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**RE: Review of the thesis "Evidence Based Rationale for Standards Providing Protection for Human Populations against Health Effects of Ultra High Frequency Radio-Frequency"**

Dear Sue

Thank you for your request for me to undertake a formal review of the MD thesis by Dr. David Black, which was written through Auckland University, New Zealand and approved in 2009. I note that in the writing of the thesis "generous support" was provided by Cable & Wireless Ltd., London. Dr. Black's thesis consists of a recollection of his involvement in setting radiofrequency and microwave (RF/MW) human exposure standards in New Zealand, Australia and internationally. I find this thesis particularly interesting because I have previously been involved in the Standards Australia RF/MW standards committee in the late 1990s with Dr. Black and have written a thesis on the same topic, titled, "The Procrustean Approach: Setting Human Exposure Standards for Telecommunications Frequency Electromagnetic Radiation (2009)[1]. This was through the University of Wollongong, NSW, Australia.

Although Dr. Black and I were ostensibly examining the same topic, the development of RF/MW human exposure standards, our respective analyses differ significantly. While Black sees this development as an unproblematic advancement of sound science that provides adequate public health protection, I have focused on the involvement of vested interests (corporate and military) in standards development and how this has significantly compromised public health protection by excluding from consideration scientific evidence that threatens the economies of those interests. I called this "The Procrustean Approach", referring to RF standards where a strict scientific conformity is demanded. With this approach, any scientific data which question the validity of the standard are rejected from consideration because they run counter to strongly held preconceptions that lay at the very foundation of the standard rationale. Unfortunately, as my thesis contends, it is this approach that typifies most RF standards today.

Before delving into the content of Black's thesis it is necessary to first examine the elements that need to be included in a university thesis. The University of Auckland defines a thesis as a written report of a research study undertaken in fulfillment or partial fulfillment of a graduate degree such as a doctorate (PhD) or a Doctor of Medicine (MD). It is stipulated that the research undertaken "must meet international standards for such scholarly research", and "should demonstrate a capacity for independent thinking and should also contribute to existing scholarship".[2] Contributing to existing scholarship means the thesis should be advancing an original point of view as

[1] D. Maisch, The Procrustean Approach: Setting Human Exposure Standards for Telecommunications Frequency Electromagnetic Radiation (2009), http://www.emfacts.com/the-procrustean-approach/ .
[2] University of Auckland, Guide To Theses And Dissertations, Graduate Centre, Nov. 2004, www.postgrad.auckland.ac.nz .

a result of the candidate's research – new understandings which would contribute to the body of knowledge in an area of inquiry. If the topic of examination is the RF standard setting process then a new or novel angle should be presented. Ideally this should be something that will enhance the process that has not previously been given consideration. Another important part of a thesis is to examine other competing viewpoints that may be at odds with the hypothesis being proposed by the candidate. The candidate may not agree with the other viewpoint(s) but needs to show why his or her thesis is a more valid position.

It is usually essential that a university level thesis has a supervisor, who ensures that the candidate stays on course and eventually produces a scholarly piece of work that conforms to what is expected by the university. For example, in the University of Auckland's *Guide To Theses And Dissertations* it is stated, "You will not be able to commence/complete a thesis or dissertation without a supervisor." However, at the time of Black's enrolment for a Doctor of Medicine (MD) degree, his thesis was allowed to be unsupervised and such a degree is usually based on the candidate's clinical research work, either conducted at the university or externally.[3] This rule has since been changed and all MD degrees now must be supervised.[4]

Considering the above, Black's thesis would have to be based on his own clinical research relevant to RF exposure and/or RF standards development that has contributed new knowledge to add to the understanding of how to provide safety for the public in RF/MW standard setting. It would not be sufficient just to go over old ground – something new and original needs to be the focus of the thesis. It is an essential requirement that at least one of these elements be fulfilled in order to meet international standards for such scholarly research.

It is a usual requirement that a university level thesis has page footnotes. In the University of Auckland's *Guide To Theses And Dissertations* instructions are given on the proper way to add footnotes on each page of a thesis[5]. Obviously this is to aid the reader in verifying information in the thesis. They are important signposts to verify the sources of quotations and statistical data, facts not generally known on the subject, and all opinions and interpretations not those of the author, whether quoted, paraphrased or summarized.[6]

The final and essential part of the body of a university level thesis is the conclusion, which is usually what a reader may look at first and which leaves a final impression on the reader. It is where the candidate should concisely state the importance and originality of his or her thesis argument and should be the best part of the thesis.[7]

Considering the above, on a number of counts, Dr. Black's appears to fall short of a standard that would normally be expected for a university thesis.

- Black's thesis does not contain any clinical research findings from research that he has conducted and apparently he has no published papers in this area. Therefore

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[3] ibid, p.22

[4] Email correspondence from Grant Wills, Executive Officer, Office of the Vice Chancellor, Auckland University, to Sue Grey, July 7, 2011.

[5] University of Auckland, Graduate Centre, Guide to Theses and Dissertations, Nov. 2004. http://www.auckland.ac.nz/webdav/site/central/shared/for/current-students/postgraduate-students/documents/policies-guidelines-forms/guide-to-theses-dissertations.pdf

[6] Princeton University, Sept, 2010. Thesis guidelines, http://www.princeton.edu/history/undergraduate/thesis_guidelines/#footnotes

[7] R. Holewa, Strategies for Writing a Conclusion, Feb 19, 2004, http://leo.stcloudstate.edu/acadwrite/conclude.html, Accessed July 27, 2011

the strength of his thesis should be based on his contribution of new knowledge to the RF standard setting debate.

- The central discussion of RF standards development in Black's thesis is not original and appear to be primarily based on the 12 RF review papers published in *Bioelectromagnetics 24, Supplement 6*, 2003 (see Appendix A), all of which are referenced in his thesis and which he had some involvement with. His thesis therefore adds no new knowledge to the standards debate and is limited to arguing that the current RF standard setting approach embodied in the ICNIRP RF Guidelines [8] and the IEEE/ICES[9] RF standard is adequate for public health. These guidelines/standards claim the only adverse biological effect from RF exposure (other than direct contact with a conducting surface) is tissue heating at high intensity (acute) exposure levels. On this basis, the standard limits are based on preventing excessive tissue heating that would exceed the human body's ability to rid itself of excess heat. This is termed a thermoregulatory response and has served as the basis for 'Western' standards since the late 1950s. Considering this, a thesis that limits its argument to defending a pre-existing premise cannot be considered as meeting the usual requirements for a university thesis unless it introduced new arguments/evidence to strengthen that premise.

- Black did not use footnotes in his thesis but instead noted authors and dates for referenced papers in the body of the text. This makes it difficult to verify the source for many of the statements and claims made in the body of the thesis.

- As a necessary requirement to be thorough, a thesis should examine in some detail all significant opposing viewpoints. The writer may strongly disagree with these viewpoints but needs to show in a scholarly, well referenced way why his or her thesis argument is superior to these opposing views. Black's thesis has a small reference base consisting of 155 references and is largely focused on papers that support his viewpoint that the only biological effect of RF exposure is thermal (heating) resulting from acute exposures. The thesis fails to mention a huge literature base that does not support that contention. For example, no mention is made of either the concerns raised by US government's Radiofrequency Interagency Work Group (RFIAWG - 1999) (Appendix B) or the Bioinitiative Report (2007) both of which Black would have been well aware of. For example, the Bioinitiative Report consists of a literature review of over 2,000 studies. The purpose of this report was to document scientific information that the authors considered directly relevant to address the inadequacy of existing exposure standards for both extremely low frequency (ELF) and RF. The authors examined what they considered to be the limitations and deficiencies in both the ICNIRP Guidelines and the IEEE/ICES RF standard[10]. As the Bioinitiative Report is diametrically opposed to Black's thesis arguments, it should have been critiqued and then reasons given to discount its importance, in Black's estimation.

  In addition to the above, there is another very relevant committee report by the US National Research Council that was published in 2008, a year before Black submitted his thesis in 2009 but was not referred to in the thesis. This report, titled, "Identification of Research Needs Relating to potential Biological or Adverse Health Effects of Wireless Communication Devices", was based on the

[8] The International Commission on Non-Ionizing Radiation Protection.
[9] The Institute of Electronic and Electrical Engineers and its RF standard setting committee the International Committee on Electromagnetic Safety.
[10] C. Blackman, M. Blank, M. Kundi, C. Sage, D. Carpenter, Z. Davanipour, D. Gee, L. Hardell, O. Johansson, H. Lai, K. Hanson Mild, Z. Xu, G. Chen, A. Sage, '*Bioinitiative report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*, released Aug. 31, 2007. http://www.bioinitiative.org

evidence presented at a workshop organized by the National Academies in August 2007.[11] The report from the outcomes of this workshop draws a number of conclusions that are at odds with a number of claims made by Black in his thesis. It is available as a free download at: **http://www.nap.edu/catalog/12036.html** (See Appendix C for a few selected quotes from the report).

As it is, Black's failure to include and critique the alternative views of the Bioinitiative report, the RFIAWG concerns, and the NRC report in his thesis significantly weakens the strength of his argument.

- Inexplicably, Black's thesis does not have a conclusion, in fact the final chapter is irrelevant to the topic of the thesis (See Comment #34). Without a conclusion the thesis is incomplete.

- Considering that there is no conclusion to Dr. Black's thesis I have quoted below what I consider to be the relevant points (to RF standards and human health) of the thesis. My comments to these points follow the relevant quote. Respecting copyright restrictions I have limited my direct quoting to a few sections that I consider most relevant, although my comments often apply to other sections as well.

**From the thesis:**

**Abstract**

**DB:** During the last 20 years the unprecedented and rapid deployment of mobile communications systems using ultra high frequency (UHF) radiofrequency energy (RF) has created a need for reliance on safety standards to ensure public and worker health. The standards already existed in their first generation but had not anticipated the ubiquitous use of radio frequency throughout communities. Many, if not the majority of concerns which rose rapidly related to health effects particularly on the basis that UHF RF energy seemed to be new and poorly understood. The provision of medical input into the development and application of standards could not proceed without correcting these misunderstandings, a process which has had to be applied to the medical profession, the legal profession and the judiciary and the makers and regulators of the environmental law. The established effects of RF energy at UHF are, according to current evidence based knowledge, limited to those caused by heating consequent on electric current circulating in tissue as a result of induced or conducted internal fields. These fields are usually the resolution of external fields encountering conductive tissue. Typical public exposure from a modern mobile telephone and from mobile phone base transmitter stations (BTS) is very low compared to that from previously common sources such as radio and television transmitters.

**Comment 1:** Although public exposures from a mobile phone base station can be lower than from radio and TV transmitters, this statement is not correct for the use of mobile phones. The exposure to the head when using a mobile phone is significantly higher than that from a radio or TV transmitter, which are usually located distant from built up urban areas.

Third generation RF Standards, which have evolved since 1990, take into account all known biological and health effects of RF. Whilst there remain hypothetical mechanisms by which RF could act on biological systems not yet understood or covered by

[11] NRC, *Identification of Research Needs relating to Potential Biological or Adverse Health Effects of Wireless Communication Devices*, The National Academies Press, Washington D.C. 2008

standards, from a public health perspective the current approach to health protection from RF exposure is adequate and indeed high compared to measures regarded as acceptable for other agents known to have significant health impacts.

**Comment 2:** This paragraph is arguable on a number of points:

- Referring to "all known biological and health effects of RF" is actually limited to a consideration of thermal biological damage as a consequence of high intensity short term exposures. Possible Non-thermal effects resulting from chronic low intensity situations are excluded from consideration in the RF standards. It is arguable that this limitation is adequate from a public health perspective, especially considering the concerns raised by the US government's Radiofrequency Interagency Work Group (RFIAWG) to the IEEE standard setting committee in 1999 (Appendix B),and the U.S. National Research Council's 2008 report on RF research needs (Appendix C).

- Black is incorrect in his comparison with standards for other hazardous agents. Acceptable measures to protect public health from other agents that are known to be hazardous, (e.g. asbestos, dioxin, benzene, etc.) are not limited to providing protection based on acute short-term exposures to the agent, which is the case with RF. This was examined in *The Procrustean Approach*, under the section "Risk assessment for chemicals reversed for non-ionizing electromagnetic radiation".

> "It is important to note that when it comes to risk assessment that serves as the basis for Western radiofrequency and microwave (RF/MW) standards there is a fundamental departure from conventional risk assessment as used for chemicals. In their 1995 review of risk assessment of environmental chemicals, Fan, Howd and Davis point out that when assessing human exposure to chemicals, environmental levels are the focus. In other words, protecting the public from toxic effects of chemicals in the environment involves consideration of possible mechanisms of low-level toxicity and likely biological effects at low levels of exposure. In addition, the potential for cumulative (long-term), irreversible effects, such as cancer induction and neurotoxicity, are important considerations. There may be debate over what is the lowest level at which a hazard from a chemical may exist, but calculations are aimed at determining the lowest-dose toxic effects to provide human health protection. The obvious adverse effects from high-level exposures are not usually a focus of risk assessment as there is no uncertainty on hazards at high-level exposure.[12] Just the reverse applies to the risk assessment of possible hazards from human exposure to non-ionizing radiation from extremely low frequency (ELF) electromagnetic fields (EMF) to RF/MW electromagnetic radiation (EMR). In this case public health protection is limited to providing protection from obvious adverse effects at high-intensity (acute) exposures unlikely to be encountered in the environment. The possibility of cumulative effects, cancer induction and neurological effects arising from low-intensity exposures that could be encountered in the environment are not a consideration in assessing human health risks for ELF and RF. This has been pointed out in a Swiss government agency publication

[12] A. Fan, R. Howd, B. Davis, 'Risk Assessment of Environmental Chemicals', *Annual Review of Pharmacology and Toxicology*, vol. 35, 1995, p. 341-368.

Electrosmog in the Environment where it is stated "Exposure limit values [in Western standards/guidelines] ensure protection against recognised, acute effects, but they do not protect against suspected effects at lower radiation intensities, especially with long-term exposure".[13] It has been suggested by this writer that such a radical departure from accepted risk assessment practice is based on reasons that primarily are to ensure the continuing development of both corporate and military technology at the expense of public health considerations.[14] This viewpoint is in agreement with Michaels & Monforton in their observations that both corporate and a revisionist political influence in the risk assessment process has affected the outcome of supposedly scientific risk assessments to marginalize the interests of the public, while at the same time maximizing the influence of the vested interest corporate sector. [15]

The Standards can also be used for the protection of other species.

