



INTERNATIONAL
COMMITTEE *on*
ELECTROMAGNETIC
SAFETY

Approved Minutes

IEEE/ICES SCC-28 Subcommittee 4

**Safety Levels with Respect to Human Exposure to Radio Frequency
Electromagnetic Fields, 3 kHz to 300 GHz**

June 19, 2004

8:00 to 5:00 PM

**Omni Shoreham Hotel,
2500 Calvert Street, NW,
Washington, District of Columbia, USA**

1. Call to Order

The meeting was called to order by co-chairman D'Andrea at 0805 h.

2. Introduction of those Present

Each of the attendees introduced him/herself. (See Attachment 1 for a list of attendees.)

3. Approval of Agenda

Following a motion by Varanelli and a second by Ziskin, the agenda was approved without modification. See Attachment 2).

4. Approval of the Minutes of the Dec 5-6, 2003 Meeting

Following a motion by Varanelli and a second by Adair, the minutes of the December 2003 SC-4 meeting were approved without modification.

5. Secretary's Report

Petersen reported that balloting on PC95.1(b) – Amendment 1 to C95.1 to address SAR in the pinnae – was complete and the draft standard was submitted to RevCom for consideration at the SASB meetings next week. He noted that David Fichtenberg asked to be heard before RevCom to speak against approval of the amendment. His concern was that what he considers key papers were not adequately addressed. Petersen said that he would attend the RevCom meeting to defend the amendment. He also said that he would be giving a more detailed report at the parent committee meeting on Sunday.

6. Chairman's Report

Co-chairman Chou reported on the progress of C95.1 revision. He noted that the first ballot

on Draft 1.8 of the revision of C95.1-1991 was successful with the required minimum number of returned ballots. He said that he will discuss the results later in the agenda. Chou then reviewed the action items from previous SC-4 and Revision Working Group meetings (Attachment 3). He noted that AI 14 from the 7th Revision Working Group (RWG) meeting (Tell, Blick) should be resolved quickly. An attempt will be made to post all previous approved minutes, going back to 2000, on the SC-4 website.

7. Report on Ballot Results

Chou briefly reviewed the history of the C95.1-1991 revision process. He pointed out that the current standard, which was approved by IEEE and ANSI in 1991 and 1992, respectively, is based mainly on literature published before 1986. The literature evaluation for the current revision began in 1995. In 1999, the Federal RF Interagency Working Group submitted a letter listing 14 issues for SC-4 to consider during the revision process. That same year an outline of the revision was prepared. He noted that the ICES leadership met with members of ICNIRP at the Munich BEMS/ICES meetings and later in 2000 in San Antonio to discuss ways of exchanging drafts in support of harmonization. Also that year, SCC-34 sought resolution of the question of the appropriate SAR for the pinnae, an issue important for the development of the head model that would ultimately be used for assessing SAR from wireless handsets. During the last four years, 8 Revision Working Group (RWG) meetings were held, a number of drafts were prepared, and the subcommittee balloting draft, Draft 1.8, was balloted by SC-4. He then briefly reviewed the results of the ballot. Specifically, 84 people joined the balloting group, of which 73 returned ballots. The ballots were distributed as follows: 26 approved without comments, 24 approved with comments, 12 disapproved (11 of them with supporting reasons) and 11 abstained. Thus, the return rate was 87%, the approval rate (number of approvals divided by the sum of approvals and disapprovals) was 81%, i.e., the ballot passed. However, under IEEE rules and ICES P & P's, all comments submitted with ballots approving the draft have to be considered, all comments submitted with negative ballots have to be addressed (incorporated into the next draft or rebutted), and the resolution of all comments and all substantive changes to the balloting draft resulting from ballot resolution have to be circulated to the balloting group to allow members to comment, reaffirm or change their vote. Chou said that the remainder of this meeting will be devoted to reviewing the comments.

8. Discussion of D1.8 Comments

a) Normative Section Discussions (Clause 4)

Tell led the discussion on Clause 4. He and Meltz summarized the comments regarding changes to the lower tier and the differences between the shapes of the two tiers. McKenzie pointed out that the draft was already approved and questioned whether we were going backward by considering any further modifications to the MPEs. Tell pointed out that the purpose of the discussion is to develop a rationale for addressing the rationale for the recirculation ballot. Chou then further explained IEEE policy on balloting, recirculation ballots, etc., pointing out that all comments accompanying negative ballots have to be addressed. Swicord pointed out that balloting on Draft 1.8 was essentially to address inconsistencies in the earlier draft, i.e., claiming a 50 times safety factor while new data, e.g., Dimbylow, shows that at some frequencies for children the safety factor is considerably lower. Chou briefly reviewed the history of the current MPEs, beginning with the 10 mW/cm² values used in the 1966 and 1974 standards, the frequency-dependent single tier used in the 1982 standard, the two-tier NCRP recommendations, and the current ICNIRP MPEs that are being used for national standards in a number of

countries throughout the world. He noted that because of its wide acceptance, we should at least consider the ICNIRP MPEs for the lower tier unless there is some good scientific support for not so doing.

Morgan criticized the ballot results/process/committee claiming that the 81% of those who approved the draft were dominated by industry and the military with no representation from the public. Meltz responded by saying that the criticism has no merit and asked Morgan how many members of the general public have the expertise to address the science issues? He also pointed out that the subcommittee is open to anyone with a material interest and representatives of the public are welcome. Morgan then went on to say that there are many papers in the literature that show effects at levels below the MPEs. Glaser added that observers, e.g., members of the public, cannot participate in the SC deliberations. The IEEE Staff Liaison Bill Ash pointed out that Glaser is mistaken; observers can participate in any meeting but cannot vote or make motions. Moreover, balance is required on all IEEE committees. Varanelli in addressing the comment from Glaser noted that he is unaware of any attempt at any SC-4 meeting to keep observers from speaking out.

Tell brought the focus of the meeting back to discussion of the normative sections of the draft. He pointed out that the change in the lower tier MPEs resulted from numerical analyses by Dimbylow and others that show that the basic restrictions (BR) may be exceeded for children over a narrow range of frequencies between 400 MHz and 1 GHz. He discussed Osepchuk's comments regarding Option 3, which was a compromise and pointed out that the lower tier MPEs in Draft 1.8 are based on a 4th option – harmonizing with ICNIRP between 400 MHz and 100 GHz. Varanelli and others said that they had problems with the child model used by Dimbylow, which appears to be a scaled version of the visible human model and anatomically would not represent an actual child. Kuster noted that the results for a more accurate model may be even worse. Tell discussed the safety factor, 50 versus 25, based on the Dimbylow data, i.e., if the 1991 MPEs for the lower tier are retained, the safety factor over a narrow range of frequencies will only be 25, not 50, for children. One option would have been to retain the current MPEs and explain the difference.

Morgan asked whether the MPEs in the revision are based on the physical shape of a model or on biological processes, claiming that there is plenty of evidence in the bioeffects literature that would support even lower MPEs, e.g., cancer studies. Meltz challenged Morgan to show reliable evidence from *in vitro* studies that there is an adverse effect on dividing cells and suggested that Morgan examine the literature – there is no evidence regarding adverse effects on proliferating cells.

Petersen explained that the reason for his negative vote was that it clearly states in the introduction and elsewhere, that the standard is science-based. He said that while he believes that the upper tier can be defended, the lower tier can only be explained as a social-policy decision and for purposes of harmonization with other standards and guidelines, e.g., ICNIRP. Varanelli agreed and was also concerned about the fallout the lower tier could have on some products and services. Adair said that she would support the lower tier in general, provided it is explained better, but the corner frequency at 100 GHz has to be changed. Chou admitted that the lower tier is somewhat arbitrary – part science-based, part based on practical considerations, e.g., implementation and acceptance.

FOR ACTION:

Petersen, Fichtenberg and Varanelli will add statements in Clause 1 explaining how portions of the lower tier are based partially on harmonization with ICNIRP, etc. and not scientifically based on established harmful effects, etc.

Mantiply suggested adding a definition of “science,” or “science-based” in the context used in the revision. Petersen said that he would consider the suggestion.

Gandhi’s comments regarding the pinnae (Comment Matrix# 282 – see Attachment 4) were discussed next. Johnston reviewed several pertinent papers on the issue that were presented at the Seville NIR Workshop (see Attachment 5). After considerable discussion it was concluded that differences in the model used for the pinnae matter less than slight changes in position of the phone held next to the head. In response to a question from Fichtenberg regarding the influence of metal implants, metal-framed eyewear, etc., on the local SAR, Kuster pointed out that these questions have already been answered – such devices have little effect on the SAR in the head when the phone is held close to the head.

b) Informative Section discussions

***i* Annex A**

Adair reported that most of the comments on Annex A are editorial. There are a few general comments but these also appear to require editorial changes.

***ii* Annex B**

Swicord reported that all the comments on Annex B are editorial in nature. Several comments related to unpublished papers or papers submitted for publication but not yet published. He said that these have been flagged and will be deleted in the final draft if they still have not been published.

***iii* Annex C**

Lang reported that there were 94 comments on Annex C, 11 of which were technical, a few were general and the majority were editorial. Kuster pointed out that the issue of uncertainty associated with the 4 W/kg threshold value has to be addressed, e.g., because of this uncertainty it cannot be concluded that the safety factor is 10 or 50 – it may be considerably more, or less.

FOR ACTION

An ad hoc task group comprised of Anderson, Bodemann, Lang, Meltz, Murphy and Varanelli will consider issue of safety factor and uncertainty in threshold and prepare statement addressing the same.

Tell noted that the rationale discusses the safety factor for the lower tier but should be expanded. Murphy noted that for ionizing radiation, the safety factor is much lower – typically about 1.25-1.5. Glaser said that she was concerned that the standard is based on thermal effects and that non-thermal effects have been dismissed, i.e., the stated safety factors do not apply to non-thermal effects, such as headaches, changes in response rates, etc. She said that we are “throwing the public a bone” and not addressing the issues that are important to them. Meltz pointed out that low-level effects, the so-called non-thermal effects, were not dismissed. The issue is that the majority of such reported effects result from poor science. Elder noted that many such reported “low-level” effects are in fact discussed in Annex B. Morgan stated

that up/down gene regulation was not examined – Meltz read a passage from Annex B that addresses the issue. Bodemann pointed out that a sound rationale is needed for the 6 and 30 minute averaging times, e.g., why the large difference in averaging time between the upper and lower tier.

Kuster again raised the issue of uncertainty by pointing out that a specific safety factor cannot be assumed without addressing the uncertainty associated with the 4 W/kg threshold. Lotz agreed that one cannot say that the safety factor is 50 until the uncertainty is addressed – at a minimum the issue has to be explained better. Kuster noted that the uncertainty in the animal data has been addressed in general, i.e., a range of thresholds has been given, but not specifically in the revision. D’Andrea agreed that that is important but noted what is really needed is an established threshold for adverse effects in humans. Adair pointed out that there is a large established database on thermal physiology from all kinds of sources. Humans are extremely tolerant to heat – 4 W/kg is a very conservative SAR for humans. Kuster stated again that the committee has to carry out an uncertainty analysis on the existing data before a specific safety factor can be established.

Sage pointed out that the definition of “adverse effect” conflicts with the WHO definition. She asked if her January letter was circulated to the subcommittee – Chou said that it was. She said that if the standard is to be accepted it has to be more transparent. She suggested abandoning the current effort and start over with a different basis, e.g., a more sensitive biomarker instead of looking at effects associated with tissue heating. Meltz said that he for one would be delighted to have an appropriate valid biomarker – but one doesn’t exist. D’Andrea agreed noting that the “set point,” perhaps in the hypothalamus, is an appropriate and reliable biomarker associated with a 1°C ΔT. Adair pointed out that the brain is thermally privileged and a caveat is needed regarding the 1°C ΔT.

iv Annex D

DeFrank discussed the comments on Annex D. Harrington recalled that at the IEC Project Team 62232 (wireless base-stations) meeting held a few days before, the issue of measurement distance was discussed, specifically the issue of whether or not measurements made closer than 20 cm from the source that comply with the MPEs, ensures compliance with the basic restrictions. He said that the issue is with the following statement in subclause 6.3.6.3 of IEEE Std C95.3-2002: “However, because some generating devices and their associated attachments that meet the field MPEs at distances of 20 cm and greater are capable of producing SARs that exceed the SAR limits, measurements should be made at a distance of 5 cm from any such generating device and its associated attachments.”

FOR ACTION

Bassen, Harrington, Mantiply and Petersen will review statements in C95.3 (6.3.6.3) and Draft 1.8 Clause 4 and Annex D regarding probe separation distance for consistency.

Fichtenberg raised questions about the definition of MPE, controlled environment, etc.

FOR ACTION

Petersen to review definition of MPE (address “established” harmful effects – not all effects)

It was pointed out that the requirements for partial-body relaxation was inadvertently left out of Draft 1.8. The question of evidence supporting a relaxation of the SAR requirements for the extremities was also discussed. This too will be further discussed in Annex C of the next draft. Mantiplay raised the issue of spatial averaging. He suggested that the issue needs to be addressed, including the rationale. Swicord noted that this is one of the items on the list of issues that need to be addressed that resulted from the recent FDA Dosimetry Workshop.

FOR ACTION

DeFrank, Kuster, Mantiplay, Sage will develop stronger justification for spatial averaging

9. Old Business

No old business was discussed.

10. New Business

No new business was discussed.

11. Date and Place of Next Meeting

The next series of ICES meeting will be held in San Antonio, TX, December 2-5, 2004.

12. Adjourn

There being no further business, following a motion by Varanelli and a second by Ziskin, the meeting was adjourned at 1500 h.

