end of all mobile telephone studies and he hopes this just another study and not the “final” study. In response to a comment from Bodemann regarding the Hardell studies, Martin noted that there have been a number of reviews of the Hardell studies but no consensus conclusion has been reached.

b) ICES comments to ICNIRP draft ELF guidelines

Bodemann reported that ICES was invited to submit comments in the ICNIRP Draft “Guidelines for limiting exposure to time-varying electric and magnetic fields (1 to 100 kHz).” Most of the detailed comments were submitted by Reilly who explained that the major issues related to inadequate description of the rationale for the reference levels and the basic restrictions. He said the ICNIRP rationale is getting closer to that of ICES but is explained poorly. In his comments he urged ICNIRP to take a close look at the ICES rationale and consider adopting it instead of the rationale found in the 1998 guidelines. Reilly explained that there was considerable discussion at the Umea meeting regarding difficulties in trying to implement the ICNIRP low frequency requirements in the workplace. He said there was some pushback by ICNIRP regarding expending a dialog with ICES but ICES was well-represented and well-received by the attendees. Reilly noted that a German proposal was submitted at the Umea meeting as a possible alternative to ICNIRP and ICES. Bodemann said that he was familiar with the document and that was concerned that none of the authors could be considered stakeholders. Bodemann explained that the reference levels and basic restrictions are closer to the corresponding ICES values than to those of ICNIRP – the document has been submitted to the working party responsible for addressing limits in the workplace. He said that if the EU recognizes the document, it will be evidence of ICES influence.
Bowman said that he is familiar with the German proposal and it should simplify dealing with multi-frequency and pulsed-fields. For example, the German proposal requires fewer Fourier components in the summation, i.e., only the strongest components are included. Reilly explained that he has not yet studied the German proposal in detail cautioned about how Fourier components are considered, e.g., linear versus non-linear responses. Chou said that he thought the Umea meeting was very successful. His and Reilly’s presentations on the C95 standards including differences between the ICNIRP and IEEE processes, e.g., open versus closed, were well accepted. One issue that might be impeding acceptance of the IEEE standards is that of freely available (ICNIRP) versus available by purchase (IEEE).

c) **ICNIRP and ICES harmonization**

Klauenberg briefly reviewed the history of efforts to set up a process for collaboration/harmonization between ICES and ICNIRP. Several meetings were held between ICNIRP members and ICES members—the first was held during the BEMS meeting in Munich in 2000, another was held in San Antonio a year later but no agreement on a dialog evolved and all attempts at harmonization failed. We are still looking for a credible system for addressing the harmonization issue. He stressed that collaboration and harmonization is becoming even more important now in light of the EU Worker’s Directive and issues with the ICNIRP low frequency limits. It is important that ICES and ICNIRP get together to try to resolve the issue since 24 of the 28 NATO members will have to follow the Worker’s Directive, which may have different limits than those in the IEEE NATO STANAG replacement standard now under development by TC95/SC3/SC4. He explained how ICES presentations at meetings in Europe, e.g., Umea Sweden, have heightened recognition of ICES and the open IEEE process. One obstacle for further acceptance is the fact that IEEE standards are not publicly available, i.e., they must be purchased. In response to a question from Needy about publishing a summary of the normative sections in a journal that would permit downloading without charge, similar to the arrangements between ICNIRP and *Health Physics*, Petersen said that depending on how detailed the summary is we probably could obtain IEEE permission. Bailey pointed out that the page charges to the authors in journals that allow downloading without charge are usually high.

**ACTION ITEM 1**

**Bodemann agreed to try to determine the arrangements between Health Physics and ICNIRP that permit downloading pdf files of published ICNIRP papers at no charge.**

It was decided that it would be useful to move forward and establish a drafting group to summarize the relevant normative sections of C95.1-2005 with the goal of publishing the document such that it would be freely available.

**ACTION ITEM 2**

**Chou will lead an ad hoc group comprised of Bodemann, Cotton, D’Andrea Erdreich, Klauenberg and Morrissey that will develop a document summarizing the salient points of the normative sections of C95.1-2005 for publication.**

Martin cautioned that the issue of compliance with a summary document, and not the standard, may be problematic. Reilly agreed—the entire standard is needed. He said that he doesn’t quite understand why cost is an issue with companies, agencies, etc.
Klauenberg explained that if NATO is expected to adopt the standard, it has to be freely available to all the members and organizations within NATO. Considerable discussion followed that included suggestions that to lower costs the standard could be published as two standards—one normative, the other informative. In response to a question from Tell, Klauenberg explained that the DoD annual license fee to access IEEE C95 standards is approximately $180 k. It was agreed that preparing a summary papers is a good first step in moving forward.

d) Status of Australian ELF standard

Martin discussed the revised Australian ELF exposure limits. He noted that the draft is complete, the limits have been changed, and a cost benefit analysis is now in progress—the issue of costs relation to a precautionary approach may be more important than costs relating to compliance. He noted that the limits at low frequencies are similar to those in the C95 standards. He expects final approval in a few weeks.

7. Issues on Merging of C95.1 and C95.6

a) Literature surveillance and review/evaluation

To open the discussion on literature review and evaluation, Morrissey briefly reviewed the September 15, 2009 US Congressional Hearing “Expert Conference on Cell Phones and Health: Science and Public Policy Questions,” chaired by Senator Specter. (See Attachment 3.) Morrissey explained that the goal of the hearing was to address a “serious question that deserves a serious answer” and was not meant to be “inflammatory” or to make “stark statements.” He then went on to note that close to 30 in-depth reviews of the of the RF bioeffect literature have been carried out during the past few years by expert panels of scientists throughout the world. He said that conclusions of these reviews are much in line with those of C95.1-2005. While some suggest precaution, none claim that there is sufficient evidence to assume that adverse effects are established.

Morrissey went on to describe the SC3/SC4 literature surveillance/evaluation process and the database. He noted a slight increase in the number or relevant studies published in 2009, compared with the number published in 2008 (see Attachment 3). He mentioned some important ongoing studies, e.g., IIT, and explained that it is important to maintain a 5-year review cycle because of the increase in the number of studies being published, particularly with glioma as the end point. The increase is partly due to increased publications from organizations in countries such as Korea that have had limited contributions in the past. He then discussed the various anatomical models that are being used for numerical analyses. In addition to the established families of models, work is ongoing to develop models of pregnant women and the fetus.

Morrissey explained that he has an invitation to publish literature review/evaluations in the International Journal of Hyperthermia. Martin pointed out that this may appear as a bias, i.e., we have made up our mind that the mechanism is solely related to tissue heating. In response to a question from Ziskin regarding the percentage of papers that address low frequencies, Morrissey explained that at this point, only RF papers are being considered; Erdreich noted that a mechanism is rarely included in the epidemiology papers, i.e., there is no underlying assumption regarding mechanism. Bailey suggested publication in Health Physics as an alternate choice. Regarding a format for the summaries, Bushberg suggested summarizing the studies by organ type. In response to a question from Bowman regarding how the weight of evidence is considered between in vitro versus in vivo versus epidemiology studies, and how study design, quality etc. are
considered in the evaluations, Morrissey explained that there is some subjectivity but generally animal studies are weighted more heavily than in vitro studies, for example. Bowman asked if animal studies, for example, are good studies for glioma—he said that we should be concerned that we may just be adding positive and negative results for the various endpoints. Morrissey explained that each study is evaluated on its own merits; Ziskin explained that each study is evaluated individually and weighted accordingly. Bassen said that he supports Martin’s concern about publishing in the International Journal of Hyperthermia, e.g., it would seem inappropriate for cancer studies. There was general consensus that depending on the outcome of the literature evaluations, an appropriate journal or journals should be decided at that time.