[Referring to the final chapter of the thesis, see Comment # 34 ]

The next generation of RF standards, which will not be in common use for at least 10 years, will use more elegant and accurate methods of estimating internal fields but are unlikely to have thresholds which are significantly different to those in use now.
(End of abstract)

**DB:** Soviet standards setting therefore required research to provide evidence of the lowest level at which any effect could be detected, a question which was receiving substantial attention throughout the world, East and West. (p. 41)

**Comment 3:** The issue of the differing Soviet standard methodology should have been examined further in the thesis and not just briefly mentioned in passing, especially as Black acknowledged that it was receiving "substantial attention" internationally. It should have been explained why there was this attention. There are a number of essential books on the differing Soviet RF standard setting methodology, none of which are referenced in Black's thesis.[16]

**DB:** The current methodology of the RF standards "depends on acceptance that energy transfer which is only observable or measurable as eventual [heat] dissipation is the only reliable and reputable benchmark for protection…(P. 41)

**Comment 4:** In August 1995, Dr. Ross Adey, who was one of the worlds leading researchers in bioelectromagnetics up to his death in 2005 [17] supplied a statement to the office of Senator Robert Bell as part of a Senate inquiry. He expressed a different viewpoint to that of the above:

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[13] Swiss Agency for the Environment, Forests and Landscape (SAEFL), Electrosmog in the environment, June, 2005, p.17. http://www.scrutiny.gov.je/documents/docs/34102-13793-1912007.pdf , Accessed April 12, 2007.
[14] D. Maisch , op. cit.
[15] Michaels, Monforton, 2005.
[16] N. Steneck, *The Microwave Debate*, MIT Press, 1984; Presman A., *Electromagnetic Fields And Life*, Plenum Press, 1970; Marha, K., Musil, J., Thua, H., *Electromagnetic Fields And The Life Environment,* San Francisco Press,1971.

[17] IN MEMORIAM, William Ross Adey, M.D.,Professor of Anatomy and Physiology, Los Angeles, 1922–2004http://www.universityofcalifornia.edu/senate/inmemoriam/williamrossadey.htm

> The laboratory evidence for athermal [non-thermal] effects of both ELF and RF/Microwave fields now constitutes a major body of scientific literature in peer-reviewed journals. It is my personal view that to continue to ignore this work in the course of standard setting is irresponsible to the point of being a public scandal. Please be advised that the U.S. National Council on Radiation Protection and Measurements (NCRP) has recently established a committee with the sole mandate of reviewing the role of modulation effects with health implications, in conditions where athermal exposures are paramount. Committee 53 of NCRP published its report 86 in 1986 and drew attention to the potential importance of ELF modulation patterns in determining health related effects. Indeed, the very existence of modulation frequency-dependent effects bespeaks athermal interactions.[18]

These very concerns were later expressed by the U.S. government's Radiofrequency Interagency Work Group (RFIAWG – Appendix B). In June 1999, Gregory Lotz, representing the National Institute for Occupational Health & Safety (NIOSH) and RFIAWG, presented to the Chairman of the IEEE's SCC-28 Subcommittee, drafting a revision to the C95.1 RF standard, a list of issues that RFIAEWG considered needed to be addressed in the standard. In particular, RFIAWG criticized the biological rationale of the standard [IEEE C95.1] on a number of fronts. A fundamental issue was the standard's failure to address chronic (low intensity/prolonged) as opposed to acute (high intensity/short term) exposures. In order to address this, and other concerns, RFIAWG recommended a comprehensive review of long-term, low-level RF exposure studies that had relevance to environmental chronic occupational RF exposures and neurological/behavioural effects to better define the adverse effect level for RF, and micronucleus assay studies with relevance to carcinogenesis.[19]

The issues raised by RFIAWG were ignored by SCC-28 in its revised RF standard and also in the series of papers subsequently published in Bioelectromagnetics, Supplement 6 (2003 – Appendix A). These papers laid out what the committee considered were 12 "guiding principles" for RF standard setting. Dr. Black references all of these papers in his thesis but mentions nothing of the concerns raised by the RFIAWG that he surely would have been aware of.

So, it can be argued that the claim that thermal effects (heat dissipation) is the only "reliable and reputable" benchmark for protection" is not based on an objective evaluation of the available scientific literature but on a selective review of papers (Bioelectromagnetics Supplement 6 - 2003) that were written to support the thermal basis for the IEEE/ICES RF Standard, and equally the rationale for ICNIRP's RF guidelines as well.

**DB:** Modern standards such as those derived from the ICNIRP or IEEE approach generally protect against adverse health effects, or indeed any perceptible biological effects, resulting from all known mechanisms…(p. 50)

**Comment 5:** As per previous comments.

**DB:** The third group are the remaining standards [apparently referring to Russian and some other Eastern European RF standards] most of which purport to have their origins

[18] Correspondence with Ross Adey, July/August 25, 1995.
[19] D. Maisch, 2009, op. cit. pp. 128 - 129

in "alternative" research, often politically inspired. These Standards often have several features which provide important demarcation. Most importantly, many carry the concept of dose time integration much further [considering possible cumulative effects from exposure], by specifying this in a manner which is characteristic of agents where there is known to be a "body burden" effect, such as is found with some chemicals which are retained, or a dose time integrated damage characteristic of agents such as noise. There is no evidence that such an effect occurs with RF exposure. Such documents justify their approach by arguing for the methodology as a protective measure in case such an effect was found in the future. (page 51)

**Comment 6:** To state that there is no evidence of cumulative effects for RF exposure is a very debatable claim. For example, in the Russian RF standard limits, which are significantly lower than those set by ICNIRP and IEEE, the possibility of cumulative effects, especially for reproductive and genetic effects was taken into account.[20] The Russians' consideration of cumulative effects was not based on ideas, hypotheses or political inspirations but on an extensive database consisting of actual observed effects on humans working with RF technology.[21] [22] [23]

**DB:** In recent times there are a further group of standards appearing sporadically, sometimes issued by local authorities, usually as a political gesture in response to public concerns. These standards, or "pseudo standards" as they are most appropriately described are usually set at small fractions of international guidelines, and they are marketed on the basis that they provide added protection for communities. However, there is no evidence of real health benefit, and in reality they are still complied with although with no alteration to technology because real world levels are so much lower than the internationally agreed standards in any event. (p. 52)

**DB:** Thus, for a standard to provide general public protection it would, by definition, have to protect the most vulnerable identified member of that population. The only exception to this, in general terms, might be an individual who is truly hypersensitive and therefore is not a contiguous member of any spread of dose response found in the population at large. This is a difficult and contentious issue when it occurs, but for RF there is no scientific confirmation of physiologically hypersensitive individuals. (p. 56)

**Comment 7:** Scientific confirmation is not the same as scientific evidence. The Bioinitiative report goes into the evidence on this issue in some detail. Black is correct in his claim that the issue is contentious but does not follow through with a fuller discussion of this potentially informative topic. For example, he could have examined the psychosomatic vs. physiological debate in relation to RF hypersensitivity. This would have been appropriate in a MD level thesis.

**DB:** Recent experiments using human volunteers exposed to moderate levels of RF energy have confirmed expected physiological responses, all of which have been shown to be non-harmful and reversible. (p. 67)

**Comment 8:** These experiments should have been referenced /footnoted so that the reader could find out more, especially the intensity and time frame of exposure

[20] D. Maisch, op.cit. pp 94 – 96.
[21] K. Hecht, H.U. Balzer, Biological Effects of Electromagnetic Fields on Humans in the Frequency Range 0 to 3 GHz: Summary and results of a study of Russian medical literature from 1960-1996. German Federal Ministy for Postal Services and Telecommunications, Berlin 1997.
[22] A.A. Letavet, Z.V. Gordon, (eds). *The Biological Action of Ultrahigh Frequencies*. USSR: Academy of Medical Sciences, 1960. (English edition by the U.S. Joint Publications Research Service.)
[23] A.S. Presman, *Electromagnetic Fields and Life*, Plenum Press, New York-London, 1970.

and what the responses were. It is not adequate to just refer to unreferenced "recent experiments using human volunteers" and use unspecified "expected physiological responses" that may give the reader an impression that all possible responses are therefore non-harmful and reversible.

**Chapter 5. Risk Perception and Precaution**

**DB:** There can be no doubt where genuine scientific uncertainty [over a possible risk] does exist, such an approach is well justified and would not generally attract argument otherwise. However, a paradoxical situation arises in that such decisions are easy where there is a small known risk, particularly when even though it is rare, the potential impact of adverse consequences might be high. The problem arises when there is apparently no risk, or at least none that has been identified.

**Comment 9:** Black claims here that there is apparently no risk but this claim is weakened by the failure to critically examine contrary scientific evidence in his thesis, as per comment 4. This is especially the case for the research needs and gaps that were identified by the 2008 NRC report mentioned previously. Claiming that there is apparently no risk from RF exposure is unjustified considering what the NRC committee found. For example:

- Little or no information is available on possible neurophysiological effects developing during long-term exposure to RF fields. [24]
- A number of potentially critical cancer-related endpoints have received only limited study and are identified in the report text. In addition to cancer-related endpoints, data gaps exist in a number of other areas of toxicology in which knowledge is needed to support a complete evaluation of the possible health effects of RF exposure; these gaps are identified in the body of the report. [25]
- There is at present a lack of information concerning the health effects associated with living in close proximity to base stations. [26]

In fact, the whole NRC report on RF research is about the level of uncertainty that exists with RF human exposure and what research needs to be conducted in order to address that uncertainty. The NRC report on the state of the RF science does not agree with Black's claim (next paragraph) that scientific uncertainty does not exist because there is an absence of adverse data and apparently no risk.

In such circumstances, and particularly when there is a rapid escalation of use or exposure, as [is] currently the case in RF technology, the absence of adverse data is inclined to generate hypotheses which usually arise either by analogy or from hypotheses generating exploratory science. . . Whilst the net meaning of this research clearly argues against any effects, the mere existence of the research and the inevitability that some of it is unsettled causes uncertainty. . . Equally, with regard to mobile telephone handsets, initial studies which have suggested minor cognitive effects (Hocking 1998; Preece, Iwi et al, 1999) have generally not been replicated, though this matter cannot be regarded as settled. However, the nature and magnitude of the effects should not give rise to concern which would overturn the use of technology (Koivisco, Haarala, 2001). These studies where relatively loosely controlled experiments are undertaken and then any results collected, not just those confined to specific research

[24] NRC, 2008, op. cit, p.7.
[25] Ibid, p. 9.
[26] Ibid, p. 25.

questions, inevitably produce a scatter of data. Such studies could reasonably be regarded as useful for the purpose of hypothesis generation but cannot provide any evidence of, or for that matter of the absence of actual health effects. Such results are inevitable as long as this research is done and as long as rapid evolution and employment of the technology continues. It is, however, absolutely essential that this data is dealt with in a disciplined and appropriate manner and the existence of hypotheses in an area where there was no evidence of any problem should not be regarded as evidence of uncertainty. Neither should it be used as a reason to justify continued speculative research in an area in which there are no obvious problems on which to base hypotheses. (pp.75 – 76)

**Comment 10:** This paragraph brings to mind Carl Sagan's statement that "Extraordinary *claims require* extraordinary evidence". Black seems to be claiming that genuine scientific uncertainty does not exist with RF exposure because there apparently is no risk. Being no risk, there is an absence of adverse data that somehow is generating hypotheses for exploratory science that argues against any effects. He then goes on to claim for mobile phones there is no evidence of any problem so this should not be regarded as evidence of uncertainty nor justification for continuing research where there is no obvious problem. These claims are simply Black's personal opinions which are in opposition to the NRC Report 2008 (Appendix A).

**DB:** Essentially, RF research is not investigating an established health problem, as there is no widespread sign that a problem exists. It is screening for safety, looking for an unknown problem and generating ideas. That should not be discouraged, but, it must be said that the inappropriate use of such data to justify a position of uncertainty could be a legitimate reason for not undertaking research, although this would be unfortunate. Nevertheless, that is now occurring to some extent. (pp. 75- 76)

**Comment 11:** References/footnotes are needed here to substantiate the source of Black's claim that "the inappropriate use of such data" is being used to "justify a position of uncertainty". Black claims that this action "could be a legitimate reason for not undertaking research" but fails to back up this claim with any examples of evidence. It appears to be just another personal opinion on the part of Black.

Black's views on the "inappropriate use of data to "justify a position of uncertainty" is in stark contrast to the analysis of the inappropriate use of scientific uncertainty by Michaels and Monforton (2005)[27], and Michaels (2008)[28]. Michaels and Monforton show how the concept of scientific uncertainty is often purposely maintained by an industrial sector in order to avoid regulatory requirements to take taking corrective action in order to protect public health. According to Michaels and Monforton:

> Opponents of regulation use the existence of uncertainty, no matter its magnitude or importance, as a tool to counter imposition of public health protections that may cause them financial harm.[29]

[27] D. Michaels, C. Monforton, 'Manufacturing Uncertainty: Contested science and the Protection of the Public's Health and Environment', *Amer. Jour. Pub. Health*, vol. 95, no. S1, 2005, p. S39-S47.
[28] D. Michaels, *Doubt Is Their Product, How Industry's Assault on Science Threatens Your Health*, Oxford University Press, 2008.
[29] Michaels & Monforton, op.cit. p. S45.

Michaels and Monforton's scholarly analysis of how the concept of scientific uncertainty can be misused is not mentioned at all in Black's version of the concept.

### 5.1. Origins of Precaution in EME Safety

**DB:** In Australia, a need for a standard for RF had arisen in a somewhat heated political and industrial environment in the mid 1980s, resulting in the publication of an Australian Standard for RF in 1985. This standard more or less followed the International Radiation Protection Association Guidelines, though there were important differences, particularly in the reference levels at high frequencies, which came to dominate later attempts to align the standard with international practice. (p. 77)

**Comment 12:** Overly simplistic. The issues that led to the first Australian standard had very much to do with the scientific debate over the limitations of basing a supposedly health based RF exposure standard solely on thermal effects. Politics had nothing to do with it. [30]

**DB:** The New Zealand adoption of the Australian Standard was followed by a period of review and then harmonization, which ended in the attempt to harmonise being abandoned in 1999. By this time, the issue of the safety of radio waves had become contentious in New Zealand, as elsewhere. The Australian Standards Authority's answer was to include the widest range of opinion and constituencies on the committee, which would seem reasonable from a democratic point of view. Unfortunately the standards rules also require 80% agreement, which could have virtually, by definition, been excluded on the basis of the consistency of the committee. Nevertheless, the New Zealand members were able to take the abandoned joint project back home and achieve nearly unanimous agreement, certainly enough to meet standards rules, thereby creating the 1999 New Zealand RF Standard. The changes that were made were effectively the introduction of an enforceable precautionary requirement in the Standard. This is clause 10 which includes a requirement for "exposure minimization" and the approach was followed later in the Australian Standard RPS3:

> Minimizing, as appropriate, RF exposure which is unnecessary or incidental to achievement of service objectives or process requirements, provided that this can be readily achieved at modest expense. Any such precautionary measures should follow good engineering practice and relevant codes of practice. The incorporation of arbitrary additional safety factors beyond the exposure limits of this standard is not supported.