Action Items Arising from June 19, 2004 Meeting

	Action	Assigned to:	Date Due	Status
1.	Review comment matrix – address comments (each clause)	Petersen: Clauses 1-3 Tell: Clause 4 Annex A: Adair Annex B: Swicord Annex C: Lang Annex D: DeFrank Annex E, F: Petersen	8/31	
2.	Add statement in Clause 1 explaining how portions of the lower tier are based partially on harmonization with ICNIRP, etc. and not scientifically based on established harmful effects	Fichtenberg, Petersen, Varanelli	8/31	
3.	Review definition 3.69 (safety factor) for consistency with definition in C95.6	Petersen	8/31	
4.	Provide edited draft of document (editorial changes, etc.) to appropriate section editors for consideration.	Meltz	6/30	
5.	Consider definition of “science” or “science-based” in Clause 3	Petersen	8/31	
6.	Consider issue of safety factor and uncertainty in threshold – prepare statement addressing the same.	Anderson, Bodemann, Lang, Meltz, Murphy, Varanelli.	8/31	
7.	Add definition of “established adverse health effects”	Petersen	8/31	
8.	Insert figures regarding E-field below which induced current does not have to be measured	Petersen	8/31	
9.	Review statements in C95.3 (6.3.6.3) and Draft 1.8 Clause 4 and Annex D regarding probe separation distance for consistency	Bassen, Harrington, Mantipliy, Petersen	8/31	
10.	Review definition of MPE (address “established” harmful effects – not all effects)	Petersen	8/31	
11.	Develop stronger justification for spatial averaging	DeFrank, Kuster, Mantipliy, Sage	8/31	

List of Attendees**IEEE ICES SC-4 Meeting**

**Omni Shoreham Hotel
Washington, DC**

**June 19, 2004
0800 – 1700 h**

	Last Name	First Name	Affiliation	Country	Status	E-mail
1.	Adair	Eleanor	Independent Consultant	US	M	eadair@comcast.com
2.	Ahlskog	Kari	Nokia Research Center	FI	O	kari.ahlskog@nokia.com
3.	Ash	Bill	IEEE	US	O	w.ash@ieee.org
4.	Baron	Dave	Holiday EMF Measurement	US	M	d.baron@ieee.org
5.	Blick	Dennis	Independent Consultant	US	M	dblick@satx.rr.com
6.	Bodemann	Ralf	Siemens AG	DE	M	ralf.bodemann@siemens.com
7.	Brecher	Aviva	US Dept Transportation	US	M	brecher@volpe.dot.gov
8.	Brown	Michele	Raytheon Missile Systems	US	O	mfbrown@raytheon.com
9.	Chikamoto	Kazuhiko	JANUS	JP	O	chika@janus.co.jp
10.	Chou	C.K.	Motorola, Inc.	US	M	ck.chou@motorola.com
11.	Cobb	Brenda	AFRL/HEDR	US	O	brenda.cobb@brooks.af.mil
12.	Cohen	Jules	Independent Consultant	US	M	jcohen@denny.com
13.	D'Andrea	John	Naval Health Res Ctr.	US	M	john.dandrea@navy.brooks.af.mil
14.	DeFrank	John	USACHPPM	US	M	john.defrank@amedd.army.mil

	Last Name	First Name	Affiliation	Country	Status	E-mail
15.	Dyberg	Karen	Raytheon	US	O	karen_i_dyberg@raytheon.com
16.	Elder	Joe	Motorola	US	M	joe.elder@motorola.com
17.	Gettman	Ken	NEMA	US	M	ken_gettmen@nema.org
18.	Glaser	Marne	Gen Public	US	O	marne325@netzero.com
19.	Haes	Donald	Independent Consultant	US	M	haes@mit.edu
20.	Hatfield	Jim	Hatfield & Dawson	US	M	hatfield@hatdaw.com
21.	Hanna	Bob	DCMNR, Ireland	IE	O	bob.hanna@dcmnr.gov.ie
22.	Harrington	Tim	FCC	US	O	tharring@fcc.gov
23.	Hubbard	Roy	ESKOM/TSI	ZA	M	roy.hubbard@eskom.co.za
24.	Ikehata	Masateru	Railway Tech Res Inst	JP	O	ikehata@rtri.or.jp
25.	Johnston	Sheila	Independent Consultant	US	M	sajohnston@btclick.com
26.	Joyner	Ken	Motorola	AU	M	ken.joyner@motorola.com
27.	Kuster	Niels	IT'IS Foundation	CH	O	kuster@it is.ethz.ch
28.	Lang	Sakari	Nokia Research	FI	M	sakari.lang@nokia.com
29.	Lathrop	Janet	Resource Strategies Inc	US	O	jclathrop@fcgnetworks.net
30.	Leonowich	John	RNW National Labs	US	M	john.leonowich@pnl.gov
31.	Lotz	Gergory	NIOSH	US	M	wlotz@cdc.gov
32.	MacLean	Kathy	APPREL Labs	CA	O	kathym@apprel.com
33.	Mantiply	Ed	FCC/OET	US	M	ed.mantiply@fcc.gov
34.	Maurer	Stewart	Ind Consultant	US	M	maureremf@juno.com
35.	McKenzie	Ray	Telstra Res Labs	AU	M	ray.mckenzie@team.telstra.com
36.	Meltz	Martin	Univ of TX, Hlth Sci Ctr	US	M	meltz@uthscsa.edu

	Last Name	First Name	Affiliation	Country	Status	E-mail
37.	Morgan	Lloyd	Cent Brain Tumor Reg -US	US	O	bilovski@aol.com
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41.	Needy	Robert	Naval Surface Warfare Ctr.	US	M	robert.needy@navy.mil
42.	Petersen	Ronald	Independent Consultant	US	M	r.c.petersen@ieee.org
43.	Reilly	J. Patrick	Metatec Associates	US	M	jpreilly@ieee.org
44.	Sage	Cindy	Sage Associates	US	O	sage@silcom.com
45.	Swicord	Mays	Motorola	US	M	mays.swicord@motorola.com
46.	Tell	Richard	Richard Tell Assoc. Inc.	US	M	rtell@radhaz.com
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49.	Varanelli	Arthur	Raytheon Company	US	M	a.g.varanelli@ieee.org
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51.	Whitmore	Jamaal	US navy	US	O	jawhitmore@us.med.navy.mil
52.	Willyard	Cassandra	Gateway Information Serv	US	O	cassiew@rs-inc.com
53.	Yoo	Done-Sik	ETRI	KR	O	dsyoo@etri.re.kr
54.	Ziskin, MD	Marvin	Temple Univ. Med School	US	M	ziskin@temple.edu
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M =Member

O =Observer



INTERNATIONAL
COMMITTEE *on*
ELECTROMAGNETIC
SAFETY

ATTACHMENT 2

Tentative Agenda

IEEE/ICES SCC-28 Subcommittee 4
Safety Levels with Respect to Human Exposure to Radio Frequency
Electromagnetic Fields, 3 kHz to 300 GHz

June 19, 2004

8:00 to 5:00 PM

**Omni Shoreham Hotel,
2500 Calvert Street, NW,
Washington, District of Columbia, USA**

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|--|----------------------|
| 1. Call to Order | <i>D'Andrea/Chou</i> |
| 2. Introduction of those Present | <i>D'Andrea/Chou</i> |
| 3. Approval of Agenda | <i>D'Andrea/Chou</i> |
| 4. Approval of the Minutes of Dec 5-6, 2003 Meeting | <i>D'Andrea/Chou</i> |
| 5. Secretary's Report | <i>Petersen</i> |
| 6. Chairman's Report | <i>D'Andrea/Chou</i> |
| 7. Report on Ballot | <i>Chou</i> |
| 8. Discussion of D1.8 comments | <i>Chou</i> |
| A. Normative Section Discussions | <i>Tell</i> |
| B. Informative Section discussions | |
| <i>i</i> Annex A | <i>Adair</i> |
| <i>ii</i> Annex B | <i>Swicord</i> |
| <i>iii</i> Annex C | <i>Lang</i> |
| <i>iv</i> Annex D | <i>DeFrank</i> |
| 9. Old Business | <i>D'Andrea/Chou</i> |
| 10. New Business | <i>D'Andrea/Chou</i> |
| 11. Date and Place of Next Meeting | <i>D'Andrea/Chou</i> |
| 12. Adjourn | |

Unfinished action items June 19, 2004

Editorial Committee Meeting Action Items:

C95.1-200X D1.7

Page	item	who	Deadline
60	Main points in the current standard; main change from the previous std → executive summary (Annex A?)	Petersen	Many are now in – probably more will be added as I read through the entire document after everything is in.

Action items from the April 2003, 7th Revision Working Group Meeting

	Action Item	Assigned to:	Due Date	Status
2	Ensure that all papers included in Annex B, that are pertinent to the revision process and have been published beyond the literature cutoff point of the 1991 Std, have gone through the review process.	Swicord (lead), Blick plus all primary White Paper authors.	31 October	Ongoing
14	Develop a summary chart(s) summarizing range of frequencies, SARs, number of acceptable papers, animal species, etc.	Tell (lead), Blick	31 August	Ongoing
15	White Paper authors review Annex B, ensure that the summaries are correct, concise and are consistent with the rest of the annex.	White Paper authors, Annex B authors	31 May	Ongoing

Action Items

SC4 Maui meeting June 21, 2003

Action Item	Assigned to:	Due	Status
1. Review mechanism issue and address how “mechanisms” will be integrated into the revision – specifically, what is the next step? Add at the end of Annex B on mechanisms	<u>Sheppard</u> , Fichtenberg	31 July	Open
2. Provide material to Tell regarding Action Item 14 of April 03 RWG meeting, i.e., “Develop a summary chart(s) summarizing range of frequencies, SARs, number of acceptable papers, animal species, etc.”	Meltz	July 31	Open
3. Relate exposure to SAR to T from results of previous action item.	<u>Swicord</u> , Kuster, Mason, Tofani	August 31	Open

Issues Arising from September 24, 2003 IAWG Meeting

	Issue	Action
1.	EPA representation at ICES meetings – observer status. Issue seems to stem from belief that organizations that sponsor development of voluntary consensus standards do not normally develop public health standards, i.e., OMB Directive A-119 only applies to technical standards.	Follow up with EPA Office of the General Counsel – (Hankin)
2.	Prepare a list of issues important to IAWG and to ICES that have to be addressed.	SC4/IAWG Action Item To be developed for future
3.	Provide references that should be included in the ICES database but are not.	IAWG Action Item
4.	Provide input regarding issues/topics that have not been addressed in Annex B but should be.	To be provided by IAWG

Action Items from 8th Revision Working Group Meeting - NEMA, 25 & 26 September 2003

	Action Item	Owner(s)	Due	Status
11.	Method to derive an SAR value from an adverse thermal threshold.	Swicord, Elder	10/31/03 future revision	
15.	A task group to be formed to look into the consistency between the MPE value and the spatial-peak SAR.	<u>Kuster</u> , Chou, D'Andrea, Tell	11/15/03 for future version	

Action Items Arising from December 5-6, 2003 SC-4 Meetings

	Action Item	Assigned to:	Date Due	Disposition
1.	Establish "Local Exposure Task Group" to obtain data and develop a thermal basis for localized exposure limits.	<u>Swicord</u> , Chadwick, Elder, Johnston, Meltz, Morrissey, , Ziskin	June 15, 2004 For future	
2.	Copy all approved SC-4 and SC-4 RWG minutes from 2000 until present and send to Varanelli for posting on ICES web	Petersen	July 15, 2004	
3.	Post all minutes from above AI on ICES website.	Varanelli	January 31, 2004	

Date	Document
Name	IEEE C95.1-200x D1.8

Commenter-Name	Section	Clause/ Subclause	Paragraph/ Figure/ Table	Type of Comment: General (G) Editorial (E) Technical (T)	Comment	Proposed Change	Observations of the Chair: Accepted (A), Noted (N), Not Accepted, (NA). Other comments and disposition
1. Elder	1. Overview	1.1	1	editorial		Delete “but are not intended to apply” and add “except for” to read: “These recommendations are intended to apply to all human exposures except for exposure of patients by, or under the direction of, practitioners of the healing arts.”	
2. Haes	1. Overview	Intro		E	— This is an unapproved IEEE Standards Draft, subject to change —	Subject	
3. Bodemann	1. Overview	1.1		E	<i>Science-based recommendations are made to avoid all known adverse effects in human beings associated with exposure to electric, magnetic and electromagnetic fields in the</i>	<i>Science-based recommendations are made to avoid all scientifically established adverse effects in human beings associated with exposure to electric, magnetic and</i>	