b) Report from Editorial Working Group – status of the merging work
Chou reviewed progress of the Editorial WG toward merging C96.1-2002 and C95.1-2005 into a single document, i.e., a single document that would cover the frequency range of 0 Hz to 300 GHz. This new standard would be numbered C95.1, but would have a broader scope. The normative clauses of this revision would also be the normative clauses of PC95.1-2345—the replacement of NATO STANAG 2345. He reported that the PAR for PC95.1-2345 was approved by the IEEE SA Standards Board (SASB) at their Sept meeting; a PAR for the revision of C95.1-2005 will be submitted early spring. Chou explained that a major task will be to address the frequency range where effects associated with electrostimulation and effects associated with tissue heating overlap, i.e., between approximately 100 kHz and 5 MHz—Reilly is the key person to address the rationale, definitions, MPEs and basic restrictions in this region. Chou noted that WG meetings were held in July and September—the September meeting was held at the FDA White Oak Campus and was followed by an Inter-Agency Working Group meeting.

c) Numerical computations at ELF
Reilly reviewed the present low frequency MPEs and basic restrictions and the induction models that were used to relate the exposure fields to the internal fields and basic restrictions (see Attachment 4). He pointed out that differences between the ICNIRP circular induction model and the ICES ellipsoidal model result in approximately a factor of two difference in the MPEs—the C95.6 values being higher. He explained that this is one of several issues that must be resolved for the revision of C95—other issues include large differences in FDTD results compared with results for the ellipsoid, differences among reported FDTD results for similar models, resolution of interface E-field peaks, and appropriate models including adult models for B-field exposure and child model for E-field exposure. The intent is to use anatomically correct models, similar to those being developed by Hirata—defining exactly what work has to be done in this area is ongoing.

Reilly introduced Dr Hirata who gave a presentation “Inter-comparison of induced fields in Japanese male model TARO due to magnetic field exposures” (see Attachment 5). He reviewed some of the factors that influence computational results, many of which appear to be artificial and possibly can be addressed post-computation. He concluded by reviewing the intercomparison study program in which six institutes participated. He focused on the calculated induced electric fields and current densities, which were in reasonable agreement between the participating institutes. Bassen pointed out that PC95.3.1 includes a number of numerical anatomical models, called the virtual family, which includes child models. Kainz explained that the resolution of these CAD models is about $1 \times 1 \times 1$ mm but different resolutions are available for different regions of the
body. Bassen discussed numerical techniques other than the FDTD method, e.g., the finite element method, the impedance method, all of which, including the FDTD method are discussed in PC95.3.1. Bodemann suggested establishing a workshop to discuss the various numerical methods, some of which are being applied in MRI research. Ziskin said that he was not certain that an in-depth workshop would be of interest to many SC3/SC4 members; Bassen pointed out that some members of SC1 and, perhaps, a few members of SC3 and SC4 may find it of interest.

d) NATO standards

Klauenberg presented a briefing on the status and background of NATO STANAG 2345 (see Attachment 6). He pointed out that STANAG 2345 is based on the C95.1 limits; it was last revised in 2003, and the triennial review to revise, reaffirm or cancel is stalled because of the EU Workers Directive that mandates use of the ICNIRP limits in the workplace. He described a survey of NATO nations that showed concerns about the operational impacts on mission safety of a reduction of the Action Level for contact currents to 40 mA. If implemented this would become a de facto limit. He pointed out that the issue has been resolved via the amendment to C95.1-2005 that provides ceiling values for induced and contact currents of 500 mA for workplace exposures. In response to a question from Tell, Klauenberg explained that the rights to IEEE STD C95.1-2345 will be owned by IEEE—not by NATO.

8. Other New Business

Morrissey presented a review of the Thermal Aspects of Radio Frequency Exposure Workshop held earlier in the week (11 – 12 January). (See Attachment 7.) He reported that the workshop was well-attended with over 100 attendees and a good representation of experts from the hyperthermia community, and included members of ICNIRP. There was also a good representation of the government public health agencies. The presentations were well-received. The goal of the workshop was to try to provide answers to the following questions: What are the most appropriate health endpoints for a given tissue / system? What are the most appropriate time periods for acute and chronic exposure? Are there any well established time-temperature thresholds? What is the cost effective and targeted research to better define time-temperature thresholds in support of human exposure standards? Morrissey said that he was not convinced of some of the conclusions of individual speakers, e.g., Miller’s conclusion that thermal effects related to spontaneous abortion and teratogenesis obey a non-threshold, linear hypothesis. Chou noted that with respect to RF safety standards, there was general agreement that behavioural disruption is an appropriate endpoint for establishing basic restrictions in terms of whole-body-averaged SAR and cataract formation in the lens is appropriate for establishing basic restrictions in terms of peak spatial-average SAR. Ziskin agreed noting that effects to sensitive tissues, e.g., the testes, occur at temperatures higher than what would be expected if the basic restrictions are met. Martin pointed out that while the lower tier may be OK for 24 hour/day exposures for people in all states of health, and questioned whether an added heat load could be significant and whether some form of caveat may be warranted. Chou explained that the large safety factor incorporated into the lower tier would protect against effects related to typical additional heat loads. Bodemann noted that in his opinion, the workshop provided important information that should be considered by ICES. However, the conclusions of a few papers were irrelevant for standard setting. For example, based on an extrapolation of the Arrhenius equation, effects on cells could be expected if the temperature of the culture was maintained at 38°C for 10^6 minutes. The overall conclusion of the attendees of this meeting was that it was an important workshop that provided information useful to SC3 and SC4.
9. Date and Place of Next Meeting

The next TC95 meetings will be held in Seoul, South Korea, tentatively 11-12 June 2010—immediately before the 32nd Annual Meeting of the Bioelectromagnetics Society. Nam Kim agreed to help with the meeting arrangements.

10. Adjourn

There being no further business, the meeting was adjourned at 1510 h.

Actions Arising from this Meeting

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### List of Attendees
**TC95/SC3/SC4 Meeting**  
**13 January 2010**  
**FDA White Oak Campus, Silver Spring, MD**

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<td>Baron</td>
<td></td>
<td>David</td>
<td>AIHA Representative</td>
<td>SC3/SC4</td>
<td><a href="mailto:d.baron@ieee.org">d.baron@ieee.org</a></td>
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<td>Howard</td>
<td>FDA/CDRH</td>
<td>SC3/SC4</td>
<td><a href="mailto:Howard.bassen@fda.hhs.gov">Howard.bassen@fda.hhs.gov</a></td>
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<td>SC3/SC4</td>
<td><a href="mailto:ralf.bodemann@siemens.com">ralf.bodemann@siemens.com</a></td>
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<td>Bowman*</td>
<td>D.</td>
<td>Joseph</td>
<td>NIOSH</td>
<td>O/O</td>
<td><a href="mailto:kirkbow@gmail.com">kirkbow@gmail.com</a></td>
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<td>Bushberg</td>
<td>T.</td>
<td>Jerrold</td>
<td>U. of California, Davis</td>
<td>O/SC4</td>
<td><a href="mailto:jtbushberg@ucdavis.edu">jtbushberg@ucdavis.edu</a></td>
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<td><a href="mailto:chika@janus.co.jp">chika@janus.co.jp</a></td>
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<td>A.</td>
<td>John</td>
<td>Naval Med Research Unit</td>
<td>SC3/SC4</td>
<td><a href="mailto:john.dandrea@navy.brooks.af.mil">john.dandrea@navy.brooks.af.mil</a></td>
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<td><a href="mailto:paul.testagrossa@alcatel-lucent.com">paul.testagrossa@alcatel-lucent.com</a></td>
</tr>
<tr>
<td>35. Thuroczy</td>
<td></td>
<td>Gyorgy</td>
<td>Nat Res Inst for Radiobiology</td>
<td>SC3/SC4</td>
<td><a href="mailto:thuroczy@hp.oski.hu">thuroczy@hp.oski.hu</a></td>
</tr>
<tr>
<td>36. Umbdenstock</td>
<td>J.</td>
<td>Donald</td>
<td>Tyco/Sensormatic</td>
<td>SC3/SC4</td>
<td><a href="mailto:djumbdenstock@tycoint.com">djumbdenstock@tycoint.com</a></td>
</tr>
<tr>
<td>37. Weller</td>
<td>D.</td>
<td>Robert</td>
<td>FCC</td>
<td>O/SC4</td>
<td><a href="mailto:bob@weller.org">bob@weller.org</a></td>
</tr>
<tr>
<td>38. Ziriax</td>
<td></td>
<td>John</td>
<td>Naval Med Research Unit</td>
<td>SC3/SC4</td>
<td><a href="mailto:john.ziriax@brooks.af.mil">john.ziriax@brooks.af.mil</a></td>
</tr>
<tr>
<td>39. Ziskin</td>
<td>C.</td>
<td>Marvin</td>
<td>Temple Univ. Medical School</td>
<td>SC3/SC4</td>
<td><a href="mailto:ziskin@temple.edu">ziskin@temple.edu</a></td>
</tr>
</tbody>
</table>