**Comment 13:** The understanding of the reasons that led to the "abandoned joint project", briefly referred to in Black's thesis, is an important part of the narrative in the history of RF standard setting and therefore should have been examined in some detail in his thesis. The interesting feature for this committee, designated the TE/7 Committee: Human Exposure to Electromagnetic Fields (1984 – 1999), was that the membership included representatives from organizations that were not willing to just 'rubber-stamp' the proposed standard but insisted on debating the issue of scientific uncertainty and its implications for public health protection and how this could be addressed in the proposed standard. Some of the TE/7 members who eventually voted against the adoption of the proposed standard represented mainstream scientific and occupational health and safety organizations, namely the Commonwealth Scientific and Industrial Research Organisation (CSIRO), The Communications, Electrical and Plumbers Union

[30] D. Maisch, op. cit. pp. 193 – 198.

(CEPU), The Australian Council of Trade Unions (ACTU) and The National Occupational Health and Safety Commission (NOHSC). Their rejection of the standard was on what they saw as an inadvisability of increasing exposure limits that were limited to thermal effects only, when a high level of controversy and uncertainty existed in the scientific literature.

Much of the TE/7 debate during 1998 – 1999 centred around the wording of an agreeable precautionary approach in order to address committee members' concerns. It is important to note that the two TE/7 committee members who represented the public interest for the Australian Consumers Federation (CFA), stated that they were willing to vote for the proposed standard, provided a suitable precautionary approach statement was included in the standard. At this point in the discussion Black introduced his version of a precautionary approach to RF standard setting and it was this approach that was eventually rejected by the above mentioned organizations as being totally inadequate for public health protection. This approach, slightly reworded, was later incorporated in the Australian Standard RPS3, mentioned previously. As for calling it a "precautionary approach", the TE/7 CEPU representative called it "deceitful and misleading to the public", the two CFA members called it "completely and utterly confounded so that the draft standard ignores all reference to precaution", and that the final result was a "homoeopathic dose of precautionary approach". [31] Essentially the TE/7 project was abandoned because the offered precautionary approach, largely composed by Black in the final draft version, was rejected by the above organizational representatives because it was inadequate for the task of protecting public health against the possibility of non-thermal biological effects. It is interesting to note that in all the years of Standards Australia, the TE/7 committee was the only one that could not come to an agreement.

An unfortunate lesson learned from the TE/7 experience was that the only way to have a committee approve an RF draft standard was to 'stack' the committee with enough members who were known to favour the draft so that its approval was a foregone conclusion. This idea was acknowledged by Black in a 2001 Australian Senate Inquiry where he stated his opinion that it was a "fundamentally flawed idea" to include in TE/7 "people with inevitably dissenting views.[32]

This idea was exampled in the later Australian RF standard committee under the auspices of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).[33] This might be a good way to push through a contentious RF standard (also exampled with the ICNIRP and IEEE RF standards committees) but it is also arguably an example of a process that psychologist Irving Janis termed "Groupthink" which is defined as the following:

> Groupthink occurs when a group makes faulty decisions because group pressures lead to a deterioration of "mental efficiency", reality testing, and "moral judgement". Groups affected by groupthink ignore alternatives and tend to make irrational actions that dehumanize other groups. A group is essentially vulnerable to groupthink when its members are similar in background, when the

[31] D. Maisch, 2009, op. cit. Chapter 5, pp. 193 – 224 and Appendix 3, pp. 243 – 248.
[32] D. Black, Parliament of Australia, "Inquiry into Electromagnetic Radiation", report of the Senate Environment, Communications, Information Technology and the Arts References Committee, Sect. 4.103, p. 147, May 2001
[33] D. Maisch, 2009, op. cit. Chapter 5, p. 220.

group is insulated from outside opinions, and when there are no clear rules for decision making.[34]

Some of the symptoms of groupthink are:

- Excessive optimism that encourages taking extreme risks.
- Collective rationalization – Members discount warnings and do not reconsider their assumptions.
- Direct pressure on dissenters – Members are under pressure not to express arguments against any of the group's views.
- Self-censorship – Doubts and deviations from the perceived group consensus are not expressed.
- Illusion of unamimity – The majority view and judgements are assumed to be unanimous.
- Self-appointed 'mindguards' – Members protect the group and the leader from information that is problematic or contradictory to the group's cohesivness, view, and/or decisions.[35]

What was historically important about the TE/7 "abandoned joint project" was that it illustrated a distinct level of scientific inflexibility within the committee when confronted by alternative scientific viewpoints that ran counter to the official RF standards. Black suggests that maintaining that inflexibility is the preferred option in setting RF standards. That is a very arguable viewpoint. For example, in his welcoming speech at the 3rd International EMF Seminar in China (2003), Professor Huai Chiang from the Bioelectromagnetics Laboratory, Zhejiang University, emphasised the Chinese view on the importance of alternative viewpoints in RF standard setting. To quote:

> Listen to both sides and you will be enlightened; heed only one side and you will be blinded. We are facing a big knowledge gap in evaluating EMF health risk at this stage. This is the reason why there is no satisfactory and generally acceptable EMF standard around the world. I think an international EMF exposure standard might only be established on the principle of science and democracy, on the principle of mutual understanding and to reach unanimity through consultation.[36]

As Black was directly involved with this debate within TE/7 it would have been preferable if his thesis had explored this issue in some detail, if for nothing else, to discount those alternative viewpoints. Unfortunately, this potentially informative discourse was not followed up in the thesis.

### 5.2 Research

**DB:** Thus the precautionary principle as it is widely understood, depends on at least the possibility of a real risk albeit remote but which would have significant consequences. At no time in the last 30 years of research into RF has such a risk been established or even seriously suspected. There have been many ideas and hypotheses but none of these

[34] Psychologists for Social Responsibility, http://www.psysr.org/about/pubs_resources/groupthink%20overview.htm
[35] Ibid.
[36] 3rd International EMF Seminar in China, 13-17 October 2003, Meeting Summary. www.who.int/entity/peh-emf/meetings/archive/en/china03mtgsummary.pdf

have been sustained and those which have been suggested from studies have invariably been overturned by better studies. (p. 78-79)

**Comment 14:** A profoundly unscientific paragraph that totally ignores the reality of the current state of knowledge on the biological effects of RF exposure. The claim that at no time in the past 30 years has any risks even been seriously suspected is falsified by the NRC 2008 report (Appendix C), the concerns raised by RFIAWG (Appendix B) and the Bioinitiative report (2007).

Black then makes an extraordinary and unsupported claim that all studies that have found evidence of biological effects not related to heating have been overturned by better studies. Where is a reference / footnote for this claim? To find such an unreferenced claim in a university level thesis is inexcusable. The truth of the matter is that studies that find evidence of biological effects not related to heating tend not to get funding to further the investigation. A valid argument here is that it is not better studies but no studies at all if those studies threaten strongly held preconceptions.

Take, for example, the study by Dr. Pamela Sykes from Flinders University in Adelaide, South Australia. Sykes' study, funded by the Australian government's EMR Program, involved exposing mice to GSM[37] cell phone radiation at a power level of 4 Watts per kilogram (4W/Kg). The aim was to test for a possible effect on DNA from RF exposure. Her preliminary study findings, published in *Radiation Research*, November 2001, found that the exposed mice had fewer DNA changes than expected. Although this might suggest a beneficial or protective effect from the microwave exposure, Sykes pointed out in her paper that some proven genotoxic agents can also express this same effect, suggesting that cell phone microwave exposure may be genotoxic.[38] Sykes then applied to the Federal Government's EME Expert Committee for further funding to continue the investigation with a larger number of mice to see if her finding could be replicated. The review committee turned this request down because they claimed that her preliminary results were "inconclusive" due to the small number of mice used in the initial study and that the findings did not support her original test hypothesis that exposure to RF promotes more DNA breakages than normal in transgenic mice. The expert committee concluded that, as the study found less DNA breakages than what would normally be expected in non-exposed mice, there was no point in conducting further research in this area.[39] This conclusion, however, failed to address the issue of possible genotoxicity that was raised by Sykes. The EME committee stated, "[a]lthough it may be interesting, from a perspective of scientific curiosity, to further explore the phenomena…is, however, unfortunately outside [our] scope." The committee then suggested that Sykes re-apply for a grant that was not specifically tied to RF bio-effects. This application was, however, also rejected. The committee wrote back, stating that while it "recognized the great potential significance of her results", it considered them "somewhat counterintuitive".[40] At the time of this rejection, the NH&MRC"s expert radiation advisor, who would have advised the review committee on whether or

[37] Global Systems Mobile
[38] L. Slesin, 'Wireless Notes', *Microwave News,* vol. 21, no.6, Nov./Dec. 200, p. 8.
[39] ARPANSA, The Mobile Phone System and Health Effects, Part 1 and 2, Health Hazard Assessment, http://www.arpansa.gov.au/mph2.htm
[40] L. Slesin, *Microwave News*, op. cit.

not to fund further research, was also employed by Motorola as an EMR strategist.

The use of the word *counterintuitive* as a reason to reject Sykes' findings was of concern as it indicated that an assumption had been made that, as Sykes' findings did not fit with what would have been expected, they did not need to be further investigated. This suggested that a dismissal of the importance of Sykes' preliminary findings was made because if Sykes' findings were ever replicated it would show a possible adverse biological effect at RF levels not related to heating – thus invalidating the RF standard's assurance of safety.

A similar fate occurred with research conducted by Dr. Ross Adey et al. and published in *Cancer Research* in April 2000. This research exposed Fisher laboratory rats to an RF signal simulating exposures that would be expected in the head of a digital mobile phone user. Overall, the two-year study showed a trend towards a reduced incidence of central nervous system (CNS) tumours in the exposed rats in comparison to unexposed controls, thus indicating a protective DNA repair effect from exposure. Although this could be considered as evidence of a lack of danger from mobile phone use causing brain tumours, Adey et al. pointed out that that the findings needed to be followed up because they indicated a possible non-thermal (low-intensity) effect. To quote: "[T]here is considerable evidence in the literature to support the suggestion that low frequency modulated radiofrequency fields are capable of interacting with biological systems when applied at athermal (non-thermal) levels, involving interactions with key messenger and growth regulating enzyme systems." Adey et al. went on to explain that the findings of the study were consistent with an action of the RF fields in lowering tumour incidence and suggested further research into non-thermal exposures.[41],[42] These suggestions cast doubt on the mobile phone industry's long-held assertion that athermal (low intensity) RF exposures were of no consequence, as there could be no interaction with biological tissue at levels that did not cause heating. Adey's request to Motorola for further funding to do a replication was refused. Motorola then confiscated all the essential equipment, including field generators and exposure chambers. Adey stated in a sworn affidavit this was done "to ensure that we could not pursue any further studies". [43]

Considering that a standard practice in science is to replicate a study in order to establish a biological effect, it could be surmised that further research to explore possible biological effects from low intensity RF exposure did not suit Motorola's interests. With both Sykes' and Adey et al.'s research, the unwillingness to attempt a replication of scientific findings of an effect (protective) between RF exposure and DNA suggests the findings were "counterintuitive" to strongly held beliefs (groupthink) that there can be no biological effects from RF exposures below the established RF standard's heating threshold.

Thus, it can be argued that Black's extraordinary claim that all such research is invariably "overturned by better studies" is not based on a proper understanding of the science – and how vested interests can distort that science. To quote Carl

[41] R. Adey et al., 'Spontaneous and Nitrosourea-Induced Primary Tumors of the Central nervous System in Fischer 344 Rats Chronically Exposed to 836 MHz Modulated Microwaves', *Radiation Research*, vol. 152, Sept. 1999, p. 293-302.
[42] L. Slesin, 'Digital Cell Phone Signals: Protection Against Brain Tumors', *Microwave News,* p. 13, Sept./Oct. 1999.
[43] Correspondence from Ross Adey to this author, January 7, 2004.

Sagan again, "Extraordinary claims require extraordinary evidence", but I see none here.

**DB:** It is paradoxical in the case of power lines, that one of the initiatives taken in recent years has been to build new lines underground. The magnitude of the magnetic field from a power line is a factor of distance of the conductor from a person in the fields and whilst electric fields are effectively screened by the ground, magnetic fields are not. Thus, although the region of exposure is less, the magnitude of exposure, which is the issue defined by IARC is often increased by a buried rather than an overhead cable. To a large extent, out of sight is out of the public mind." ( p. 79)

**Comment 15:** Insufficiently researched. According to the UK national grid, although the magnitude of exposure is higher immediately above a buried transmission cable when compared to an overhead transmission line it drops off much greater with distance. At 5 meters distance from an underground transmission line the cable actually produces a lower magnetic field than the overhead line. So for nearby residences that are built outside of the right of way, magnetic field exposures will be less. [44] In addition, with the use of modern XLPE underground cables that provide far improved shielding, underground lines can be engineered to emit practically no magnetic fields.[45] Other research has found that by encasing underground power lines in ferromagnetic material it can reduce magnetric field values near the underground power line by more than 80%.[46] In addition, there are many other advantages to undergrounding overhead lines, such as significantly reduced transmission line losses, increased reliability, and reduced risk of storm damage just to mention a few.[47]

**DB:** The World Health Organisation (WHO) have grappled with this problem, having been under substantial political pressure to condone or encourage precautionary approaches. The WHO have, over the last 20 years, taken substantial initiatives in non-ionising radiation control and have many times reiterated their support for contemporary standards. In a fact sheet published in 2000, (World Health Organisation, 2000) WHO carefully avoided the exact term "precautionary" and used the word "cautionary" in the hope of being more generic and have outlined the various possibilities for an approach along these lines. At about the same time, a more academically orientated paper was published by the members of the WHO group preparing the fact sheet. Support for this approach has continued, and at a meeting of the European Bioelectromagnetics Association (EBEA) in Helsinki in September 2001, the Responsible Officer, Radiation Protection and Global Hazards Assessment, Dr. Michael Repacholi, clearly stated the WHO's position as:

> "WHO has seriously considered how the precautionary principle could be used for EMF protection of the public. There seems to be significant support for the approach of mandating the use of science-based exposure limits in conjunction with voluntary precautionary approaches to reducing EMF exposure to lower levels. What does not seem appropriate is the arbitrary adoption of additional safety factors into exposure limits in the name of being cautionary. Introducing ad

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[44] The UK National grid, Undergrounding high voltage electricity transmission.
The technical issues, p. 15, http://www.nationalgrid.com/NR/rdonlyres/A7B84851-242F-496B-A5E8-697331E15504/36546/UndergroundingTheTechnicalIssues5.pdf

[45] Leonardo Energy, "Underground High Voltage Cables: Wiring Europe for the Future", Winter 2006, http://www.leonardo-energy.org/drupal/book/export/html/868

[46] J.R. Riba Ruiz, X. Alabern Morera, 'Magnetic Shields for Underground Power Lines',
1 Department d'Enginyeria Elèctrica, UPC EUETII-"L'Escola d'Adoberia" (Spain)
http://www.icrepq.com/PONENCIAS/4.230.RIBA_full.pdf

[47] ibid.

hoc additional safety factors into science-based standards as a precautionary measure undermines hundreds of millions of dollars of research for no apparent benefit to health." (pp. 79 - 80)

**DB:** Contemporary understanding based on research evidence indicates that the only adverse effects of ultra high RF exposure are acute, deterministic and result from heating effects of deposited energy. In contrast to ionizing radiation, stochastic and dose dependent cumulative effects have not been shown to occur as a result of low or moderate levels of RF exposure within established safety limits (ICNIRP 1998). Nevertheless, these concerns persist regarding the use of mobile phones connected to cellular systems. (p. 81)

**Comment 16:** Black is apparently suggesting here that the "concerns" that "persist" are not based on a proper understanding of the science. This would therefore suggest that the NRC report (2008), the RFIAWG concerns (1999) and the authors of the Bioinitiative Report (2007) all have it wrong, but he does not even refer to them in his thesis.