					<i>frequency range of 3 kHz to 300 GHz.</i>	<i>electromagnetic fields in the frequency range of 3 kHz to 300 GHz.</i>
4. Bodemann	1. Overview	1.2		E	Reference to RF safety programs are made in 1.3.2, 2. and other chapters.	Delete the last sentence of 1.2
5. Cohen	1. Overview	1	1.2	E	Missing word	5th line: Insert "with" before "IEEE"
6. Adair	1. Overview	1.2	1	E	2 poor adverbs (lines 1 and 2); 1 word insertion (line 5)	Line 1: change "on" to "to" Line 2: change "from" to "by" Line 5: insert "with" before IEEE
7. Adair	1. Overview	1.3	4	T	Line 4. "caution" has no role in the IEEE Standard	Delete the final clause "erring on the side of caution."
8. Testagrossa	1. Overview	1 – All subclauses	n/a	E, T	Reference is made to protect against adverse effects associated with "electrostimulation" and "heating". In section 1.3.1: "For exposure durations considerably greater than the averaging time, the adverse effect being avoided is the most sensitive disturbance (behavioral) seen in animals as extrapolated to humans.	Include a general statement in 1.1 (Scope) to mention all three (electrostimulation, heating and behavioral) are part of the recommendations
9. Testagrossa	1. Overview	1.1, 1.3	1, 2	E, T	"exposure to electric, magnetic and electromagnetic fields" while it is understood there can be exposure to just the	"exposure to electric, magnetic and electromagnetic fields" replace with "exposure to

					either or all of the fields, I believe it is any “easier” read just use “ electromagnetic fields” for all. And explain it to reference all fields	electromagnetic fields”	
10. Testagrossa	1. Overview	1	1	E, T	“heating” the term “heating” could be replaced with “thermal” or “thermal conditions” (SEE 1.3.1, first paragraph)	Global search & where appropriate replace “heating” with “thermal conditions” or just “thermal”	
11. Bushberg	1. Overview	1.1	1	G	Science-based recommendations are made to avoid all known adverse effects in human beings See 1.2 for consistency	Global search & replace by “adverse health effects”	
12. Bushberg	1. Overview	1.1	1	G	...to all human exposures, but are not intended to apply to exposure of patients by, or under the...	...to all human exposures, but are not intended to limit exposure to patients by, or under the.....	
13. Bushberg	1. Overview	1.3	3	G	I do not agree that it is not “scientific”. Science often involves judgements based on available evidence. For example the magnitude of a safety factor may, in part, incorporate the consensus of the magnitude of uncertainty in the biological effects data base. This is a scientific judgement about the state of knowledge.	Delete : “The attention to public concern in establishing an additional safety factor for the general public is not scientific.”	
14. Bushberg	1. Overview	1.3	5	G	Delete “ethics”	Replace with “human subjects intuitional review	

						board”...	
15. Bushberg	1. Overview	1.3.2	2	G	Emphasis on burns is unnecessary	Delete “burns and other”	
16. Sheppard	1. Overview	1.1; 3		G, E, T	electrostimulation is discussed at length, but never defined; the scope (1.1) and elsewhere do not make clear that RF shocks occur, but are understood to be other than electrostimulation and not subject to current limits; this situation is confusing because clearly the nervous system is stimulated by a RF shock at 100 MHz, 20 times the cutoff for “electrostimulation”. RF shock is discussed in A.1.18, B.1, C.1.2.1, C3.2 and perhaps other places.	Revise to sharpen meaning of electrostimulation. Consider discussion RF shock in normative section—or at least a footnoted reference App. C. Provide definitions for electrostimulation & RF shock	
17. Sheppard	1. Overview	1.1 1.3 3 3.2		T	Electrostimulation by pulsed fields occurs above 5 MHz. There is not much discussion and the meaning of frequency for short pulses is not stated.	Add fuller treatment of electrostimulation by pulsed fields. Consider way to indicate when the pulse, its width, repetition rate, and amplitude, are the important entities rather than the frequency under the envelope.	
18. Baron	1. Overview	1.3.1		E, T	“Fourth sentence contradicts later statements regarding averaging time.	Harmonize with 4.1.2.1, which talks of a 0.2 second averaging time. The principles are OK but the words should be clearer. Also add a comma, “At low frequencies,	

						electrostimulation...”	
19. Baron	1. Overview	1.3.2		E	Sentence is ambiguous	Add () or commas to separate clause “that exceed the MPE values.”	
20. Bodemann	1. Overview	1.3	3. Paragr.	E	<i>The safety factors incorporated in the MPEs are generally greater than the safety factors in the BRs. Are they always greater? If they are sometimes smaller, the conclusion in the next sentence cannot be drawn in the way it has been done.</i>	<i>Delete the word “generally” or explain in which frequency region etc. they are not greater.</i>	
21. Bodemann	1. Overview	1.3.2	Headline	E	<i>The paragraph mainly outlines a risk assessment procedure.</i>	RF risk assessment and RF safety programs	
22. Bodemann	1. Overview	1.3.2		T	<i>“exposures should be controlled through the implementation of an RF safety program, as described in IEEE Std C95.7-200X [B89].” The standard is for international use. There are other OHS regulations in the world than C95.7.</i>	<i>“, exposures should be controlled through the implementation of appropriate protective measures e.g. according to an RF safety program, as described in IEEE Std C95.7-200X [B89].</i>	
23. Baron	2. References	2		E	Clarify second sentence	When any of the following standards ...	
24. Reilly, JP	3. Definitions	Table 8, column 2, rows 2,3,4,5		T	Incorrect numbers. CK, we talked about doing this, but it didn’t seem to get into the draft.	First 4 data entries in Column 2 should read: 1814 1814/fM 60.4 60.4	

25. Reilly, JP	3. Definitions	Table 8, title or notes		E	Metric needs clarification	Include in Title (or in a note) that quantities in table are <i>rms</i> numbers.	
26. DeFrank	3. Definitions	3.35		T	<p>The definition of “localized exposure” is no longer consistent with the changes to the method for determining the value for the maximum value of the localized MPE. The averaging area changes from whole body to 100 cm².</p> <p>There is no need to include the MPE value in the definition, since it is specified in the MPE section. Furthermore, the exposure need not exceed the MPE to be localized.</p>	<p>3.35 localized exposure: For frequencies exceeding 100 kHz, an exposure of a portion of the body that is small compared with the projected (cross-sectional) area of the body and wherein the incident plane wave equivalent power density (or the squared field strength) exceeds 10 times the spatially averaged value over the entire body. See “RF hot spot.”</p>	
27. Cohen	3. Definitions	3	3.27	E	"distal" is from attachment	change "to distal" to "from distal"	
28. Sheppard	3. Definition	3.64		E	<p>Existing text gives no hint at to whether a “highly localized” area is 1 mm or 10 m in size and part 2 seems to contradict the notion of localization.</p> <p>Also, needs new paragraph for item 2” and new paragraph for non-uniform exposure.</p>	<p>3.64 RF “hot spot”: A localized area of relatively more intense RF energy that manifests itself in two principal ways:</p> <p>1—Near a conductive object that is the immediate source of intense electric or magnetic fields and is surrounded by ambient fields of lower intensity (often referred to as re-radiation), and</p> <p>2— By reflections and/or narrow beams produced by</p>	

						<p>high-gain radiating antennas or other highly directional sources.</p> <p>In both cases, there are very rapid changes in field strength over distances that are small with respect to the objects and wavelength. RF hot spots are normally associated with very non-uniform exposure of the body (localized exposure). This is not to be confused with an actual thermal hot spot within the absorbing body.</p>	
29. Lt. Colonel Dr. Amnon Duvdevany	3. Definitions	3.83	Definitions (pp.7)	E	Thermal fields	"Thermal fields"	
30. Sheppard	3. Definitions	3.60		E	<p>Definition is circular: "pulse-modulated field: An electromagnetic field produced by amplitude modulation of a continuous wave carrier by one or more pulses."</p>	<p>"pulse-modulated field: An electromagnetic field characterized by a form of amplitude modulation in which a continuous wave is abruptly shifted in amplitude from zero to a level at or near the maximum and returning to zero; often characterized by a series of such shifts in a repeated pattern;</p>	
31. Baron	3. Definitions	3.1	Notes	E	Definitions states "harmful change in health," definition refers to "detrimental health		

					effect,” one is ambiguous.	
32. Baron	3. Definitions	3.1	Note 1	E	“ ... impacts of RF infrastructure that are not related to RF emissions.” - what does that mean?	
33. Baron	3. Definitions	3.1	Note 2	E	“ under the underlying special conditions.” - what does that mean?	
34. Baron	3. Definitions	3.2		E	Sentence 2, series ‘ands’ the last term. Seems as if it should be ‘or.’	...and specific absorption rate) or an exposure characteristic (such...
35. Baron	3. Definitions	3.17		E	Seems as if decibel (bel actually) is defined as a ratio of two power levels. When the power levels relate to a single circuit/impedance, the voltages/fields can be used in the ratio with a factor 2 to account for the squaring of the terms.	
36. Baron	3. Definitions	3.73		E	I am confused regarding the acceptability of spatial averaging below 100 kHz. First, the standard seems to confirm that spatial averaging is not allowed below 100 kHz. If it is allowed, my understanding is that the field is averaged (not the square of the field). Does the term ‘root-mean-square’ have a different meaning here?	
37. Baron	3. Definitions	3.79		E	This definition underscores that need for an informative appendix on neural stimulation	

					parameters.		
38. Baron	3. Definitions	3.84		T	Touch contact area is defined as 1 sq cm. Is the basis for this outlined elsewhere? The number seems large and will tend to reduce current density figures.		
39. Curtis	3. Definitions	3.14	Definition in 1 st paragraph	G, T	We have two conflicting definitions of “controlled environment” The first paragraph gives the old definition.	Delete the first paragraph and make the current “Note” the definition. Some of the words from the old definitions could be used as examples.	
40. Ammann	3. Definitions	3		(G)	Should we define “derived limits”		
41. Reilly, JP	3. Definitions	Section 3.		E	Can’t remember all the abbreviations & acronyms.	Include list of symbols, abbreviations, and acronyms (as in C95.6)	
42. Reilly, JP	3. Definitions	Sect. 3.69, Def. Safety Factor line 1. Section 4.1		T	Incorrect definition; inconsistent w/C95.6, [existing def. has (> or equal sign)]	First sentence should begin: “A multiplier (less-than-or-equal-to-sign 1) used ...” [note change in “multiplier” and < sign.]	
43. Lt. Colonel Dr. Amnon Duvdevany	3. Definitions	3.2	Definitions (p.2)	G	Property of source – polarization can be added	Property of source – polarization can be added	
44. Lt. Colonel Dr. Amnon Duvdevany	3. Definitions	3.10	Definitions (p.3)	E	An extra space	deleting	
45. Lt. Colonel Dr. Amnon Duvdevany	3. Definitions	3.18	Definitions (p.4)	E	Duty cycle or duty factor?	Mentioning both?	
46. Lt. Colonel	3.	3.21	Definitions	E	The units are missing [J]	Adding units	

Dr. Amnon Duvdevany	Definitions		(p.4)			
47. Lt. Colonel Dr. Amnon Duvdevany	3. Definitions	3.68	Definitions (p.7)	E	An extra space: "root-mean-..."	deleting
48. Adair	3. Definitions	3.12	line 1	E	"media" is plural	Replace "media" with "medium"
49. Adair	3. Definitions	3.13	line 1	E	"media" is plural	Replace "media" with "medium"
50. Adair	3. Definitions	3.23	line 1	E	symbol (S) is missing	Insert "(S)" after ")" and before ":"
51. Adair	3. Definitions	3.29	line 1	E	Even though "exposure" has been defined, this definition remains vague.	Insert "(cf. 3.26)" after "exposure"
52. Adair	3. Definitions	3.55	line 1	E	The first 2 sentences make no sense and are each incomplete	Join the two sentences, i.e. "...waveform for a sine wave..."
53. Adair	3. Definitions	3.82	line 2	E	The subject is plural, the verb is singular.	In line 2, change "is" to "are"
54. Adair	3. Definitions	3.88	line 1	E	Bad adverb	Change "in" to "for"
55. Testagrossa	3. Definitions	3.9	1	E	extra space between "biological" and the comma	remove space after the word "biological" and before comma
56. Testagrossa	3. Definitions	3.20	1	T	not sure the word "electrical" is needed here 3.20 electromagnetic field: A manifestation of electrical forces associated with electric charges or current.	remove "electrical" 3.20 electromagnetic field: A manifestation of forces associated with electric charges or current.
57. Testagrossa	3. Definitions	3.23	1	E,T	3.23 equivalent plane-wave power density (plane-wave equivalent power density):	change "Specifically, the normalized value of the square of the electric or the

					I believe some clarification needs to be made. Not sure the term near field should be used. Third sentence states "...at a point in the near field of a radiating source." Also, when in the near field both E and H need to be measured.	magnetic field strength at a point in the near field of a radiating source." to "Specifically, the normalized value of the square of the electric or the magnetic field strength."	
58. Bushberg	3. Definitions	3.10		E	Delete "lifetime".	Replace with "lifespan"	
59. Bushberg	3. Definitions	3.14		E	Delete "The RF Safety Program"	Replace with "Implementation of an effective RF Safety Program...."	
60. Bushberg	3. Definitions	3.2	1	G	<p>"Adverse effects exposure levels may depend on environmental factors and the portion of the body that is exposed. Adverse effects exposure levels may differ according to which tissues and organs are exposed."</p> <p>While true it does not belong in the definition and may lead the reader to think that the standard has tissue and environmental specific exposure limits</p>	Delete text in quotes	
61. Bodemann	3. Definitions	3.16		E	<i>Current density is not a current</i>	<i>"The ratio of a current flowing though a given cross sectional area to the value of the cross sectional area."</i>	

62. Bodemann	3. Definitions	3.65		E	Don't forget protective measures like shielding, design of workplaces, PPE etc.	"Programs typically include RF awareness training, implementation of protective measures , incident response, periodic evaluation of program effectiveness, and assigned responsibilities for implementing the program."
63. Bodemann	3. Definitions	3.67		E	Risk is not just a probability	" The product of the probability of experiencing harm from one or more hazards and the severity of adverse effects. "
64. Bodemann	3. Definitions	3.69		E	" 3.69 safety factor (Fs): A number (≥ 1)..." In IEEE C95.6 as well as in chapter C.6.1.1 we use the term safety factor in conjunction with numbers smaller than 1.	Add a bullet point in the Notes explaining the inconsistency.
65. Sheppard	3. Definition	3.1.4		G, E	definition of controlled environment includes the phrase, "to individuals cognizant of exposure and potential adverse effects," which seems to make a residential apartment a controlled environment if the landlord sends me a notice and statement that their are potential adverse effects. The method and form making individuals aware would need	Omit this phrase.

