A CRITIQUE OF THE NEW ZEALAND REPORT:

"HEALTH AND SAFETY ASPECTS OF ELECTRICITY SMART METERS"

MARCH 4, 2014

EMFactsConsultancy

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Overview

During a trip to New Zealand in November 2013 for a series of public presentations on issues raised by the introduction of Advanced Metering Infrastructure (Smart Meters) I was given two pieces of literature on smart meters in New Zealand.

The first was copy of a statement titled "Smart Meters" issued by the Ministry of Health NZ in 2013.[1] This statement claimed, among other things, that smart meter emissions are low, when compared to the New Zealand radiofrequency standard (NZS 2772.1:1999) and that smart meters "only transmit periodically, using very brief signals." This second claim is patently incorrect and is of concern that the Ministry of Health could get this fact so wrong as even a brief look at the available information on how smart meters work clearly shows that they do emit "very brief signals" but that they are emitted constantly throughout a 24 hour cycle. This will be discussed later in this paper.

The second was a widely circulated report: *Health and Safety Aspects of Electricity Smart Meters* produced by New Zealand's Electric Power Engineering Centre (EPEC) at the University of Canterbury, Christchurch in 2012.[2] This report is now being circulated in New Zealand as evidence of the safety of smart meter technology. As the EPEC report claims to be addressing the health aspects of smart meter deployment in relation to the official radiofrequency exposure standard I address the following points:

1. The underlying assumption of smart meter safety based on emissions being well under the safety limits of the New Zealand RF standard NZ2772: Part1: 1999 – Maximum Exposure Levels – 3kHz to 300 GHz.
2. The downplaying of electromagnetic hyper-sensitivity (EHS) based primarily on the research of James Rubin.
3. The problem of averaging smart meter emissions over time (6 minutes) especially because of their unique characteristics.
4. Research recommendations to determine the extent of a possible public health risk from smart meters emissions.

Background

My interest in this controversy stems from my involvement in telecommunications standard setting since 1992. From 1998 to 2001 I was a member of the joint Standards Australia/New Zealand TE/7 Committee: Human Exposure to Electromagnetic Fields (Radiofrequency standards) which concluded in 2001. As the events that transpired in this committee lay at the very foundations of the current New Zealand RF standard, excerpts of my thesis chapter on this are in **Appendix A**.

From 2004 to 2009 I was enrolled in a PhD research program at the University of Wollongong, New South Wales, Australia. My area of research was examining the risk assessment process as it applied to the development and maintenance of Western telecommunications standard exposure settings. In 2010 my thesis, *The Procrustean Approach: Setting Exposure Standards for Telecommunications Frequency Electromagnetic Radiation*, passed external review and was accepted by the university.[3] The thesis examines the limitations of the health protection provided by the RF standards developed under the auspices of the Institute of Electrical and Electronic Engineers (IEEE C95.1), the RF

[1] Smart Meters, Ministry of Health, Manatu Hauora, Oct. 30, 2013, http://www.health.govt.nz/your-health/healthy-living/environmental-health/household-items-and-electronics/smart-meters
[2] Health and Safety Aspects of Electricity Smart Meters, EPEC, May 2012, http://www.epecentre.ac.nz/docs/media/ARC_Full_Final_02.pdf
[3] Available online at: http://www.emfacts.com/download/The_Procrustean_Approach.pdf

guidelines promoted by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the joint Australian New Zealand RF standard AS/NZ 2772.1:1998. Although not covered in my thesis, the U.S. Federal Communications Commission (FCC) RF exposure limits (under review) are largely based on the IEEE C95.1 recommendations, such as using specific absorption rate (SAR) limits as a primary metric for compliance. My understanding is that the FCC still uses the old C95.1 thermal limit of 1.6 W/Kg averaged over 1g while the current IEEE standard has increased its limit to 2.0 W/Kg averaged over 10g of body tissue to 'harmonize' with ICNIRP's RF guidelines. Thus, my criticisms of IEEE C95.1's limitations would also apply to the FCC RF limits which are mentioned in the EPEC report, although they are somewhat more cautious than the IEEE standard. As my thesis addresses the inadequacy of these RF exposure standards, which are often referred to as the basis for assurances of smart meter safety, the thesis abstract and overall conclusions are reproduced in **Appendix B**.

Point 1: The underlying assumption of smart meter safety based on emissions being well under the safety limits of the New Zealand RF standard NZ2772: Part1: 1999 – Maximum Exposure Levels – 3kHz to 300 GHz.

In my opinion there is no argument in the claim that smart meters emissions fall far below the above mentioned RF standard/guideline limits, including NZS 2772.1:1999. In this regard, the NZ Ministry of Health statement that "smart meter emissions are low, when compared to the New Zealand radiofrequency standard" is correct. However, this assurance is not followed up with a disclaimer that the limits are restricted to providing protection against well-known thermal effects (tissue heating in high-level (acute) exposure situations). Consideration of other possible biological effects unrelated to heating has not been taken into account in the actual setting of maximum exposure limits in the standard. Crudely put, all the NZ RF standard can assure the people of New Zealand is that they will not be internally heated up (cooked) by smart meter emissions. Nothing else.

A historical perspective on thermally based RF standards

The vast bulk of the historical research effort that serves as the basis of Western RF standards has focused on thermoregulatory studies (how the body handles excessive heat from RF exposure – a thermal effect) and the establishment of maximum exposure levels to eliminate excessive temperature increases. Much of this research consisted of exposing small laboratory animals to acute short term RF/MW to determine at what level of exposure their body's ability to dissipate heat (thermoregulatory) was breached. The results of these studies were then extrapolated to what was thought would happen to a human. Adair and Black (2003) have pointed out, however, that, *"these small animals are poor models for human beings because their physiological heat loss mechanisms are limited"*.[4] This was referring to thermal research (thermal effects) but in this admission the authors were effectively implying that the 'weight-of-evidence' for Western RF thermally based standards is based on a poor and inadequate data-base for human exposure.

Established adverse health effects

The definition of an "established adverse health effect" in thermally based RF standards standard is restricted to acute heating and electrostimulation (shocking) effects only. For example, in the IEEE C95.1 RF standard they are defined as (1) "adverse or painful electrostimulation due to excessive RF internal electric fields, (2) RF shocks and burns due

[4] E. Adair, D. Black, 'Thermoregulatory Responses to RF Energy Absorption', Bioelectromagnetics, Supplement 6 , 2003, pp. S17 – S38.
http://journals2.scholarsportal.info/details.xqy?uri=/01978462/v24is6/s17_trtrea.xml

to contact with excessively high RF voltages, (3), heating pain or tissue burns due to excessive localized RF exposure, and (4) behavioral disruption, heat exhaustion or heat stroke due to excessive whole body RF exposures. The IEEE standard states (in part) that, in their definition, adverse effects do not include: "biological effects without a harmful health effect [the above mentioned 4 effects]" and "changes in subjective feelings of well-being that are a result of anxiety about RF-effects or impacts." [5] This is an underlying unquestioned assumption of all thermally based RF standards, including New Zealand's.

Thus, as there are no thermal effects (acute exposure) associated with smart meter exposures, the assumption is made that all reported effects from smart meters must be the result of "changes in subjective feelings of well-being that are a result of anxiety about RF-effects or impacts", otherwise referred to as a Nocebo Effect. This is the viewpoint now being taken globally by authorities and other vested interests pushing for the introduction of the smart grid.