**5.3. Official Advice** [After discussing Black's observation that DECT cordless phone exposure levels are significantly higher to the user than a 3G-UMTS mobile phone]

**DB:** This does not appear to be reflected in contemporary public understanding, or for that matter some official advice, although according to current scientific understanding no adverse health effects should be expected from either system. (p. 84)

The basis of current standards such as those of ICNIRP and ICES, rely on well supported data indicating that health effects of RF absorption are entirely deterministic, only acute and are absent below current ruling limits. No stochastic or cumulative low level effects have been established. (p. 84)

**Comment 17:** This often repeated statement indicates that this viewpoint is the central argument of Black's thesis - defending the existing thermoregulatory approach to RF standard setting. In order for the thesis to meet the usual requirement for originality, new or original facts should be presented to defend this viewpoint. As Black apparently places prime importance on the collection of papers published in *Bioelectromagnetics Supplement 6* (2003) this viewpoint cannot be considered either new or original.

**DB:** For typical domestic users, including children, DECT handsets may now provide a more significant fraction of RF exposure than GSM 3G-UMTS phones. Thus, research into effects which are hypothesised to result from cumulative exposure from mobile phones may be severely confounded unless the use of cordless telephones is accounted for. (pp. 84 – 85)

The much greater integrated time of exposure likely with cordless phones has to be taken into account when it is noted that much of the advice to date has been to encourage children to keep mobile calls short. There is no scientific evidence nor is there a rational basis to hypothesise that that there is a time accrued [cumulative] effect. However, since this does appear to be of concern of some authorities the fact that more weight is not given to the advice regarding cordless phone exposure is simply wrong. (p. 84 - 85)

**Comment 18:** Generally valid points except for the arguable claim that there is "no scientific evidence" or that there is no rational basis for a cumulative effect. This claim is in conflict with the concerns raised by the U.S. government's

Radiofrequency Interagency Work Group (RFIAWG) in 1999 (Appendix B) and the Bioinitiative Report (2007). In addition the NRC report (Appendix C) highlights the high level of uncertainty in the scientific data. For example, on page 26 the NRC committee states: "There is at present a lack of information concerning the health effects associated with living in close proximity to base stations." The NRC has identified this as a research gap needing ongoing research. As for children and mobile phone use, the NRC expressed concern: "Owing to widespread use of mobile phones among children and adolescents and the possibility of relatively high exposures to the brain, investigation of the potential effects of RF fields in the development of childhood brain tumors is warranted."

Living near a mobile phone base station is a chronic exposure, raising the issue of possible cumulative effects. The possibility of a link between mobile phone by children and subsequent brain tumours is also obviously a cumulative effect over time. These possible effects may be small, if they exist, but considering the large numbers of people exposed, even a small risk may equate to a significant public health issue. To infer that the NRC concerns are not rational, as Black suggests, is without justification.

**DB:** It has been the writers [sic] observation as an expert witness in a number of high profile environment court cases regarding cellphone base stations, that the judgments tend not to encourage the adoption of the precautionary principle in respect to RF. Reasons for this are often expressed in slightly different ways, which means there are a number of good reasons for not doing it. However, a common theme surrounds the inevitable understanding, from proper evidence that there is no quantifiable risk of any magnitude. Also, both the manner in which RF is regulated by contemporary standards, and often the legal instruments used, such as the New Zealand Resource Management Act, are already precautionary. As Judge Jackson said in the Shirley decision (Shirley - Environment Court (NZ) Decision 1998) to apply the principle to a further degree results in *"double counting"*. (p. 86)

**Comment 19:** Re the Shirley School Decision.

When discussing RF standard setting in the Australian and New Zealand context, it is important to examine the 1998 New Zealand Environment Court Shirley School Decision in some detail because it has come to be considered a benchmark for subsequent Environment Court cases in New Zealand.

This case was an important topic of discussion in the TE/7 meetings in 1999 with the main argument being on whether or not the court decision was relevant to the precautionary approach discussion then taking place within TE/7. This discussion centred around the level of scientific uncertainty over possible adverse non-thermal effects that were not addressed in the ICNIRP (nor in the draft standard) RF guidelines, and how to derive an acceptable precautionary approach that addressed this uncertainty. There was no issue over the need for such approach to known thermal effects as it was generally agreed that the standards were sufficiently protective in this regard.

During the final round of TE/7 meetings in 1999, Black brought up the Shirley School decision and argued that since the judge in the case had ruled that the ICNIRP RF Guidelines (and derivative RF standards) incorporated a precautionary approach, no additional measures were necessary. This argument was rejected by dissenting members of TE/7 because it was clear that the judge's ruling was

only relevant to thermal effects and so did not apply for possible non-thermal effects. For clarification, a brief background to the Shirley School case follows.

Growing concerns over the possibility of health hazards from the growing number of mobile phone towers appearing in New Zealand led to a one-day scientific symposium on November 18, 1995 in Christchurch to debate the potential health impacts. Among the speakers were Professor Ivan Beale from Auckland University, Dr. John Goldsmith from Ben-Gurion University, Israel, Dr. Richard Luben from the University of California and Neil Pearce of the Wellington NZ Clinical School. The meeting was prompted by "local officials' lack of sufficient knowledge and information for making critical decisions about safety and siting within residential areas."[48] The attendees urged a "precautionary approach on the most vulnerable groups in our society." In 1996 New Zealand's Ministry of Education issued a policy statement, following a precautionary approach that prevented cellular phone transmitters from being built at public schools. In the official statement from the ministry it was stated that:

> Of paramount importance to the ministry is the provision of an environment where boards of trustees, parents, teachers, pupils and other occupants of the school site can feel comfortable. For this reason the ministry has decided cell phone transmitters will not be sited on Crown-owned school sites in the future.[49]

In 1997 the New Zealand Environment Court was asked to rule on a high profile case involving a proposed Telecom cellular phone base station site at 9 Shirley Road, Christchurch, that was adjoining the Shirley Primary school. Both the Shirley Primary School and some nearby residents lodged objections to the Christchurch council which then enacted a by-law on the site, requiring Telecom to ensure that the maximum emissions to the school property not exceed 2 uW/cm2 as a precaution. Telecom NZ then appealed this decision. Due to the high publicity given to the case, especially the school's threat to relocate if the facility was erected, a back-down by Telecom NZ could have seen other precautionary emission requirements being used in other facility locations and so the case ended up in the Environmental Court for a ruling. [50]

Though it was estimated that exposure levels at the Shirley School would be far below the New Zealand RF standard of 200uW/cm2 for the general public, it was argued by several expert witnesses, including TE/7 member Professor Ivan Beale that a precautionary approach should be followed by not allowing the Telecom facility near the primary school grounds.

Beale concluded, (to quote):

> The operation of this cell-site could cause adverse health effects in people spending significant amounts of time on the ground and in buildings within 30 metres of the installation." And that "Persons residing, working or playing in the vicinity of the proposed cell-site would be exposed, in places, to levels exceeding 10 uW/cm$^2$. On the roof of the DSW building exposure levels as

[48] L. Slesin,'Opposition to Communication Towers on the Rise in the U.S. and Around the World', *Microwave News*, vol. 15, no. 6, Nov./Dec. 1995, p. 12.
[49] L. Slesin, 'New Zealand Bans Cellular Antennas at Public Schools', *Microwave News*, vol.16, no. 5, Sept/Oct 1996, p. 7.
[50] Correspondence with Ivan Beale, Nov 8, 2004.

> high as 52 uW/cm$^2$ are predicted. These levels are 1000 times greater than my estimates of the current levels in this vicinity. They are well within the range at which adverse neuro-behavioural effects have been reported in humans chronically exposed to comparable types of radiation. In addition to the direct effects of radiation exposure on some people, many more would experience adverse effects related to the stress caused by imposition of an unacceptable risk.[51]

The decision by the New Zealand Environment court rejected any consideration of a precautionary approach for the Shirley school site on the grounds that "a precautionary approach is already implicit in the Act." This was on the grounds that the judge considered that the Australia /New Zealand RF standard already "provides for a factor much greater than is required to eliminate the possibility of any thermal effects". [52] The judge clearly indicated here that the issue of non-thermal effects was not to be considered.

In making this decision Judge Jackson quoted from ICNIRP that:

> Overall, the literature on athermal effects is so complex, the validity of reported effects so poorly established, and the relevance of the effects to human health is so uncertain, that it is impossible to use this body of information as a basis for setting limits on human exposure to these [a-thermal] fields.[53]

It was on these grounds that Black in TE/7 reasoned that the N.Z. Environment Court ruling validated ICNIRP as already having a precautionary approach and therefore a further tier of precaution was unnecessary. However, as was pointed out to the TE/7 Committee, the decision by the Environment Court Judge to reject a precautionary approach on the grounds that it is already incorporated in the standard was not relevant to the discussions in the TE/7 Committee. There was no argument in TE/7 about ICNIRP Guidelines providing protection against the well established thermal effects. The precautionary approach statement under discussion in TE/7 was specifically meant to cover the possibility of low-level non-thermal effects, similar to what was stated in the foreword of the 1985 Australian RF standard. However, this did not stop those TE/7 members wanting ICNIRP standards from using the Shirley School Decision to try to deflect members' insistence of a precautionary approach to cover low-level non-thermal effects. It was also noted in the CFA submission to TE/7 that while Judge Jon Jackson in the Shirley decision accused the expert testimony of some of the witnesses who supported a precautionary approach in the siting of transmitters near the school as being biased, he uncritically accepted the industry's evidence as correct in its interpretation of the science.[54] For instance Judge Jackson stated that ICNIRP accurately portrayed the general scientific view of the research [55], a viewpoint very much disputed by a number of TE/7 members.

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[51] I. Beale, (Statement of Evidence). 1997/8, Decision No: C 136/98. Between Shirley Primary School and Telecom Mobile Communications Ltd. New Zealand Environment Court, Document RMA NO /97, May/June 1998, pp. 89, 113.
[52] J.R. Jackson, Decision No: C 136/98. Between Shirley Primary School and Telecom Mobile Communications Ltd. New Zealand Environment Court, Judge JR Jackson, May/June 1998, p. 113.
[53] ibid, p. 89.
[54] FINAL VOTE submission by Don Maisch, March 3rd 1999. Available at: http://www.emfacts.com/papers/submissions.html .
[55] Jackson, 1998, op. cit., p. 87.

ICNIRP chairman Paulo Vecchia set the record straight about ICNIRP's definition of a precautionary approach at a Conference on Mobile Communications and Health, held in Moscow, Russia in September of 2004. During Vecchia's presentation on ICNIRP he explained ICNIRP's understanding of the precautionary principle. To quote:

> ICNIRP only considers acute effects in its precautionary principle approach. Consideration of long term effects is not possible. [56]

Thus, for possible long-term, non-thermal effects, the ICNIRP guidelines do not include a precautionary approach. Therefore any blanket claims that derivative standards (such as the New Zealand Resource Management Act) are already precautionary for RF are disingenuous in this regard.

It is important to note that Black's claim made in TE/7 that ICNIRP's limits were already precautionary and nothing more was needed because of the Shirley School decision was rejected by enough members to block the approval of the draft RF standard in TE/7. As mentioned earlier, this was the only time in the entire history of Standards Australia that a standard committee failed to gain a consensus.

For thoroughness the conflicting viewpoints in TE/7 over the Shirley School decision should have been examined in more detail in the thesis. They were not.

**DB:** When looking at the issue from a scientific or particularly a medical point of view, the conclusion is the same as that reached by the Courts. The difficulty facing local body administrators and the WHO alike is meeting the demands of a democratic society in excising [sic] the rights to be suspicious and not unconditionally accepting of science. It is for this reason that recent standards do acknowledge that the application of best practice in resource conservation can equate to a precautionary approach to some extent. That is the maximum extent to which it is acceptable to require any limitation on the use of RF given the high level of certainty and scientific consensus about its safety." (p. 87)

**Comment 20:** The "high level of certainty" and "scientific consensus about its safety" are statements limited to thermoregulatory biological effects, and do not apply <u>to non-thermal long-term exposures.</u> "[A]pplication of best practice in resource conservation" was an idea raised in TE/7 and it too was rejected as not being precautionary by enough members to block approval of the draft standard.

In addition, the claim that there is a "high level of scientific certainty" for RF safety is falsified by the NAS report, as mentioned earlier.

**DB:** [Discussing hand held mobile phone use] Those advocating hands free kits as a 'precautionary' measure persist in their argument by claiming virtue for absorption in tissues [the hand] other than the head. However, the balance of scientific evidence is clearly against any established adverse effect to the head and so the possibility of an adverse effect, being by definition unknown and therefore uncharacterized on merely the total magnitude of energy absorbed is therefore greater when in a pocket or held in the hand.

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[56] D. Maisch, Report on the International Conference: 'Mobile Communications and Health: Medical, Biological and Social Problems, Sept 20-22, 2004, Moscow, Russia, *European Biology and Bioelectromagnetics*, vol. 1, issue 1, Jan. 2005.

The reality is that neither is likely to pose a risk or a problem but to advocate a theoretical benefit, or possible benefit from the use of a hands free kit is unscientific to say the least. (p. 88)

**DB:** Ultimately, any precautionary measures taken or advocated with regard to RF used for communication needs to be evaluated objectively in terms of intended mechanism of precaution. If this is agreed to be a reduction in incident power density to which people are exposed then it is incumbent on there being data on which individuals or regulators can make recommendations with potential to affect public health. This would ensure that in the absence of any objectively expected benefit, at least the factors which are being altered are relevant or potentially relevant and are receiving a change of a magnitude and direction which would make a difference if there turned out to be a problem. (p. 89)

**Comment 21:** It is more to the point that precautionary measures taken or advocated in regard to RF need to be evaluated objectively in terms of the level of scientific uncertainty that exists. For example, such a measure may be advising parents to limit the use of cell phones by their children because the NRC identified the possibility that relatively high RF exposures to the brains of children and adolescents with cell phone use may have potential effects on the development of childhood brain tumours.[57] The "objectively expected benefit" in this precautionary measure would be a reduction in risk for the child. What point Black is trying to make here in his convoluted wording is unclear.