					to be regulated. This is a huge loophole.		
66. Lt. Colonel Dr. Amnon Duvdevany	4. Overview	contents	4 (overview) p. vi	E	The order is not clear and does not match pp. 16-18. "General public"	Matching to the contents, "General public" should be deleted	
67. Lt. Colonel Dr. Amnon Duvdevany	4. Overview	1.1	Scope	G	Medical equipment is not mentioned	Mentioning that it is out of scope	
68. Hammer	4. Recommendations	Attachment 1, 4.2.1		T	4.2.1 causes problems because no one can agree on what the conductive area is, we should use the I&CC Tables in place of 4.2.1.	Delete 4.2.1 & use the I&CC Tables	
69. Hammer	4. Recommendations	4.2.2			SAME COMMENTS AS ABOVE	SAME COMMENTS AS ABOVE	
70. Lt. Colonel Dr. Amnon Duvdevany	4. Overview	1.3	3 (p. 1 line 7 from bottom)	T	BR includes SAR	Internal fields, SAR and current density	
71. Baron	4. Recommendation	4.1.2.1		T	1.3.1 states that averaging time does not apply to this frequency range. 0.2 is close to 'none' but not quite there. For this frequency range, the acceptability of spatial averaging should be discussed more specifically.		
72. Baron	4. Recommendation	4.1.2.4.1		E	The term "environmental field" is used for, I think, the first time. Should be defined.		
73. Baron	4. Recommendation	4.1.2.4.2	c	E	Why is the second sentence there (it's what the standard says).		
74. Baron	4.	4.1.3.2		E	Clarify: Is spatial averaging		

	Recommendation				of electric fields permitted below 100 kHz? If so, is the field averaged or the square of the field?		
75. Baron	4. Recommendation	4.1.4.1	5	E,T	For practical purposes, the limits of this table extend only to 100 kHz (above that the limits of table 7 are more restrictive). Having the user trying to figure this out just invites confusion.		
76. Baron	4. Recommendation	4.2.1		E	The phrase, “Consistent with the philosophy of the prior standard,” begs for clarification. Unlike Playboy, I was not really aware of the philosophy of the prior standard.		
77. Baron	4. Recommendation	4.2.3		T	Where two sets of limits apply, is the more restrictive the controlling value, or is the choice up to the user?		
78. Baron	4. Recommendation	4.4	Table note a	E	Have not noticed previous use of WBA. Does it mean Whole Body Average?		
79. Baron	4. Recommendation	4.4	Note h	E	Specific reference to two frequency ranges but nothing about the remainder of the covered spectrum.		
80. Ammann	4. Recommendations	4.1.4	Table 5	(E)	Grasping contact (a)	Change (a) to (1)	
81. Ammann	4. Recommendations	4.2.1	Table 7	(E)	Grasping contact (a)	Change (a) to (1)	

82. Reilly, JP	4. Recommendations	Sect. 4.1, Par. 1, last 2 lines.		E/T	Not sure what “isolated” is supposed to mean.] Original statement does not apply to “long term” as defined in definitions section.	2nd last line” delete “isolated” last line delete “long-term exposures, e.g.”	
83. Reilly, JP	4. Recommendations	Sect. 4.1.2.1		E	Table 2 might appear to be in conflict with Tables 8 & 9.	At end of section, add: “Table 2 protects against adverse electrostimulation effects; Tables 8 and 9 apply to thermal effects. All three tables must be satisfied at all applicable frequencies.	
84. Reilly, JP	4. Recommendations	Table 4, 2nd column bottom row		T	Incorrect number	Change “604” to “614”	
85. Reilly, JP	4. Recommendations	Sect. 4.1.4.1		T	Application of Table 5 needs clarification. Tables 5 & 7 might appear to be in conflict.	add: “f) Table 5 protects against adverse electrostimulation effects; Table 7 protects against adverse thermal effects. Both tables must be satisfied at all applicable frequencies.”	
86. Reilly, JP	4. Recommendations	Sect. 4.2.1, line 3		E	Safety factor for electrostimulation and thermal may be different. Need to distinguish.	Change “... applied to this threshold” to “... applied to adverse thermal thresholds.”	
87. Osepchuk	4. Recommendations	4.4	Table 9	Technical	The adoption of Option2 for the MPE in departing from Option1 was not based on any science but was proposed for apparent reasons of social	Return to Option 1—i.e. retain the MPE values in the existing C95.1 standard above 3 GHz. I would consider as a	

					policy introducing large margins of safety in the MPE up to 300 GHz. Furthermore the resultant MPE curve shows the dramatic _____ Step between 100 and 300 GHz with no basis in engineering or science. A large change in MPE needs scientific rationale. There is none for the Option 2	compromise only a small change in the MPE curve between 1 and 4 GHz not quite as large as in Option 3 but with some similarity	
88. DeFrank	4. Recommendations	4.1	Table 5 & 7	E	Note 1 is intended to refer to (a) in the table.	Change (a) to (1) or ‘Note 1’ to (a).	
89. DeFrank	4. Recommendations	4.2.3		E & T	“Contact and induced current shall be limited as specified in Table 7, subject to the conditions enumerated in 4.1.4.1.” Condition c contradicts the averaging time given in Table 7.	Duplicate the conditions from 4.1.4.1 here (4.2.3), except replace 0.2 seconds with 6 minutes. Without this change, the reader could be confused by the ambiguity.	
90. DeFrank	4. Recommendations	4.4	Table 8&9 Note a	T	Currently reads: “From 3 GHz to 30 GHz, power density is spatially averaged over any contiguous area corresponding to $100 \lambda^2$ where λ is the free space wavelength of the RF field in centimeters with a maximum one-square centimeter power density average of 1000 W/m ² . For frequencies exceeding 30 GHz, the power density is the point-in-space	Replace with: From 3 GHz -30 GHz, the power density is spatially averaged over any contiguous area corresponding to $100 \lambda^2$, where λ is the free space wavelength of the RF field in centimeters. For frequencies exceeding 30 GHz, the power density is spatially averaged over any	

					value as determined by a calculation or a conventional field probe.” The statement regarding maximum power density of 1000 W/m ² would not apply to frequencies greater than 30 GHz. There is no averaging area specified for frequencies greater than 30 GHz.	contiguous area 100 cm ² . Not to exceed a maximum power density of 1000 W/m ² in any one square centimeter as determined by a calculation or a conventional field measurement.	
91. Hammer	4. Recommendations	Table 4 / page 15			Why is Table 4 V/m different there Table * & 9???	Maybe have all the same V/m	
92. Cohen	4. Recommendations	4	Table 5	G	When time is less than one second	Use singular, not plural	
93. Cohen	4. Recommendations	4	4.1.4.1	T	Provision in C95.1-1999 re no requirement for induced current measurements absent	Restore	
94. Cohen	4. Recommendations	4	Table 9	E	Extra period in superscript	Change “.3.336” to “3.336”	
95. Elder	4. Recommendations	4.1	1	editorial		Delete “the adverse effects of” to read “This standard provides protection against aversive or painful electrostimulation...”	
96. Lt. Colonel Dr. Amnon Duvdevany	4. Recommendations	4	PP. 11,16, BR and MPE tbales	G	The overlapped area (100k-5M) can confuse	Writing clearly at each table that the other table should be used as well	
97. Lt. Colonel Dr. Amnon	4. Recommend	4	Tables 8,9	E	Inconsistency – MPE/"Maximum ..."	Using one of them	

Duvdevany	ations						
98. Lt. Colonel Dr. Amnon Duvdevany	4. Recommendations	4.3	P. 21		Inconsistency – RF/"Radio frequency ..."	Using one of them	
99. Lt. Colonel Dr. Amnon Duvdevany	4. Recommendations	B.42	P 34, sent. 4	E	Underestimate?		
100.Lt. Colonel Dr. Amnon Duvdevany	4. Recommendations	B.14	p.60, sent. 10 of par. B.14	E	An extra "o"	deleting	
101. Hatfield	4. Recommendations	4.2.3		G	On page 9 for frequencies below 100 KHz it is implied that electrostimulation is not an effect that matters for occupational situations. Is this an accurate depiction of the research upon which the standard is based?	It would be very helpful to have a contact voltage limitation in 4.2.3 since this is, in general, the greatest hazard for those situations where high powered medium wave or short wave transmission towers are near a site where construction large cranes are in use. I have witnessed currents as high as 1 ampere flowing through a persons arm, for 30 seconds, which was conducted by an iron bar touching a crane hook for 30 seconds, without complaint. He conducted this current through a 1" arc between the crane hook and the iron bar. The voltage, 4000 volts, was a much greater hazard than the contact current	
102. Varanelli	4.	IEEE	Column 4	T	The decrease in the MPE's	Return this draft General	

	Recommendations	C95.1/D1.8, May 1, 2004 Table 9 – MPE values for exposures of the general public			from Uncontrolled Environments (1991) and General Public (draft) are not supported by science or the literature data base. A prime tenet of this standard is to be science based. The Draft MPE values so specified are capricious, political, and represent the risk of harm as being far greater than reality dictates.	Public MPE's to those of the Uncontrolled Environment of the current standard.	
103.Tenforde	4. Recommendations		Table 8	E	It would be very helpful to have a graphic depiction of the occupational MPE values over the entire frequency range covered by the guidelines		
104.Tenforde	4. Recommendations		Table 9	E	Same as comment no. 3		
105.Adair	4. Recommendations	4.1.4.1	Table 5	E	(a) above "grasp" in the table does not appear in the NOTES below	In the NOTES, change "1" to "(a)"	
106.Adair	4. Recommendations	4.2.1	line 3	T	"this threshold" is not designated	In place of "this threshold" insert "a hazard threshold of 4 W/kg,"	
107.Adair	4. Recommendations	4.2.1	Table 6	E	In the table, (b) should be applied to the extremities only. In note (b) below table makes little sense Note (c) blow table does not appear in the table itself	Move "(b)" from "pinna" to "extremities" Insert "to be" between "considered" and "the arms" Either put "SAR" in the table or delete note (c)	
108.Adair	4. Recommend	4.2.2	line 7	E	"any tissue" is nonsense	Insert something between "any" and "tissue", such as	

	ations					"lack of" or "missing" or "absent"	
109.Adair	4. Recommendations	4.2.3	Table 7	E	Same as comment 11 above	Same as comment 11 above	
110.Adair	4. Recommendations	4.4	Table 9	T	I am opposed to the lower tier as revised for this draft standard. See my detailed comments on Section C.2.4	Restore the lower tier for the current C95.1 -1991 standard except for minor frequency changes related to the human resonance region	
111.Adair	4. Recommendations	4.4	Table 9 - note a), Para.2, line 2	E	The acronym "WBA" needs to be defined. This is the first time it is used in the draft.	Suggest the following: "...limiting the whole body average (WBA) SAR...."	
112.Testagrossa	4. Recommendations	Table 8	1	E	The asterisk "note" below the table does not appear to be referenced within the table	add asterisk to appropriate location within the table	
113.Testagrossa	4. Recommendations	Table 9	1	E	The asterisk "note" below the table does not appear to be referenced within the table	add asterisk to appropriate location within the table	
114.Testagrossa	4. Recommendations	Table 9	1	T	DISAGREE with Frequency range changes	leave Frequency range the same as controlled	
115.Testagrossa	4. Recommendations	Notes to Tables 8 & 9	b)	E,T, G	protocol for E & H are established for "below 300 MHz" and "between 30 and 300 MHz". Should include statement for above 300 MHz	include statement for frequencies above 300 MHz	
116.Petersen	4. Recommendations	4.4	Table	Table 9	While there is an explanation for moving the corner frequency from 300 to 400 MHz (to account for the Dimbylow data, etc.), there is no explanation as to why the corner frequency where the		

					MPEs begin to increase from 10 W/m ² to 100 W/m ² (100 GHz) is as high as it is, other than to harmonize with ICNIRP. With all that is known regarding the thresholds for sensation, pain, etc. at mm-wave frequencies it would seem that a lower and more scientifically based corner frequency could be chosen.	
117.Bodemann	4. Recommendations	Table 9	Ave time 100-300 GHz	E	Add brackets to clarify that everything behind the slash is in the denominator	$5048 / \sqrt{(9f_G - 700)f_G^{0.476}}$
118.Cohen	Annex A	Annex A	A.1.7	E	Extra words	Delete “with two” from second sentence
119.Swicord	Annex A	Appendix A		E	Requires further editing to be consistent with the processes that was actually used to develop the standard	Too much to add here. But this is just a clean up job.
120.Haes	Annex A	A.1.7			A special Revision WG with two was created	Two what ??
121.Adair	Annex A	A.1	line 1	E	"IEEE" is missing	Insert "IEEE" between "the" and "International"
122.Adair	Annex A	A.1.6	Para 3, last line	E	"system" should be plural	"systems"
123.Adair	Annex A	A.1.7	Para 1, line 4, line 11, and line 12	E,T	line 4: something is missing between "two" and "was" line 11: Break up this sentence line 12: Needs to be a new sentence	Fix it. Put a period after "Society" and delete "and" Capitalize "Subsequently" and change "13" to "12"

124.Bushberg	Annex A	A1.7			A special Revision WG with two was created to prepare a framework for the new	Words missing after “with two”....	
125.Bushberg	Annex A	A1.8	2	G	Paragraph beginning with “For some time, the RAWG has been particularly concerned about the lack of rigor in defining the...” is unnecessary and confusing	Delete paragraph	
126.Bushberg	Annex A	A2	1	G	“but not identical,” similar implies not identical	Delete “but not identical,”	
127.Bushberg	Annex A	A2	1	G	“assessment of risk from threshold-acting physical and chemical agents.” This is true of non threshold acting physical and chemical agents as well.	Delete “threshold-acting”	
128.Bushberg	Annex A	A.2.3	1	G	“an agent or” unnecessary and confusing	Replace with “a”	
129. Sheppard	Annex A	A.1.5		E	Is it strictly true that no papers from technical conferences appear in the primary database, per the text “Abstracts and presentations at scientific meetings or technical conferences were expressly excluded from the database”?	Abstracts and presentations at scientific meetings were expressly excluded from the database.	
130.Reilly, JP	Annex B	B.13.2, Par. 3, line 1		T	Inadvertent error above/below	Change start of sentence from; “At frequencies above ...” to “At frequencies below ...”	
131.Cohen	Annex B	Annex B	B.1	E	Missing comma	Add at end of 3)	
132.Cohen	Annex B	B	B.2	E	Wrong word in 4 th line	Change “principals” to	

						principles”	
133.Cohen	Annex B	B	B.2.1	E	Singular instead of plural	4th par., 11th line "analysis" should be "analyses"	
134.Cohen	Annex B	B	B.12.1	E	Wrong word	2 nd par., first line “with” should be “within”	
135.Cohen	Annex B	B	B.12.3	E	Question	In 11th line, should "medium" be "median"?	
136.Cohen	Annex B	B	B.12.11	E	Missing word	10th line from end, put "in" between "resulting" and "small"	
137.Cohen	Annex B	B	B.12.12	E	Incorrect verb	18th line: either "a recent report shows" or "recent reports show"	
138.Cohen	Annex B	B	B.12.12	G	inconsistency	Penultimate sentence refers to "studies presented at meetings" - not peer reviewed articles.	
139.Cohen	Annex B	B	B.12.15.1	E	Wrong word	pg.58, 4th line: "pulsed" should be "pulse"	
140.Cohen	Annex B	B	B.14	E	Extra letter	In penultimate sentence in first par., remove "o" between "to" and "access"	
141.Swicord	Annex B	Appendix B		E	Requires further editing to assure all references are actually peer reviewed publications.	Too much to add here. But this is just a clean up job.	
142.Elder	Annex B	B.15	1	General	References to expert reviews need work.	World Health Organization [2004]	