However, if one takes into consideration the body of available peer reviewed and published research, there has long been evidence that RF exposures well below that which causes tissue heating may cause non-thermal biological effects[6, 7]. For example, this was a concern in 1999 ofthe U.S. Radiofrequency Interagency Work Group (RFIAWG) , a governmental interagency committee working under the House of Representatives' Committee on Commerce. Even though this dates back to 1999, the concerns expressed then are still very relevant today.

Working group membership included the Food and Drug Administration (FDA), the Center for Device and Radiological Health (CDRH), the National Institute for Occupational Safety and Health (NIOSH), the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission (FCC)[8]. This working group expressed a significant difference of opinion over the adequacy of the thermally based proposed IEEE C95.1 standard revisions, compared to that of the (industry make-up) IEEE standard setting committee, the SCC-28 subcommittee. These differing expert opinions illustrated that differing scientific interpretations of the same scientific literature base varied considerably according to one's affiliations.

In June 1999 Gregory Lotz, representing NIOSH on the RFIAWG, presented the Chairman of the SCC-28 subcommittee IV a list of issues that RFIAWG considered needed to be addressed in the IEEE RF standard. This letter is reproduced in **Appendix C**. Many of these concerns equally apply to New Zealand's RF standard. A fundamental issue was the standard's failure to address chronic (low intensity/prolonged) as opposed to acute (high intensity/short term) exposures. This was seen in the proposed standard limiting the definition of an "adverse effect level" to only acute exposure situations and the use of time-averaged calculations that were not suitable for prolonged exposure situations, and therefore may not adequately protect the public. RFIAWG recommended that a clear rationale needed to be developed to also include chronic exposures. There was also a concern expressed about failure to include consideration of the body of research on the biological effects of exposure to ELF-modulated and pulse-modulated RF that was relevant to public exposures. No research has yet been done to clarify this concern.

[5] D. Maisch, The Procrustean Approach, p. 143, http://www.emfacts.com/download/The_Procrustean_Approach.pdf

[6] **"**Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter**",** eds.L Giuliani, M. Soffritti**,** *European Journal of Oncology*, Vol.5, 2010.

[7] The Bioinitiative Report, A Rationale for Biologically-based Public Exposure Standards for Electromagnetic Fields (ELF and RF), 2012, http://www.bioinitiative.org/

[8] E. Jacobson, Deputy Director, Center for Devices and Radiological Health, FDA Letter Regarding Cellular Phones, May 5, 1997, http://www.osha.gov/SLTC/radiofrequencyradiation/fda.html

To address these concerns the working group recommended a comprehensive review of long-term, low-level exposure studies that had relevance to environmental chronic occupational RF exposures and neurological-behavioural effects to better define the adverse effect level for RF.[9]

These concerns raised by the RFIAWG in 1999 are still valid and are directly relevant to smart meter emissions which, rather than being a continuous wave, pulse thousands of times over a 24-hour period of time. This is clearly seen in **Table 1**, taken from a document from Pacific Gas and Electric Co. where over a 24-hour period up to 190,000 transmission pulses can occur.[10] These are very brief but frequent transmissions, as seen in **Table 2**.

Table 1

Electric System Message Type	Transmission Frequency Per 24-Hour Period: Average	Transmission Frequency Per 24-Hour Period: Maximum (99.9th Percentile)
[a]	[b]	[c]
Meter Read Data	6	6
Network Management	15	30
Time Synch	360	360
Mesh Network Message Management	9,600	190,000
Weighted Average Duty Cycle	45.3 Seconds[4]	875.0 Seconds

Table 1 presents scheduled smart meter system messages and their durations. This is only for the 900Mhz smart meter transmitter radio and represents data for all scheduled messages that are required to sustain the mesh network communications.

As for the reason for all this activity, a 2013 report by Richard Tell Associates, states the following:

> Smart meters emit short duration pulses of RF energy in their communication with other meters and data collection points. These emissions generally happen all through the day. Besides the normal three (in the case of BED) or four (in the case of GMP) times a day that electric energy consumption data are reported back to a data collection point for subsequent transmission to the company, smart meters must maintain their organization within the RF LAN to which they belong and this necessitates the transmission of beacon signals from time to time. Additionally, each meter can, when required by the mesh network, assist neighbouring smart meters by transmitting the neighbour's data on to another meter or data collection point. Further, the HAN radio can produce pulsed fields in its search for and communication with IHDs. All of this means that most smart meters remain relatively active in terms of brief signals being transmitted.[11]

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[9] G. Lotz, RFIAWG, RF Guideline Issues: Identified by members of the Federal RF Interagency Work Group, June 1999, letter from Gregory Lotz to Richard Tell, Chair of IEEE SCC28 IV, www.emrpolicy.org/litigation/case_law/docs/exhibit_a.pdf

[10] Ref: Pacific Gas and Electric Co., http://emfsafetynetwork.org/wp-content/uploads/2011/11/PGERFDataOpt-outalternatives_11-1-11-3pm.pdf

[11] Richard Tell Associates, An Evaluation of Radio Frequency Fields Produced by Smart Meters Deployed in Vermont,: http://publicservice.vermont.gov/sites/psd/files/Topics/Electric/Smart_Grid/Vermont%20DPS%20Smart%20Meter%20Measurement%20Report%20-%20Final.pdf

As for what this might look like in a 'real world' situation, **Table 2** shows measurements taken outside, one metre from a smart meter on a suburban house in Melbourne, Victoria Australia.[12]