* Via telephone
O = Observer
Unapproved Agenda (Revised)

IEEE/ICES TC95 Subcommittee 3
Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 - 3 kHz

and

IEEE/ICES TC95 Subcommittee 4
Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

FDA Campus (White Oak), Silver Spring, Maryland
WO-Bldg 02, Room 2031
13 January 2010 (Wednesday)
0900 – 1600 h

1. Call to Order
2. Introduction of those Present
3. Approval of Agenda
4. Approval of the SC3/SC4 Minutes (June 2009 Meeting)
5. Secretary's Report
6. Chairmen's Report
   a. Recent ICNIRP reviews – RF bio-effects and mobile phones & tumor risks
   b. ICES comments to ICNIRP draft ELF guidelines
   c. ICNIRP and ICES harmonization
   d. Status of Australian ELF standard
7. Issues on Merging of C95.1 and C95.6
   a. Literature surveillance and review/evaluation
   b. Report from Editorial Committee – status of the merging work
   c. Numerical computations at ELF
   d. NATO standards
8. Other New Business
9. Date and Place of Next Meeting
10. Adjourn
IEEE ICES Literature Review Report

ATTACHMENT 3

- IEEE ICES EMF database
- Literature Review
- Issues to Consider
- Temperature Workshop
Recent Activity Focusing on RF Health Concerns
Prior US Congressional Hearing  
September 25, 2008

- **Senator Dennis Kucinich** (D-Ohio)
  - Chair, Domestic Policy Subcommittee (Oversight and Government Reform Committee)
  - Jurisdiction: domestic policy on energy, labor, education, criminal justice, economy, and drug control

- **Hearing “Brain Tumors and Cell Phone Use: What Science Says”**

  “... Recently, the [cell phone brain tumor] debate caught the public's attention with the publication in July of a warning from a preeminent oncologist about the human health effects of cell phone use...”

  “The question ... is whether the evidence is sufficient to merit action by regulators and legislators to protect public health? What have other national government health authorities done ... ? What should Congress or the Administration do, if anything, here in the United States?”
US Congressional Hearing
September 15, 2009

Senator Arlen Specter (D-Pennsylvania)
– Chair, Subcommittee on Labor, Health and Human Services, and Education
– Currently on Senator Specter’s [website](#)

• Hearing “Expert Conference on Cell Phones and Health: Science and Public Policy Questions”

Panelists
– John Bucher (Assoc Director NTP, USA)
– Dariusz Leszczynski (STUK, Finland)
– Siegal Sadetzki (Gertner Inst, Israel)
– Linda Erdreich (Exponent, USA)
– Devra Davis (Environ Health Trust)
– Olga Naidenko (Environ Working Group, USA)

• not meant to be "inflammatory" or to make "stark statements," but to address a "serious question that deserves a serious answer"
<table>
<thead>
<tr>
<th>Organization/Media</th>
<th>Report/Statement</th>
<th>Date</th>
</tr>
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<tbody>
<tr>
<td>French Acad Medicine, Science, Technol</td>
<td>Joint Statement “Reduced Exposure to Waves of Base Stations is not Scientifically Justified”</td>
<td>2009</td>
</tr>
<tr>
<td>Federal Office for Radiation Protection (BfS)</td>
<td>Statement &quot;Influence of Mobile Phone Use on Male Fertility&quot;</td>
<td>2009</td>
</tr>
<tr>
<td>UK Health Protection Agency</td>
<td>Report “A Children's Environment and Health Strategy for the UK”</td>
<td>2009</td>
</tr>
<tr>
<td>Health Physics Society</td>
<td>Fact Sheet on Mobile phones</td>
<td>2009</td>
</tr>
<tr>
<td>US FDA Website</td>
<td>“Cell Phones and Health” update</td>
<td>2009</td>
</tr>
<tr>
<td>Institution/Authority</td>
<td>Title</td>
<td>Year(s)</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
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<tr>
<td>French environmental Agency AFSSET</td>
<td>Statement “L'AFSSET Mise a jour de l'Expertise Relative aux Radiofrequences”</td>
<td>2009</td>
</tr>
<tr>
<td>European Commission’s Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)</td>
<td>“Possible Effects of Electromagnetic Fields (EMF) on Human Health”</td>
<td>2008, 2007</td>
</tr>
<tr>
<td>German Mobile Telecommunication Research Programme: (DMF)</td>
<td>Report “Health Risk Assessment of Mobile Communications”</td>
<td>2008</td>
</tr>
<tr>
<td>Spanish Committee on Assessment of Radiofrequency (CCARS)</td>
<td>Report on Radiofrequency and Health</td>
<td>2008</td>
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<tr>
<td>Isle of Man Council of Ministers</td>
<td>Working Group Report</td>
<td>2008</td>
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<tr>
<td>US National Cancer Inst</td>
<td>Fact Sheet &quot;Cellular Telephone Use &amp; Cancer Risk&quot;</td>
<td>2007</td>
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<tr>
<td>Organization/Authority</td>
<td>Report/Statement</td>
<td>Year</td>
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<td>--------------------------------------------------------------</td>
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<tr>
<td>Japan Ministry Internal Affairs and Comm</td>
<td>Statement on “… Possible Biological Effects of Electromagnetic Fields”</td>
<td>2007</td>
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<tr>
<td>New Zealand Ministry of Health Report, National Radiation Laboratory</td>
<td>“Safety of Cell Phones”</td>
<td>2007</td>
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<tr>
<td>Australian Comm Media Authority</td>
<td>Report “Mobile Phones, Your Health, and Regulation of RF Electromagnetic Energy”</td>
<td>2006</td>
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<tr>
<td>Swedish State Radiation Protection Authority (SSI)</td>
<td>report “Recent Research on EMF Health Risk, 4th Annual Report from an Independent Expert Group”</td>
<td>2006</td>
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<tr>
<td>US FCC Website</td>
<td>“Mobile Phones and Health Concerns”</td>
<td>update 2006</td>
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</tbody>
</table>
Publication Trends
The IEEE ICES EMF Literature Database contains information accumulated from a number of sources and may contain occasional inaccuracies. If such inaccuracies are discovered, please respond to the webmaster at joe.morrissey@nova.edu and we will be glad to correct the information.