**DB:** The use of SAR figures provided by cellphone manufacturers to choose a 'safer' phone has absolutely no scientific basis. The tests are undertaken under theoretical conditions. There is no correlation from such testing to absorption experienced by users under conditions of dynamic power control, various individual techniques of use and positioning and differing grips on the phone. The use of SAR is appropriate to determine compliance with a limit but it cannot be usefully extended further than that for there is no correlating human data. . . . Use of hands free kits may enable a user to shift the point of maximum absorption away from the head, however, there are other potential mechanisms by which these devices could cause more exposure, and there is no reason to believe that moving it [away from the head] carries any alteration in risk or benefit. (p. 89)

**DB:** The application of a precautionary trend to the use of RF where the public is exposed is appropriate and should be advocated and supported. That means efficient use of the modality using best contemporary practice to minimize energy and spectrum wastage, confining the energy as far as practical to the signal path and minimizing incidental human exposure. . . However, other strategies are at best hard to justify and at worst and unfortunately commonly downright misleading and should be avoided by professionals providing independent and reliable advice. (p. 90)

**Comment 22:** This approach effectively allows the unfettered introduction of new technology free of precautionary restraints other than not emitting more radiation in excess of the needs of the technology. This is arguably not a precautionary approach at all because it avoids the issue of uncertainty over possible long-term non-thermal health effects. It is based on maintaining the transmission needs of the technology.

**DB:** One observation frequently encountered is that even when standards are lowered or tightened, the process tends to be repeated and so there is an ongoing call for

[57] NRC, 2008, op cit., p 26

lowering and lowering again. That might tell us that there is no level which will be accepted, but an alternative explanation is that it is a demand for them to be as low as possible. And that point is important, even though the concept is unworkable and would not provide a useful basis for science based standards to protect the public health. (p. 91)

**COMMENT 23:** Black claims that he has frequently encountered situations where RF standards were lowered, and then there were subsequent calls made for a further lowering, again and again. He should have provided an example or reference for this claim.

Black also mentions the unworkability of the demand for exposures to be kept as "low as possible". This is a bit vague but perhaps he is referring to the ALARA principle, meaning radiation exposures be kept "As Low As Reasonably Achievable". This principle means keeping radiation exposures as low as can be achieved, based on technological and economic considerations. The ALARA principle is an accepted concept in radiation protection, so what is the justification for Black's personal opinion that such a concept is unworkable and is not suitable for protecting public health?

### 5.5 Exposure Minimisation

**DB:** If it is accepted that power density is indeed the parameter of interest, it may be that this information together with knowledge of nature and trends in public concern can result in the evolution of a precautionary policy which goes some distance to provide reassurance and comfort. If the foregoing are accepted then that would be an approach which reduces the exposure of RF power density to the lowest level, which is possible under particular circumstances, analogous to the type of approach which is common in any event in both environmental resource management and environmental and occupational hygiene. If it arose from control of emissions to this end, the approach could also be consistent with the conservation of resources of spectrum and energy, both of which are finite and should be conserved. However, such a requirement would not be achieved simply by placing some limits on emissions. That could not be justified on the basis of security of current standards which are already in place. (p. 92)

**DB:** It is therefore apparent that mobile telephony has in fact been undergoing a process of continuous improvement, which has resulted in substantial lowering of transmitter power required for each end of the circuit and that this approach meets not only the requirements of the system but also any requirements which could be imposed in terms of conservation of spectrum and energy and would therefore also probably meet the goals of the type of precaution demanded by the public.

**Comment 24:** Not true for the many public submissions on precaution made to the TE/7 Committee where the main concern about RF exposure from telecommunications was about possible adverse health effects from long-term non-thermal exposures, not what Black terms "conservation of spectrum and energy".

## Chapter 6: Difficult Issues for RF Standards

### 6.1 The Effect of Mobile Handset Exposure

**DB:** Temperature regulation is achieved in mammals through sophisticated thermoregulatory systems (Adair and Black 2003). Effectively the standards (ICNIRP 1998; Australian Standard 2002; IEEE 2005) permit mobile phone RF exposure to impose an additional thermal load of 2 W/kg. [A]t that level it is expected that some heating of

tissue would occur. However that threshold has to be compared with the basal metabolic rate of both localized tissue and the whole body and the ability of the circulatory systems to achieve continuous energy dissipation. The average human has a basal metabolic rate of at least 100 Watts at rest and so 2 W/kg applied to a small area of tissue is an insignificant challenge to that overall system. (p.95)

**Comment 25:** What is not mentioned here is that 2 W/kg applied to a small area (say the head) can cause 'hot spots' of energy that may increase tissue temperatures in that area to a level in excess of the mobile phone compliance standards.[58] This is a bit like claiming that if you average the impact energy of a bullet over the entire body, the bullet's energy is insignificant to challenge the overall system.

**DB:** Furthermore, this has to be looked at in the context of the total RF power available in a mobile phone which is generally much less than 1 Watt. Thus, the only remaining concern becomes any effects of localized tissue heating caused by the rate limiting in local pathways for heat dissipation which might cause an accumulation of heat energy in some tissues. Such effects can be modeled and tested against the intention of standards to limit local temperature rise to less than 1 degree Celsius. Research has shown that in practice levels of heating are less than one quarter of this (Schonborn, Burkhardt et al, 1998; Van Leeuwen, Lagendijk et al, 1999). There has also been substantial speculation and research about the possibility of effects at lower levels caused by small rises in temperature or by effects other than heat. The inevitable presence of temperature rise is a significant confounding factor in any research and it is virtually impossible to eliminate. (p. 95)

[On the Interphone studies]

**DB:** In recent years, large multi-centre trials have been co-ordinated by the World health Organisation (WHO) with the intention of providing detailed metanalysis in preparation for the International Agency [for] Research on Cancer (IARC) review and writing of a Monograph on this topic, which was originally scheduled for publication in June 2007 but is still delayed at June 2009. In the meantime, a number of studies have already been published particularly regarding exposure to mobile phones and brain tumours. These are generally negative, although there is some conflicting data (Kundi, Mild et al., 2001). In Sweden, two groups have studied identical Swedish cancer registry data and reached different conclusions (in press). Ahlbon et al. found no effect, while Hardell et al. report an epigenetic effect. In the meantime, the official WHO led Scandinavian data has been published (Schoemaker, Swerdlow et al., 2005). As these authors conclude "there was no association of risk of duration of use. Lifetime cumulative hours of use or number of calls for phone use or for analogue or digital phones separately.". . . The discrepancy with the Hardell et al. work remains outlying and unexplained, but is most likely due to the nature of control data used by Hardell compared with that used by Ahlbom et al. in their analysis of the Swedish data. This has delayed the publication of the Interphone study which is still not available in May 2009. Otherwise studies regarding RF and cancer are generally negative (Ellwood, 2003) (p. 96)

**6.4 Effects on the Blood Brain Barrier**

**DB:** Effects on the blood brain barrier of RF from mobile phones have been hypothesised and explored. The issue has been raised largely because of the potential importance of such an effect, if it exists. The blood brain barrier is relied on to keep many substances out of the central nervous system and its integrity may be significant in areas such as pharmacological dosage of therapeutic agents. There are a relatively small number of studies, some with apparently conflicting results. However, the latest and best controlled

[58] D. Maisch, op cit, pp. 129 – 131.

studies which have been undertaken at Brooks Air Force Base in the USA are indicating no effect, including studies which are replicating those which have previously been reported as positive. The latter have been undertaken with the assistance of the original researchers and were most recently presented at the annual scientific meeting of the Bioelectromagnetics Society in Dublin in 2005. No effects have been confirmed other than by heating at high levels. (p. 97)

**Comment 26:** Some references/footnotes are essential here for the reader to be able to follow up and verify the accuracy of Black's analysis, especially the quality of the later research that he mentions. It is important to note that the Brooks Air Force's BBB research was led by Patrick Mason and was designed to see whether Leif Salford and Bertil Persson's experiments on the effects of microwaves on the blood-brain barrier could be replicated. This was at the same time that Mason was defending the safety of the new military active denial technology using 94 GHz millimeter waves. [59] This set up a significant conflict of interest because if Mason's BBB research replicated Salford and Persson's findings it could compromise Mason's claims of safety for the millimetre wave technology. Even though Mason's findings were presented at a Bioelectromagnetics seminar in Dublin in 2005, they have never been published. It is a significant omission that although Salford and Persson's BBB research is central to this topic it is not referenced anywhere in the thesis, nor is the BBB work of Allan Frey (Appendix D). Also omitted is the work by Dariusz Leszczynski from STUK, the Finnish Radiation and Nuclear Safety Authority. Leszczynski found that mobile phone radiation could activate heat-shock proteins in the endothelial cells of the blood brain barrier, suggesting that repeated exposure could damage the cells and lead to BBB breaches that could then lead to health problems.[60]

What is especially interesting about Leszczynski's findings was the attempt by Motorola to suppress its mention in the Bioelectromagnetics Newsletter when Motorola's Mays Swicord exercised editorial control over the publication. The May/June 2004 edition included a summary of the outcomes of the Heat Shock Protein (HSP) Workshop held in Helsinki, Finland in April 2004. Even though the workshop was organised partly because of Leszczynski's controversial HSP findings, and Leszczynski hosted the meeting, no mention of his research was included in the newsletter summary. As a result of this omission a number of Bioelectromagnetics Society members called for an editorial board that could rein in Swicord's control.[61]

### 6.6 The Eye

**DB:** The ICNIRP Guideline originally regarded the eye as the most sensitive organ in the body and indeed this is the rationale for the 10 gram averaging mass in that standard. However, more recent analysis of research by Elder (Elder 2003) has found that the previously suspected sensitivity of the eye was over-estimated and that this organ is not affected by levels well in excess of current standards. In preparation for the 2005 review,

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[59] L. Slesin, 'News & Comment', *Microwave News*, January 26, 2004, http://www.microwavenews.com/nc_jan2004.html

[60] D. Leszczynski et al., 'Non-thermal Activation of the hsp27/p38 MAPK Stress Pathway by Mobile Phone Radiation in Human Endothelial Cells, *Differentiation* 70 (2-3), 2002, pp.120-29.

[61] L. Slesin, Industry Rules RF, 'Controlling Research, Setting Standards and Spinning History', *Microwave News*, July 2004, http://www.microwavenews.com/IndustryRulesRF.html

in addition to those previously mentioned the ICES arranged for extensive reviews of epidemiology (Elwood 2003) (Heynick, Johnston et al 2003) (Elder 2003) (D'Andrea, Chou et al. 2003) (Elder and Chou 2003; Heynick and Merritt 2003) (Black and Heynick 2003) (Meltz 2003). The net meaning of this research, which was extensively discussed and peer reviewed before publication, has confirmed the safety of existing standards, which has resulted in their reconfirmation and continuation, or in the case of the ICES document, realignment with ICNIRP. The eyes are therefore fully protected by current standards by a much higher safety margin than was previously thought. (p. 98)

**Comment 27:** The above mentioned papers were all published in Bioelectromagnetics Supplement 6 (2003) and it is this group of papers which serve as a central foundation to Black's thesis. See Appendix B for a discussion of some of the issues raised by the papers as well as a significant conflict of interest surrounding the papers and their publishing in Bioelectromagnetics Supplement 6 (2003).

**Presumptions about Sensitive Populations**

**DB:** [ Discussing the 2000 UK Stewart report and its call for a precautionary approach for mobile phone use, especially for children.]

Predominant in these concerns was the idea that children are inherently more susceptible to the use of mobile phones on the basis of both an electrophysiological idea that the smaller size of their heads increases the potential for effects and also on the general idea that any adverse effects have the potential for lifelong consequences. Many of these ideas have been robustly disputed to the point where they can no longer be regarded as credible. For example, the basis of the head size arguments have been dealt with by Schonborn et al (Schonborn, Burkhardt et al. 1998). One study by Gandhi et al. in 1996 (Gandhi O.P.; Lazzi G.; Furse C. 1996) suggested deeper penetration into children's skulls but this is inconsistent with other published data. Schonborn showed that the Gandhi analysis was flawed but these ideas became embedded into the Stewart Report and are erroneously seen as conflicting scientific ideas. In reality Gandhi's approach has little support in the international dosimetry community. Current standards are widely accepted as providing protection against any established effects in all members of the population. (pp. 98 - 99)

**COMMENT 28:** Black's assertion that children are no more sensitive to mobile phone radiation than adults hangs on his referencing just two conflicting studies, Gandhi 1996 and Schonborn 1998. It is as if one cancels out the other to give no effect. This is not an adequate scientific analysis of this issue. For example, Black could have expanded upon the topic with a deeper examination as exampled by the analysis in the New York publication Microwave News in 2002. The article, "Are Children at Greater Risk from Mobile Phone Radiation? No Consensus Yet, Reviews Under Way", covered the opposing viewpoints in depth and showed that the issue was far more complex, and unresolved, than indicated in Black's thesis.[62]

As for the latest scientific opinion on this issue, The WHO/International Agency for Research on Cancer (IARC) on May 31, 2011, classified RF radiation as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with mobile phone use. In its review of the existing scientific literature, the IARC noted in relation to children's use of

[62] L.Slesin, "Are Children at Greater Risk from Mobile Phone Radiation? No Consensus Yet, Reviews Under Way", *Microwave News*, Vol. 22, No. 3, May/June 2002, pp. 1, 9-10. http://www.microwavenews.com/news/backissues/m-j02issue.pdf, Accessed July 31, 2011.

mobile phones that "when used by children, the average RF energy deposition is two times higher in the brain and up to ten times higher in the bone marrow of the skull, compared with mobile phone use by adults. [63]

### 6.7 Precautionary Approaches

**DB:** Precautionary approaches to the use of mobile phones and mobile telephone technology have been recommended from a socio-political basis as a means of dealing with public concerns.

**Comment 29:** Incorrect. In the Australian / New Zealand TE/7 committee, mentioned earlier, the debate over a suitable precautionary approach had nothing to do with "socio-political" concerns. It was over factual uncertainties in the science and the thermal limitations of the RF standard for public health protection. To attempt to reduce this to just a socio-political stunt is disingenuous.