Table 2

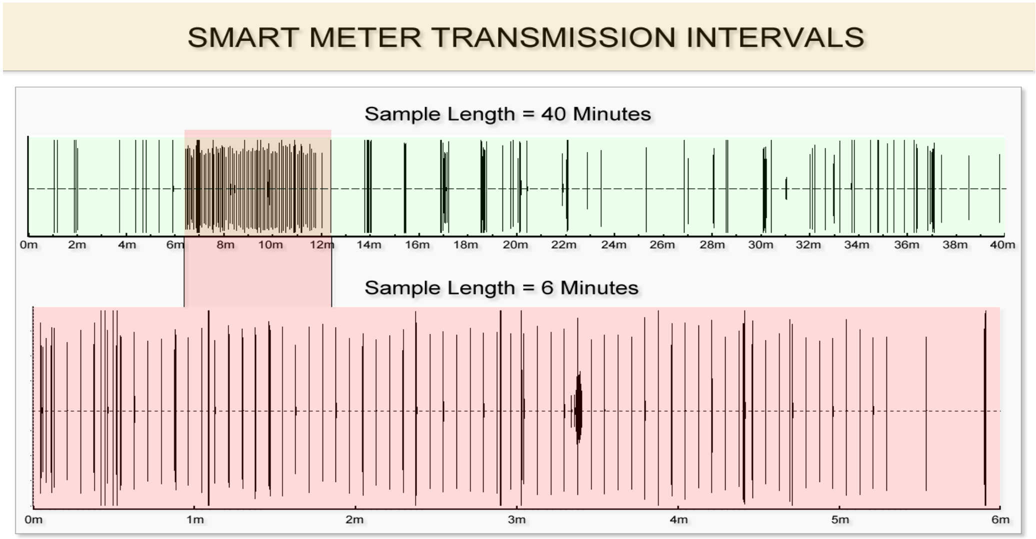

Table 3

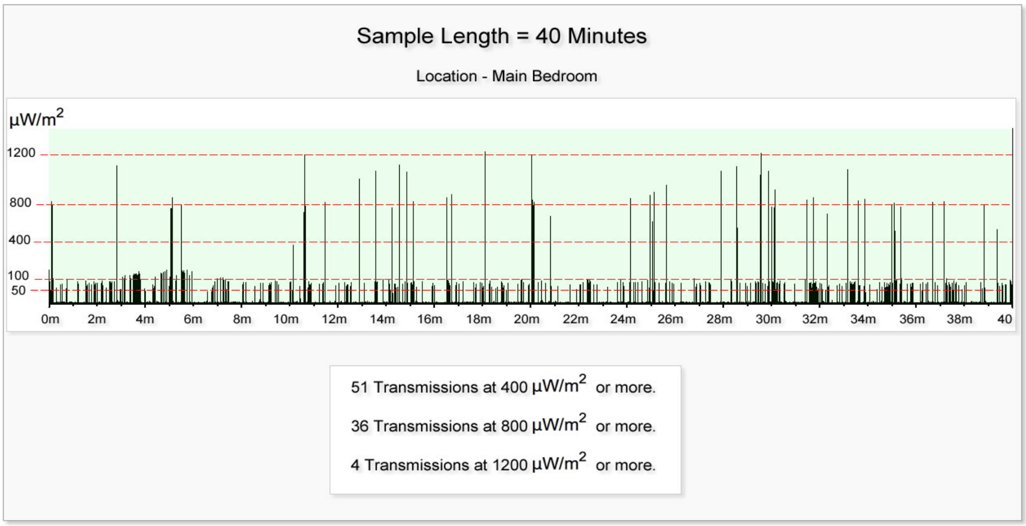

Table 3 shows the same house, this time with measurements taken by the bedhead in a bedroom adjacent to the smart meter. These levels are well below the New Zealand RF standard which is irrelevant to this situation.

This exposes as false the statement by the NZ Ministry of Health that smart meters only transmit periodically and raises a question about the quality of the advice being provided to the New Zealand government.

The 900 MHz frequency used in smart meters may also be an issue

Besides the constant pulsing of smart meter emissions there is the issue of the 900 MHz frequency range used. In 1976, Lin concluded that 918 MHz energy constitutes a greater health hazard to the human brain than does 2450 MHz energy for a similar incident power

[12] Using a Gigahertz Solutions HF 35C RF meter, January 2013. They are only meant to illustrate the frequent transmission intervals of the smart meter measured

density. In addition studies of diathermy applications consistently show that electromagnetic energy at frequencies near and below 900 MHz is best suited for deep penetration into brain tissue.[13] So a possibility exists that in situations where people are in close proximity to an active smart meter, the combination of the frequent transmission bursts at around 900 MHz constitutes a new and unique human exposure situation that may have unintended biological effects, especially on sleep.

The above information clearly suggests that with the widespread rollout of smart meters we may have a significant and new public exposure situation that lies outside the thermally protective parameters of the RF standards referred to previously. In my opinion it is unjustified for the EPEC report to refer to thermally restricted RF exposure standards as somehow inferring an unqualified safety for exposure to smart meter emissions.

Point 2: The downplaying of electromagnetic hyper-sensitivity (EHS) based primarily on the research of James Rubin.

On page 7 of the EPEC report acknowledgement is given over the possibility of electromagnetic hypersensitivity but this is then downplayed by the statement: *"However, there are also review papers from reputable sources highlighting a lack of consistency in such published findings".* The reference for this is given as simply [Rubin].

This is referring to provocation studies carried out by James Rubin et al. from King's College London, Institute of Psychiatry. Rubin has long been of the opinion that all cases of electrosensitivity are the result of a Nocebo effect and not from electromagnetic exposure.

His reason for dismissing any possible health effects from RF exposure has been reliance on the findings of specifically designed provocation studies to evaluate the reality of electromagnetic hypersensitivty (EHS). This type of study simply consists of exposing subjects who have identified themselves as electrosensitive to electromagnetic radiation (EMR) to see if they can feel when the field is turned on or off. These tests have generally found that the subjects failed to distinguish whether the field was present or not - leading to a conclusion by the researchers that the fields were not the cause of their reported symptoms and therefore the problem may be psychosomatic. Central to EMR provocation studies is the hypothesis that if a person is sensitive to EMR they should be able to feel when the exposure is taking place. If not, it must then be a psychological problem. For example, Rubin and colleagues reviewed over 40 provocation studies on EHS volunteers and concluded that, overall, people with EHS did not react to EMR exposure any differently from the way subjects react to a sham exposure. Thus, the authors suggested that EMR was not the cause of their condition.[14]

A significant weakness of provocation studies when applied to possible adverse health effects of EMR exposure, however, is that by their very design, they limit the definition of electrosensitive persons to those who claim that they can feel when they are being exposed. This definition excludes the possibility that there may be people who are adversely being affected by EMR exposure but cannot feel when they are being exposed. Such an assumption would quickly be rejected if it were applied to ionizing radiation. A significant problem in limiting subjects to people who claim to be affected by RF is that it

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[13] Marko Markov, Research International, Williamsville, NY,
USA & Yuri G. Grigoriev, Russian National Committee of Non-
Ionizing Radiation Protection, Moscow, Russia
http://www.viewdocsonline.com/document/6kn1ey

[14] Rubin, GJ, Electrosensitivity: A Case for Caution with Precaution,
http://archive.radiationresearch.org/conference/downloads/011555_rubin_extra.pdf

could include people who are influenced by the nocebo effect and thus skew the findings towards a null RF effect finding.

Rubin's work has come under extreme criticism from Dr. Andrew A. Marino, PhD, Director of Research at the Division of Sleep Medicine, Department of Neurology, Department of Cellular Biology and Anatomy, Louisiana State University Health Sciences Center at Shreveport, LA. Marino is known for not mincing his words, to quote:

> James Rubin, King's College London published a blindingly biased paper in which he argued that there was no such thing as electromagnetic hypersensitivity (no robust evidence). His numerous studies on electromagnetic hypersensitivity are all negative, but that negativity was manufactured by employing experimental designs and statistical analysis that were virtually guaranteed to produce negative results. By means of jaundiced analyses he comes to the conclusion that EHS sufferers have a purely psychosomatic disease, a viewpoint that has untold benefits for his clients and funders, particularly the cell-phone companies. His work is a scientific Ponzi scheme, in which he gets money from the phone industry effectively by promising negative results, creates and publishes such results, and is then rewarded by the industry with even more funds, like petting a trained dog. The natural consequence of his work is to stigmatize EHS sufferers as neurotics who need the care of a psychiatrist, not an internist or allergist. Rubin is almost a perfect example of a scandalous scientist in a scandalous system that consists of cell-phone companies having enough money to buy any results they want, dependable trained dogs who produce the desired results, and scientific journals such as *Bioelectromagnetics* that publish the results without properly vetting them, and without insistence on simultaneous publication of conflict-of-interest statements. [15]

On the Nocebo Effect

Central to the nocebo claim with the reported smart meter health complaints is the proposition that without a conscious pre-existing worry there would be no symptoms at all; it's all in the mind. With this viewpoint all the adverse smart meter health reports are simply the result of individuals from the uninformed public hearing or reading about the alleged health effects and then, when smart meters are rolled out in their neighborhood, they worry themselves sick. This would be in agreement with the IEEE's view that it's all just "changes in subjective feelings of well-being that are a result of anxiety about RF-effects or impacts."