Because of the increasing number of studies, the simple searches listed as “View EMF Studies (xxx)” may not always provide prompt returns. If this is the case, please use the “Advanced Search” option and narrow the selection criteria - the results can be delivered either by individual study or in different chart forms.
Radiofrequency Research
(Human / Provocation)

Global

US
Radiofrequency Research
*(In Vivo)*

![Graph showing trends in global and US radiofrequency research from 1990 to 2010. The graph indicates a significant increase in global research from 2005 onwards.]
Radiofrequency Research
(In Vitro)
RF Research Programs and Budgets

<table>
<thead>
<tr>
<th>Country/Program</th>
<th>Time period</th>
<th>Budget (M€)</th>
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</thead>
<tbody>
<tr>
<td>Australia</td>
<td>2004-2009</td>
<td>1.5</td>
</tr>
<tr>
<td>Denmark</td>
<td>2004-2008</td>
<td>4.0</td>
</tr>
<tr>
<td>Finland</td>
<td>2004-2007</td>
<td>1.9</td>
</tr>
<tr>
<td>Germany</td>
<td>2002-2007</td>
<td>17.0</td>
</tr>
<tr>
<td>UK: MTHR 1</td>
<td>2002-2008</td>
<td>12.2</td>
</tr>
<tr>
<td>MTHR 2</td>
<td>2007-2012</td>
<td>8.3</td>
</tr>
<tr>
<td>France</td>
<td>2006-2010</td>
<td>4.8</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2006-2014</td>
<td>16.6</td>
</tr>
<tr>
<td>South Korea</td>
<td>2005-2010</td>
<td>10.8</td>
</tr>
<tr>
<td>Switzerland</td>
<td>2006-2010</td>
<td>3.2</td>
</tr>
<tr>
<td>USA: NTP</td>
<td>2005-2010</td>
<td>18.0</td>
</tr>
<tr>
<td>NIH/NIOSH</td>
<td>2007-2010</td>
<td>1.0</td>
</tr>
<tr>
<td>EC COST</td>
<td>2008-2012</td>
<td>1.9</td>
</tr>
<tr>
<td>EU 7th Framework</td>
<td>2007-2013</td>
<td>?</td>
</tr>
<tr>
<td>Japan</td>
<td>1997-2007</td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>2007-2017</td>
<td>?</td>
</tr>
<tr>
<td>India</td>
<td>2008-2012</td>
<td>?</td>
</tr>
<tr>
<td>China</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>&gt;165 M€</strong></td>
<td><strong>($&gt;250 M)</strong></td>
</tr>
</tbody>
</table>


Currently available numerical models for human RF dosimetry
Ongoing modelling efforts for pregnant women and the fetus
Agreed Approach

- Step 1: Literature Capture – ongoing through current database
- Step 2: Selection - ongoing / we agreed to all peer-reviewed citations
- Step 3: Division - specialty areas for review per existing database subcategories
- Step 4: Critical Evaluation - ongoing
- Step 5: Synoptic Review
Status of Critical Reviews

- Linda Erdreich: epidemiology
- Myron Maslanyj: epidemiology exposure assessment
- Eric van Rongren: human studies
- Joe Elder: animal cancer bioassays
- John D’Andrea: animal behavior and brain biochemistry
- CK Chou: auditory pathology / MW hearing
- Marv Ziskin: teratogenicity and reproduction
- Joe Elder: blood brain barrier permeability
- Elizabeth Repasky: immune function
- (TBD): hormone changes
- Mark Dewhirst: time-temperature thresholds
- Joe Morrissey: in vitro studies
- Lutz Haberland: membrane biochem, Ca++ signaling
- Q Balzano: theoretical mechanisms
INTERPHONE
Environmental Working Group Report

- released September 2009
- public warning statement re: mobile phone use
- key recommendations:
  - “US government should require phones be labeled ... so consumers can make informed decisions ...”
  - “Cell phone industry should offer phones ... with the least possible [SAR] and make radiation emissions available at the point of sale”
  - "Cell phone users can protect themselves ... by buying low-radiation phones”
  - "Cell phone users can reduce exposures by using their phone in speaker mode or with a headset"
Expert Conference on Cell Phones and Health: Science and Public Policy Questions

• September 13-15, 2009

• Major Organizers
  – Devra Davis (Environmental Health Trust)
  – Ronald Herberman (U Pittsburgh)
  – David Servan-Schrieber (U Pittsburgh)
  – Dariusz Leszczynski (STUK, Finland)

• Goal: develop a research agenda

• Emphasized “scientific uncertainty” and the need for further research
EMF Induction Models for ICES Low-frequency standard

J. Patrick Reilly
The Johns Hopkins University
Applied Physics Laboratory
Laurel, MD 20723

Presented at ICES Meeting
US Food & Drug Administration
Silver Spring, MD Campus
January 13, 2010
Human Exposure Limit Classifications

- **Basic Restrictions (BRs)**
  - Limitations on electrical forces within the body to avoid adverse reactions with acceptable safety factor.

- **Maximum Permissible Exposure (MPE) limits**
  - Limitations on external fields or applied current that would ensure adherence to BRs
Dominant Mechanisms in Exposure Standards

- **Low Frequency (< 100 kHz CW; < 5 MHz pulsed)**
  - Electrostimulation
  - Magneto-Hydrodynamic (static to very low frequencies)

- **High Frequency (> 100 kHz, typically)**
  - Thermal Effects
Basic restrictions in ICES C 95.6-2002

<table>
<thead>
<tr>
<th>Tissue</th>
<th>( f_e ) (Hz)</th>
<th>Public</th>
<th>Contr. environ.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( E_O - \text{rms} ) (V/m)</td>
<td>( E_O - \text{rms} ) (V/m)</td>
</tr>
<tr>
<td>Brain</td>
<td>20</td>
<td>5.89x10^-3</td>
<td>1.77x10^-2</td>
</tr>
<tr>
<td>Heart</td>
<td>167</td>
<td>0.943</td>
<td>0.943</td>
</tr>
<tr>
<td>Hands, wrists, feet &amp; ankles</td>
<td>3350</td>
<td>2.10</td>
<td>2.10</td>
</tr>
<tr>
<td>Other tissue</td>
<td>3350</td>
<td>0.701</td>
<td>2.10</td>
</tr>
</tbody>
</table>

Also for head & torso:

- \( B \leq 167 \text{ mT}, \text{ general public} \)
- \( B \leq 500 \text{ mT}, \text{ controlled environment} \)
Basic Restrictions of ICES & ICNIRP for General Public with Safety Factors

Broken lines = assumed adverse reaction levels.

\[ F_s = \text{Safety Factor used by ICES & ICNIRP.} \]

\[ F_p = \text{Probability factor used by ICES.} \]

From Reilly, 2005
Magnetic Field Induction Models

- Uniform conductivity medium within loops
- Used to relate induced electric field to external magnetic field

ICNIRP: Circular loop
- $r = 64$ cm

IEEE: Elliptical induct. Loop for whole body (sagittal)
- $a = 90$ cm
- $b = 20$ cm
Ellipsoidal Magnetic Induction Model 
Applied to Human Body

Numerical callouts: induced E-field (V/m) for $dB/dt = 100$ T/s 
(Fig. 9.1 of Reilly, 1998)
ICES Magnetic Field
Max. Exposure Limits

Broken lines:
Median adverse reaction thresholds

Solid lines:
Max. permissible exposure limits

![Graph showing magnetic field exposure limits](image)
Example Anatomical Models for FDTD Applications

<table>
<thead>
<tr>
<th>Visible Human</th>
<th>Norman</th>
<th>Korean</th>
<th>Zubal</th>
<th>Japan Male</th>
<th>Japan Female</th>
</tr>
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<tbody>
<tr>
<td>Figures from Conil et al. (2008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>
Detailed Anatomical Models

Internal E-field in response to 50 mA current:
• surface electrodes,
• sweat-soaked skin,
• central sagittal plane illustrated,
• voxel resolution 2 - 5 mm.