					Addition	UK IEE [2004] The Possible Harmful Biological Effects of Low-level Electromagnetic Fields of Frequencies up to 300 GHz IEE Position Statement - May 2004. The Institution of Electrical Engineers (IEE) Policy Advisory Group on the Biological Effects of low-level Electromagnetic Fields.	
143.Elder	Annex B	B.15	all	General	Suggest that Summary of Annex B be written as an “Executive Summary” briefly describing the conclusions in each of the major sections in Annex B in no more than 2 pages.	Job for editorial committee.	
144.Van Rongen	Annex B	B.2.2 B.13.1 B.15		E	Ref to Health Council of the Netherlands [B79] not correct	Health Council of the Netherlands: ELF Electromagnetic Fields Committee. Electromagnetic Fields (0 Hz - 10 MHz). The Hague: Health Council of the Netherlands, 2000; publication nr 2000/06	
145.Van Rongen	Annex B	B.2.2 B.15		E	Add additional ref to Health Council of the Netherlands	Health Council of the Netherlands: Radiofrequency Electromagnetic Fields Committee. Radiofrequency Electromagnetic Fields (300 Hz - 300 GHz). Rijswijk:	

						Health Council of the Netherlands, 1997; publication nr 1997/01	
146.Adair	Annex B	B.2.1	Para 4, line 11 and line 22	E	line 11: 'analysis" should be plural line 22 "he" has no referent	Change "analysis" to "analyses" Delete "he" and insert "Hardell"	
147.Adair	Annex B	B.3.4	Para 1, line 4	E	Fix "90min" and "weeks SAR"	Change to "90 min" and insert "at" between "weeks" and "SAR"	
148.Adair	Annex B	B.5.1	Para 5, next to last line	E	"Pound (1980)" is incorrect. The number here is the date of publication	Reference number is [B115]	
149.Adair	Annex B	B.6.2	line 13	E	"on the on" is incorrect	Delete second "on"	
150.Adair	Annex B	B.12.15.2	line 10	E,G	Query in text	Suggest this should read "prolonged refractory phase"	
151.Adair	Annex B	B.14	Para 1, line 10	E	"0" between "to" and "assess"	Delete "0"	
152.Adair	Annex B	B.15	Para 1, line 2	E	3 typos on this line	Corrections: "publications" "reveals", and "effects"	
153.Testagrossa	Annex B	B.14	1	E	1 st paragraph, second to last sentence – "...biological measures used to o assess health and...".	remove extra letter "o" "...biological measures used to assess health and..."	
154.Testagrossa	Annex B	B.14	4	E	4 th paragraph, 2 nd sentence – sentence seems to be floating, not connected "In the case of exposure to fields over the range 3 kHz to 300 GHz."	Is the sentence part of the 1 st or 3 rd sentence?	
155.Bushberg	Annex B	B.3.1	1	E	1298), 1329),	Missing (before 1329	
156.Bushberg	Annex B	B.3.1	1	G	"In the only other study	Delete sentence	

					to...right cerebral cortex (1302).” This study is not worthy of citation insofar as it is only one animal and without control. If we cite these kinds of studies to support the absence of effects, we would have to cite similarly limited and flawed studies that show positive effects		
157.Bushberg	Annex B	B.5.1	5	E	“Similarly, Pound (1980) has demonstrated that absorbed RF energy can increase the thermal comfort of people in cold environments.” Wrong citation	Replace (1980) with (1696)	
158.Bushberg	Annex B	B.7.1	4	G	“not be expected to be due to RF energy but to other physical factors present during MRI exposure.” What are the “other factors”	Provide example (e.g.....)	
159.Bushberg	Annex B	B.7.2	7	E	risk in infertility 1168)	Missing (before 1168	
160.Bushberg	Annex B	B.12.12	1	G	“although recent report show a failure to replicate in the same laboratory.” Reword and provide reference	Although a recent report in the same laboratory failed to replicate their earlier findings (Insert Reference)	
161.Bushberg	Annex B	B.12.13	1	G	“Other studies presented at meetings have reported no effects of RF	Delete	

					<p>exposure <i>in vivo</i> (Anane BEMS meeting 2000) and on cell lines (Spitz BEMS meeting 1998) using mobile phone signals and exposure levels.”</p> <p>Unless we are going to start citing unpublished positive findings we should not include negative one</p>		
162.Bushberg	Annex B	B.14	1	E	“used to o assess”	Delete “o”	
163.Bushberg	Annex B	B.14	3		extrapolation of these behavioral results to humans is conservative,”	Replace comma with a period after “conservative”	
164.Bushberg	Annex B	B.14	4		“humans to taking of or putting on a coat”	Change of to “off”	
165. Sheppard	Annex B	Variously, particularly, B.12		E, T	Citations to submitted work clearly are outside the rules for the primary database.	Replace with published paper or omit study and related statement.	
166. Sheppard	Annex B	Variously, e.g., B.12.15.2			Incomplete sections of text.		
167.Bodemann	Annex B	B		General	<i>We should pay proper attention that the phrases in the summaries match with the final overall conclusions. There should not be any doubt left.</i>		
168.Bodemann	Annex B	B.6.4		General	<i>Is the cited literature comprehensive? Are there really only 6 provocative</i>	<i>Check the literature database!</i>	

					<i>studies on hypersensitivity available?</i>	
<i>169.Bodemann</i>	<i>Annex B</i>	<i>B.9.2</i>		<i>E</i>	<i>The statements in the summary are confusingly careful.</i>	<i>Replace summary by: “The reports showed that the basic restrictions of the current standard protect against adverse changes of BBB permeability. BBB leakage occurred only at temperature increases which cannot be gained with a SAR value of 2 W/kg. Reports by a single group about BBB effects at SAR values < 4 W/kg lack of internal consistency e.g. a clear dose-response-relationship and still need replication. Therefore, they do not provide sufficient evidence for standards setting.”</i>
<i>170.Bodemann</i>	<i>Annex B</i>	<i>B.12.17.</i>		<i>E</i>	<i>The basic limitations of in vitro studies should be highlighted in the summary.</i>	<i>Add as first paragraph of the summary: “In the assessment of in vitro studies, one has to bear in mind a basic limitation of these kind of studies: the limited transferability of in vitro findings to living organisms. Often, effects occur in cell cultures that cannot be found in animals. This is due to repair mechanisms in animals which are not always present in isolated</i>

						<i>cell cultures.</i> ”	
171.Reilly, JP	Annex C	C.6.1.1, Par. 1, line 4/5		E	Clarification	Beginning with “At these low frequencies, ...” delete the rest of the sentence and replace it with “... exposure measurements require an averaging time of 0.2 s for <i>rms</i> metrics, and peak measurements require instantaneous values.	
172.Reilly, JP	Annex C	Sect. C.1.1.1, item (d)		E	Averaging time needs clarification.	Add the following after the end of item (d): “... for thermal effects. For electrostimulation, effects, the averaging time is 0.2 seconds for an <i>rms</i> measurement. Peak electrostimulation limits apply to instantaneous values within the applicable bandwidth.	
173.Reilly, JP	Annex C	Sect. C.1.1.2, item (a), line 3		E	Grammar	At end of line, change “is” to “are”.	
174.Reilly, JP	Annex C	Sect. C.1.1.2, item (a), lines 3-7.		E	In sentence beginning “Controlled environments are now considered ...”, what follows is not consistent with the definition section.	Use definition for “controlled environment” appearing in definition section.	
175.Reilly, JP	Annex C	Sect. C.1.2, item 4, 2nd sentence.		T	Apparent inadvertent word omission makes statement incorrect.	At the end of line 3, insert “not” between “is adverse” to read “is not adverse”	
176.Reilly, JP	Annex C	Fig. C.1		E	*Vertical axis label and units	Fix the figure	

					are missing. *Curves are labeled “Depth of penetration” and “percent of body mass.” These would require two different units, and two different vertical scales. *Can’t figure out how to interpret the % callouts within the figure.		
177.Reilly, JP	Annex C	Sect. C.2.4, para. 5, line 4		E	When mentioning Dosimetry Handbook, need a citation.	Add the citation	
178.Reilly, JP	Annex C	Fig. C.3		E	Can’t correlate curves with legends in box when printing in B&W. Curves are broken & discontinuous.	Use line style that can be distinguished in B&W (e.g. continuous, ---, ..., etc.) Are the full curves available?	
179.Reilly, JP	Annex C	Sect. C.3.1, Par. below (c), line 3 sentence beginning “This level		E	Data cited apply specifically to 100 kHz.	Start the sentence “At 100 kHz, for example, the level ..”	
180.Reilly, JP	Annex C	Sect. C.3.1, line 6 below item (c), sentence beginning “For the general public..”		E	Not sure if citations and explanation in this section are correct.	Add “at 100 kHz” between the words “values are” to read “...the corresponding values at 100 kHz are ...” This section needs further review. I can work on it after the June meeting,	

181.Reilly, JP	Annex C	Sect. C.3.1, Par. 2 below item (c) beginning “For frequencies ...”, line 6		E	Needs clarification of thermal versus electrostimulation mechanism.	At the end of the sentence ending with “250 mA –rms, add “based on thermal perception.	
182.Reilly, JP	Annex C	Sect. C.3.1, Par. below eqn $I=0.167f$ mA, line 2-3 (sentence 2)		E	Need to clarify that burns, if they do occur, are not widespread.	At end of line, modify sentence to read; “...could lead to startle reactions or small burns that, ...”	
183.Reilly, JP	Annex C	Sect. C.3.2, Par. 1, line 3		E	I was responsible for this section. It was modified by someone else without consulting me. The result is inaccurate.	<p>In line 3, starting with “volume”, change to read: “...volume of skin to cause localized RF ...:</p> <p>Replace second paragraph with the following:</p> <p>“To initiate a spark discharge, a minimum voltage must exist between the object and the person. At 60 Hz, the minimum peak voltage supporting a spark discharge is 500 V on dry skin and 330 V on damp skin, or on surfaces where the corneal layer of skin has been removed [B132]. For</p>	

						frequencies in the MHz range, the breakdown potential across metallic electrode gaps is reduced by about 15 - 20% , suggesting that a similarly lower spark discharge threshold with human skin contact might be possible. At frequencies of several GHz, much more substantial reductions in breakdown potential can occur [B41].”	
184.Reilly, JP	Annex C	Sect. C.3.2, Par. 2		E	As above	<p>Replace second paragraph with the following:</p> <p>“To initiate a spark discharge, a minimum voltage must exist between the object and the person. At 60 Hz, the minimum peak voltage supporting a spark discharge is 500 V on dry skin and 330 V on damp skin, or on surfaces where the corneal layer of skin has been removed [B132]. For frequencies in the MHz range, the breakdown potential across metallic electrode gaps is reduced by about 15 - 20% , suggesting that a similarly lower spark discharge threshold with human skin contact might be possible. At frequencies of several GHz, much more</p>	

						substantial reductions in breakdown potential can occur [B41].”	
185.Reilly, JP	Annex C	Sect. C.4.1, heading		E	Improper term	Change “electromagnetic field” to “electric field”	
186.Reilly, JP	Annex C	Sect. C.4.1, Par. 2, line 4		E	I was responsible for this section. It was modified by someone else without consulting me. The result is inaccurate.	In the 4th line, after the phrase “... at points where the ...”, delete replace the rest of the sentence with the following” “internal field is oriented with the long axis of an excitable cell that bends or terminates within the induced field, such as with receptors or motor neuron end plates [B135].”	
187.Reilly, JP	Annex C	Sect. C.4.1, Par. 2, line 5		E	Clarification	In line 5, replace “This metric ...” with “The electric field metric ...”	
188.Reilly, JP	Annex C	Sect. C.5		E	Section treats averaging time for thermal effects. Averaging time for electrostimulation also needs mention.	At the end of this section, add the following new paragraph: Considerations for averaging time in electrostimulation involve different mechanisms than the thermal effects discussed in the foregoing. Integration time constants for electrostimulation with repeated or sinusoidal waveforms can be as great as 0.2 s [B87].	