It must be acknowledged that the nocebo effect (and its opposite, the placebo effect) are well recognized as real conditions[16]. For example, in tribal Australian aborigines the act of "pointing the bone" by a tribal shaman (a form of voodoo curse) at an accused wrongdoer has been known to cause death of the wrongdoer. The necessary element being that the accused person must believe in the power of the curse. Paul Martin's book, *The Sickening Mind: Brain, Behaviour, Immunity and Disease,* is replete with examples of the complex interplay between a person's state of mind and its effect on the immune system, and vice versa.[17] Considering the evidence, it is entirely possible that, with the widespread internet information available reporting on smart meter health hazards, some psychologically vulnerable people who have had a smart meter installed on their home will succumb to

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[15] A Marino, Five of the Top EMF scandals of 2011, http://andrewamarino.com/blog/?p=289

[16] J Stromberg, What Is the Nocebo Effect? smithsonianmag.com, July 23, 2012, http://www.smithsonianmag.com/science-nature/what-is-the-nocebo-effect-5451823/

[17] P Martin, *The Sickening Mind: Brain, Behaviour, Immunity and Disease*, Flamingo , 1998

worry and exhibit symptoms that are not related to exposure. This does not diminish the issue of smart meter adverse health effects but, as with all medical research involving humans, both the placebo and nocebo effect must be factored into the study criteria.

However, to assume that all reports of health effects from RF exposure are a nocebo effect, as Rubin does, is not good science, especially when the assumption is coming from individuals and organizations with a vested financial interest in promoting the technology.

In conducting population-based research on electrohypersensitivity (EHS), it's important to consider both the placebo and the nocebo effects. For this reason, in an Australian study on EMF exposure which examined residential exposures to mains-power magnetic fields (not RF) in a group of chronic fatigue patients, a decision was made before the start of the study not to include subjects who had any preconception that their illness might be caused by electromagnetic field exposure. In other words, none of the participants were worried about EMF, thus a nocebo effect was ruled out as far as possible. It was found that reducing "excessive" night-time ELF magnetic fields significantly improved fatigue symptoms and quality of sleep. Interestingly, one of the symptoms reported, tinnitus, especially at night, disappeared after removal of the source of exposure.[18, 19]

The absence of any nocebo effect was also seen in a WorkCare compensation case that took place in Melbourne in 1991–1992. In this case, a number of women who had worked in an office directly over an electrical substation had remarkably similar symptoms that ceased when they no longer worked in the area. None of the women had any idea that there were high power-frequency magnetic fields (not RF) in the office. Common symptoms were chronic tiredness/fatigue, insomnia, stress, increased susceptibility to viral infections, inability to concentrate, depression, facial rashes and headaches. One woman summed it up as "a permanent severe case of jet lag". [20]

The absence of a nocebo effect was suggested in a study of population effects of a short-wave RF transmitter facility at Schwarzenburg, near Berne, Switzerland. In the early 1990s, a study was conducted because of persistent health complaints in the population near the transmitters. The findings were "highly suggestive of a direct effect of the radio shortwave transmitter on sleep quality" (disturbances in falling asleep and maintaining sleep). Other effects found were restlessness, joint pain, disturbances in concentration, general weakness and tiredness. The researchers specifically looked for a nocebo effect, which they called "health-worry personality", but found no evidence of it. This was highlighted when the transmitter was turned off unexpectedly, unknown to the residents, in the middle of the study. Normal sleep patterns re-established until the transmitter was turned on again, at which point deterioration set in once more.[21]

The authors concluded that “our findings support a relationship between the operation of the radio transmitter under investigation and sleep disturbances in the exposed

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[18] D. Maisch, B. Rapley, J. Podd, Changes in Health Status in a Group of CFS and CF Patients Following Removal of Excessive 50 Hz Magnetic Field Exposure, *JACNEM*, Vol. 21 No. 1; April 2002: pages 15-19 http://www.emfacts.com/download/cfs_changes.pdf

[19] J. Podd, D. Maisch, Reducing EMF exposure improves sleep and reduces CFS symptoms, Poster presentation at the 2nd International Workshop on "Biological effects of Electromagnetic fields", 7-11 October 2002 , Rhodes, Greece. http://www.emfacts.com/download/Reducing50.pdf

[20] D. Maisch, D., (compiled) The Ross House Substation: Chronic Fatigue Syndrome (CFS) symptoms attributed to exposure to electromagnetic fields (EMF) due to proximity to an electrical substation, Workcare compensation case, Melbourne Victoria, 1991-1992, February 1999. Full report available upon request, Summary: http://www.emfacts.com/download/The_Ross_House_Electrical_Substation.pdf

[21] N. Cherry, Swiss shortwave transmitter study sounds warning, *Electromagnetics Forum*, Vol. 1, No. 2, Article 10, http://www.emfacts.com/forum/issue2/mag_9.html

population…From a public health perspective, our findings call for caution in exposing populations to EMF from short-wave radio transmitters."[22] Such advice would be a good public health policy when dealing with mass public exposure to smart meter emissions.

In my opinion the nocebo effect may be a factor in some smart meter health complaints but that this is a distraction from the likelihood that we are facing a significant public health risk that has not yet been investigated because of entrenched preconceptions.

Point #3: The problem of averaging smart meter emissions over time (6 minutes) especially because of their unique characteristics.

As is seen with Tables I, 2 and 3 smart meter emissions consist of many very brief transient spikes that are occurring constantly. However by averaging them over a period of time, say 6 minutes, these spikes will disappear, giving a very false impression of a much lower overall exposure. This is also not suitable for prolonged exposures, such as when a smart meter is positioned externally on a bedroom wall. In addition the use of averaging is only for thermal considerations[23], which as explained previously, is not the issue for possible smart meter health impacts. Also se Appendix C, page 19: **Issue: Time averaging.**

Point # 4: Research recommendations to determine the extent of a possible public health risk from smart meters emissions.

From a public health perspective, the suggestive evidence that smart meter RF emissions may be having an adverse health impact calls for an urgent research effort. Even if the number of affected people is small, the sheer number of people exposed represents a potentially significant public health risk. To dismiss this possibility simply as just a nocebo effect without undertaking a serious research effort is inexcusable. Even if it were eventually found that the reported adverse effects from smart meter exposure were simply the effects of worry (nocebo) the size of the numbers affected by worry should call for research specifically to address the reality, or otherwise, of their concerns. If it could be shown by specific sleep research that there was no effect on sleep patterns (the primary reported effect) that would go a long way to resolving public concerns. If, on the other hand, an effect on sleep was found and replicated, that would be another matter. For those with a vested interest in the technology this is a Pandora's Box. However, from a public health perspective this is a box that should be opened as a matter of urgency.