Color Key
Orange: $E > 49.2$ V/m
Yellow: $E > 24.6$ V/m, but $< 49.2$ V/m
Sky blue: $E > 12.3$ V/m, but $< 24.6$ V/m
Dark Blue: $E > 6.15$ V/m, but $< 12.3$ V/m
Very Dark Blue: $E < 6.15$ V/m

Courtesy of Gianlucca Lazzi, North Carolina State University, 2009.
Methods described in Lazzi, 2001; Schmidt & Lazzi, 2003.
Issues Needing Resolution

- Large differences FDTD vs. ellipsoid
- Differences among FDTD publications
  - 5:1 peak differences (2001)
  - 2:1 differences organ averages (2001)
- Interface E-field peaks
- Various models
  - Large human stressful for B-field exposure
  - Child model stressful for E-field exposure
### Conversion factors: External B-field to in-situ E-field

<table>
<thead>
<tr>
<th>Body Location</th>
<th>ICES(^1)-2002 Ellipsoid (mV/m)/(T/s)</th>
<th>ICNIRP-1998 Circle (mV/m)/(T/s)</th>
<th>ICNIRP(^3)-2009 FDTD (mV/m)/(T/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve, periphery</td>
<td>160</td>
<td>270 (?)(^2)</td>
<td>340 (Brand ‘02) 200-250 (So ‘04) 650 (Bencsik ‘07)</td>
</tr>
<tr>
<td>Heart (apex)</td>
<td>135</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brain</td>
<td>52</td>
<td>-</td>
<td>97</td>
</tr>
<tr>
<td>Leg</td>
<td>86</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>650 (?)(^4)</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:
1) IEEE C95.6-2002
2) Reilly (2005)
3) ICNIRP draft revision, 29 July ’09
4) ICNIRP 1998 as stated in ICNIRP Draft ’09
In-situ E-field in human model exposed to $H_y = 80 \text{ A/m, } f = 50 \text{ Hz}$, with and without components at tissue interfaces. (Bahr et al., 2007)
Interface Effects to Investigate

- Large enhancement of E-field @ tissue interfaces.
- Spatial averaging
  - How thick is interface enhancement?
  - Does a nerve fiber “feel” interface?
  - Impact of spatial averaging (5 mm in ICES)
- Reject 1-2% highest values each organ?
- Does fiber trajectory rule out interface effect?
CNS Basic Restriction
Need to recalculate

- CNS BRs determined from Phosphene data using mag. field stimulation
  - ICES (& ICNIRP) Phosphene E-field thresholds determined from magnetic stimulation experiments.
  - Used ellipsoidal model
- Need to recalculate E-field thresholds if use FDTD model.
  - Shouldn’t change B-field MPEs for CNS
Citations

- ICNIRP (1998). Guidelines for exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Physics 34(3): 494-522
Intercomparison of Induced Fields in Japanese Male Model TARO Due to Magnetic Field Exposures

A. Hirata (Nagoya Inst. Tech.), K. Yamazaki (CRIEPI), S. Hamada (Kyoto Univ.)
H. Tarao (Takamatsu Nat’l Coll. Tech.), K. Wake (NICT)
Y. Kamimura (Utsunomiya Univ.), Y. Suzuki (Tokyo Metro. Univ.)
N. Hayashi (Kyusyu Univ.), O. Fujiwara (Nagoya Inst. Tech.)
This intercomparison has been conducted under the auspices of the “Investigation Committee on Non-uniform and Transient Electromagnetic Field Exposure on Human”, IEEJ, July 2006 – June 2009 (Chairperson: Prof. Osamu Fujiwara)

*IEEJ: Institute of Electrical Engineers of Japan
Stuchly and Gandhi has conducted intercomparison for the data by three groups; Dimbylow (HPA, former NRPB), Gandhi (Utah Univ.), Stuchly (Univ. Victoria).

Even though Dimbylow’s data are based on the computation for high-resolution human model (2 mm), the human models used by Gandhi and Stuchly were rather coarse (6 mm and 3.6 mm) to focus on induced fields in the central nerve tissues.

Measures used for comparison

- Organ-averaged E-field (Stuchly and Gandhi)
- Organ-averaged current density (electrical constants did not coincide) (Stuchly and Gandhi)
- Maximum current density (Dimbylow and Stuchly)

Attention was not paid to the induced quantities in the central nerve tissues (ICNIRP, 1998)
There are the main possible three factors influencing the computational results.

- **Computational Method and Coding**
- **Human Body Model** (Japanese adult male model)
- **Electrical Constants** (based on Gabriel’s report)

Our attention here focuses on the uncertainty caused by computational methods and their coding.
Japanese adult male model named TARO

Tissues: 51
Resolution: 2mm

http://www2.nict.go.jp/pub/whatsnew/press/010426/010426.html
# Electrical Constants of Tissues

<table>
<thead>
<tr>
<th>tissues</th>
<th>S/m</th>
<th>tissues</th>
<th>S/m</th>
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</thead>
<tbody>
<tr>
<td>cerebellum *</td>
<td>0.10</td>
<td>pancreas</td>
<td>0.35</td>
</tr>
<tr>
<td>C.S.F.</td>
<td>2.00</td>
<td>prostate</td>
<td>0.40</td>
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<tr>
<td>cornea</td>
<td>0.40</td>
<td>small intestine</td>
<td>0.50</td>
</tr>
<tr>
<td>eye humor</td>
<td>1.50</td>
<td>spleen</td>
<td>0.10</td>
</tr>
<tr>
<td>grey matter *</td>
<td>0.10</td>
<td>stomach</td>
<td>0.50</td>
</tr>
<tr>
<td>hypothalamus *</td>
<td>0.08</td>
<td>stomach contents</td>
<td>0.35</td>
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<td>eye lens</td>
<td>0.25</td>
<td>tendon</td>
<td>0.30</td>
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<td>pineal body *</td>
<td>0.08</td>
<td>testis</td>
<td>0.35</td>
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<td>pituitary *</td>
<td>0.08</td>
<td>thyroid gland</td>
<td>0.50</td>
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<td>salivary gland</td>
<td>0.35</td>
<td>trachea</td>
<td>0.35</td>
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<tr>
<td>thalamus *</td>
<td>0.08</td>
<td>urine</td>
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<td>tongue</td>
<td>0.30</td>
<td>blood</td>
<td>0.70</td>
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<tr>
<td>white matter *</td>
<td>0.06</td>
<td>cortical bone</td>
<td>0.02</td>
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<td>adrenals</td>
<td>0.35</td>
<td>bone marrow</td>
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<td>bladder</td>
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<td>0.10</td>
<td>fat</td>
<td>0.04</td>
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<tr>
<td>duodenum</td>
<td>0.50</td>
<td>muscle</td>
<td>0.35</td>
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<tr>
<td>esophagus</td>
<td>0.50</td>
<td>spinal cord *</td>
<td>0.03</td>
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<td>skin</td>
<td>0.10</td>
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<td>0.20</td>
<td>tooth</td>
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<tr>
<td>heart</td>
<td>0.10</td>
<td>ligament</td>
<td>0.30</td>
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<td>kidney</td>
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<td>diaphragm</td>
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<td>liver</td>
<td>0.07</td>
<td>seminal vesicle</td>
<td>0.35</td>
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<td>lung</td>
<td>0.14</td>
<td>cavernous body</td>
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<td>large intestine</td>
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<td>small intestine</td>
<td>0.35</td>
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<tr>
<td>thalamus *</td>
<td>0.08</td>
<td>contents</td>
<td></td>
</tr>
<tr>
<td>white matter *</td>
<td>0.06</td>
<td>contents</td>
<td></td>
</tr>
</tbody>
</table>

*: Tissues of CNS

Computational Methods

- Impedance Method
  CRIEPI
  NICT

- SPFD Method
  Takamatsu Nat’l College of Tech (TNCT)
  Utsunomiya University

- Fast-multipole surface-charge-simulation method for voxel data
  Kyoto University

- Quasi-static Finite-Difference Time-Domain Method
  Nagoya Institute of Technology (NIT)
Measure used for comparison

Induced Electric Field:
(1) the maximum one-voxel value in the whole body
(2) the 99th percentile one-voxel value in the whole body
(3) the 99th percentile one-voxel value in the CNS tissue

Induced Current Density:
(4) the maximum one-voxel value in the whole body
(5) the maximum value averaged over an area of 1 cm$^2$ in the whole body
(6) the maximum value averaged over an area of 1 cm$^2$ in the CNS tissue
### Results of Intercomparison