**DB:** The WHO published a useful paper on cautionary approaches in 2000 (World Health Organisation 2000) which was followed up by a working group to define the relevance of this area to electromagnetic energy. However, this group was escalated by the organization into covering many other areas including food safety and began to include many areas in which there are established risks and significant legitimate concerns. Ultimately this approach ran into substantial problems in the comparison of areas where risks are proven (such as food safety) and risks are speculative, particularly RF electromagnetic energy. The project has now been renamed to reflect its relevance in areas where there is genuine scientific uncertainty and it is likely that many aspects of electromagnetic energy, including some applications of RF will no longer qualify for inclusion on the basis of the absence of any established risks. (p. 99)

**Comment 30:** Black's extraordinary claim that the use of RF technology no longer qualifies for a precautionary approach because there is no scientific uncertainty and an absence of any established risks is not backed up with any references to substantiate this claim and is arguably not based on science. As with many other statements made in the thesis this is stated as some sort of self-evident truth, more suited to a theological text than a supposedly scientific thesis.

### 6.11 The Problem of Research

**DB:** A number of research questions have been raised, on theoretical grounds from first principles or to pursue research questions which have been generated by other studies. (p. 100)

**Comment 31:** The many problems with RF research have been a major part of the RF debate ever since the 1950s and so why is this section limited to just the one brief sentence? Was this an incomplete section that Black forgot to complete? What is the reader to make of such a vague statement? Why weren't these research questions then spelt out to at least fill out this section and why didn't his external reviewers pick him up on this?

A balanced examination of problems with RF research would also examine the significant problem of conflict of interest with RF research when funded by vested

[63] R.Baan , Y.Grosse ,B. Lauby-Secretan, F.El Ghissassi ,V.Bouvard, L.Benbrahim-Tallaa, N.Guha, F Islami, L.Galichet, K Straif, "Carcinogenicity of Radiofrequency Electromagnetic Fields," *The Lancet Oncology*, June 22, 2011, http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(11)70147-4, Accessed July 31, 2011.

interests and how that influences research outcomes. [64] [65]Black's thesis avoids this issue altogether.

## Chapter 7. Current Standards

### 7.2 The Australian Standard

**DB:** In 2002, the Commonwealth Government in Australia commissioned and published a major new Standard to replace AS2772. This was published as RPS3 in 2002 (ARPANSA 2002). . . . The Standard RPS3 is also justified by detailed rationale, which was written by a group of scientists working to a consensus approach referenced to peer reviewed literature. . . . The ARPANSA basic restriction which applies in this case for whole body exposure, is 0.08 W/kg. . . . 0.08 W/kg is a very widely accepted parameter for whole body restrictions universally accepted as providing protection from any conceivable adverse effects. (p. 102)

### 7.3 Reference Levels specified by the Australian Standard RPS3

**DB:** During the preparation of the Australian Standard, public comment was sought and the committee noted a high level of requests for the incorporation of a precautionary approach. Accordingly, this was analyzed in some detail, and as stated in Annex 6 on page 113m an application of the precautionary approach is encapsulated in clause 5.7 (e) of the standard *"minimizing, as appropriate, RF exposure which is unnecessary or incidental to achievement of service objectives or process requirements, provided this can be readily achieved at reasonable expense. Any such precautionary measures should follow good engineering practice and relevant codes of practice. The incorporation of arbitrary additional safety factors beyond the exposure levels of this Standard is not supported."* In my opinion, this is a substantial requirement of the Standard . . . Since Australia has the benefit of a modern Standard with the requirements of a precautionary approach spelled out it is important that this is understood and followed consistently throughout the Commonwealth. As well as requiring that RF exposure that is unnecessary or incidental to achievement of service objectives must be minimized, Standard (clause 5.7(e)) explicitly states that the incorporation of arbitrary additional safety factors beyond the exposure limits of the Standard is not supported. Those words were deliberately included because of the damaging effect of the adoption of local pseudo-standards which has occurred elsewhere and continues to have an adverse effect on the proper application of well designed Public Health Initiatives. (p. 104 – 105)

### 7.7 Third Generation Standards

**DB:** Now that RF standards are in their third generation there is a case for accepting that adequate techniques for public health protection are now promulgated and understood and there is little room for further exploration or research. However, in both the scientific arena and in the mind of the general public that is far from the case. There are a number of reasons for this.

**Comment 32:** This is apparently the main thrust of Black's thesis, trying to make the case that "adequate techniques for public health protection are now promulgated and understood and there is little room for further exploration or research." It is interesting that he admits that this suggestion is not supported in the "scientific arena". If it is not supported by the scientific community or the public, the question is just who is

[64]D. Maisch, op. cit.
[65] D. Maisch, *A Machiavellian Spin, Political and corporate involvement with cell phone research in Australia,* 2010. http://www.emfacts.com/download/A_Machiavellian_Spin_Sept_2010.pdf

supporting the ending of further research? The answer to that is the industry, as examined by Slesin (2004).[66]

**DB:** Firstly, current standards are quite properly evidence based and the evidence is that the only effects on health of RF exposure are the deterministic effects of neurostimulation and tissue heating. The standards technology has looked at the body of research and evidence which has explored the possibility of other effects, particularly at low levels but has found these insufficiently established to meet the criteria for use in health standard setting. To the scientists this is not a great problem, and they are regarded as an observed effect which needs further research but not one with an established or plausible health impact. . . . To the scientific mind this is an entirely acceptable approach and reflects the nature of an evidence-based approach. However, for much of the public the apparent disregarding of evidence of effects at lower levels, permitted by the standards, is alarming. The consequences of this range from calls for a precautionary approach to be applied in concert with the standard to accusations of conspiracy to hide evidence of harmful effects which are not taken into account.

**Comment 33:** It is not a conspiracy theory. The evidence that the standard setters have steadfastly avoided the evidence of low-level, non-thermal possibly harmful biological effects in the course of setting RF exposure standards is well documented. [67] [68] [69] To claim that this is just a conspiracy is not only false, it is an attempt to revise the history of RF standard setting in a thesis purportedly documenting the history of the process.

**DB:** The acceptance that thresholds on which standards are based are well validated does withstand rigorous scrutiny. The thermal threshold of 0.4 W/kg was originally arrived at from several perspectives of research both experimental and empirical. All of this now confirms that there are no effects which are not readily accommodated in human thermal physiology at whole body exposure below 0.4 W/kg. (pp. 105 – 106)

The question of possible hypersensitivity to RF energy has been studied to some extent and to electricity in general in much more detail. There is an emerging consensus view that whilst electrical sensitivity is a definable condition, although probably not directly caused by electric or magnetic fields, sensitivity to RF has no basis in terms of stimulus from a physical entity. (p. 109)

## Chapter 8. Effects of Radiofrequency on other Species

**Comment 34:** This final chapter (pp. 111 – 121) consists of two sections, "8.1. Example Mobile Phone BTS and Phascolarctos cinereus (Koala)" and "8.2 Example Radio Transmitter and Columbia livia (Homing Pigeons)". Section 8.1 examines how a mobile phone base station might affect Koalas in nearby trees. It concludes that, going by the thermal methodology of the ARPANSA Standard "the permitted exposure level in terms of power density should remain below 2 W/m2, if there is to be an assurance of no possibility of any conceivable effect."

Section 8.2 examines the direction location ability of homing pigeons and whether or not RF emissions might interfere with this ability. There is a detailed and succinct discussion of the various theories on how the birds accomplish their

[66] L. Slesin, "Industry Rules RF Controlling Research, Setting Standards and Spinning History', Microwave News, July 2004. http://www.microwavenews.com/IndustryRulesRF.html
[67] D. Maisch 2010, op. cit.
[68] N. Steneck, *The Microwave Debate*, MIT Press, 1985.
[69] R. Kane, *Cellular Telephone Russian Roulette, A Historical and Scientific Perspective*, Vantage Press2001.

navigation feats. The conclusion of this section is that the influence of RF from mobile phone base stations "is very small, compared to both the fields [natural earth magnetic] which are known to affect or be detected by the birds as well as in comparison to the magnetic component [of] radio signals."

Although of interest in other settings, the entirety of Chapter 8 is irrelevant to the topic of examination in Black's thesis – RF standard setting for human populations. Black attempts to tie this chapter in to his thesis with the brief statement in the Abstract that "The Standards can also be used for the protection of other species" but does not follow this up with a discussion on why he considers this to be so. Considering that the total number of species on the earth is estimated to range from 5 to 100 million, with 2 million identified to date[70] a blanket claim that the standards can be used to protect other species, based on just limited research on koalas and pigeons is pushing the bounds of reason and should not be included in a university thesis without a strong justification.

Being at the end of the thesis, just before the Glossary, and with no concluding section, this gives an impression of incompleteness. If this thesis had been supervised, the supervisor could have advised that an overall conclusion was essential to tie together the separate elements of the thesis.

**Conclusion to this review**

A brief summary of the central thesis argument presented by Black is as follows:

The scientific data used by the RF standard setters, IEEE/ICES and ICNIRP, is well supported and indicates that the only adverse effects from RF exposure are well established and decided beyond dispute or doubt (deterministic). These effects are biological damage caused by tissue heating from high-level (acute) exposure and are absent below the current RF limits promulgated by ICNIRP and IEEE/ICES. These standards give adequate public health protection against any perceivable biological effects resulting from all known mechanisms and are high compared to standards for other agents known to have significant health impacts.

Possible cumulative low level effects not related to heating have not been established and at no time in the last 30 years of research into RF has any risk been established or even seriously suspected. Whenever risks have been suspected from research they have invariably been overturned by better studies. A precautionary approach is therefore not needed for RF because scientific uncertainty does not exist for RF with, apparently, no risk being identified. Being no risk, there is an absence of adverse data that are generating hypotheses for exploratory science that argues against any effects.

For mobile phone use there is no evidence of harm so this should not be regarded as evidence of uncertainty nor justification for continuing research where there is no obvious problem. There is, however, a problem of the inappropriate use of such data

[70] National Science Foundation, How many species exist on Earth? http://www.msnbc.msn.com/id/20109284/ns/technology_and_science-science/t/how-many-species-exist-earth/#.TlLOTjsjjJw

that are being used to justify a position of uncertainty in order to justify further research. This action could itself be a legitimate reason for not undertaking research.

There is now the case for accepting that adequate techniques for public health protection (ICNIRP/IEEE/ICES) are promulgated and understood and there is little room, or need for any further exploration or research.

**Comment 35:** Whether or not the reader agrees or disagrees with the above conclusions is not the central issue. The important questions here are:

1) Has Black fulfilled the requirements of original thought for a thesis? To this question the answer can only be no. His whole argument is one of restating a viewpoint that has been in existence since the late 1950s. His central base of reference is the collection of papers published in *Bioelectromagnetics Supplement 6* (2003) and contributes nothing new to the debate.

2) Has Black successfully presented his case with convincing arguments that counters alternative viewpoints on the adequacy of the current RF standards for public health protection? The answer here is also no. His arguments seem to be largely personal opinions based upon a select review of papers that support his views. Most significantly he fails to address, or even include, essentially opposing viewpoints in his thesis and makes a number of factual errors.

It is my opinion that this thesis fails to meet even the basic requirements of a university level thesis that are now the norm internationally. Why this was able to successfully pass Auckland University's thesis review process is up to others to question.

Don Maisch, PhD

# Appendix A

**Extract from Chapter 3 of *The Procrustean Approach* on *Bioelectromagnetics Supplement 6***

The literature base of C 95.1–2005 is quite large, with over 1300 papers having been reviewed by ICES members from the Engineering Evaluation Working (EEWG) Group. The peer review process consisted of each paper being evaluated by two randomly selected members from EEWG and two members of the appropriate Biological Evaluation Working Group (BEWG). Summaries of these evaluations were then sent to the Risk Assessment Working Group (RAWG) "to evaluate the levels of possible risk to humans and define the lowest threshold SAR above which potentially adverse effects are likely to occur."[71] As SAR is a unit of energy absorption most of which is converted to heat and SAR limits are based on preventing adverse effects from this heat. By referring to SAR, RAWG is stating that only research relevant to thermal-regulatory responses are useful in setting standards. As a result of this review process, at a 2002 U.S. Air Force Research Laboratory Workshop *"Setting a Science-Based Standard for Safe Human Exposure to RF Electromagnetic Fields"*, 14 review papers were presented that were commissioned by Subcommittee 4 (SC4) of ICES. These papers were to assist with the Working Group's assessment of the RF literature. 12 of these papers were subsequently published in the *Bioelectromagnetics Supplement 6 (2003*), "Reviews of the Effects of RF Fields on Various Aspects of Human Health "[72].

Publishing in a peer review journal was meant to place the literature summaries before the bioelectromagnetics scientific community and the public[73] as a definitive evaluation of the science. It was the publication of Supplement 6 that clearly raises the issue of a possible, and perhaps inevitable, potential for a conflict of interest and resultant bias in both RF/MW standard setting and independent peer review of RF research literature. As examined in this chapter, an apparent conflict of interest and bias in interpreting the scientific literature has been an ongoing controversial issue in the almost half-century history of RF standard setting in the U.S.

The potential for conflict of interest is inevitable in evaluating the scientific literature for RF standard setting, considering that the majority of the various committee members who determine the standard limits, define what constitutes an adverse health effect and funding research, also are affiliated with organisations fully committed to developing wireless technology, either for civilian or military purposes. Of course, having a conflict of interest does not translate to an inability to evaluate the literature objectively. Epidemiologist Kenneth Rothman in an article about conflict of interest in the *Journal of the American Medical Association* expressed the situation well with his referring to conflict of interest as temptation and then asking "but is temptation sin?"[74]

When making judgements about the scientific objectivity of studies on the health effects of RF, specifically on mobile phone use, however, the potential for financial conflicts of interests affecting scientific outcomes must be seriously considered. This is the

[71] C-K.Chou, J. D'Andrea, Reviews of Effects ofRF Fields onVarious Aspects of Human Health: Introduction', Bioelectromagnetics, Supplement 6, 2003. pp. S5-S6.
[72] ibid.
[73] B. Greenbaum, 'Editor's Note: Reviews of the Effects of RF Fields on Various Aspects of Human Health', *Bioelectromagnetics,* Supplement 6, 2003, pp.S3-S4.
[74] K. Rothman, 'Conflict of Interest: The New McCarthyism in Science', *JAMA*, vol. 269, issue 21, June 2, 1993, pp. 2782-2784.

conclusion of a study by Huss et al, published on Sept 15, 2006. This study reviewed human exposure studies (electroencephalogram, cognitive, cardiovascular function, hormone levels, symptoms and subjective wellbeing) on controlled exposures to RF relevant to mobile phone use. The authors found that "the studies exclusively funded by industry were indeed substantially less likely to report statistically significant effects on a range of endpoints that may be relevant to health. Our findings add to the existing evidence that single source sponsorship is associated with outcomes that favour the sponsors' products (Bakelman et al 2003; Davidson 1986;Lexchin et al. 2003; Stelfox et al. 1998)."[75] The authors concluded that, "Our study indicates that the interpretation of the results from existing and future studies of the health effects of radiofrequency radiation should take sponsorship into account."[76]

As mentioned elsewhere in this thesis, the problem of financial conflict of interest was examined in 2003 by the International Committee of Medical Journal Editors (ICMJE) and it is worthwhile to compare this to both Bioelectromagnetics *Supplement 6* and the entire IEEE ICES peer review process. ICMJE found that conflicts of interest can exist even if an individual believes their funding situation does not influence their scientific judgement. They concluded that "Financial relationships … 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."[77]

Eliot Marshall (1992) contends, however, that financial conflict of interest issues are simple when compared to intellectual conflicts of interests which have been an issue scientists have long had to deal with. Marshall explains that scientists are also human beings and "often begin their work with a hypothesis and become deeply invested in it…Along the way to proving a thesis…scientists must be sustained by something that approaches faith." Marshall quotes palaeontologist and historian Stephen-Jay Gould: "It is a pervasive fact of human existence as social beings that we find it extraordinarily difficult to step out of our own convictions and see them through the eyes of a detached observer." [78]

This thesis argues that long held intellectual convictions over how RF/MW interacts with biological tissue have had an inordinate influence it comes to objectively evaluating the scientific literature. When long held convictions are combined with financial relationships, the ability of science to advance in research areas in conflict with these factors is severely limited.