One way to proceed with this research is to take the "worst-case scenario"—when a bedhead is next to a smart meter on the outside of the wall—and design a study to determine if smart meter emissions affect sleep patterns. This should be done as a double-blind study through an independent sleep center with the testing facility and investigators having no present or former financial or employment ties with an industry sector that might be affected by the findings of the study. The importance of this is highlighted by the International Committee of Medical Journal Editors in their "uniform requirements" statement (in part):

> Financial relationships (such as employment, consultancies, stock ownership, honoraria, and paid expert testimony) are the most easily identifiable conflicts of interest and the most likely to undermine the credibility of the journal, the authors, and of science itself.[24]

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[22] http://www.ideaireland.org/2006.00%20Altpeter%20et%20al.pdf

[23] Foster KR, Lozano-Nieto A, Riu PJ, Ely TS, Heating of tissue by microwaves: a model analysis. *Bioelectromagnetics* 19: 420-428, 1998.

[24] The International Committee of Medical Journal Editors "uniform requirements" statement. http://www.icmje.org/ethical_4conflicts.html

The researchers could set up a sleeping room with a functioning smart meter close to the bedhead on the other side of the wall so that it is not seen by the participants. As it might be difficult to set up an operating smart meter in a laboratory situation, it may be easier to use an existing residence with a bed placed by an existing smart meter that has been modified to be able to be switched on and off at random times. Smart meter emissions would be confidentially recorded throughout the study, using suitable equipment to determine if there is a correlation between sleep patterns and emissions. Recruit healthy volunteers (equal numbers of males and females) to spend a few nights sleeping in the room, while collecting electroencephalogram (EEG) data to gauge sleep and brain wave patterns, etc. The smart meter source would be switched on and off for some of the volunteers, but neither the volunteers nor the people overseeing the experiment would know whether or not the smart meter was active or not. A questionnaire would also be used to assess subjective feelings such as depression, stress, anxiety levels and tinnitus, for example. A second part of the study would call for volunteers who claim to be affected adversely by smart meter emissions to see if their symptoms correlate with the times when the meter is emitting. A provocation study could be included here to see if these subjects can sense whether or not the meter is active while they are awake.

Most importantly, an independent oversight committee would be created for this research and include members from concerned community organizations, public interest groups and the medical fraternity. This would ensure that the eventual findings have been obtained without the influence of vested interests.

If at the end of the first part of the study the volunteers show no differences in sleep patterns, even when sleeping next to an active smart meter that would go a long way in assuring the public that smart meters are safe. If, on the other hand, clear differences in sleep patterns are seen, that would call for a re-evaluation of the current mass deployment of smart meter technology in New Zealand. It is inexcusable that to date, absolutely no research focusing specifically on possible smart meter health hazards has been conducted. It is a sad state of affairs that this research is avoided simply because the findings may constitute a risk to the deployment of AMI technology.

Conclusion

The EPEC report, *Health and Safety Aspects of Electricity Smart Meters*, purports to be a study of the potential health effects from exposure to smart meter emissions but is limited by its unquestioning conformity to the current New Zealand RF standard. This standard is only designed to provide protection against acute RF exposures of sufficient intensity to cause immediate thermal biological damage. It is not designed to address lower-intensity prolonged exposures with the potential to cause biological effects other than thermal. Thus, the EPEC report does not adequately examine what it claims to address. This may be due to a pro-smart meter bias on part of the Electric Power Engineering Centre and the Wireless Research Centre, both located at the University of Canterbury, Christchurch. This highlights the inadvisability of having an organization that is essentially promoting a technology investigating the possible health impacts of that technology.

Considering that the roll-out of smart meters will expose the vast majority of the New Zealand population to varying levels of a new and chronic exposure situation (pulsing 900 MHz in all homes) it is imperative that independently conducted research, with oversight, be carried out to determine the extent of risk to public health before any further roll-out of the technology.

Don Maisch PhD

Appendix A

A case study on ICNIRP Harmonization and the Australian (and New Zealand) RF exposure standard (Chapter 5 introduction and conclusion of *The Procrustean Approach)*

Introduction

The thermally based RF standard setting paradigm, originally established by the U.S. military in the 1950s, and embodied in the IEEE C95.1 standard revisions (Chapter 3), through to the current ICNIRP RF guidelines (Chapter 4), was the central issue of conflict in the development of the Australian and New Zealand RF standard. An examination of this development makes a convenient case study to further explore the restrictions placed upon the scientific risk assessment of RF bio-effects by vested interests working through standard setting committees.

A driving factor in the various revisions of the Australian and New Zealand RF standard from the 1970s to the 1990s was the introduction of new wireless technological innovations, operating at increasingly higher frequencies. In many cases these new devices operated with emission levels that were close to, or in excess of, the then current AUS/NZ RF exposure standard. This led to calls from both government and industry to relax (increase) the RF standard limits in order to assure compliance of new technologies with the RF standard. The fact that the standard was supposed to be health based, while very little research had been carried out on the possible health hazards at these higher frequencies, posed moral and ethical questions for the committee members charged with updating the RF standard. Did the benefits to society from the technology justify the possibility that some members of society may be placed at increased risk? Would public participation enhance the standard setting process? Should the telecommunications industry have inordinate influence in setting standards? As the government was a major share-holder of Telstra, the major Australian telecommunications company, and therefore a major benefactor of the roll-out of new wireless technology, would this bias its judgment on evaluating possible health impacts? Could agency scientists freely give advice without fear of repercussions if that advice ran counter to both government and industry corporate policy? In such a committee, made up of various stake holders with significantly differing views on hazard protection, was a consensus even possible?

To address the setting of RF exposure standards for both the workforce and general public, successive Australian federal governments had long relied on committees created and run under the auspices of the Standards Association of Australia, later renamed Standards Australia. In these committees scientific, industry and other professional experts, as well as community representatives in the later years, addressed the above questions in attempting to reach a consensus for a health based RF standard.

During this time the Commonwealth Scientific and Industrial Research Organisation (CSIRO) played an active role in the standard setting process, essentially acting in the public interest and recommending areas that urgently needed research. After the Standards Australia TE/7 Committee failed to reach a consensus and was wound up, the job of drafting the RF standard was taken over by the Australian Radiation Protection And Nuclear Safety Agency (ARPANSA). This Chapter will follow the above questions to determine what has been the impact of this complex interplay of stakeholders and the public participatory interests on the Australian RF standard setting process, and whether the final outcome reflects an unbiased understanding of the scientific literature.

The story of the development of the Australian RF exposure standard is intimately bound up with the involvement of the CSIRO from the very beginning in the late 1970's by Dr. David Hollway, up till October 2003 when CSIRO representative on the ARPANSA RF standard working group, Dr. Stan Barnett, resigned after consultation with CSIRO management because he saw no further benefit to CSIRO continuing its involvement in the RF standard setting process. The long involvement of CSIRO in the RF standard setting process was very much in the mould of the traditional role of government scientific advisers providing objective information to the policy makers, or as the turn of phrase goes, "speaking truth to power" even when that advice was counter to government policy. As this Chapter examines however, there were many other influences at work, quite unrelated to the scientific literature, which had a major impact in determining the eventual policy on RF exposure that was established by the Australian Radiation Protection & Nuclear safety Agency (ARPANSA) on behalf of the Australian government.