189.Reilly, JP	Annex C	Sect. C.6.1.1, Par. 1, line 1.		E	Several imprecise statements need fixing.	After "... is associated with ..." delete the rest of the sentence, and complete it with "... painful or adverse electrostimulation."."	
190.Reilly, JP	Annex C	C.6.1.1, Par. 1, 5 lines from bottom		E	Controlled environ. not necessarily same as occupational, or vice versa.	Replace "(occupational exposures)" with "(such as with certain occupational exposures.)"	
191.Reilly, JP	Annex C	C.6.1.1, Par. 3, line 2		E	Intended term	Par. 3, line 2, replace "current density" with "the <i>in situ</i> electric field."	
192.Reilly, JP	Annex C	C.6.1.1, Par. 3		E	Definitions	Is "HT" defined somewhere?	
193.Reilly, JP	Annex C	C.6.1.1, Par. 4, lines 1-5		E	I can't make sense out of the first sentence of Par. 4, beginning with "Although .." It doesn't seem to add anything.	Par. 4. Delete first sentence (5 lines)	
194.Reilly, JP	Annex C	C.6.1.1, Par. 4, line 8, start of line		E	Workers/controlled env. not necessarily the same.	Replace "worker" with "person in the controlled environment.	
195.Reilly, JP	Annex C	C.6.1.1, Par. 4, 6 lines from bottom.		E	Workers/controlled env. not necessarily the same.	Replace "under occupational conditions" with "in the controlled environment."	
196.Reilly, JP	Annex C	C.6.1.1, Par. 4, 4 lines from bottom		E	Workers/controlled env. not necessarily the same.	At end of sentence, replace "worker" with "individual."	
197.Reilly, JP	Annex C	C.6.1.1, Par. 6, 8 lines fr. bottom		E	Incomplete sentence	Change "cardiac excitation" to "excitation of the brain or heart."	

198.Reilly, JP	Annex C	C.6.1.1, Par. 6, 7 lines fr. bottom		E	Incomplete sentence	Change “cardiac excitation” to “excitation of the brain or heart.”	
199.Reilly, JP	Annex C	Sect. C.6.1.2, Par. 1, line 7.		E	Need to distinguish thermal vs. electrostimulation	Between “factor” and “for”, add “(in terms of SAR or SA)”.	
200.Reilly, JP	Annex C	Citation [B134]		E	Update	In parentheses at end of citation, delete “to be published,” and retain “2003”.	
201.DeFrank	Annex C	7.2.1 & 7.2.2		E	Paragraph headings without text. The topic of localized exposure is covered throughout. Definition 3.35 and C2.2.2 are noteworthy.	Remove.	
202.Tell	Annex C	C 1.2	4	T	The perception of a barely audible click, buzz or hiss, from pulsed radar type signals in a very quiet environment, based on real-world exposures, is adverse to health.	The perception of a barely audible click, buzz or hiss, from pulsed radar type signals in a very quiet environment, based on real-world exposures, is not adverse to health.	
203.Tell	Annex C	C.2.2.2.1		E	The three justification listed above also apply to these limbs and this change removes the ambiguity of establishing compliance.	The three justifications listed above also apply to these limbs and this change removes the ambiguity of establishing compliance.	
204.Tell	Annex C	C.2.4	3	T	This revision imposes a different frequency dependency on the MPE limits compared with the presently published standard. The	The MPE limits for the general public should parallel those applicable to controlled environment exposures by a factor of five	

					presumed added protection, afforded by extending the most restrictive MPE limit for the general public to 400 MHz, is not justified when compared to uncertainty associated with the dosimetry analyses upon which this change is based.	as in the past.	
205.Cohen	Annex C	Annex C	C.12(4)	T	inconsistency	We concluded previously that microwave hearing is not adverse to health.	
206.Cohen	Annex C	C	Fig. C.1	E	Missing scale	Add vertical scale	
207.Cohen	Annex C	C	C.2.2.2.1	E	“distal” again	“distal from” not “to”	
208.Cohen	Annex C	C	C.2.2.2.2	E	Plural case	2nd par., 2nd sentence: change "pinna" to "pinnae"	
209.Cohen	Annex C	C	C.2.3	E	Wrong word	First par., last sentence: "rational" should be "rationale"	
210.Cohen	Annex C	C	C.2.4	E	Missing word	4th line: add "and" before "the equivalent"	
211.Cohen	Annex C	C	C.6.1.2	E	Meaning not clear	Rewrite second sentence of third par.	
212.Cohen	Annex C	C	C.6.3	E	Wrong word	4th line "principal" not "principle"	
213.Cohen	Annex C	C	C.6.3	E	question	Should references to 6 GHz be changed to 3 GHz?	

214.Cohen	Annex C	C	C.7.1	T	Spelling	“covected”should be “convected”	
215.Cohen	Annex C	Annex D	D.4.2.1	G	Absent standard provision	See comment re 4.1.4.1	
216.Swicord	Annex C	Appendix C		E	Requires further editing to assure technical aspects of the standard are actually addressed	Too much to add here. But this is just a clean up job.	
217.Elder	Annex C	C.7.12	Last paragraph	typo		Add “in” to read “literature previously reviewed in Annex b.7”	
218.Elder	Annex C	C.7.12.1	3	Reference omitted		Add (667) to read “three frequencies (667), (668), (669), (670), (671), (672).”	
219.Elder	Annex C	C.2.2.1	2	Technical	Use of the term “median threshold” could be problematic; therefore, suggest deletion of the word “median.”	One could argue that the words “...4 W/kg is the median threshold for potentially adverse health effects ...” implies that SARs less than 4 W/kg cause adverse effects and, therefore, the safety factors are less than 10 and 50 for some adverse effects.	
220.Lt. Colonel Dr. Amnon Duvdevany	Annex C	C.1.1.2	Differences. P.64	T	Reducing the factor of peak spatial-average MPE to 10 from 20-40 (p. 22, par. h)) was not mentioned as a difference, and was not rationalized (while the peak spatial-average BR were increased)	Rationalize, mentioning as a difference	
221.Lt. Colonel Dr. Amnon Duvdevany	Annex C	C.3.3.4	Par. 3, sent. 6	E	Missing ")"	adding	
222. Ivans	Annex C	Annex C	Last Paragraph in	E, T	The paragraph is misleading – active implantable medical	The paragraph should be reworded as follows:	

			<p>section C.7.9: "Another concern resulting from RF overexposur es is electrical interference </p>		<p>devices may be susceptible to interference even when they are properly designed. This is due to their intended operation and the fact that the basic restrictions in human exposure standards allow emitters much higher fields.</p>	<p>" Another concern resulting from RF exposure is electromagnetic interference with the correct operation of active implantable medical devices (such as implantable pacemakers, implantable defibrillators, implantable neurostimulators and infusion pumps, etc.). Sufficiently high electromagnetic fields and/or modulations in the bandpass of these devices may inappropriately interfere with the their intended operation. Any doubts about the susceptibility of such medical electronic devices should be referred back to the patient's medical practitioner and/or device manufacturer.</p>	
223.Varanelli	Annex C	C.2.4 MPE values: 100 kHz - 300 GHz	As copied and highlighted in yellow	T	This change in the MPE values is based on recent dosimetry research indicating that the WBA SAR for small children, in the 1-3 GHz frequency range, could potentially exceed the 0.08 W/kg basic restriction for the general public forexposures at the 1991 MPEs [B55].	On the basis of my comments in the previous column, the Dimbylow(2002) data must be eliminated from consideration, and the change proposed to the MPE for the general public as a consequence of Dimbyloe(2002) must be removed and the 1991 MPE restored.	

					<p>Using a more realistic human model and FDTD methods, the WBA SAR was computed for several different size children as well as an adult from approximately 70 MHz to 3 GHz [B55].</p> <p>Similar data for the adult only using an alternative human model but also using the FDTD modeling method [B110] can be used for comparing nominal consistency between the two studies.</p> <p>Figure C.2 illustrates how these two data sets compare. Two important observations are apparent.</p> <p>The two methods are in good agreement with only a 5.3% difference between the two independently obtained values at 1.4 GHz.</p> <p>Comment:</p> <p>The rationale used to affirm the legitimacy of the change in MPE as described is flawed, not scientifically grounded, and is inconsistent with the process used to derive MPE's elsewhere in the standard.</p> <ol style="list-style-type: none"> 1. The "good" agreement between Mason(2000) and 	
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					<p>Dimbylow(2002) is inferential up to 2000MHz. Above 2000MHz and up to 3000GHz, there is no comparison data available from Mason (2000). It is therefore not possible to draw any inference, conclusion, or relative “goodness” of the Dimbylow (2000) data between 2000MHz and 3000MHz. The rationale offered is only imaginative speculation not driven by any peer reviewed science. Furthermore, there is no peer reviewed science supporting the applicability of the Dimbylow(2002) modeling as appropriate for the realities of exposure and energy absorption.</p> <p>2. The shrunken adult model used by Dimbylow(2002) for modeling of children is not correct. Actual MRI data for children</p>	
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					<p>must be used in the characterization of tissue type, geometry, etc., in order to achieve any accuracy whatever in any modeling scheme. Therefore, any "accuracy" implicated for the adult model cannot be transferred for any data related to children.</p> <p>3. On the basis of 1 and 2 above, the Dimbylow(2002) data must be eliminated from consideration, and the change proposed to the MPE for the general public as a consequence of Dimbyloe(2002) must be removed and the 1991 MPE restored.</p>	
224.Curtis	Annex C	C.1.2	4. Microwave	T	Declares microwave hearing as adverse to health	"was considered to not be adverse to health.
225.Adair	Annex C	C.1.1.2	Item a), line 3 and item g) line 2	E	a) line 3: verb should be plural g) This is very confusing because an occupational	Change "is" to "are" g) The statement should be

					situation is being discussed and yet the general public is also referenced.	redrafted and clarified. Check with Bob Curtis.	
226. Adair	Annex C	C.1.2	Item 4, line 3	E	Statement that microwave hearing is adverse to health is incorrect.	Insert "not" between "is" and "adverse"	
227. Adair	Annex C	C.2.3	line 5	E	Misspelled word	Change "rational" to "rationale"	
228. Adair	Annex C	C.2.4	Entire section	T,G	<p>Comments:</p> <p>The following relates to the lower tier (General Public). FD-TD modeling of children, based on a greatly reduced scale version of a 70-kg man (originally a 115 kg man) is not representative of youngsters. The original version of the visible man is the essential basis for all this recent modeling, whether by Dimbylow, Mason et al., or Bit Babik, and it has no empirical basis whatever. It is clearly premature to present these theoretical formulations as the reason for altering the current C95.1-1991 (1999) lower tier, especially in view of the fact that we have no experimental data whatever on live children to back it up. We should not rush to judgment on the models of "children". Based on the modeling techniques used by Dimbylow and others, we have no</p>	<p>Response regarding the lower tier:</p> <p>ICES SC-4 is charged to generate a science-based standard. This charge must apply throughout the new revision insofar as is possible, given our current knowledge. SC-4 "jumps the gun" with the introduction of made-up "children", uses these models as a rationale to "harmonize with ICNIRP to 100 GHz", and then fabricates a precipitous ramp from 100 to 300 GHz to harmonize with the laser standard. This arbitrary exercise effectively destroys much of the hard work of the SC-4 members over the last 13 years and undermines our credibility. Instead, we should stay with the current lower tier because this first pass as proposed may well be false</p>	

					<p>certainty whatever that the calculated SARs for "children" (or even the calculations for "adult humans") are accurate, graphed in Figure C.3 (page 73 of the draft standard) as the calculated ratio of whole body average SAR to the hazard threshold, 4 W/kg. Nor do we know what this ratio would be at frequencies above 3 GHz, since we have neither data nor calculations. This procedure is not science; it is simply wishful thinking, and ultimately politics. Had a Figure of the actual two tiers been included with this draft (as with the current C95.1-1999), the folly of the lower tier would have been self-evident.</p>	<p>and therefore highly misleading. Models of real children that result from e.g., FMRI determined (with parental consent) in hospital or clinic, can be encoded slice-by-slice, just as the original visible man was encoded. A collaborative effort to generate such models of children and then subject the models to FD-TD analysis across selected frequencies, is the only truly scientific way to determine both whole-body and partial-body SARs for children of various ages, e.g., 1, 5, 10, and 15 years (both males and females). I encourage the members of SC-4 to prepare a new revision for ballot that will adopt the basics of the lower tier of the current C95.1-1991 (1999). The two tiers, as first published in 1991, have served us well and there is no evidence of harm to anyone exposed to RF energy under these guidelines. There is no shame in re-issuing the current exposure levels as we search for valid data to underwrite changes. Further, if SC-4 so agrees, it</p>	
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						would also be appropriate to modify the lower human resonance contour as agreed upon in the SC-4 Editorial WG, i.e., $f = 3 - 6$ GHz as a transition zone for SAR and power density, and $f = 400$ MHz as the upper boundary of the Gandhi gully. Clearly, models of real children, as well as models of adult females, will provide a far more scientific basis for setting both tiers of the C95.1 standard in the future. For example, an amendment (containing these new data) to a new C95.1-200X standard (that essentially repeats the present 2 tiers) could be submitted within 2-3 years, given a large collaborative effort of the SC-4 membership devoted to this task. In this way we would preserve our integrity as we support our charge to generate a science-based revised C95.1 standard.	
229.Adair	Annex C	C.3.1	Para 2, page 74, line 4	E	Nasty typo	Change "pubic" to "public"	
230.Adair	Annex C	C.3.3.2.1	Para 2 line 6	E	Reference requested	Shellock FG, Schaefer DJ, Kanal E. 1994. Physiologic responses to an MR imaging	

						procedure performed at a specific absorption rate of 6.0 W/kg. Radiology 192:865- 868.	
231.Adaair	Annex C	C.3.3.2.2	Para 1 line 3	E	Reference requested	Adair ER. 1988. Microwave challenges to the thermoregulatory system. In: O'Connor ME, Lovely RF (eds.). Electromagnetic Waves and Neurobehavioral Function. New York:Alan R. Liss, pp.179-201.	
232.Adaair	Annex C	C.3.3.2.2	Para 5 line 10	E	Typo	change "as" to "at"	
233.Adaair	Annex C	C.3.3.3.2.2	Para 1 line 1	E	Typo	Change "features" to "featured"	
234.Adaair	Annex C	C.3.3.4	Para 4 line 7	E	I believe that 6 GHz is incorrect, given the decisions of the Editorial WG.	Change "6 GHz" to "3 GHz"	
235.Adaair	Annex C	C.5	Para 5 line 2	E,G	Reference requested	Delete "in June 1999" The correct reference follows: Walters TJ, Blick DW, Johnson LR,Adair ER, Foster,KR. 2000. Heating and pain sensation produced in human skin by millimeter waves: comparison to a simple thermal model. Health Physics 78(3):259-267.	
236.Adaair	Annex C	C.6.1.1	Para 4 lines 12, 13, 14	E	Typos	Line 12: Insert "the" between "main" and "body" Line 13: Duplication. Delete ",for both tiers" Line 14: Replace "is" with	