Concerns have been raised that *Bioelectromagnetics Supplement 6* was financed by a single vested interest group, the U.S. Air Force[79], an organisation that for the past half century has been fully committed to the thermal-effects-only viewpoint and, as examined in this chapter, has long discouraged consideration of non-thermal effects in standard setting.

A very significant mobile phone industry presence is seen in the editorship of Supplement 6. Until 2003, the Associate Editor of "Bioelectromagnetics", whose responsibility was to edit papers on high-frequency RF fields, was C-K Chou, Chief EME Scientist and Director of the Corporate EME Research Laboratory at Motorola

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[75] A. Huss, 'Source of Funding and results of Studies of Health Effects of Mobile Phone Use: Systematic Review of Experimental Studies', NIEHS, *Env. Health Perspectives*. Online, Sept. 15, 2006 http://dx.doi.org/ , Accessed Sept. 28, 2006.

[76] ibid

[77] International Committee of Medical Journal Editors, Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication, Nov. 2003, p. 8 http://wwwicmje.org/index.html#peer , Accessed Sept. 28, 2006.

[78] E. Marshall, 'When Does Intellectual Passion Become Conflict of Interest?', *Science*, vol. 257, July 31, 1992, pp. 620-623.

[79] C. Sage, 'Comment on Reviews of the effects of RF fields on various aspects of human health, *Bioelectromagnetics* Supplement 6 (2003)', *Bioelectromagnetics*, vol. 26 issue 2, 2003, pp.157-158.

Laboratories, Florida.[80] The role of BEMS Newsletter Editor was then taken over by Mays Swicord, also a senior researcher at Motorola Laboratories.[81] [82] As mentioned previously in this chapter, Chou was instrumental in incorporating the exclusion of the outer ear from the rest of the head, thus increasing the SAR limit from 1.6 W/kg to 2 W/kg for reasons of compliance testing – a move of obvious benefit to Motorola. Motorola had four members on ICES SC4 that prepared the 2005 standard, two of whom also authored a RF risk assessment on children's use of mobile phones. That Motorola risk assessment involved RF exposure studies on laboratory animals during early life to young adulthood. It was conducted in order to identify studies pertaining to the effects of RF exposure on the developing nervous system of children. This risk assessment concluded that there was no evidence in the scientific literature that there was a health risk for children who use mobile phones. A significant conflict of interest exists in Motorola's conclusions because Motorola had previously signed a contract with Walt Disney to tap the 6 to 12 year old "customer electronics market". New 'kids orientated' products include a range of wireless phones.[83]

In the January / February 2006 issue of the *Bioelectromagnetics Newsletter*, the issue of possible conflict of interest and bias was addressed with the newsletter editor simply asking "all contributing writers to submit a sentence or short statement on their affiliation and or disclosing possible conflict of interest along with items they send to the Newsletter".[84] Merely stating one's affiliation or other possible conflicts of interests – assuming honesty in doing this - does not remove a possible bias, but is perhaps merely being a bit more open about it. However, finding out one's affiliations for members of ICES SC4 is not always so easy. To take four examples:

- On the ICES Subcommittee 4 membership list, Eleanor Adair's affiliation was given as "Independent Consultant" [85]whereas in *Bioelectromagnetics Supplement 6* she is listed as "Air Force Senior Scientist Emeritus."[86]
- In *Bioelectromagnetics Supplement 6*, Louis Heynick is listed a an Independent Consultant but a search through "Storming Media", the internet source for official Pentagon Reports, lists a number of papers by Heynick on RF issues "pertinent to Air Force operations". Before becoming an independent consultant, Heynick was listed as being affiliated with the U.S. Air Force School of Aerospace Medicine.[87]
- Supplement 6 lists Martin Meltz as affiliated with The University of Texas Health Science Center, but in the ABC documentary "20/20" in October 1999, he is introduced as "a scientist at the University of Texas and a paid industry consultant whom the industry said we should talk to."[88] The University of Texas is in financial and "educational partnership" with the Brooks City Air Force Base, both located at San Antonio, Texas.[89]

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[80] M. Swicord, (ed.), 'C-K Chou will receive the 2006 D'Arsonval Award' *Bioelectromagnetics Newsletter,* no. 188, Jan./Feb. 2006, pp. 1, 3.
[81] ibid.
[82] L. Slesin, 'Industry Rules RF Controlling Research, Setting Standards and Spinning History', *Microwave News*, Aug. 9, 2004, http://www.microwavenews.com/IndustryRulesRF.html, Accessed Sept. 27, 2006.
[83] D. Maisch, 'A Corporate Risk Assessment or RF Bioeffects Studies Relevant to the Use of Mobile Phones by Children: Is it Really Science?', *International Conference: Childhood Leukaemia, Incidence, Causal Mechanisms and Prevention*, London England, Sept 6-10, 2004.
[84] M, Swicord, (ed.), 'New Disclosure Policy Begins With This Issue', *Bioelectromagnetics Newsletter,* no. 188, Jan./Feb. 2006, p. 4.
[85] Internal membership list "SCC28_SC4_Active_1" supplied by SC4 member anonymously, Nov. 1997.
[86] E. Adair E, D. Black, 'Thermoregulatory Responses to RF Energy Absorption', *Bioelectromagnetics, Supplement 6*, 2003, pp. S17 – S38.
[87] L. Heynick LN, A Comprehensive Review Pertinent to Air Force Operations, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas, Final Report USAFSAM-TR-87-3, 1987.
[88] ABC News, 20/20 program transcript (report on cell phones), Oct. 20, 1999. http://www.junkscience.com/oct99/2020tran.htm, Accessed Sept 23, 2006.
[89] 'Brooks City-Base diversifying its strategy', *San Antonio Business Journal*, Sept. 1, 2006.

- SCC-28 Subcommittee 4 lists Dennis Blick's affiliation as an independent consultant, but a paper in Bioelectromagnetics gives his affiliation as the Systems Research Laboratories Inc., located at Brooks Air Force Base.[90]

In the Editor's Note for *Bioelectromagnetics Supplement 6* it is mentioned that the 12 review papers published in the supplement were commissioned by ICES Subcommittee 4 (SC4) to assist the discussion within the committee. However, in a departure from previous standard setting processes, it was decided to publish the papers in order to make the information widely available to the scientific community and the public. After being reviewed by the ICES review committee the papers then underwent the usual Bioelectromagnetics journal peer review process. Specific acknowledgement was given to C-K Chow (Motorola) for his help in getting the papers finished and submitted, Michael Murphy and the Air Force in encouraging publication and underwriting the cost of producing the supplement. In addition the supplement was dedicated to Eleanor Adair on the occasion of her retirement from the Air Force Laboratory.[91] In the overview of the papers in Supplement 6, by Chow and D'Andrea it is mentioned that 11 out of the 12 papers were written by SC4 members and that the supplement "serves in a large measure as a scientific basis for the IEEE C95.1 standard revision, but will be a valuable reference on the subject for many years to come." [92] (See Table 1, next page)

**Table 1: Authors affiliations for the 13 papers in Supplement 6, (including introduction):**

| Author | Affiliation/Specialisation | No. of papers contributed to |
|---|---|---|
| C-K Chou | Motorola | 3 |
| Joe Elder | Motorola | 3 |
| John D'Andrea | Navy | 3 |
| Louis Heynick | USAF (former) | 3 |
| Eleanor Adair | USAF | 2 |
| Shelia Johnston | Neuroscience consultant | 2 |
| Patrick Mason | USAF | 1 |
| James Merritt | USAF | 1 |
| John Osepchuk | Industry Consultant | 1 |
| Ron Peterson | (formerAT&T/Bell labs/Lucent) | 1 |
| Mark Ellwood | Epidemology | 1 |
| John de Lodge | Researcher | 1 |
| David Black | Academic/Industry consultant | 1 |
| Martin Meltz | Academic/Industry consultant | 1 |

What can be seen in the above table is the significant involvement in the writing of the review papers by both the telecommunications sector and the military. In addition, as mentioned previously, the publication of Supplement 6 was underwritten by the U.S. Air Force.

In the ***Introduction*** by Chou and D'Andrea the overall theme for the entire group of papers is set with the rejection of non-thermal bioeffects as not being established and not proven hazardous to health, essentially ignoring the concerns raised by RFIAWG. Therefore, the thermal effect was deemed the only established adverse health effect that

[90] D. Bick, E. Adair, W. Hurt, C. Sherry, T. Walters, J. Merrit, 'Thresholds of microwave-evoked warmth sensations in human skin', *Bioelectromagnetics*, vol. 18, no. 6, Dec. 6, 1998, pp. 403-409.
[91] B. Greenebaum, 'Editor's Note: Reviews of the Effects of RF Fields on Various Aspects of Human Health', *Bioelectromagnetics, Supplement 6*, 2003, pp. S3-S4.
[92] C-K. Chou, J. D'Andrea, op. cit. pp. S5-S6.

can be considered in setting safety standards. Chou and D'Andrea list 12 "guiding principles"[93] that ICES Subcommittee 4 used in revising the RF standard. To Quote:

- The RF safety standard should be based on science.
- RF safety standard revision should be derived from peer reviewed publications and documents that are reviewed by the SC4.
- The adverse effect level remains at 4 W/kg subject to revision following completion of the literature evaluation and review papers.
- The maximum exposure limits should be based on established adverse effects [thermal] after inclusion of an appropriate safety factor(s).
- Safety factor(s) should consider uncertainties in the biological database (e.g., measurements, environmental conditions, exposure duration, individual variability, and other factors.
- Nonthermal RF biological effects have not been established and none of the reported nonthermal effects are proven adverse to health (does not apply to electrostimulation). Thermal effect is the only established adverse effect.
- The microwave hearing effect is not adverse and should not be used for setting the peak power limit.
- The shape and size of the averaging volume and the peak SAR limit are still to be determined. The important end point is the temperature change.
- The RF standard should be harmonized with other international standards [ICNIRP] to the extent where scientifically defensible.
- Rationales must be documented for all changes relative to the current standard.
- The editorial committee will add in the informative section a paragraph dealing with potentially sensitive sub-populations, such as children.
- Reconsider the two tier approach (whole body average SAR 0.4 and 0.08 W/kg), the peak SAR value and the averaging volume.[94]

Despite the fact that the "guiding principles" of ICES SC4 dismiss low intensity (non-thermal) effects some of the authors of the 12 papers in *Bioelectromagnetics Supplement 6* acknowledged the possibility of adverse RF bio-effects, even at exposure levels below the RF standard limits. This is illustrated below with a few selected quotes from the papers.

Adair and D'Andrea admitted that a number of behavioural studies found evidence for other kinds of behavioural changes that may not be thermally caused. They stated that, "Conclusions regarding health and safety cannot be drawn from the few human cognitive studies until additional research is done…It is difficult to draw any conclusions at this time because there are too few studies with human subjects." They conclude that further research on cognitive performance in humans under RF exposure "would add greatly to our understanding of RF biological effects".

Ellwood examined the epidemiological evidence and concluded that most of the studies suffered from deficiencies and that the possibility of a connection between RF exposure and an increased risk of cancer could not be ruled out. Ellwood recommended further research be carried out, including focusing on brain tumours and cell phone use. Despite the uncertainty, however, Ellwood did not consider that the epidemiological evidence indicated that the RF standards needed to be revised downwards.[95]

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[93] C-K.Chou, J. D'Andrea,op. cit. p. S6.
[94] ibid.
[95] M. Ellwood, 'Epidemiological Studies of Radio Frequency Exposures and Human Cancer', *Bioelectromagnetics Supplement 6*, 2003, pp ; S63 – S73.