Chapter Conclusions

Ostensibly the task given to the original SAA committee and later the Standards Australia TE/7 Committee was to conduct a risk assessment on the available peer reviewed scientific literature for RF exposures and then draft a standard specifically for Australia (and New Zealand). However, two distinct and different risk assessments took place and by the time TE/7 was wound up, these proved to be irreconcilable. On one hand the CSIRO played a central role in critically examining all the available information, including the Russian literature and the more restrictive RF in-house standard set by the Applied Physics Laboratory at Johns Hopkins University. As a result David Hollway from the CSIRO took a more conservative risk assessment approach taking into consideration the possibility of hazards from low-level RF exposures not related to heating. This assessment was scientifically supported by a number of publications by CSIRO and former CSIRO scientists. Following CSIRO's lead, in the later TE/7 committee, a number of other standard committee members took a similar stance in their various written submissions to the committee. Their shared stand can loosely be termed as calling for a precautionary approach due to the many uncertainties and gaps in the literature. Some opposed the proposal to increase the limits to that of ICNIRP outright, while others indicated that they might support the increase, provided a strong precautionary statement was incorporated into the standard that acknowledged the level of uncertainty that existed in relation to low-level non-thermal exposures. On the other hand, the opposing assessment supported by the majority of committee members (the telecommunications industry, broadcasters, the military, allied professional bodies, including government representatives from the Australian Radiation Laboratory) was that the assessment promoted by ICNIRP (originally proposed by Repacholi in 1984, see Chapter 4, page 1) was sufficient. This was that the only health issue to address in standard setting was short-term effects due to the absorption of RF energy of sufficient power to heat up biological tissue. Their shared viewpoint was that the ICNIRP risk assessment was beyond question. This is seen in the TE/7 committee requirement that the only information they would consider in submissions was new scientific information not previously seen by the committee. Reanalyses of pre-existing data, such as referenced by ICNIRP was not to be considered. An example of the unwillingness to re-examine data was seen in a statement by David Black at a 2004 EMF Health Forum held in Hamilton, New Zealand on November 15, 2004. Black, a former TE/7 member and current consulting expert for ICNIRP, was replying to a criticism of another speaker who had incorrectly stated that the 1997 National Cancer Institute Linet study of 638 children with leukaemia was a negative study with no association with the disease and power-frequency EMF exposures. This writer pointed out that the higher exposed children in the Linet study did in fact have a positive association between leukaemia and EMF exposure but that these children had been removed from the analysis and so it was deceptive to claim, without this qualification, that no association was found. Black agreed that there was a positive association at a 3 milliGauss (mG) exposure level but then dismissed it by claiming that one must go with the published statements by the authors / journals for the purposes of standard setting. In this context this would suggest that one must take uncritically published statements used in standard setting regardless of their validity. This was apparently the case in TE/7 with those members wanting to approve ICNIRP Guidelines without qualification.

At the conclusion of TE/7 in 1999 the two opposing risk assessments could not be reconciled and the committee was concluded without approving the proposed ICNIRP based standard. This placed the Australian government in an unviable situation just when it was planning to sell off further parts of the electromagnetic spectrum in the microwave range to accommodate new technology as well as planning on selling more of its shareholdings in Telstra. With the failure of TE/7 to approve the draft ICNIRP based standard there was now no RF standard in force. In addition, the longer the stalemate continued the greater risk that the public would become increasingly concerned about possible health hazards from the technology. The task of drafting and approving an ICNIRP based standard was then given to a newly created agency, ARPANSA, which convened a Radiation Health Committee (RHC) to finish the task of drafting an ICNIRP based standard for Australia and therefore end the uncertainty.

Thus it is concluded that the long push to increase Australia's former RF exposure standard's limits had little to do with better science but all to do with the 'realpolitik' of pushing through ICNIRP's thermal–effects-only paradigm in order to advance economic interests. This situation belies the claim by ICNIRP chairman Paolo Vecchia that ICNIRP's advice was solely based on established health effects, with no consideration given for economic or social issues. The Australian experience was that the push to accept ICNIRP standards was, above all else, an economic imperative. This was borne out by essentially the same debate in the Czech Republic, examined in Chapter 4. The whole history of SAA, TE/7 and finally ARPANSA's RHC committee is one where CSIRO scientific advice to government was largely ignored in favour of economic considerations in government policymaking. This is compatible with Collingridge and Reeve's observations in their analysis of technical policy in which they concluded that the impact of science advice on rational government policy was negligible. They saw science advice as always being placed in either an "under-critical" or "over-critical" environment and in each situation science loses out. [124] In the case of RF standard setting and ICNIRP's attempted hegemony over science this is especially the case because both environments apply.

In an "under-critical" environment a policy paradigm (such as ICNIRP Guidelines) already exists and any scientific claims or research findings that appears to support the paradigm are easily accepted, such as by pro-ICNIRP-standards TE/7 members. In the "over-critical" environment adversaries are sharply divided over science claims and research findings (such as the existence of low level non-thermal bioeffects from RF exposures) are subjected to intense analysis and differing conclusions by opposing factions. This was very much the case with TE/7 where all research that was presented to the committee to support a precautionary approach to RF standard setting was summarily dismissed as it conflicted with ICNIRP. Collingridge and Reeve's observations about the fate of scientific advice in supposedly national government policy making is reflected by the actions of the Australian government in ignoring CSIRO's advice, and later silencing CSIRO altogether. The government's actions can be attributed to the fact that CSIRO advice ran counter to its economic policy to facilitate the roll out of telecommunications technology. This was the underlying theme that was played out in the final round of TE/7 meetings.

NOTE: After the conclusion of the TE/7 committee, New Zealand's representative on the committee (who had voted against accepting the ICNIRP's RF guidelines in TE/7) split off from Standards Australia and voted in favour if ICNIRP for NZ which gave New Zealand its current RF standard. The reasons for his change of heart are not known.

Appendix B

Abstract and overall conclusions from *The Procrustean Approach: Setting Exposure Standards for telecommunications frequency Electromagnetic Radiation*

Abstract: Since the 1950s there has been an ongoing controversy regarding the possibility of health hazards from exposure to non-ionizing radiation emissions from radiofrequency and microwave (RF/MW) sources ranging from military radar to telecommunications. In response to these concerns, and with support from the World Health Organization's International EMF Project (IEMFP) human exposure limits have been developed by the Institute of Electrical and Electronics Engineers (IEEE) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP). These limits, although differing in detail, are founded on the same scientific literature base and deem that the primary hazard to be considered in setting human exposure limits is thermal. This is defined as an excessive and harmful rise in body temperature as a consequence of exposure to high-level RF/MW emissions. This viewpoint has come to dominate the debate at an international level and is justified by these organizations as a product of expert risk assessments of peer reviewed data. The thesis challenges the validity of this viewpoint by critiquing regulatory risk assessment and the peer review and advisory processes that have shaped RF/MW regulation. It is shown that these processes have been prone to political manipulation and conflicts of interests leading to various scientific perspectives being marginalized with reluctance on the part of regulators to make decisions that might inconvenience industry interests. To substantiate these claims the thesis provides an assessment of the development of the American RF/MW standard from the 1950s and its later revisions under the IEEE, the ongoing development of guidelines and standards by ICNIRP and IEMFP and RF/MW standard development in Australia. The thesis concludes with the argument that, given the sheer number of people exposed to RF/MW from telecommunications devices, there is an urgent need to reform the standard setting process and to conduct an international re-assessment of the biological limits placed on current RF/MW standards.