						"are"	
237. Adair	Annex C	C.7.1	Para 1 lines 2, 12, 14	E	1 typo and matter of 3 vs 6 GHz as upper boundary for resonance	Line 2: Change "fields" to "field" Line 12: Change "6 GHz" to "3 GHz" Line 14: Ditto in 2 places.	
238. Adair	Annex C	C.7.7.2.3	Para 1 line 1	E	Typo	Change "combined" to "combines"	
239. Adair	Annex C	C.7.7.2.3	Last Para line 1	E	Typo	Change "(HIS)" to "(HSI)"	
240. Adair	Annex C	C.7.9	Para 2 Item 10	E	Typo (?) Check meaning with author.	Either delete "a" before "thermal" or change "environments" to "environment"	
241. Adair	Annex C	C.7.11	Para 10 on page 110	E	This paragraph refers to C.7.2 located on page 97. However C.7.2 has nothing to do with human reproductive studies of workers. It discusses non-uniform exposure fields and how to measure them.	Author of this clause should find the appropriate source for the material in this paragraph.	
242. Adair	Annex C	Annex D	All		Comment: I did not review Annex D, which is material best reviewed by electrical engineers (of which I am not one.)		
243. Testagrossa	Annex C	C.1.2	1	E	I believe the word "not" is missing before "...adverse to health" 4. Microwave hearing effects: These effects, while a possibility, are even more rare than items 1, 2 and 3 above. The perception of a barely audible click, buzz or hiss,	add the word "not" before adverse 4. Microwave hearing effects: These effects, while a possibility, are even more rare than items 1, 2 and 3 above. The perception of a barely audible click, buzz or hiss, from pulsed radar type	

					from pulsed radar type signals in a very quiet environment, based on real-world exposures, is adverse to health.	signals in a very quiet environment, based on real-world exposures, is not adverse to health.	
244. Testagrossa	Annex C	Figure C.1	1	E	no label for y-axis	label y-axis “Depth of Penetration (cm)”	
245. Testagrossa	Annex C	C.2.4	2	G,E,T	aren’t the BR above 3 GHz the MPEs? If so, the second paragraph should reference this	Include a statement in the 2 nd paragraph “ above 3GHz the MPEs are the BRs.”	
246. Testagrossa	Annex C	C.6.1.2	11	G,E	last sentence “ ...beam area decreases...” should this be “increases”, or “decreases” or “ beam area changes”	change sentence appropriately last sentence “ ...beam area ?????...”	
247. Bushberg	Annex C	C.1.2	4	G	C.1.4. “ 4. Microwave hearing effects: These effects, while a possibility, are even more rare than items 1, 2 and 3 above. The perception of a barely audible click, buzz or hiss, from pulsed radar type signals in a very quiet environment, based on real-world exposures, is adverse to health: This is inconsistent with 3.1 Note 2—Sensations (perceptions by human sense organs) per se are not considered an adverse effect.	Change “is adverse to health.” To “is not adverse to health.”	

					Thus sensation of warmth at millimeter- and other wavelengths and the microwave auditory effect under the underlying special conditions are not recognized as effects to be avoided by the rules of this standard.		
248.Bushberg	Annex C	C.1.2	6	G	<p>“6. Low-level speculative effects: RF biological effects ... any significant impact on human health.”</p> <p>Inappropriate. This section is about what we are protecting against not the universe of things that are not considered potentially adverse to human health. In addition the statement is internally inconsistent. The statement “do not present a theoretical possibility of adverse outcome”</p> <p>is inconsistent with the statement</p> <p>“occur rarely and only in conjunction with some synergistic factor, e.g., disease or chemical agent, which has not been studied,”</p>	Delete 6 in its entirety.	

249.Bushberg	Annex C	C.3.3.3.1	1	G	“Heat stroke, a true hazard to human beings.”	Delete underline
250.Bushberg	Annex C	C.6.2	1	G	been assumed that both the HT threshold and the “T” and threshold is redundant	Delete “threshold” after “HT”
251.Bushberg	Annex C	C.7.10	2	G	These drugs include anesthetics, antihistamines, sedatives, alcohol, tranquilizers, and many psychoactive drugs. Too definitive a list –see recommended change	These drugs include, but are not necessarily limited to, anesthetics, antihistamines, sedatives, alcohol, tranquilizers, and many psychoactive drugs.
252.Bushberg	Annex C	C.7.12.2	1	E	Histopathological analysis of the brain and other CNS tissues was a special focus of three lifetime studies in rats incorporating exposure of the animals during gestation (1298), (1406), (2147). Cannot find citation 2147 in WHO/IEEE database This citation also appears further down.	Provide correct citation
253. Sheppard	Annex C	C.3.3.2		T	Text is imprecise; confounds SAR and SA.	Exposures equivalent to the MPE limit in the body resonance range result in energy deposition, averaged over the entire body mass for any 6 min period of

						about 144 J/kg or less. This SA corresponds to an SAR of about 0.4 W/kg or less, as spatially and temporally averaged over the entire body mass.	
254. Sheppard	Annex C	C.5		E	This is the only place the word exclusion is used. Hence it dangles undefined and unexplained.	Omit.	
255. Bodemann	Annex C	C		General	<i>This is an important issue: The different averaging times (AT) between the two tiers, especially the elevated AT for the general public, need explanation. This affects mainly C.1.1.1.d), C.1.1.2., and C.5.</i>	<i>Add a rationale for the elevated averaging times for the general public for frequencies above 1.34 MHz.</i>	
256. Bodemann	Annex C	C.1.1.1.d		E	<i>Averaging time is not 6 min for general public.</i>	<i>“The averaging time remains six minutes for frequencies below 3 GHz for controlled environments.” When the averaging times have not changed for general public exposure, add a sentence.</i>	
257. Bodemann	Annex C	C.1.1.2.		E	<i>Add a paragraph on averaging times.</i>	<i>Add the following as it applies: “i) Avering times were changed for frequencies above 3 GHz. Also the averaging times for general public exposure were</i>	

						<i>elevated.”</i>	
258.Bodemann	Annex C	C.1.2.4		E	<i>Microwave hearing is an adverse health effect? This is in contradiction to B11.2</i>	<i>“The perception of a barely audible click, buzz or hiss, from pulsed radar type signals in a very quiet environment, based on real-world exposures, is not adverse to health.”</i>	
259.Bodemann	Annex C	Figure C.3		Editorial/General	<i>The curves can hardly be distinguished. The figure is not easily understandable.</i>	<i>Redesign the figure (esp. bright background colour). Add a figure showing the same ratios for the new MPE values to demonstrate that the present MPE values ensure compliance with the basic restrictions even for 1-yr-old children.</i>	
260.Bodemann	Annex C	C.5		General	No rational is given for the 30 min av. Time for the general public.	Add a rational for the elevated averaging time for the general public. This is important as this states a basic difference to the ICNIRP guidelines and therefore needs explanation.	
261.Bodemann	Annex C	C.6.1		General/Editorial	“Thus the benefit of greater peace of mind is afforded the general public through this greater margin of safety. This judgment is, of course, one of socio-political policy and not strictly scientific.” This polemic statement causes “war of mind” and does not help anybody. The paragraph reads well without these two sentences.	Skip the sentences!	

262.Bodemann	Annex C	C.6.1		General/Editorial	<p>“Because the two tiers are mandated for the resonance range and up to 300 GHz and not low frequencies, the standard employs somewhat arbitrary ramp functions in both MPEs and averaging times. The resulting variation in safety factor for the lower tier as a function of frequency is not meaningful since the extra safety factor is not derived from science or real exposure considerations.“ The ramps in the MPEs above 100 GHz are introduced to match the laser standard. This is, in my understanding, a scientific demand. Again, the whole statement is provocative, as it sounds somewhat sloppy and unmotivated.</p>	<p>Skip the paragraph! Maybe consider replacement by more moderate statements like: “The MPE as well as the averaging times ensure a minimum safety factor of 10 for controlled environments and 50 for general public exposure over the whole frequency range from 3 kHz to 300 GHz. In some frequency bands, the real safety factors may be considerably higher.”</p>	
263.Bodemann	Annex C	C.6.3		E	<p>“An RF Safety Program is required to provide part of the margin of safety for those exposed above the lower tier.” The reference to RF safety programs does not fit into the argumentation line of the paragraph and appears somewhat misplaced. Additionally, the statement is not necessary at this point.</p>	<p>Skip the sentence!</p>	

264. Bodemann	Annex C	C.7.9.8		E	“The potential for excessive localized SARs around an implant is only realistic in parts of the body where <i>in vitro</i> fields are already relatively high.” Do you really mean “in vitro”?	“The potential for excessive localized SARs around an implant is only realistic in parts of the body where <i>in situ</i> fields are already relatively high.	
265. Bodemann	Annex C	C.7.11		Editorial/General	A clear summarizing statement at the end of the chapter is missing.	Add at the end of the chapter: “In summary, the C95.1 basic restrictions protect safely against adverse effects to both pregnant women and the fetus.”	
266. Ammann	Annex D	D 1.1.2.3	Figure H.1	(G)	Invert colours for clarity		
267. Ammann	Annex D	D.1.1.2.3	Figure H2	(G)	Invert colours for clarity		
268. Williams	Annex D	D.4.2.1		E, T	"Results of those calculations have been included in the standard as percent of maximum permitted electric field strength versus frequency." The results are not included.	Include results. For example, see Figures E.6 and E.7 in the 1999 edition of C95.1.	
269. Bushberg	Annex D	D.1.1.1	2	E	squared that obtains in the far field does missing word	Replace with “squared that one obtains in the far field does”	
270. Bassen	Annex D	D.4.1 Field measurements	1	T	It is incorrect to state that no H field measurements need to, be measured below 100 MHz. This depends on the location of the region of concern with respect to the radiator or re-radiator.	Most commonly, Measurements of both E and H fields are required unless the region of concern is in the far field of the radiator or re-radiator.	
271. Bassen	Annex D	D.4.1	2	T	It is incorrect to state that there	When metallic (conducting)	

		Field measurements			are standing waves of electric and magnetic energy. The suggested wording describes the correct physics of the situation.	surfaces are immersed in a radio-frequency field, currents are induced in those surfaces. These currents produce electric and magnetic fields which produce near-field radiation near the metallic object. Accurate depiction of exposure to determine compliance with exposure standards therefore requires the measurement of both field components.	
272. Bergeron, John	General Comment			My Comment – I vote to reject the current draft	The efforts of the group have produced the proverbial camel as the design for a horse. Ten engineers and as many lawyers are needed for anything except the decision of whether a given number, obtained in a given way meets the guidelines. This comment matrix itself exemplifies the problem. Anything can be fixed by changing a word or punctuation here and there. The current version acknowledges the lack of science in the general public guidelines but ignores the lack of a coherent, self-consistent design throughout the covered spectrum. The grafting of the sensation based 3kHz-100KHz thru a transition to the		

					previously developed RF-Microwave threshold /effects research is unsatisfactory. If the sensation of shock shifts smoothly into warmth, then that threshold should either continue forward or be better rationalized with the whole body averaging. There is a lack of continuity of logic, etc due to the attempt to go down to 3kHz		
273.Cleveland	General Comments				I am abstaining to avoid a conflict of interest, since the FCC may eventually have to consider adopting this standard through a legal rule making proceeding.		
274.Mantiplly	General Comments				I am abstaining to avoid a conflict of interest, since the FCC may eventually have to consider adopting this standard through a legal rule making proceeding.		
275.Bailey	General Comments			G	A number of citations to manuscripts submitted for publication are made	If not accepted for publication prior to publication of the standard references to these manuscripts should be deleted.	
276. Karpowicz	General Comments	Clause 4		G	- changes introduced for the frequency range up to 0.1 MHz are important for harmonisation between IEEE C95.1 and C95.6		

					- general idea for changes introduced for the frequency range above 0.1 MHz seems to be reasonable, but I'm afraid that practical implementation of different "shape" of MPE for general public and occupational environment would be very "uncomfortable" and too expensive for common use		
277. Hurt	General Comments			G	Based on science the standard should not be reduced. If anything it should be raised, especially for GP. Adair has demonstrated how exquisite the human body is at thermally regulating and this and other data give reason to even reduce the safety factor. Harmonization should not take precedence over a science based standard. We should take the lead if no one else is. Considerations should also be given to the impact a standard has on operations. The operational parameters for devices that have socially redeeming uses should not be limited by ludicrous safety standards. This would diminish the over all safety and well being of the general population.		
278. Tenforde	General Comments			G	The proposed revision of the		

					1999 version of C95.1 represents an improvement, and I vote to approve it with the understanding that there will be an ongoing effort to further refine the basic restrictions and MPE values. Further refinements are especially needed in the intermediate frequency and high frequency ranges.		
279. Tenforde	General Comments			G	The organization of the report is not very useful. The format used in the 1999 revision of the 1991 document was much more informative and easier for the reader to follow insofar as it contained a Section 6 entitled “Rationale” that provided a concise summary of the technical basis for the revised guidelines relative to the 1991 guidelines. I would highly recommend restructuring the final version of the current document in a format similar to the 1999 C95.1 version of the guidelines.		
280. Baron	General Comments				I agree with the basic concept of the revised standard, however, several of my comments are of sufficient concern to me that I would be opposed to the standard being issued with its current content.		