D'Andrea, Chou, Johnston and Adair acknowledge in their paper that there "are some reports of biological effects that cannot be explained by thermal mechanisms are in the scientific literature" but that in such reports "it is difficult to draw conclusions concerning hazards to human health. The many exposure parameters such as frequency, orientation, modulation, power density, and duration of exposure make direct comparison of many experiments difficult". Consideration of these factors in setting standards are dismissed by the authors because they state that in setting limits for RF standards, "it is often necessary to make assumptions about underlying mechanisms" and to define an established mechanism "as one where effects on a living person and the thresholds of reaction are understood". The authors conclude that "the only firm conclusion that may be drawn is the potential for hazardous thermal consequences of high power RF exposure". [96]

An illustration of the level of uncertainty in the historical RF literature is the admission by Adair and Black in their paper that "most of the published research on thermo-physiological responses in the presence of RF fields has been conducted on laboratory animals, with a heavy emphasis on laboratory rodents (e.g., mice, rats, and hamsters). These small animals are poor models for human beings because their physiological heat loss mechanisms are limited". This is referring to thermal research, not possible non-thermal bio-effects, but the authors imply that the 'weight-of-the-evidence' for Western RF thermally-based standards is founded on a poor and inadequate data base.[97]

The overall 'message' of the above papers published in *Bioelectromagnetics Supplement 6* is to banish consideration of non-thermal effects in standard setting. The authors of the review papers in Supplement 6 have careers within a technological peer community that has long accepted the thermal mechanism as the only established and well understood mechanism with RF exposure. Researchers who focus their investigations to further refine thermal thresholds under different conditions are at the cutting edge of EMF research but researchers who dare focus on non-thermal effects risk being branded as "extra-scientific". This would be because of their "beliefs or speculations" about non-thermal bio-effects, to quote from Osepchuk and Peterson's *Bioelectromagnetics Supplement 6* paper.[98] Evidence that RF bio-effects not directly related to heating were arbitrarily dismissed by the ICES Subcommittee 4 is contained in the "Consensus Statement" that was initially placed on the Internet from the COST281 [99]workshop, held in Helsinki, Finland, April 28-29, 2004. This statement contained in the opening paragraph the sentence: "Based largely on the evidence presented at the workshop, there is no substantiation of the hypothesis that RF exposures result in the induction of stress proteins." The statement was soon pulled from the web site after Dariusz Leszczynski from Finland's Radiation and Nuclear Safety Agency complained to the COST281 chairman as well as the head of FGF, Germany's wireless industry research group. Leszczynski, who hosted the workshop, has published a number of papers showing that RF can activate heat shock proteins. Leszczynski pointed out that the offending sentence was not in the earlier (May) circulated version of the consensus statement. As for who changed the previously agreed consensus statement, according to FGF, it was Blair Henderson from Austria's Innsbruck University and Martin Meltz from the University of Texas[100] who is a member of ICES Subcommitee 4, and author of the paper in Supplement 6, as examined previously. An examination of the book of abstracts of the Helsinki workshop finds three papers that invalidate the "consensus" statement

[96] J. D'Andrea, C-K. Chou, S. Johnston, E. Adair, 'Microwave Effects on the Nervous System', *Bioelectromagnetics Supplement 6*, 2003, pp. S107 – S147.
[97] E. Adair, D. Black, 2003.
[98] Osepchuk, R. Petersen, Historical Review of RF Exposure Standards and the International Committee on Electromagnetic Safety (ICES), Bioelectromagnetics Supplement 6 (2003), pp. S7-S16.
[99] Acronym for "European Cooperation in the Field of Scientific and Technical Research".
[100] L. Slesin, 'News & Comment: What's New', *Microwave News* , Jul. 22, 2004, http://www.microwavenews.com/nc_ja2004.html, Accessed Sept. 30, 2006.

improperly inserted by Henderson and Meltz. These papers are: Leszczynski D. et al "Effects of RF-EMF on Cellular Stress Response, Gene and Protein Expression"; Goodman R, Weisbrot D, and Blank M, "Biological Effects on growth and Development from Exposures to Radiofrequency" and Kwee S, "The Generation of Heat-Shock Proteins in Cells Exposed to RF Electromagnetic Fields".[101] Another inconsistency with actual events was seen in Motorola's Mays Swicord's write-up of the Helsinki heat shock workshop in the Bioelectromagnetics Newsletter, May/June 2004. Much of the data presented at the workshop that indicated a heat-shock effect from RF exposure was somehow omitted from Swicord's article and the research by Leszczynski, presented at the workshop, failed even to get a mention.[102]

[101] Abstracts: FGF-Workshop: *"Influence of RF Fields on the Expression of Stress Proteins"*, Helsinki, Finland, 28-29 April 2004.
[102] L. Slesin, 'Industry Rules RF…' 2004.

# Appendix B

**DEPARTMENT OF HEALTH AND HUMAN SERVICES Public Health Service**

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 participation 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,
(Signature)
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: Biological basis for local SAR limit**

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: <u>One tier vs two tier guidelines:</u>**

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: <u>Controlled vs. uncontrolled</u> (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: <u>Uncertainty factors</u>**

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: <u>Intensity or frequency modulated (pulsed or frequency modulated) RF radiation</u>**

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: <u>Time averaging</u>**

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: <u>Lack of peak (or ceiling) limits for induced and contact current</u>**

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: <u>Criteria for preventing hazards caused by transient discharges</u>**

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: <u>Limits for exposure at microwave frequencies</u>**

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: <u>Replication/Validation</u>**

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: <u>Important Health Effects Literature Areas:</u>**

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: <u>Compatibility of RFR guidelines</u>**

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.

# Appendix C

## Selected quotes from the 2008 NRC report

**Committee on Identification of Research Needs Relating to Potential Biological or Adverse Health Effects of Wireless Communications Devices**

**Page 2:**
The committee judged that important research needs included, in order of appearance in the text, the following:
• Characterization of exposure to juveniles, children, pregnant women, and fetuses from personal wireless devices and RF fields from base station antennas.
• Characterization of radiated electromagnetic fields for typical multiple- element base station antennas and exposures to affected individuals.
• Characterization of the dosimetry of evolving antenna configurations for cell phones and text messaging devices.
• Prospective epidemiologic cohort studies of children and pregnant women.
• Epidemiologic case-control studies and childhood cancers, including brain cancer.
• Prospective epidemiologic cohort studies of adults in a general population and retrospective cohorts with medium to high occupational exposures.
• Human laboratory studies that focus on possible adverse effects on electroencephalography2 activity and that include a sufficient number of subjects.
• Investigation of the effect of RF electromagnetic fields on neural networks.
• Evaluation of doses occurring on the microscopic level.
• Additional experimental research focused on the identification of potential biophysical and biochemical/molecular mechanisms of RF action.

**Page 4:**
"Research gaps" are defined as areas of research where the committee judges that scientific data that have potential value are presently lacking.

**Page 5:**
Dosimetry and Exposure/Research Needs: There is a need to characterize exposure of juveniles, children, pregnant women, and foetuses, both for personal wireless devices (e.g., cell phones, wireless personal computers [PCs]) and for RF fields from base station antennas including gradients and variability of exposures, the environment in which devices are used, and exposures from other sources, multilateral exposures, and multiple frequencies.

Research Gaps: Although several dosimetric models are currently available for children and individuals of reduced stature, a research gap remains in the further development of models of several heights for men, women, and children of various ages for use in the characterization of SAR distributions for exposures characteristic of cell phones, wireless PCs, and base stations.

**Page 6:**
Epidemiology/Adults/Research Needs:
2. Occupational Cohorts with Medium to High Exposure. None of the occupational studies to date have been based on an adequate exposure assessment. Much work is needed to identify occupations with potentially high RF exposures and to characterize them.

**Page 7:**
Children/Research Needs:
1. Prospective Cohort Studies of Pregnancy and Childhood. Children are potentially

exposed from conception through maternal wireless device use and then postnatally when they themselves become users of mobile phones.
2. Case-control Study of Children Mobile Phone Users and Brain Cancer. Owing to widespread use of mobile phones among children and adolescents and the possibility of relatively high exposures to the brain, investigation of the potential effects of RF fields in the development of childhood brain tumors is warranted.

HUMAN LABORATORY STUDIES
Research Needs: There are some significant research needs for human laboratory studies. Due to the paucity of data from identically replicated experiments,

1. There is a need for experiments focusing on possible adverse RF effects identified by changes in electroencephalogram activity as well as a need to include an increased number of subjects.

Research Gaps:

1. Little or no information is available on possible neurophysiological effects developing during long-term exposure to RF fields.
2. Risks of exposure to RF fields in elderly volunteers are not well explored.
3. There is a continuing need for experiments focusing on possible adverse RF effects identified by changes in cognitive performance functions.

**Page 8 - 9:**
MECHANISMS
Research Needs

1. The effect of RF electromagnetic fields on neural networks is a topic needing further investigation. There are indications that neural networks are a sensitive biological target.
2. Evaluation of doses occurring on the microscopic level is a topic needing further investigation.

IN VIVO AND IN VITRO STUDIES IN EXPERIMENTAL MODEL SYSTEMS
Research Needs

1. Additional experimental research focused on the identification of potential biophysical and biochemical/molecular mechanisms of RF action is considered to be of the highest priority.

Research Gaps:

5. A number of potentially critical cancer-related endpoints have received only very limited study and are identified in the report text.
6. In addition to cancer-related endpoints, data gaps exist in a number of other areas of toxicology in which knowledge is needed to support a complete evaluation of the possible health effects of RF exposure; these gaps are identified in the body of the report.

**Page 16:**
**(Mobile Phones)**
Presently, there is negligible or relatively little knowledge of local SAR concentration (and likely heating) in close proximity to metallic adornments and implanted medical devices for the human body. Examples include metal rim glasses, earrings, and various prostheses (e.g., hearing aids, cochlear implants, cardiac pacemakers). Research is therefore lacking to quantify the enhanced SARs close to metallic implants and external metallic adornments.

**Page 17 - 18:**
Laboratory Exposure Systems
Research Needs

1. There is a need to characterize exposure of juveniles, children, pregnant women, and fetuses both for personal wireless devices (e.g., cell phones, wireless PCs)

and for RF fields from base station antennas including gradients and variability of exposures, the environment in which devices are used, and exposures from other sources, multilateral exposures, and multiple frequencies. The data thus generated would help to define exposure ranges for various groups of exposed populations.

2. Wireless networks are being built very rapidly, and many more base station antennas are being installed. A crucial research need is to characterize radiated electromagnetic fields for typical multiple-element (four to six elements) base station antennas for the highest radiated power conditions and with measurements conducted during peak hours of the day at locations close to the antennas as well as at ground level. A study of the wireless RF fields in a properly selected sample of the population is needed to characterize and document rapidly changing exposures.
3. The use of evolving types of antennas for hand-held cell phones and text messaging devices need to be characterized for the SARs that they deliver to different parts of the body so that this data is available for use in future epidemiologic studies.
4. RF exposure of the operational personnel close to newer multi-element base station antennas is unknown and could be high. These exposures need to be characterized. Also needed are dosimetric absorbed power calculations using realistic anatomic models for individuals, including both men and women of different heights.

Research Gaps

1. Although several models are available for children and individuals of reduced stature, a research gap remains in the further development of models of several heights for men, women, and children of various ages for use in the characterization of SAR distributions for exposures characteristic of cell phones, wireless PCs, and base stations.

**Page 22**

Noncancer Health Effects

Few studies have been conducted on health effects other than cancer risk of RF electromagnetic fields from wireless communication devices (Auvinen 2007). The existing studies have been small and have methodological limitations such as lack of rigorous exposure assessment, inadequate control of confounding, and cross-sectional design.

**Page 23:**

Children

With the rapid advances in technologies and communications utilizing RF fields, children are increasingly exposed to RF energy at earlier ages (starting at age 6 or before). Environmental exposures could be particularly harmful to children because of their vulnerability during periods of development before and after birth. Although it is unknown whether children are more susceptible to RF exposures, they may be at increased risk because of developing organ and tissue systems, particularly of the nervous system (Kheifets et al. 2005).

**Page 26:**

Research Needs

1. Prospective Cohort Studies of Pregnancy and Childhood. Children are potentially exposed from conception through maternal wireless device use and then postnatally when they themselves become users of mobile phones.
2. Case-control Study of Children Mobile Phone Users and Brain Cancer. Owing to widespread use of mobile phones among children and adolescents and the possibility of relatively high exposures to the brain, investigation of the

potential effects of RF fields in the development of childhood brain tumors is warranted.

Research gaps

There is at present a lack of information concerning the health effects associated with living in close proximity to base stations. Epidemiological studies of mobile phone base stations present unique challenges that need to be addressed to make such studies rigorous.

**Page 27:**

Human Laboratory Studies

Neurophysiological and Cognitive Effects

In spite of the large number of investigations, RF-induced neurophysiological effects need further study. While several studies have focused on spectral power of EEG, regional cerebral blood flow (rCBF), 1 and event- related (evoked) potentials (ERP), 2 most of the present data are collected by investigations evaluating acute effects on healthy adults during short exposures to RF fields.

**Page 31:**

In addition, most human studies have examined healthy young adults, a group not necessarily representing the most susceptible part of the population. Therefore, future research needs to include children, the elderly, and people with underlying diseases.

Research Gaps

1. Little or no information is available on possible neurophysiologic effects developing during long-term exposure to RF fields.
2. Risks of exposure to RF fields in elderly volunteers are not well explored.
3. There is a continuing need for experiments focusing on possible adverse RF effects identified by changes in cognitive performance functions.

**Page 33 – 34:**

Mechanisms

The basic question still under debate is whether there are other inter- action mechanisms of low-intensity RF electromagnetic fields that could have health consequences. Of particular interest is the possible existence of health effects that occur due to the accumulation of multiple, long-term, low-intensity RF exposures.

**Page 36:**

Research Needs

1. Effects of RF electromagnetic fields on neural networks are research needs. There are indications that neural networks are a sensitive biological target.

**Page 41 – 42:**

Other health Effects (Noncancer)

In addition to cancer-related endpoints, data gaps exist in a number of other areas of toxicology in which knowledge is essential to support a complete evaluation of the possible health effects of RF exposure.

Research Needs

1. Additional experimental research focused on the identification of potential biophysical and biochemical/molecular mechanisms of RF action are considered to be of the highest priority.

**Page 44:**

Cancer-related Endpoints: Other

5. A number of potentially critical cancer-related endpoints have received only very limited study.

# Appendix D

## Quoting from the Newsletter of the U.S. based Environmental Health Trust, **July 12, 2011**

http://www.environmentalhealthtrust.org/content/newsletter-allan-frey-and-inconvenient-truth-about-radio-frequency-radiation

In 1960, neuroscientist Allan Frey, then with Cornell University's General Electric Advanced Electronics Center, became curious about the impact on the nervous system of electromagnetic fields moving at the speed of light. Long before cell phones were commercialized, his findings would eventually prove that radio frequency radiation has a measurable effect on the brain—and attempts were made by the powers-that-be to suppress his work in ways that uncannily echo the ways such results are being marginalized today. Among other key results, Frey determined that the carrier wave of 1,900 megahertz—precisely the same wavelength used by many cell phones today—had significant biological effects.

Inject a mouse with a fluorescent dye into its blood and the entire body and all of the organs fluoresce—except for the brain, which remains pink-gray. Research in the 1920s had shown why: The brain is protected from taking in poisons or contaminants that get into the bloodstream due to a barrier appropriately known as the "blood-brain barrier."

But Frey found something interesting. He showed that weak radio frequency signals—just like those from today's cell phones—opened up this normally closed barrier. Frey first injected the dye into the bloodstream of rats and then exposed them to very weak pulsed microwave signals. Within a few minutes, the injected rats' brains began to fluoresce, signaling that the blood-brain barrier had been breached. Frey's studies were reported in the Annals of the New York Academy of Sciences in 1975. Soon after two other labs, using other blood-brain-barrier study techniques, showed similar effects of radio frequency radiation.

But there were some in the military and industry who didn't want to accept that such radiation could have any biological impact. For example, several "critiques" of the effect that Frey had discovered completely ignored relevant information. Frey himself recalls the falsity of some critiques. One group claimed to have repeated his team's rat studies and said they found nothing. However, instead of injecting the dye into the femoral vein so it would go directly to the heart and into the brain in seconds, as Frey had, they injected it into the abdomen. They sprayed it onto the intestines. Within five minutes they killed the animals and looked at the brain. They reported that they found no evidence that the dye had gone into the brain. Of course not! There have been many studies confirming and extending Frey's work since then.

In later years, Frey has noted the intensity of pressure during the Cold War to stay away from studies that suggested that low-intensity radio frequency radiation had biological impacts of any kind. More than three decades later, recalling attempts to discredit his work, Frey has said, "What happened then was a naked use of power to try to discredit what had been basic scientific work because it did not comport with what some people in the military and industry wanted to hear." Today's researchers are still fighting the battle Frey waged in the 1970s.