Conclusions: The marginalization of criticisms of the validity of the thermal approach to RF standard setting has been an important issue raised in this thesis and is what I call the Procrustean Approach, where all scientific evidence not in conformity with the thermal bed of knowledge is simply cut off from consideration. Such a state of affairs has been maintained by the creation of restricted risk assessment methodologies, conflicted peer review and expert committees constituted primarily by individuals who have a vested interest in maintaining the status quo. This has been illustrated in this thesis by the analysis of the IEEE's peer review processes for accepting research papers for consideration in RF standard setting, the IEGMP/ICNIRP's risk assessment committees and the case study of the Australian RF standard setting process. In all three cases the problem of conflict of interest can be more accurately described as a majority shared interest in maintaining the status quo in standard setting for vested interest considerations… It is important to note that the concerns raised in this thesis also apply to other broader environmental debates where industry and other vested interests, following revisionist principles, have been able to influence the parameters for regulation of their activities. In this context, this thesis contributes to the debate over the role played by peer review and expert advisory committees by illustrating that these processes, far from being a source of unproblematic and objective expert advice, can be prone to conflict of interest and a biased interpretation of scientific information, as exampled herein by the RF controversy.

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Appendix C

DEPARTMENT OF HEALTH AND HUMAN SERVICES Public Health Service

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National Institute for Occupational
Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998
June 17, 1999

Mr. Richard Tell
Chair, IEEE SCC28 (SC4)
Risk Assessment Work Group
Richard Tell Associates, Inc.
8309 Garnet Canyon Lane
Las Vegas, NV 89129-4897

Dear Mr. Tell:

The members of the Radiofrequency Interagency Work Group (RFIAWG) have identified certain issues that we believe need to be addressed to provide a strong and credible rationale to support RF exposure guidelines.
I am writing on behalf of the RFIAWG members to share these ideas with you and other members of the IEEE SCC28, Subcommittee 4 Risk Assessment Work Group. Our input is in response to previous requests for greater partic ipation on our part in the SCC28 deliberations on RF guidelines. The issues, and related comments and questions relevant to the revision of the IEEE RF guidelines, are given in the enclosure. No particular priority is ascribed to the order in which the issues are listed.

The views expressed in this correspondence are those of the members of the Radiofrequency Interagency Work Group and do not represent the official policy or position of the respective agencies.

The members of the RFIAWG appreciate your consideration of our comments and welcome further dialog on
these issues. Feel free to contact me or any member of the RFIAWG directly. A list of the members of the RFIAWG is enclosed, with contact information for your use.

Sincerely yours,
W. Gregory Lotz, Ph.D.
Chief, Physical Agents Effects Branch
Division of Biomedical and
Behavioral Science

Enclosures (2)
cc: N. Hankin
J. Elder
R. Cleveland
R. Curtis
R. Owen
L. Cress
J. Heale

RF Guideline Issues

Identified by members of the federal RF Interagency Work Group, June 1999

Issue: <u>Biological basis for local SAR limit</u>

The C95.1 partial body (local) exposure limits are based on an assumed ratio of peak to whole body SAR; that is, they are dosimetrically, rather than biologically based. Instead of applying a dosimetric factor to the whole body SAR to obtain the local limits, an effort should be made to base local SAR limits on the differential sensitivity of tissues to electric fields and temperature increases. For example, it seems intuitive that the local limits for the brain and bone marrow should be lower than those for muscle, fat and fascia; this is not the case with the current limits which implicitly assume that all tissues are equally sensitive (except for eye and testicle). If no other data are available, differential tissue sensitivity to ionizing radiation should be considered.

If it is deemed necessary to incorporate dosimetric factors into the resulting tissue-specific SAR limits these should be based on up-to-date dosimetric methods such as finite-difference time-domain calculations utilizing MRI data and tissue-specific dielectric constants. For certain exposure conditions FDTD techniques and MRI data may allow better simulation of peak SAR values. Consideration should be given to the practical tissue volume for averaging SAR and whether this volume is relevant to potential effects on sensitive tissues and organs.

Issue: Selection of an adverse effect level

Should the thermal basis for exposure limits be reconsidered, or can the basis for an unacceptable/adverse effect still be defined in the same manner used for the 1991 IEEE guidelines? Since the adverse effect level for the 1991 guidelines was based on acute exposures, does the same approach apply for effects caused by chronic exposure to RF radiation, including exposures having a range of carrier frequencies, modulation characteristics, peak intensities, exposure duration, etc., that does not elevate tissue temperature on a macroscopic scale?

Selection criteria that could be considered in determining unacceptable/adverse effects include:

a) adverse effects on bodily functions/systems
b) minimal physiological consequences
c) measurable physiological effects, but no known consequences

If the adverse effect level is based on thermal effects in laboratory animals, the literature on human studies (relating dose rate to temperature elevation and temperature elevation to a physiological effect) should be used to determine if the human data could reduce uncertainties in determination of a safety factor.

Issue: Acute and chronic exposures

There is a need to discuss and differentiate the criteria for guidelines for acute and chronic exposure conditions. The past approach of basing the exposure limits on acute effects data with an extrapolation to unlimited chronic exposure durations is problematic. There is an extensive data base on acute effects with animal data, human data (e.g. MRI information), and modeling to address thermal insult and associated adverse effects for acute exposure (e.g., less than one day). For lower level ("non-thermal"), chronic exposures, the effects of concern may be very different from those for acute exposure (e.g., epigenetic effects, tumor development, neurologic symptoms). It is possible that the IEEE RF radiation guidelines development process may conclude that the data for these chronic effects exist but are inconsistent, and therefore not useable for guideline development. If the chronic exposure data are not helpful in determining a recommended exposure level, then a separate rationale for extrapolating the results of acute exposure data may be needed. In either case (chronic effects data that are useful or not useful), a clear rationale needs to be developed to support the exposure guideline for chronic as well as acute exposure.

Issue: One tier vs two tier guidelines:

A one tier guideline must incorporate all exposure conditions and subject possibilities (e.g., acute or chronic exposure, healthy workers, chronically ill members of the general public, etc.). A two tier guideline, as now exists, has the potential to provide higher limits for a specific, defined population (e.g., healthy workers), and exposure conditions subject to controls, while providing a second limit that addresses greater uncertainties in the data available (about chronic exposure effects, about variations in the health of the subject population, etc.). A greater safety factor would have to be incorporated to deal with greater uncertainty in the scientific data available. Thus, a two-tier guideline offers more flexibility in dealing with scientific uncertainty, while a one-tier guideline would force a more conservative limit to cover all circumstances including the scientific uncertainties that exist.

Issue: Controlled vs. uncontrolled (applicability of two IEEE exposure tiers)

The current "controlled" and "uncontrolled" definitions are problematic, at least in the civilian sector, particularly since there are no procedures defined in the document to implement the "controlled" condition. The new guidelines should offer direction for the range of controls to be implemented and the training required for those who knowingly will be exposed (e.g. workers), along the lines of the existing ANSI laser safety standards. This essential element needs to be included for whatever limits are defined, be they one-tier or two-tier. For example, the OSHA position is that the "uncontrolled" level is strictly an "action" level which indicates that there is a sufficiently high exposure (compared to the vast majority of locations) to merit an assessment to determine what controls and training are necessary to ensure persons are not exposed above the "controlled" limit. Many similar "action" levels are part of OSHA and public health standards. Should this interpretation be incorporated into the IEEE standard as a means to determine the need to implement a safety plan? [The laser standard has a multi-tiered (Class I, II, III, IV) standard which similarly requires additional controls for more powerful lasers to limit the likelihood of an excess exposure, even though the health effect threshold is the same.]