<p>281. Testagrossa</p>	<p>General Comments</p>			<p>I do not believe Frequency range for General Public MPEs needs to altered solely to reflect recent dosimetry research. The standard should be consistent with frequency ranges for both controlled and general public. Changing just the general public frequency range when there is no "scientific" credible reason to even justify or support a second tier in the first place only lends credibility to the tier. The recent research and discrepancies regarding safety factors can be addressed within the text body of the standard.</p>		
<p>282. Gandhi</p>	<p>General Comments</p>			<p>1. Making an exception of pinna as an extremity vitiates the desire of the ICES SCC 28.4 to harmonize with the ICNIRP Standard for General Public Exposures</p> <p>2 .Allowing a higher SAR for pinna when no such exception is made in any other standard worldwide would allow twice as much radiated power for the cellular telephones in the U.S. than in other countries (Utah research accepted for publication) . Also it would perpetuate a different product</p>	<p>Suggestion Remove pinna as an add-on to the extremities in Table 6 of the Draft to be consistent with the ICNIRP standard</p>	

					<p>compliance standard in the U.S. than in other countries for a global product such as a cellular telephone.</p> <p>3. There is no research that I know of that 20 W/kg for any 10-g of tissues of the pinna would not result in a substantial increase of temperature both for the pinna as well as the brain particularly since the pinna is also conductively heated by electronics in the handset.</p> <p>4. Lastly including pinna as an extremity tissue smacks of favoritism shown to wireless industry, which is an employer of one of the cochairs of SCC 28.4. We should not forget that an exception for was voted on when we were still struggling with peak 1-g SAR of 1.6 W/kg.</p>	
283.Fichtenberg	General Comments				<p>SC4 co-chairs have adopted a procedure whereby balloters who have not finished the comment matrix by June 4, 2004 may send it in later. See email below from co-chair C-K Chou. Accordingly, and per SC4 modified rules, later I shall send in my comment</p>	

					matrix and comments giving reasons for my negative ballot.		
284. Baron	General Comments				I agree with the basic concept of the revised standard, however, several of my comments are of sufficient concern to me that I would be opposed to the standard being issued with its current content.		
285. Sheppard	General Comments	Throughout		E	Are E_0 – rms (V/m) and V – rms and similar constructs the IEEE way? An unusual notation to me.	Whatever IEEE style is.	
286. Baron	General Comments	General			This document cries for an application matrix that describes the controlling factors (averaging, peak, etc.) for the various frequency ranges. ⁹		
287. Testagrossa	Table of Contents	Table of Contents	n/a	G, E	Include heading for table of contents – currently page vi	“Table of Contents”	
288. Testagrossa	Table of Contents	Table of Contents	n/a	G, E	Page numbers do not match text body	Most likely “should” be resolved when std is re-formatted	
289. Testagrossa	Table of contents	Clauses – All	n/a	G, E	Page numbers do not match “Table of Contents”	Most likely should be resolved when std is re-formatted	

**Review of M.Taki's (Dept EE, Tokyo U)
Presentation 'Wireless Coms Dosimetry'
5th NIR Workshop, Seville, May 2004**

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Topics

- **Exposure metric for mobile phones**
 - **Significance and limitation of SAR**
- **Dependence of SAR distribution**
 - On device
 - On head properties
- **Concluding remarks**

Dosimetry

- **Is SAR a relevant metric for thermal effects ?**

SAR vs. Temperature elevation (1)

Numerical studies by Hirata, et al., IEEE Trans. EMC, 2003

- **SAR distribution compared to Temperature increase distribution in 2 heads (X copy, diagram)**
- **No strong point-to-point correlation between SAR and temperature increase.**

SAR vs. Temperature elevation (2)

Numerical studies Hirata & al. IEEE Trans MTT 2003

- Fairly good correlation between Y Axis: **Max. Temp. increases**, line graph 1: in the head (averaged over 10g) & line graph 2: in brain (averaged over 1g), and on X Axis: **peak SAR** from numerical calculation for 660 different exposure conditions with a) normal ear & b) pressed ear.
- **though maximum temperature elevation does not necessarily appear at the same location as peak SAR Local SAR is a relevant metric for thermal effect**

Metric for non-thermal effects

- Increasing concerns re possible **non-thermal** effects of wireless communication devices
- SAR, which represents heat generation rate, is not necessarily a relevant metric ?
- No way to determine a metric for **unidentified effects** ?
- Fundamental physical quantities of EMF in tissue:
- **Electric field in tissue (E)**- **Magnetic field in tissue (H)**
- **Could H-field also be considered as a metric ?**

Significance of SAR as a Metric

Standing waves: E & H

- Higher SAR means lower H-field in standing waves (diagram plane wave E&H, $\lambda/2$)

For wireless communication devices ?

- Comparison of 3 x 4 (12) head distributions, scale 0 (Max) -9 dB
- Y axis: 1. SAR, 2. Internal E-Field, 3. Internal H-field.
- X axis: 1. Infinitesimal electric, 2. Infinitesimal magnetic, 3. Half wavelength, 4. Plane wave.

SAR as a non-thermal metric re H & E:

While SAR is a metric for heat generation rate:

- Local SAR is proportional to the square of internal electric field.
- Local SAR has, to some extent, correlation with internal magnetic field for near-field exposures.
- **Local SAR could also be relevant metric for non thermal effect, as it represents exposure gradient of E- and H- field, to some extent.**

Conclusion of SAR as a metric

- **Local SAR is a relevant metric for thermal effect (though maximum temperature elevation does not necessarily appear at the same location as peak SAR)**
- **For both normal ear and pressed ear**
- **For both E & H fields:(Non thermal effects)**

Summary

- **Exposure metric for mobile phones**
 - Significance and limitation of SAR
- **Dependence of SAR distribution**
 - On device
 - On head properties
- **Concluding remarks**

Typical SAR distributions of Mobile Phones

- **C1 Fliptop 900MHz**
- **C2 Flip Hinge**
- **C3,C3' Straight 800MHz**
- **C4 Flip Top 1.5 GHz**
- **C5 Straight 1.5 GHz**

Principle Component Analysis

- Categorization of phones obtained from principal component analysis
- from four parameters representing the SAR distributions (76 phones).
- (From M.Taki and K. Wake, Proc. 2002 URSI 27th General Assembly)
- **Penetration depth** for plane waves (d_h)
- Measured -3dB depth is smaller than d_h due to the nature of near-field. **Difference is also ~20%.**
- **14.4 mm at 900MHz; 11.5 mm at 1450 MHz.**

Volume of Brain Exposed

Volume **in brain** with SAR > 10 % of the maximum 10g average local SAR

- 7 % at 900 MHz
- 2 % at 1500 MHz
- 0.8 % at 2000 MHz
- 20% difference of penetration depth results in 3.5 times difference in exposed volume

Conclusion Dependence of SAR distrib'n on mobile phone classific'n

- SAR distributions are different for different phones
- They can be categorized into several classes, which correspond to different external view & specifications
- Penetration depth decreases for higher frequencies, which results in **significant difference in exposed volume in brain.**

Dependence of SAR distribution on head properties: Ear effect

Ear effect investigation

- There is a controversy whether ear enhances local SAR in brain
- They present some recent data regarding this issue
- Collaboration with S. Watanabe's group in NiCT
- Phantom Head model with and without ear
- Shape and size of standard Japanese male developed by NiCT (CRL)

Dependence of SAR distribution on head properties: Ear effect.

Head model with and without ear

- **Metal mock-up phone (Thin type)**
- - **S. Mochizuki, S. Watanabe, et al.**
unpublished
- **Without ear, Cheek & tilt positions;**
- **With ear, Cheek & tilt positions;**
- **Measurement & Calculation of SAR Distribution**

Effect of ear on maximum SAR (3 mock-up phones)

- 3 model phones (thick, thin & foldable) of metal box with a monopole antenna in tilt and cheek position.
- Maximum 1-g average SAR, Maximum 10-g average SAR
- Maximum SAR inside the head (auricle not included) is larger in the model without ear both by calculation and by measurement for the three mock-up phones (from S. Mochizuki, S. Watanabe, et al., unpublished)
- Three model phones of metal box with a monopole antenna

Dependence of SAR distribution on head properties: Ear effect.

Effect of ear on maximum SAR

Measurement with **real** phones

- Phone A (antenna extended) 900MHz straight
**With ear, Without ear Cheek, Tilt, Cheek,
Cheek (-20 deg) (+20 deg)**
- Phone B (antenna extended) 900MHz Flip
antenna on top on the left **With ear, Without
ear Cheek, Tilt, Cheek, Cheek (-20 deg)
(+20 deg)**

Dependence of SAR distribution on head properties: Ear effect.

Effect of ear & position on maximum SAR measurement with **real** phones

Results of measurement on **real** phones

- Consistent with the results for mock-up phones, the maximum SAR inside the head is **larger in the model without ear than in the model with ear**
- There are some exceptions depending on the position of the phone, however.

Conclusion of ear effect

- SAR distribution is affected by the presence of lossy ear
- Maximum SAR in the head (not including auricle) is rather larger in the earless model than in the with-ear model
- Ear can increase the local SAR in some cases but not often
- Effect of phone position to head is much more significant than ear effect.

Child issue

- **Shape**
- **Electric constant**
- **Wang and Fujiwara's studies on this issue**

SAR in a head of a child

- OP Gandhi, G. Lazzi, and C.M. Furse, *IEEE Trans. Microwave Theory Tech.*, Vol. 44, No. 10, pp. 1884-1897, 1996

Adult, Scaled 10y-old child, Scaled 5y-old child

- F. Schönborn, M. Burkhardt, and N. Kuster
Health Physics, vol.74, pp.160-168, Feb. 1998

Adult, 7 y-old child, 3y-old child

- Wang and Fujiwara

Adult, 7-year-old child, 3-year-old child

Peak SAR Comparison 900 MHz

Wang & Fujiwara - IEEE Trans MTT. 51:3: 966-971 reproduced Gandhi's measurements

Peak SAR at 835 MHz by Gandhi et al., 1996

- **Antenna: $\lambda/4$ monopole ; Antenna output power : $P=0.6$ W**
- **Decreased antenna input impedance increases the antenna current and then the peak SAR (10g & 1g average)**
- *Fixed antenna power*

Peak SAR Comparison 900 MHz

Wang & Fujiwara - IEEE Trans MTT. 51:3: 966-971 reproduced Kuster's measurements

Local peak SAR at 900 MHz by Kuster et al., 1998

- **Antenna: 0.45λ dipole ; Antenna effective current : $I_a=100$ mA**
- *Fixed antenna current*
- **Almost constant antenna input impedance & insignificant variation on peak SAR (10g & 1g average)**

Dependence of SAR distribution on head properties: Child issue Effect of higher electric constants of infancy

- Finding of higher electric constants of infant rat
- (Peyman et al. Phys. Med. Biol. 2001)
- Higher conductivity can result in higher SAR
- **Wang and Fujiwara*** estimated electric constants of human 3- & 7- year-old children, assuming total body water explains the difference, & examined the effect on peak SAR
- ***Asia-Pacific Electromagnetic Field (EMF) Conference, Jan 2004, in Bangkok**

Dependence of SAR distribution on head properties: Child issue
Effect of higher electric constants of infancy

Derivation of Human Dielectric Properties

Biology data book, Washington DC, 1974

Klichtnecker's Exponential Law,

900 MHz, MRI Model for ϵ_r , σ [S/m] of Blood, Bone, Bone marrow, Cartilage, CSF, Dura, Vitreous humor, Fat, Parotid gland, Grey matter, Muscle, Skin, White matter, Mucous membrane, Lens, Cornea, Sclera, of 7 & 3 year old & Adult

Dependence of SAR distribution on head properties: Child issue
Effect of higher electric constants of infancy
Result of Wang and Fujiwara

- **Peak SAR [W/kg] Comparison --- 900 MHz**
- **1g average & 10g average**
- **With adult properties, With estimated child properties**
- **Almost no age effect on the peak SAR of dielectric properties**
- **From Wang and Fujiwara, Asia-Pacific Electromagnetic Field (EMF) Conference, Jan 2004, in Bangkok**

Dependence of SAR distribution on head properties: Child issue
Effect of higher electric constants of infancy
Wang and Fujiwara's Conclusion

- **Peak SAR in heads of adult v.s. children is mainly dependent on the antenna current which is determined by the antenna input impedance.**
- **Higher electric constants of children slightly increase SAR but the difference is not very significant**

Conclusion of SAR as a metric

- **Local SAR is a relevant metric:**
- **for thermal effect (though maximum temperature elevation does not necessarily appear at the same location as peak SAR)**
- **for both normal ear and pressed ear**
- **for both E & H fields: (Non thermal effects)**

Conclusion Dependence of SAR distrib'n on mobile phone classific'n

- SAR distributions are different for different phones
- They can be categorized into several classes, which correspond to different external view & specifications
- Penetration depth decreases for higher frequencies, which results in **significant difference in exposed volume in brain.**

Conclusion of ear effect

- SAR distribution is affected by the presence of lossy ear
- Maximum SAR in the head (not including auricle) is rather larger in the earless model than in the with-ear model
- Ear can increase the local SAR in some cases but not often
- Effect of phone position to head is much more significant than ear effect.

Wang and Fujiwara's Conclusion: Effect of higher electric constants of infancy:

- **Peak SAR in heads of adult v.s. children is mainly dependent on the antenna current which is determined by the **antenna input impedance**.**
- **Higher electric constants of children slightly increase SAR but the difference is not very significant**

Concluding remarks

- SAR can be used as a metric of exposure not only for thermal effect but also for non-thermal effect with some limitations
- SAR distribution and its maximum is dependent on various factors of **phones** & head properties
- Real exposure conditions are so complex but **characteristics of exposure are consistently understood by physics.**

- Ministry of Public Management, Home Affairs,
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