<table>
<thead>
<tr>
<th>X LAT</th>
<th>CRIEPI values</th>
<th>NICT values</th>
<th>Taka Tech values</th>
<th>Utsunomiya Univ. values</th>
<th>Kyoto Univ. values</th>
<th>NIT values</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>128 cortical bone</td>
<td>13.7 cortical bone</td>
<td>16.3 cortical bone</td>
<td>17.6 cortical bone</td>
<td>19.9 cortical bone</td>
<td>17.7 cartilage</td>
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<tr>
<td>(ii)</td>
<td>8.70</td>
<td>3.30</td>
<td>3.48</td>
<td>3.36</td>
<td>3.79 fat</td>
<td>3.66</td>
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<tr>
<td>(iii)</td>
<td>44.1 spinal cord</td>
<td>2.90 gray matter</td>
<td>3.09 spinal cord</td>
<td>2.90 white matter</td>
<td>2.83 gray matter</td>
<td>2.77 gray matter</td>
</tr>
<tr>
<td>(iv)</td>
<td>3.72 CSF</td>
<td>7.39 CSF</td>
<td>15.7 CSF</td>
<td>8.13 CSF</td>
<td>7.50 CSF</td>
<td>7.48 CSF</td>
</tr>
<tr>
<td>(v)</td>
<td>2.59 CSF</td>
<td>2.40 CSF</td>
<td>3.75 CSF</td>
<td>2.41 CSF</td>
<td>1.97 CSF</td>
<td>1.70 CSF</td>
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<tr>
<td>(vi)</td>
<td>1.85 spinal cord</td>
<td>2.24 spinal cord</td>
<td>3.48 spinal cord</td>
<td>2.24 spinal cord</td>
<td>1.76 spinal cord</td>
<td>1.56 gray matter</td>
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<table>
<thead>
<tr>
<th>Y AP</th>
<th>CRIEPI values</th>
<th>NICT values</th>
<th>Taka Tech values</th>
<th>Utsunomiya Univ. values</th>
<th>Kyoto Univ. values</th>
<th>NIT values</th>
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<td>79.3 cortical bone</td>
<td>31.1 Skin</td>
<td>39.0 skin</td>
<td>31.2 skin</td>
<td>37.0 skin</td>
<td>31.2 skin</td>
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<tr>
<td>(ii)</td>
<td>12.4</td>
<td>5.76</td>
<td>5.89</td>
<td>5.80</td>
<td>6.35</td>
<td>6.46</td>
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<tr>
<td>(iii)</td>
<td>15.0 spinal cord</td>
<td>2.49</td>
<td>2.83 spinal cord</td>
<td>2.53 gray matter</td>
<td>2.51 white matter</td>
<td>3.71 spinal cord</td>
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<tr>
<td>(iv)</td>
<td>2.80 muscle</td>
<td>8.09 CSF</td>
<td>12.4 CSF</td>
<td>7.48 CSF</td>
<td>4.81 CSF</td>
<td>8.15 CSF</td>
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<tr>
<td>(v)</td>
<td>1.88 CSF</td>
<td>4.07 CSF</td>
<td>4.27 CSF</td>
<td>4.10 small intestine</td>
<td>3.20 small intestine</td>
<td>2.42 CSF</td>
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<tr>
<td>(vi)</td>
<td>1.64 gray matter</td>
<td>1.54 spinal cord</td>
<td>3.40 spinal cord</td>
<td>1.50 gray matter</td>
<td>1.42 gray matter</td>
<td>2.24 spinal cord</td>
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</table>

<table>
<thead>
<tr>
<th>Z TOP</th>
<th>CRIEPI values</th>
<th>NICT values</th>
<th>Taka Tech values</th>
<th>Utsunomiya Univ. values</th>
<th>Kyoto Univ. values</th>
<th>NIT values</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>60.0 cortical bone</td>
<td>16.2 fat</td>
<td>11.5 fat</td>
<td>16.2 fat</td>
<td>18.8 fat</td>
<td>16.2 fat</td>
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<tr>
<td>(ii)</td>
<td>7.56</td>
<td>3.60</td>
<td>3.65</td>
<td>3.61</td>
<td>4.00</td>
<td>4.07</td>
</tr>
<tr>
<td>(iii)</td>
<td>10.4 spinal cord</td>
<td>2.10</td>
<td>1.98 white matter</td>
<td>2.14 gray matter</td>
<td>2.15 white matter</td>
<td>2.29 gray matter</td>
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<tr>
<td>(iv)</td>
<td>2.10 CSF</td>
<td>5.07 CSF</td>
<td>7.93 CSF</td>
<td>5.08 CSF</td>
<td>4.09 CSF</td>
<td>5.09 CSF</td>
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<tr>
<td>(v)</td>
<td>1.52 CSF</td>
<td>2.03 CSF</td>
<td>2.23 CSF</td>
<td>1.40 muscle</td>
<td>1.42 muscle</td>
<td>1.30 CSF</td>
</tr>
<tr>
<td>(vi)</td>
<td>1.46 gray matter</td>
<td>1.22 gray matter</td>
<td>1.63 white matter</td>
<td>1.21 gray matter</td>
<td>1.00 gray matter</td>
<td>1.21 gray matter</td>
</tr>
</tbody>
</table>
Results of Intercomparison

- Comparison was made using the relative difference $D$,

\[ D = \frac{|A_r - A_i|}{A_r} \]

- Where, $A_r$: reference value (a mean value of the four groups excluding the maximum and minimum values among the joined 6 groups), and $A_i$: individual result by each group
Relative deference (1) E-field: Maximum Voxel Value in the Body

- within 30% except for those obtained by one group.
Relative deference (2) E-field: 99th percentile Voxel Value in the Body

-the relative differences are suppressed to several percent from the maximum voxel value.
Relative deference (3) E-field: 99th percentile Voxel Value in the CNS tissue

- larger than those for the whole body, presumably because the nerve tissues are surrounded by cerebrospinal fluid, which has a large conductivity
Relative difference (4) Current Density: Maximum Voxel Value in the Whole Body

-the maximal current density appears in the CSF
Relative difference (5) Current Density: Maximum Value Averaged Over 1cm² of Whole Body

- the maximum value of current density averaged over 1 cm² are smaller than those for the voxel-maximal current density.
Relative difference (6) Current Density Maximum Value Averaged Over 1cm² of CNS Tissues

- the relative difference in the maximal value of current density averaged over 1 cm² for the CNS tissue is smaller than that for the whole-body
- the relative difference in most cases is generally smaller than 10%, except for the results at one group
Summary

- Intercomparison using a Japanese adult male model for uniform magnetic field exposures was conducted
- Total of six institutes has joined
- Reasonable agreement was obtained between the induced electric fields/current densities calculated at 6 different groups
TC95 NATO WORKING GROUP

NATO JOINS FORCES WITH IEEE

First Standard Transfer Ever
NATO to a Civilian Standards Organization

15 January, 2010
Food and Drug Administration
Silver Spring, MD

Dr. B. Jon Klauenberg
Senior Research Physiologist
Human Effectiveness Directorate
Air Force Research Laboratory
NATO Standardization Agreement (STANAG) 2345 (2003)

- Standardization Agreement (STANAG) 2345: “Evaluation and Control of Personnel Exposure to Radio Frequency Fields – 3 kHz to 300 GHz”

- Provides guidance to protect personnel from potential electromagnetic health and safety hazards in the military operational environment

- Based on Institute of Electrical and Electronics Engineers (IEEE) C95.1-1991

- NATO designated “Essential STANAG”

- Provides minimal exposure guidance

- Two major revisions; Last 13 Feb 2003

- Triennial review: reaffirm, revise, cancel

- Revision stalled due to proposed EU Worker Safety Directive
• Two military occupational unique components:
  – Contact Current
    • RMS limit of 100 mA is established for grasp
    • For any 6-min exposure
    • 500 mA ceiling temporal peak value (IEEE C95.1a Amendment)
  • Touch and grasp are distinguished

  – All exposures are limited to a single pulse maximum peak (E-field) of 200 kV/m
Interoperability Threatened By Proposed EU Directive

- Survey of NATO nations showed operational impact on safety from new EU Worker Safety Directive limits on contact currents

- Reduction of Action Level to 40 mA contact current is not mitigatable if implemented as a *De Facto* Exposure Limit Value

- Operations impacted (non-mitigatable)
  - HF communications often last 6 – 8 hrs
  - Vertical replenishment operations
  - Man-Overboard & Search-And-Rescue
  - Ship to ship supply transfers
  - Fuel transfer
  - Armaments test and transfer

- Entire deck of ship “off limits”
Exclusion Zones at 100mA

HNLMS Oblong

Representation of Measurements on Netherlands frigate
Exclusion Zones at 40mA

HNLMS Oblong

Representation of Measurements on Netherlands frigate

No space on deck is open to workers! A new risk to safety

PA case #09-466
Shifting Risks
Creating New Risks

Sorry. EU Directive doesn’t permit man overboard operations during HF transmission.