On the other hand, if it is determined that certain populations (due to their health status or age) are more susceptible to RF exposures, then a multi-tiered standard, applicable only to those specific populations, may be considered.

The ANSI/IEEE standard establishes two exposure tiers for controlled and uncontrolled environments. The following statement is made in the rationale (Section 6, page 23): "The important distinction is not the population type, but the nature of the exposure environment." If that is the case, consideration should be given to providing a better explanation as to why persons in uncontrolled environments need to be protected to a greater extent than persons in controlled environments. An uncontrolled environment can become a controlled environment by simply restricting access (e.g., erecting fences) and by making individuals aware of their potential for exposure. After such actions are taken, this means that the persons who previously could only be exposed at the more restrictive uncontrolled levels could now be exposed inside the restricted area (e.g., inside the fence) at controlled levels. What biologically-based factor changed for these people? Since the ostensible public health reason for providing greater protection for one group of persons has historically been based on biological considerations or comparable factors, it is not clear why the sentence quoted above is valid.

Issue: Uncertainty factors

The uncertainties in the data used to develop the guideline should be addressed. An accepted practice in establishing human exposure levels for agents that produce undesirable effects is the application of factors representing each area of uncertainty inherent in the available data that was used to identify the unacceptable effect level. Standard areas of uncertainty used in deriving acceptable human dose for agents that may produce adverse (but non-cancer) effects include

(1) extrapolation of acute effects data to chronic exposure conditions,
(2) uncertainty in extrapolating animal data to humans in prolonged exposure situations,
(3) variation in the susceptibility (response/sensitivity) among individuals,
(4) incomplete data bases,
(5) uncertainty in the selection of the effects basis, inability of any single study to adequately address all possible adverse outcomes.

If guidelines are intended to address nonthermal chronic exposures to intensity modulated RF radiation, then how could uncertainty factors be used; how would this use differ from the historical use of uncertainty factors in establishing RF radiation guidelines to limit exposure to acute or sub-chronic RF radiation to prevent heat-related effects?

There is a need to provide a clear rationale for the use of uncertainty factors.

Issue: Intensity or frequency modulated (pulsed or frequency modulated) RF radiation

Studies continue to be published describing biological responses to nonthermal ELF-modulated and pulse-modulated RF radiation exposures that are not produced by CW (unmodulated) RF radiation. These studies have resulted in concern that exposure guidelines based on thermal effects, and using information and concepts (time-averaged dosimetry, uncertainty factors) that mask any differences between intensity-modulated RF radiation exposure and CW exposure, do not directly address public exposures, and therefore may not adequately protect the public. The parameter used to describe dose/dose rate and used as the basis for exposure limits is time-averaged SAR; time-averaging erases the unique characteristics of an intensity-modulated RF radiation that may be responsible for producing an effect.

Are the results of research reporting biological effects caused by intensity-modulated, but not CW exposure to RF radiation sufficient to influence the development of RF exposure guidelines? If so, then how could this information be used in developing those guidelines? How could intensity modulation be incorporated into the concept of dose to retain unique characteristics that may be responsible for a relationship between exposure and the resulting effects?

Issue: Time averaging

Time averaging of exposures is essential in dealing with variable or intermittent exposure, e.g., that arising from being in a fixed location of a rotating antenna, or from moving through a fixed RF field. The 0.1 h approach historically used should be reassessed, but may serve this purpose adequately. Time averaging for other features of RF exposure is not necessarily desirable, however, and should be reevaluated specifically as it deals with modulation of the signal, contact and induced current limits, and prolonged, or chronic exposure. These specific conditions are discussed in a little more detail elsewhere. If prolonged and chronic exposures are considered to be important, then there should be a reconsideration of the time-averaging practices that are incorporated into existing exposure guidelines and used primarily to control exposure and energy deposition rates in acute/subchronic exposure situations.

Issue: Lack of peak (or ceiling) limits for induced and contact current

A recent change in the IEEE guidelines allows for 6 minute, rather than 1 second, time-weighted-averaging for induced current limits. This change increases the concern about the lack of a peak limit for induced and contact currents. Will the limits for localized exposure address this issue, i.e., for tissue along the current path?

Issue: Criteria for preventing hazards caused by transient discharges

The existing IEEE recommendation states that there were insufficient data to establish measurable criteria to prevent RF hazards caused by transient discharges. If specific quantitative criteria are still not available, can qualitative requirements be included in the standard to control this hazard (e.g., metal objects will be sufficiently insulated and/or grounded, and/or persons will utilize sufficient insulating protection, such as gloves, to prevent undesirable transient discharge.)?

Issue: Limits for exposure at microwave frequencies

Concerns have been expressed over the relaxation of limits for continuous exposures at microwave frequencies above 1500 MHz. The rationale provided in the current guideline (Section 6.8) references the fact that penetration depths at frequencies above 30 GHz are similar to those at visible and near infrared wavelengths and that the literature for skin burn thresholds for optical radiation "is expected to be applicable." The rationale then implies that the MPE limits at these high frequencies are consistent with the MPE limits specified in ANSI Z136.1-1986 for 300 GHz exposures. This is apparently the rationale for "ramping up" to the MPE limits for continuous exposure of 10 mW/cm^2 at frequencies above 3 GHz (controlled) or 15 GHz (uncontrolled). The rationale should be given as to why this ramp function has been established at relatively low microwave frequencies (i.e., 1500 MHz and above), rather than being implemented at higher frequencies that are truly quasi-optical. For example, one option could be two ramp functions, one beginning at 300 MHz, based on whole- or partial-body dosimetry considerations, and another at higher frequencies (say 30-100 GHz) to enable consistency with the laser standard. Such a revision should help reduce concern that the standard is not restrictive enough for continuous exposures at lower microwave frequencies where new wireless applications for consumers could make this an issue in the future.

Issue: Replication/Validation

Published peer-reviewed studies that have been independently replicated/validated should be used to establish the adverse effects level from which exposure guidelines are derived. The definition of "replicated/validated" should not be so restrictive to disallow the use of a set of reports that are scientifically valid but are not an exact replication/validation of specific experimental procedures and results. Peer-reviewed, published studies that may not be considered to be replicated/validated, but are well done and show potentially important health impacts provide important information regarding uncertainties in the data base used to set the adverse effect level (e.g., incomplete data base).

Issue: Important Health Effects Literature Areas:

Documentation should be provided that the literature review process included a comprehensive review of the following three areas:

1) long-term, low-level exposure studies (because of their importance to environmental and chronic occupational RFR exposure);
2) neurological/behavioral effects (because of their importance in defining the adverse effect level in existing RFR guidelines); and
3) micronucleus assay studies (because of their relevance to carcinogenesis).

Issue: Compatibility of RFR guidelines

Compatibility of national and international RFR guidelines remains a concern. It is important for the IEEE Committee to address this issue by identifying and discussing similarities and differences in a revised IEEE guideline and other RFR guidelines.
Compatibility/noncompatibility issues could be discussed in the revised IEEE guideline or as a companion document distributed at the time the revised IEEE guideline is released to the public.