We have to protect our personnel you know.

Can you wait 8 hours?

However in reality......
Noncompliance Slippery Slope

Of course Man Over-Board Operations are underway !!!
(even it EU Directive doesn’t permit man overboard operations during HF transmission)

We have to protect our personnel you know.

Thanks!!!

Ignoring One Safety Standard Will Lead To Ignoring Others
Action Levels (AL) Without Exposure Limit Values (ELV)

• At Action Level, all that is legally required is a safety management program be instituted to prevent reaching ELV

However,
• Without ELVs, how can Action Levels be set?
• Without ELVs, Action Levels will become *de facto* ELVs
• Some NATO nations have already implemented ALs as ELVs
• Recent publication by the group reviewing stakeholder impacts notes Action Levels will become *de facto* limits!
European Worker Standards

• Most EU nations are already working to the “action levels” in Directive 2004/40/EC

• USA, CAN and some Non-EU Nations military unlikely to adopt similar standard

• EU and Non-EU cooperation needed for interoperability

• Possible NATO - EU coordination in the civil standards area

• **NATO Civil Initiative**
NATO Civil Standards Initiative

• Use suitable civil standards to the maximum practicable extent
• Develop NATO standard only when no applicable civil standard is available
• Promote existing NATO standards to civilian use
  – Make available to a maximum number of users
    • In accordance with NATO security rules
• Promote interoperability

NATO/EAPC(NCSREPS)D(2006)0001)
Benefits of “Going Civil”

- Reduction in cost of maintaining standards
- Leverage resources
- Avoid duplication of effort: *Don’t remake the wheel*
- Gain access to wider spectrum of standards
- Make available to a maximum number of users
- Remain abreast of industry advancements
- Use the experts: SDOs focus on drafting standards
Drivers for Military Use of Civil Standards


• Public Law 104-113, The National Technology and Transfer and Advancement Act of 1995

• DoD 4120.24M "DoD Standardization Program (DSP) Policies and Procedures”, March 9, 2000

• NATO Framework For Civil Standards (C-M(2004)0009)

• “Participation in Non-Governmental Standards Bodies is a ‘good business model’” G. Saunders DSP Journal Jan/Mar 2009.
Develop standards that

– Are widely recognized and used in NATO Nations

– Use Open, Transparent, Consensus procedures

– Use due process in adjudication of comments or complaints from materially affected parties

– Are relevant to NATO standardization requirements

Be recognized as developing standards of high technical quality and global relevance
Technical Cooperation Agreement not a firm requirement
Transition to Civil Standard Development Organization

• **First-ever** trial of NATO Standardization Agency (NSA) civilian standards initiative
  – Opportunity to “solve” impasse to S2345 revision

• 26 Oct 07: European Committee for Standardization (CEN) contacts NATO Standardization Agency Civil Standards Management Working Group (CSMWG):
  – CEN recommends European Committee for Electrotechnical Standardization (CENELEC)
  – Discussions held 12 Dec 07, 14 Mar 08 at NATO & CENELEC, Brussels: CENELEC prohibited by EU Parliament from setting exposure limits….. Will not respond

• Marketing proposal to SDOs: Two respond
  – International Electrotechnical Commission (IEC)
    (Same prohibition against setting exposure limits as CENELEC)
  – Institute of Electrical and Electronics Engineers (IEEE)
IEEE/ICES Selection Factors

- IEEE International Committee on Electromagnetic Safety (ICES) operates under the extensive rules, requirements, and audit procedures of the IEEE Standards Association to ensure **openness, transparency and due process** at every level.
- ICES meets NATO requirements for **openness and consensus**.
- ICES members participated in prior editions of STANAG 2345 and NATO Advanced Research Workshops on RF standards.
- Chair of IEC TC106 is also Secretary of IEEE/ICES high frequency subgroup and a member of the IEEE Stds Board.

The Bottom Line

**IEEE/ICES: The only Civil Standards Developmental Organization that has a charter to set EMF exposure limits**
International Committee On Electromagnetic Safety (ICES)

• The ICES subcommittee (SC4) is open to anyone with a direct and material interest in the activities of the subcommittee

• The IEEE/ Committee, ICES that developed the latest (2005) edition of the RF safety standard C95.1 consists of:
  – 132 participants
  – **Multinational** membership: 24 countries
  – **Open**: Government, universities, industry, and the public
  – **Multidisciplinary**: 14 disciplines including medicine, epidemiology, biology, biophysics, physics, risk assessment, risk communication, and engineering
A No Brainer!

IEEE/ ICES!!

CENELEC?

IEC?
“NATO Standardisation Agency (NSA) and the Institute of Electrical and Electronics Engineers (IEEE) Standards Association signed a Technical Cooperation Agreement today, 14 May, 2009.”

- Share knowledge of standards development activities
- Avoid duplication whenever possible
- Exchange information about standards development activities in the electrical, electronics, computer, and related fields.
- Exchange technical data and information regarding standards, standards development and standards revisions in areas related to human health and safety
- Covers all IEEE standards
Technical Cooperation Agreement
NSA-IEEE Signed

TECHNICAL COOPERATION AGREEMENT
SIGNING BETWEEN THE NSA AND IEEE - 14 MAY 2009
First Transfer of a NATO Standardization Agreement

“"I am very glad to establish this new relationship with IEEE, which constitutes the basis for the very first transfer of a NATO STANAG to a civil Standards Developing Organization,” said Vice Admiral Juan A. Moreno, Director NSA. “For the first time in NATO’s 60 year-old history, a STANAG will be converted into a civil standard that will meet civil and military requirements.” NATO News 15 May 2009
“New IEEE Military Workplace Standard” signed 30 July 2009

- IEEE shall develop, maintain, revise, and update a new IEEE military workplace standard that will address normative military occupational/workplace-specific exposure limits to electric, magnetic and electromagnetic fields

- Seven pages, 24 Sections
  - Introduction
  - General Provisions
  - Grant and Reservation of Rights
  - Outline of Action Plan
Specific Agreement for the Development of a New IEEE Civil Standard to Replace the NATO EMF Standard, Adopted Under STANAG 2345 (effective 1 August 2009)

From and after the Effective Date, the IEEE shall develop, maintain, revise, and update a new IEEE military workplace standard that will address normative military occupational/workplace-specific exposure limits to electric, magnetic and electromagnetic fields, i.e., limits for exposures in controlled environments, over the full frequency spectrum from 0 Hz to 300 GHz (the “New IEEE Military Workplace Standard”)

The NATO EMF Standard will become a core document contribution to the New IEEE Standard.
The NATO Standards Transfer Process

- Selection of NATO standardization documents for transfer
- Market survey (1st Jun 08, 2nd Sep 08)
- SDO response (1 Oct 08) and selection of the SDO (22 Jan 09)
- Specific Agreement for standard (1 August 2009)
- SDO accepts NATO standard
- SDO forms technical group (1st meeting 22-23 July 2009)
- Revise or draft new (expected in 9 months)
- Publish (additional year)
- NATO adoption / recognition of civil standard (6-12 months)
Way Ahead for Transition of Standard Under STANAG 2345

- ICES coordinates with the Custodian
- Custodian coordinates with other NATO subject matter experts
- IEEE publishes the “IEEE Military Workplace Standard”
- Nations subject matter experts determine if the standard meets NATO requirements (and National requirements)
- Custodian, on behalf of the Tasking Authority (TA), works to develop Standardization Agreement (STANAG 2345) to formally adopt the civil standard.
- TA (Custodian) develops a covering STANAG 2345
- NATO nations ratify/agree to the document, and NSA promulgates the STANAG
• 22 Jan: NATO Medical WG approved transfer to IEEE
• 24 Apr: Delegated Tasking Authority, Medical Board approves
• 14 May: Technical Cooperation Agreement NSA-IEEE signed
• 30 Jul: Specific Agreement with IEEE signed
• 14 Jul: 1st draft IEEE PC95.2345TM/D1.0
• 17 Jul: Project Authorization Request (PAR) PC95.1-2345 submitted
• 22-23 Jul: 1st meeting of IEEE TC95 NATO Working Group
• 4 Sep: 2nd draft IEEE PC95.2345TM/D1.1
• 10 Sep: PC95.1-2345 PAR to IEEE New Standards Committee (Approved 11 Sep until Dec 2013)
• 28-29 Sep: 2nd meeting of IEEE TC95 NATO Working Group
Inclusion of Military Relevant Needs

“If not totally suitable: include defence needs in the body of the civil standard or as an Annex;”

“If not totally suitable: include military options or ‘grading’ to cover defence needs in the Civil Standard.”

NATO/EPAC (NCSREPS)D(2007)0001

“…there are circumstances that require unique defense specifications and standards because of the nature of the system and in these cases a “defense unique standard” may be the better option…”

G. Saunders, NATO Policy on Civil Standards, 7 Mar 2009
Door Opened for NATO Involvement in EU Commission

• 3 Feb 09: Director NATO Standardization Agency letter to EU
  – Requests NATO participation in EC Directive review
  – Cites potential impacts to military operations and interoperability and safety concerns

• 18 Feb 09: Custodian invited brief to EU Commission WG; Ljubljana, SLO

• 21 Apr 09: Director General European Union Commission invites NATO to participate in future stakeholder meetings

• 9 July 09: Briefing on impacts to EU Commission WG: Luxembourg, LUX

• 6-8 Oct 09: Umea, SWE: Invited stakeholder to EU Presidency Conference on electric and magnetic fields (EMF) worker safety
Summary

- Medical Standards Board approves transfer to IEEE: Jan 09
- Technical Cooperation Agreement NATO/IEEE signed: May 09
- Specific Agreement signed: Jul 09
- IEEE working group formed: Jul 09
- TC95.1-NATO WG editorial meetings: Jul, Sep 09
- PAR approved: Sep 09
- EU Commission invites NATO/NSA to working group: A Door Opened
- New IEEE NATO Standard in 9-12 months
- Transfer-conversion ON TRACK
Thank you for your attention!

QUESTIONS?

B. JON KLAUENBERG, Ph.D.,
AFRL 711 HPW/RHDR
Air Force Research Laboratory
711 Human Performance Wing
Human Effectiveness Directorate
Directed Energy Bioeffects Division
Radio Frequency Radiation Branch
bertram.klauenberg@us.af.mil
210-536-4837
Workshop

Thermal Aspects of Radio Frequency Exposure

Jointly sponsored by US FDA, MMF, GSMA

January 11-12 in Gaithersburg, Maryland
Participants

**Academia**
- Dartmouth
- Harvard
- U Michigan
- UCLA
- U Maryland
- U Pennsylvania
- U Bordeaux
- Duke U
- Temple U
- UC London
- U Rochester
- Roswell Park Can Inst
- UC San Francisco
- University Uppsala
- Nagoya Inst Tech
- INERIS, France
- Chungbuk Nat’l U
- Nat’l Inst Comm Tech (Japan)

**Government**
- US FDA
- US FCC
- US EPA
- Nat’l Inst Drug Abuse
- Nat’l Inst Athletic Health
- US NIH
- US NCI
- UK HPA
- German BfS
- Health Canada
- Health Council Netherlands
- ARPANSA
- Japan EMF Info Center

**Military**
- US Army Med Res Detach (Brooks AFB)
- Air Force Research Lab

**Industry**
- Motorola
- Nokia
- Ericsson
- France Telecom
- Siemens
- Cisco
- Alcatel-Lucent
- Nextel
- Mobile Manufacturers Forum
- GSMA Association
- IT’IS Foundation
- Industry Canada
- Philips Medical
- nContact Surgical
- Ethicon Endo-Surgery
- Procter & Gamble
Focus on *Thermal* Interactions
GOAL Questions

• What are the most appropriate health endpoints for a given tissue / system?
• What are the most appropriate time periods for acute and chronic exposure?
• Are there any well established time-temperature thresholds?
• Cost effective and targeted research to better define time-temperature thresholds in support of human exposure standards?

• Support / contrast with the REPORT
Tissue Specific Time-Temperature Thresholds

- Several numerical studies suggest 10 W/kg can result in increases ~1°C (10g avg)

  - 0.55°C / 10 W/kg (brain)

- Ghandi et al (2001)  
  - 0.5°C / 10 W/kg (brain)

  - 1.6°C / 10 W/kg (brain)

- Van Leeuwen, Lagendijk (1999, 2007)  
  - 1.35°C / 10 W/kg (eye)
  - 0.68°C / 10 W/kg (brain)

  - 1.75°C / 10 W/kg (eye)
  - 1.0 - 1.5°C / 10 W/kg (head)

- Buccella et al (2007)  
  - 1.5°C / 10 W/kg (eye)

  - 0.5°C / 10 W/kg (brain)

- Samaras et al (2007)  
  - 1-2°C / 10 W/kg (eye)
Percent embryological defects vs \( t_{4.0} \) based on the results for Kimmel (K) et al.\(^{22}\), Germain (G) et al.\(^{20}\), and Shiota (S)\(^{31}\). These were obtained from temperature:time combinations represented by some of the points plotted in figure 2, using the relationship represented by equation (2). These data were used to establish dose-response relations for heat-induced teratogenic effects in laboratory animals (rats, rats, and mice, respectively). The keyed, author-specific designations refer to the maximum temperature increase (\( \Delta T \)) above core value for a specific experimental protocol. Equivalent \( t_{4.0} \) values were determined by integrating at 0.5°C intervals during the heating:cooling periods (see figure 1 and table 1 for an example) and using the temperature profiles given in the original reports. Equation (2) with \( R=0.25 \) was used. The solid line is a best fit to the data of Germain et al. and Shiota, the dashed line a best fit to the data for Kimmel et al. Both line plots essentially intersect at the origin. The control and sham-exposed levels of foetal malformations were 12.3 and 9.1%, respectively, in Kimmel et al.\(^{22}\), and the sham-exposed levels for foetal malformations in Germain et al.\(^{20}\) and Shiota\(^{31}\) were 0%; see text.

Miller et al Int J Hyperthermia 2002; 18:361-384
Naked gun: airport T-ray scanners will be able to see through clothes to find hidden weapons.
Environmental Working Group Report

• released September 2009
• public warning statement re: mobile phone use
• key recommendations:
  – “US government should require phones be labeled ... so consumers can make informed decisions ...”
  – “Cell phone industry should offer phones ... with the least possible [SAR] and make radiation emissions available at the point of sale”
  – "Cell phone users can protect themselves ... by buying low-radiation phones”
  – "Cell phone users can reduce exposures by using their phone in speaker mode or with a headset"
Expert Conference on Cell Phones and Health: Science and Public Policy Questions

• September 13-15, 2009

• Major Organizers
  – Devra Davis (Environmental Health Trust)
  – Ronald Herberman (U Pittsburgh)
  – David Servan-Schrieber (U Pittsburgh)
  – Dariusz Leszczynski (STUK, Finland)

• Goal: develop a research agenda

• Emphasized “scientific uncertainty” and the need for further research